Grade 11 Biology

A Foundation for Implementation

Manitoba

GRADE 11 BIOLOGY

A Foundation for Implementation

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INTRODUCTION

Background

Grade 11 Biology: A Foundation for Implementation presents student learning outcomes for Grade 11 Biology. These learning outcomes are the same for students in the English, French Immersion, Français, and Senior Years Technology Education Programs, and result from a partnership involving two divisions of Manitoba Education: School Programs Division and Bureau de l'éducation française Division.

> Student learning outcomes are concise descriptions of the knowledge and skills [and attitudes] that students are expected to learn in a course or grade in a subject area (Manitoba Education and Training, *A Foundation for Excellence* 14).

Manitoba's student learning outcomes for Grade 11 Biology are based, in part, on those found within the *Common Framework of Science Learning Outcomes K to 12: Pan-Canadian Protocol for Collaboration on School Curriculum* (Council of Ministers of Education, Canada) and on those developed as components of the 1998 Manitoba Transitional Curricula. The former, commonly referred to as the *Pan-Canadian Science Framework*, was initiated under the Pan-Canadian Protocol for Collaboration on School Curriculum (1995). It was developed by educators from Manitoba, Saskatchewan, Alberta, British Columbia, the Northwest Territories, the Yukon Territory, Ontario, and the Atlantic Provinces.

Grade 11 Biology: A Foundation for Implementation provides the basis for learning, teaching, and assessing biology in Manitoba. This document also serves as a starting point for future development of curriculum support documents, related teacher support materials, learning resources, assessment tools, and professional learning for teachers. This document also complements the *Pan-Canadian Science Framework* by providing support for its implementation, including suggestions for instruction and assessment.

Vision for Scientific Literacy

Factors such as global interdependence, rapid scientific and technological innovation, the need for a sustainable environment, economy, and society, and the pervasiveness of science and technology in daily life reinforce the importance of scientific literacy. Scientifically literate individuals can more effectively interpret information, solve problems, make informed decisions, accommodate change, and achieve new understandings. Science education makes possible the development of the foundations necessary to develop a functional scientific literacy and assists in building stronger futures for Canada's young people.

The *Pan-Canadian Science Framework* and *Grade 11 Biology: A Foundation for Implementation* support and promote an attainable and realistic vision for scientific literacy.

> The *[Pan-Canadian Science Framework]* is guided by the vision that all Canadian students, regardless of gender or cultural background, will have an opportunity to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them.
>
> Diverse learning experiences based on the *[Pan-Canadian Science Framework]* will provide students with many opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their future (Council of Ministers of Education, Canada 4).

Goals for Canadian Science Education

Several goals promoting the achievement of scientific literacy within Canadian science education were developed as part of the *Pan-Canadian Science Framework*. These goals are addressed through the Manitoba science curricula. It is hoped that science education will

- encourage students at all levels to develop a rational sense of wonder and curiosity about scientific and technological endeavours
- enable students to use science and technology to acquire new knowledge and to solve problems, so they may improve the quality of their own lives and the lives of others
- prepare students to address science-related societal, economic, ethical, and environmental issues critically
- provide students with a proficiency in science that creates opportunities for them to pursue progressively higher levels of advanced study, prepares them for science-related occupations, and engages them in science-related activities appropriate to their interests and abilities
- develop in students of varying aptitudes and interests a knowledge of the wide variety of careers related to science, technology, and support for the natural and human environments

Beliefs about Learning, Teaching, and Assessing Science

To promote a rational, achievable approach to developing scientific literacy among future citizens, it is crucial to recognize how students learn, how science can best be taught, and how learning can be assessed. Students are curious, active learners who have individual interests, abilities, and needs. They come to school with prior knowledge and various personal and cultural experiences that generate a range of attitudes and beliefs about science and life, and connections between these realms.

Students learn most effectively when their study of science is rooted in concrete learning experiences related to a particular context or situation, and applied to their world of experiences, where appropriate. Ideas and understandings that students develop should be progressively extended and reconstructed as students grow in their experiences and in their ability to conceptualize more deeply. Learning involves the process of linking newly constructed understandings with prior knowledge, and then adding new contexts and experiences to current understandings. It is increasingly important that biology educators draw professional attention to how fundamental research in learning theory will affect their efforts in the science classroom.

Changing Emphases in Science

Student learning outcomes in Grade 11 Biology encompass changing emphases in *science education content delivery* and changing emphases to promote *inquiry*, as envisioned in the *National Science Education Standards* (National Research Council 113).

Changing Emphases in Science Education Content Delivery*

The *National Science Education Standards* envision change throughout the system. The science content standards [or student learning outcomes] encompass the following changes in emphases:

Less Emphasis On	More Emphasis On
Knowing scientific facts and information	Understanding scientific concepts and developing abilities of inquiry
Studying subject matter disciplines (physical, life, earth sciences) for their own sake	Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science
Separating science knowledge and science process	Integrating all aspects of science content
Covering many science topics	Studying a few fundamental science concepts
Implementing inquiry as a set of processes	Implementing inquiry as instructional strategies, abilities, and ideas to be learned

*Source: Reprinted with permission from *National Science Education Standards*, 1996 by the National Academy of Sciences, courtesy of the National Academies Press, Washington, DC.

Changing Emphases to Promote Inquiry*

The *National Science Education Standards* envision change throughout the system. The science content standards [or student learning outcomes] encompass the following changes in emphases:

Less Emphasis On	More Emphasis On
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time
Process skills out of context	Process skills in context
Individual process skills such as observation or inference	Using multiple process skills—manipulation, cognitive, procedural
Getting an answer	Using evidence and strategies for developing or revising an explanation
Science as exploration and experiment	Science as argument and explanation
Providing answers to questions about science content	Communicating science explanations
Individuals and groups of students analyzing and synthesizing data without defending a conclusion	Groups of students often analyzing and synthesizing data after defending conclusions
Doing a few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry, and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations
Management of materials and equipment	Management of ideas and information
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates

*Source: Reprinted with permission from *National Science Education Standards*, 1996 by the National Academy of Sciences, courtesy of the National Academies Press, Washington, DC.

Processes That Engage Students in Science Learning

Development of increased scientific literacy is supported by instructional environments that engage students in the following:

- **Science inquiry:** Students are encouraged to converse, ask penetrating questions, and then seek to explore their own constructed explanations alongside scientific explanations through guided research, writing, and planned investigations.
- **Problem solving:** Students apply their acquired expertise and knowledge in novel, often unforeseeable, ways.
- **Decision making:** As students identify rich, large-context problems, questions, or issues related to the life sciences, they pursue new knowledge that will assist them in making informed, rational, defensible decisions.

Through these processes, students discover the significance of science in their lives and come to appreciate the interrelatedness of science, technology, society, and the environment. Each of these processes can be a starting point for science learning, and may encompass the exploration of new ideas, the development of specific investigations, and the application of ideas that are learned.

To achieve the vision of a scientific literacy for all according to personal interests and inclinations, students could become increasingly more engaged in the planning, development, and evaluation of their own learning experiences. They should have opportunities to work cooperatively with other students, to initiate investigations, to communicate their findings, and to complete projects that demonstrate their learning in a personal, although peer-reviewed, manner.

At the beginning of instructional design, teachers and students should identify expected student learning outcomes and establish performance criteria. It is important that these criteria correspond with provincial learning outcomes. This communication between students and teachers helps identify clearly what needs to be accomplished, thereby assisting in the learning process (see the assessment rubrics in Appendix 11).

When students are aware of expected learning outcomes, they will be more focused on their learning, and may be more likely to assess their own progress. Furthermore, they can participate in creating appropriate assessment and evaluation criteria. Assessment methods must be valid, reliable, and fair to students.

NOTES

SECTION 1: MANITOBA FOUNDATIONS FOR SCIENTIFIC LITERACY

MANITOBA FOUNDATIONS FOR SCIENTIFIC LITERACY

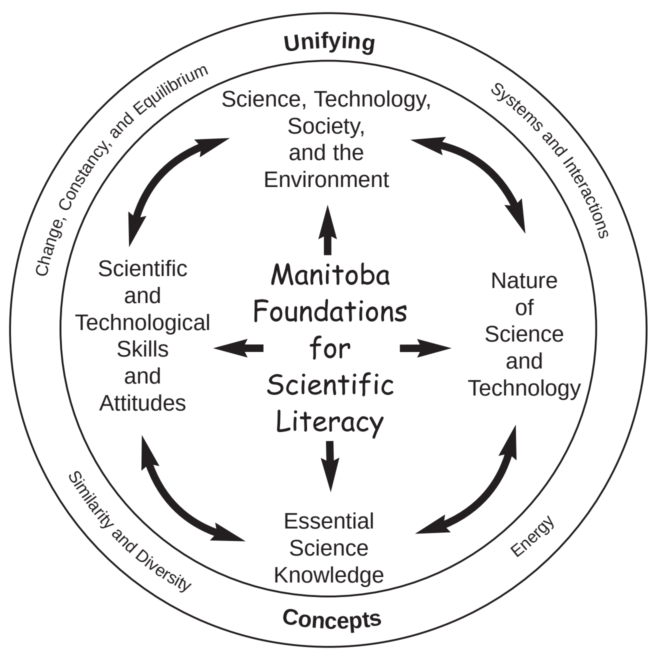
The Five Foundations

To develop scientifically literate students, Manitoba science curricula are built upon five foundations for scientific literacy that have been adapted from the *Pan-Canadian Science Framework* to address the needs of Manitoba students:

- Nature of Science and Technology
- Science, Technology, Society, and the Environment (STSE)
- Scientific and Technological Skills and Attitudes
- Essential Science Knowledge
- Unifying Concepts

The following conceptual organizer illustrates the five foundations for scientific literacy representing the goals of science learning from Kindergarten to Grade 12 in Manitoba.

Manitoba Science Curriculum Conceptual Organizer



These foundations, which are described in more detail on the following pages, have led to the development of the general learning outcomes identified for Grade 11 Biology.

Nature of Science and Technology

Students learn that science and technology are creative human activities with long histories in all cultures. Science is a way of learning about the universe. This learning stems from curiosity, creativity, imagination, intuition, exploration, observation, replication of experiments, interpretation of evidence, and debate over that evidence and its interpretations. Scientific activity involves predicting, interpreting, and explaining natural and human-made phenomena. Many historians, sociologists, and philosophers of science presently argue that there is no definable, set procedure for conducting a scientific investigation. Rather, they see science as driven by a combination of theoretical concerns, knowledge, experiments, and processes anchored in the physical world.

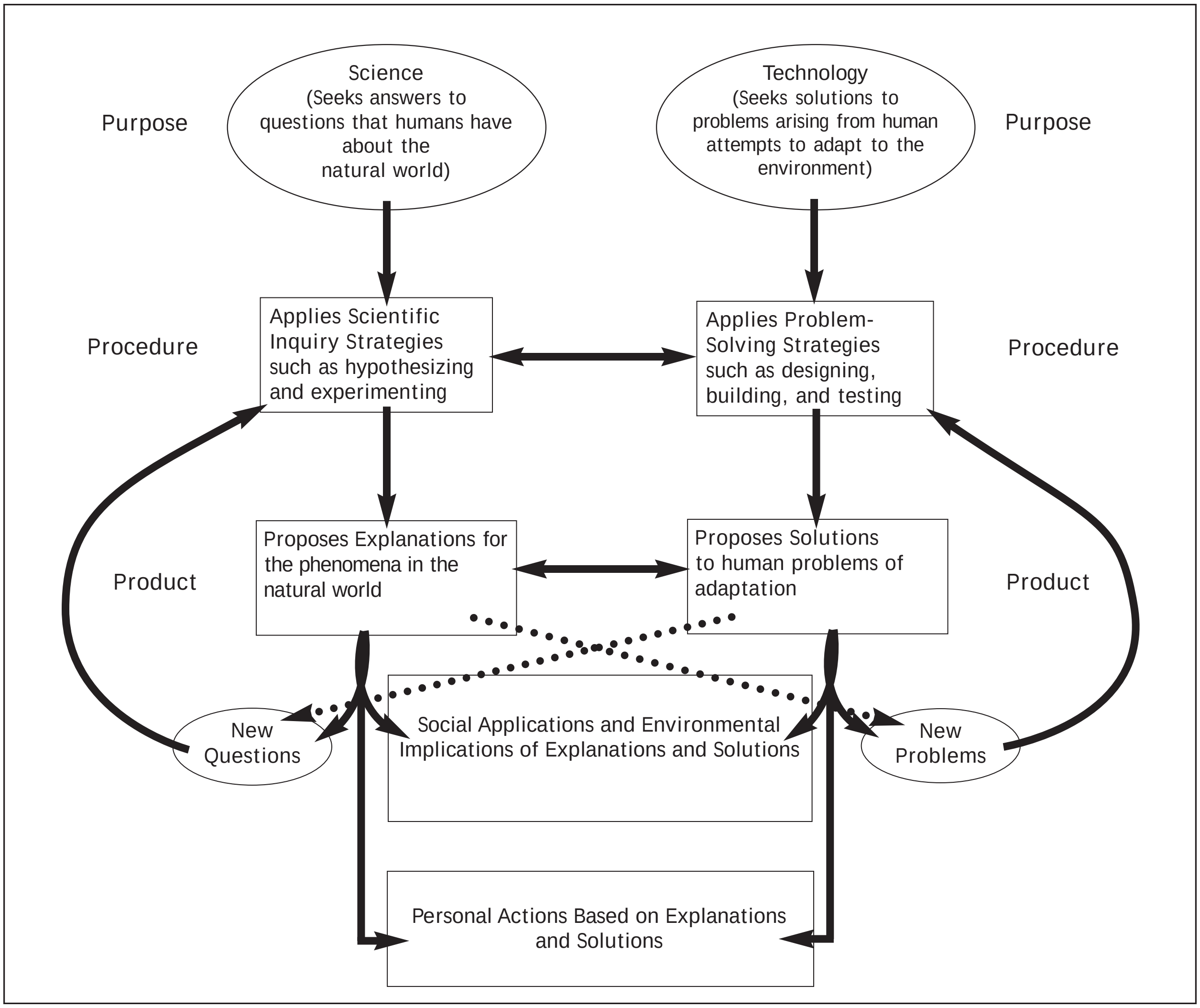
> Producing science knowledge is an intrinsically collective endeavour. There is no such thing as stand-alone science done in isolation. Scientists submit models and solutions for the assessment of their peers, who judge their logical, rational and experimental soundness through reference to the body of existing knowledge and modes of representation (Larochelle and Désautels 235).

Scientific theories are being tested, modified, and refined continually as new knowledge and theories supersede existing knowledge bases. Scientific debate, both on new observations and on hypotheses that challenge accepted knowledge, involves many participants with diverse backgrounds. This highly complex interplay, which has occurred throughout history, is animated by theoretical discussions; experimentation; social, cultural, economic, and political influences; personal biases; and the need for peer recognition and acceptance. Students will realize that while some of our understandings about how the world works are due to revolutionary scientific developments, many of our understandings result from the steady and gradual accumulation of knowledge. History demonstrates, however, that great advances in scientific thought have completely uprooted certain disciplines, transplanting practitioners and theoreticians alike into an entirely new set of guiding assumptions. Such scientific revolutions, as discussed by Thomas S. Kuhn in his influential *The Structure of Scientific Revolutions*, constitute exemplars that can energize the science teaching enterprise, particularly in biology education.

Technology results mainly from proposing solutions to problems arising from human attempts to adapt to the external environment. Technology may be regarded as "a tool or machine; a process, system, environment, epistemology, and ethic; the systematic application of knowledge, materials, tools, and skills to extend human capabilities" (Manitoba Education and Training, *Technology as a Foundation Skill Area* 1). Technology refers to much more than the knowledge and skills related to computers and their applications. Technology is based on the knowledge of concepts and skills from other disciplines (including science), and is the application of this knowledge to meet an identified need or to solve a problem using materials, energy, and tools (including computers). Technology also has an influence on processes and systems, on society, and on the ways people think, perceive, and define their world.

Grade 11 Biology emphasizes both the distinctions and relationships between science and technology. The following illustration shows how science and technology differ in purpose, procedure, and product, while at the same time relating to each other.

Science and Technology: Their Nature and Interrelationships*



*Source: Bybee, Rodger W., et al. *Science and Technology Education for the Elementary Years: Frameworks for Curriculum and Instruction.* Rawley, MA: The NETWORK, Inc., 1989. Adapted with permission.

The following general learning outcomes (GLOs) have been developed to define expectations related to the Nature of Science and Technology foundation area. (For a complete listing of the general and specific learning outcomes, see Appendix 12.)

Nature of Science and Technology General Learning Outcomes

As a result of their Senior Years science education, students will:

A1 Recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena.

A2 Recognize that scientific knowledge is based on evidence, models, and explanations, and evolves as new evidence appears and new conceptualizations develop.

A3 Distinguish critically between science and technology in terms of their respective contexts, goals, methods, products, and values.

A4 Identify and appreciate contributions made by women and men from many societies and cultural backgrounds that have increased our understanding of the world and brought about technological innovations.

A5 Recognize that science and technology interact with and advance one another.

Science, Technology, Society, and the Environment (STSE)

Understanding the complex interrelationships among science, technology, society, and the environment is an essential component of fostering increased scientific literacy. By studying the historical context, students come to appreciate ways in which cultural and intellectual traditions have influenced the questions and methodologies of science, and how science, in turn, has influenced the wider world of ideas.

Today, most scientists work in industry, where projects are more often driven by societal and environmental needs than by pure research. Many technological solutions have evoked complex social and environmental issues. Students recognize the potential of scientific literacy to inform and empower decision making of individuals, communities, and society as a whole.

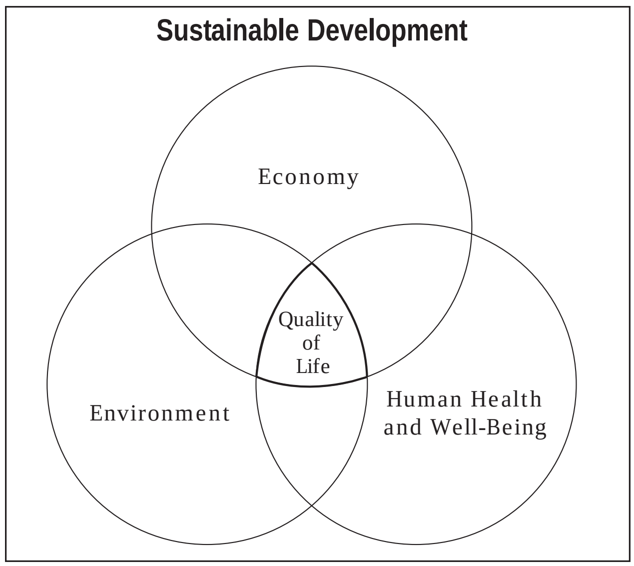
Scientific knowledge is necessary, but not sufficient, for understanding the relationships among science, technology, society, and the environment. To understand these relationships fully, it is essential that students consider the values related to science, technology, society, and the environment.

Sustainable Development as a Decision-Making Model

As a component of achieving scientific literacy, students must also develop an appreciation for the importance of sustainable development. Sustainable development is a decision-making model that considers the needs of both present and future generations, and integrates and balances the *health and well-being of the community*, the *environment*, and the *impact of economic activities*.

- *Sustainable human health and well-being* is characterized by people coexisting harmoniously within local, national, and global communities, and with nature. A sustainable society is one that is physically, psychologically, spiritually, and socially healthy. The well-being of individuals, families, and communities is of considerable importance.

- A *sustainable environment* is one in which the life-sustaining processes and natural resources of the Earth are conserved and regenerated.
- A *sustainable economy* is one that provides equitable access to resources and opportunities. It is characterized by development decisions, policies, and practices that respect cultural realities and differences, and do not exhaust the Earth's resources. A sustainable economy is evident when decisions, policies, and practices are carried out to minimize their impact on the Earth's resources and to maximize the regeneration of the natural environment.
- Decisions or changes related to any one of the three components—human health and well-being, the environment, or the economy—have a significant impact on the other two components and, consequently, on our *quality of life*. Decision making must take into account all three components to ensure an equitable, reasonable, and sustainable quality of life for all.



Educators are encouraged to consult *Education for a Sustainable Future* (Manitoba Education and Training), a document that outlines ways of incorporating precepts, principles, and practices to foster appropriate learning environments that would help direct students toward a sustainable future. The document is available online at <www.edu.gov.mb.ca/k12/docs/support/future>.

Sustainable Development, Social Responsibility, and Equity

Sustainable development supports principles of social responsibility and equity. This includes equity among nations, within nations, between humans and other species, as well as between present and future generations.

Sustainable development is, at the same time, a decision-making process, a way of thinking, a philosophy, and an ethic. Compromise is an important idea that underlies the decision-making process within a sustainable development approach. In order to achieve the necessary balance among human health and well-being, the environment, and the economy, some compromises will be necessary.

> There can be no greater contribution or more essential element to long-term environmental strategies leading to sustainable development that respects the environment . . . than the education of future generations in matters relating to the environment (UNESCO).
>
> Public awareness and understanding of the concept of sustainable development and its practices are essential. If we are to change our way of life we must equip present and future generations with the knowledge and training to put sustainable development into effect (Manitoba Sustainability Development Coordination Unit 19).

As students advance from grade to grade, they identify STSE interrelationships and apply decision-making skills in increasingly demanding contexts, such as the following:

- **Complexity of understanding:** from simple, concrete ideas to abstract ideas; from limited knowledge of science to more in-depth and broader knowledge of science and the world
- **Applications in context:** from contexts that are local and personal to those that are societal and global
- **Consideration of variables and perspectives:** from one or two that are simple to many that are complex
- **Critical judgment:** from simple right or wrong assessments to complex evaluations
- **Decision making:** from decisions based on limited knowledge, made with the teacher's guidance, to decisions based on extensive research that are made independently and involve personal judgment

The following GLOs have been developed to define expectations related to the STSE foundation area.

Science, Technology, Society, and the Environment (STSE) General Learning Outcomes

As a result of their Senior Years science education, students will:

B1 Describe scientific and technological developments—past and present—and appreciate their impact on individuals, societies, and the environment, both locally and globally.

B2 Recognize that scientific and technological endeavours have been, and continue to be, influenced by human needs and the societal context of the time.

B3 Identify the factors that affect health, and explain the relationships among personal habits, lifestyle choices, and human health, both individual and social.

B4 Demonstrate a knowledge of, and personal consideration for, a range of possible science- and technology-related interests, hobbies, and careers.

B5 Identify and demonstrate actions that promote a sustainable environment, society, and economy, both locally and globally.

Scientific and Technological Skills and Attitudes

A science education that strives for developing scientific literacy must engage students in answering questions, solving problems, and making decisions. These processes are referred to as scientific inquiry, technological problem solving (the design process), and decision making (see the following chart). While the skills and attitudes involved in these processes are not unique to science, they play an important role in the development of scientific understandings and in the application of science and technology to new situations.

Processes for Science Education*

	Scientific Inquiry	Technological Problem Solving (Design Process)	Decision Making
Purpose:	Satisfying curiosity about events and phenomena in the natural world.	Coping with everyday life, practices, and human needs.	Identifying different views or perspectives based on varying information.
Procedure:	What do we know? What do we want to know?	How can we do it? Will it work?	What are the alternatives or consequences? Which choice is best at this time?
Product:	Knowledge about events and phenomena in the natural world.	An effective and efficient way to accomplish a task or meet a need.	A defensible decision in a particular circumstance.

	Scientific Question	Technological Problem	STSE Issue
Example:	Why does my coffee cool so quickly?	How can I keep my coffee hot?	Should we use foam cups or ceramic mugs for our meeting?
	An Answer: Heat energy is transferred by conduction, convection, and radiation to the surrounding environment.	*A Solution:* A foam cup will keep liquids warm for a long time. So will an insulated cup.	*A Decision:* Since we must use disposable cups for the meeting, we will choose a biodegradable type.

*Source: Adapted with permission of the Minister of Education, Province of Alberta, Canada, 2010.

A description of each of these *processes* follows. *Attitudes*, which are an important element of each process, are also examined, and are treated as indicators along the pathway of student achievement. Hence, attitudes are to be modelled by teachers and students, but are not formally assessed in the same manner as other specific learning outcomes.

Scientific Inquiry

Scientific inquiry is a way of learning about the universe. It involves posing questions and searching for explanations of phenomena. Although no single "scientific method" exists, students require certain skills to participate in science-related experiences using a variety of appropriate methods.

Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, and collecting, analyzing, and interpreting data are fundamental to scientific inquiry—as are attitudes such as curiosity, skepticism, and creativity. These skills are often represented as a cycle. This cycle involves posing questions, generating possible explanations, and collecting and analyzing evidence to determine which of these explanations is most useful and accurate in accounting for the phenomena under investigation. New questions may arise to reignite the cycle. It must be noted, however, that many scientific inquiries (past and present) do not necessarily follow a set sequence of steps, nor do they always start at the "beginning" of the cycle; scientists can be creative and responsive to scientific challenges as they arise.

Technological Problem Solving

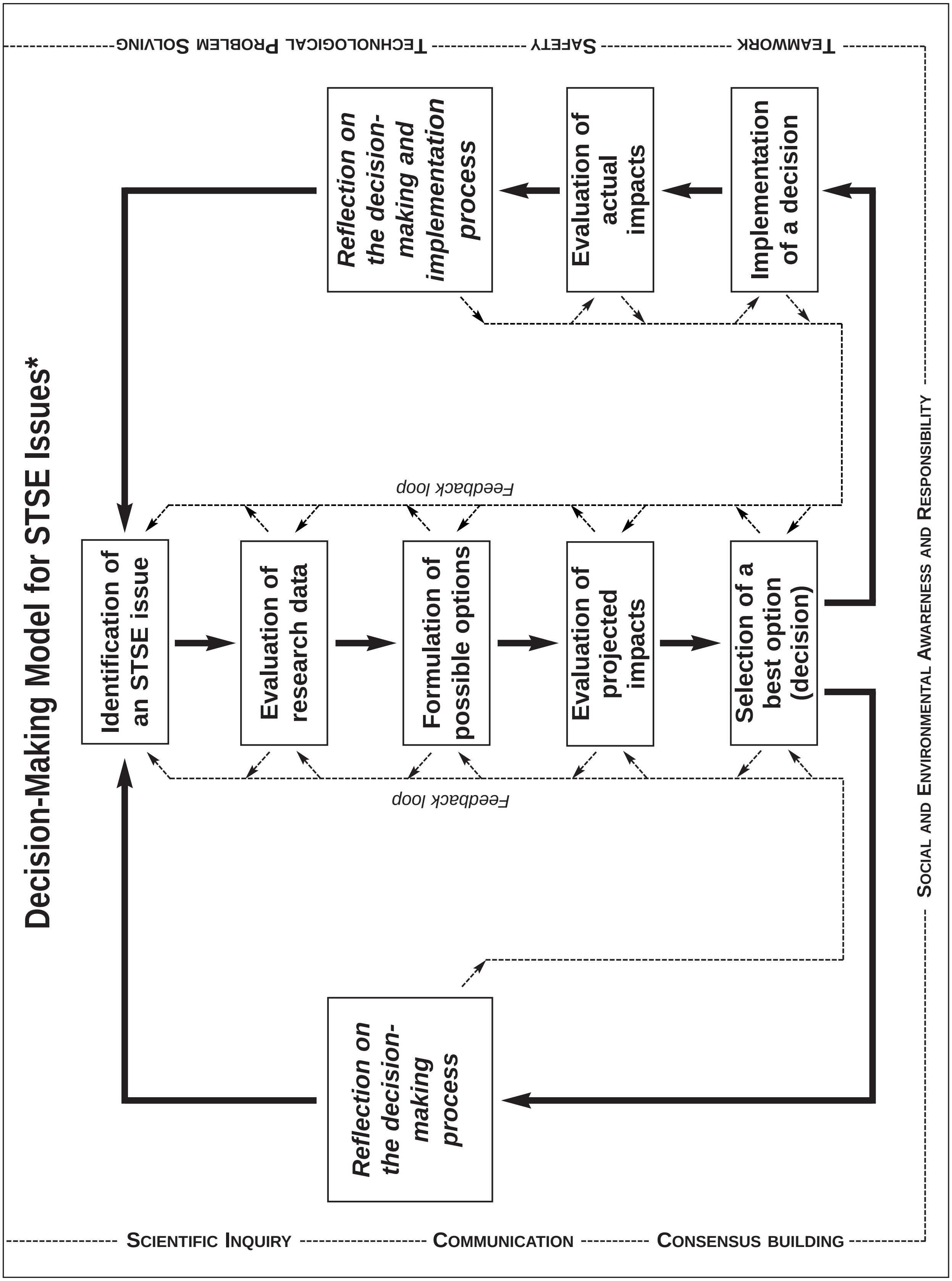
Technological problem solving seeks solutions to problems arising from human attempts to adapt to or change the environment. In Kindergarten to Grade 8 science, students have been developing these skills using a cycle of steps called the *design process.* This design process includes the proposing, creating, and testing of prototypes, products, and techniques in an attempt to reach an optimal solution to a given problem. Feedback and evaluation are built into this cycle. In Senior Years science, these technological problem-solving skills are incorporated into a *decision-making process.*

STSE Issues and Decision Making

Students, as individuals and global citizens, are required to make decisions. Increasingly, the types of issues they face demand an ability to apply scientific and technological knowledge, processes, and products to the decisions they make related to STSE. The decision-making process involves a series of steps, which may include

- clarifying the issue
- critically evaluating all available research
- generating possible courses of action
- making a thoughtful decision
- examining the impact of the decision
- reflecting on the process

Students should be actively involved in decision-making situations as they progress through their science education. Not only are decision-making situations important in their own right, but they also provide a relevant context for engaging in scientific inquiry, problem solving, and the study of STSE relationships (as shown in the following illustration).



*Source: Manitoba Education and Youth. *Senior 2 Science: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Youth, 2003. Introduction, p. 12.

Attitudes

Attitudes refer to generalized aspects of behaviour that are modelled for students. Attitudes are not acquired in the same way as skills and knowledge. They cannot be observed at any particular moment, but are evidenced by regular, unprompted manifestations over time. Development of attitudes is a lifelong process that involves the home, the school, the community, and society at large. The development of positive attitudes plays an important role in students' growth, affecting their intellectual development and creating a readiness for responsible application of what they learn.

The following GLOs have been developed to define expectations related to the Scientific and Technological Skills and Attitudes foundation area.

Scientific and Technological Skills and Attitudes General Learning Outcomes

As a result of their Senior Years science education, students will:

C1 Recognize safety symbols and practices related to scientific and technological activities and to their daily lives, and apply this knowledge in appropriate situations.

C2 Demonstrate appropriate scientific inquiry skills when seeking answers to questions.

C3 Demonstrate appropriate problem-solving skills when seeking solutions to technological challenges.

C4 Demonstrate appropriate critical thinking and decision-making skills when choosing a course of action based on scientific and technological information.

C5 Demonstrate curiosity, skepticism, creativity, open-mindedness, accuracy, precision, honesty, and persistence, and appreciate their importance as scientific and technological habits of mind.

C6 Employ effective communication skills and use information technology to gather and share scientific and technological ideas and data.

C7 Work cooperatively and value the ideas and contributions of others while carrying out scientific and technological activities.

C8 Evaluate, from a scientific perspective, information and ideas encountered during investigations and in daily life.

Essential Science Knowledge

The subject matter of science includes theories, models, concepts, and principles that are essential to an understanding of life sciences, physical sciences, and Earth and space sciences. It will be increasingly important for students of biology to make interdisciplinary connections among the following:

- **Life sciences:** This study deals with the growth and interactions of life forms within their environment in ways that reflect their uniqueness, diversity, genetic continuity, and changing nature. Life sciences include the study of organisms (including humans and cells), ecosystems, biodiversity, biochemistry, and biotechnology.

- **Physical sciences:** Primarily associated with chemistry and physics, the physical sciences deal with matter, energy, and forces. Matter has structure, and interactions exist among its components. Energy links matter to gravitational, electromagnetic, and nuclear forces of the universe. The laws of conservation of mass and energy, momentum, and charge are addressed by physical science.
- **Geosciences and the space sciences:** These studies provide students with local, global, and universal perspectives. Earth exhibits form, structure, and patterns of change, as does our surrounding solar system and the physical universe beyond. Earth and space sciences include fields of study such as geology, hydrology, meteorology, and astronomy.

The following GLOs have been developed to define expectations related to the Essential Science Knowledge foundation area.

Essential Science Knowledge General Learning Outcomes

As a result of their Senior Years science education, students will:

D1 Understand essential life structures and processes pertaining to a wide variety of organisms, including humans.

D2 Understand various biotic and abiotic components of ecosystems, as well as their interaction and interdependence within ecosystems and within the biosphere as a whole.

D3 Understand the properties and structures of matter, as well as various common manifestations and applications of the actions and interactions of matter.

D4 Understand how stability, motion, forces, and energy transfers and transformations play a role in a wide range of natural and constructed contexts.

D5 Understand the composition of the Earth's atmosphere, hydrosphere, and lithosphere, as well as the processes involved within and among them.

D6 Understand the composition of the universe, the interactions within it, and the implications of humankind's continued attempts to understand and explore it.

The Unifying Concepts

An effective way to create linkages within and among science disciplines is to use unifying concepts—the key ideas that underlie and integrate all science knowledge and extend into areas such as mathematics and social studies. Unifying concepts help students construct a more holistic, systems-related understanding of science and its role in society.

The following four unifying concepts were used in the development of Grade 11 Biology:

- **Similarity and diversity:** The concepts of similarity and diversity provide tools for organizing our experiences with the world. Beginning with informal experiences, students learn to recognize attributes of materials, organisms, and events that help to make useful distinctions between and among them. Over time, students adopt accepted procedures and protocols for describing and classifying objects, organisms, and events they encounter, thus enabling them to share ideas with others and to reflect on their own experiences.

- **Systems and interactions:** An important part of understanding and interpreting the world is the ability to think about the whole in terms of its parts and, alternately, about parts in terms of how they relate to one another and to the whole. A system is a collection of components that interact with one another so that the overall effect is often different from that of the individual parts, even when these are considered together. Students will study both natural and technological systems.
- **Change, constancy, and equilibrium:** The concepts of constancy and change underlie most understandings of the natural and technological world. Through observations, students learn that some characteristics of living things, materials, and systems remain constant over time, whereas others change. Through formal and informal studies, students develop an understanding of the processes and conditions in which change, constancy, and equilibrium take place.
- **Energy:** The concept of energy provides a conceptual understanding that brings together many aspects of natural phenomena, materials, and the processes of change. Energy, whether transmitted or transformed, is the driving force of both movement and change. Students learn to describe energy in terms of its effects and, over time, develop a concept of energy as something inherent within the interactions of materials, the processes of life, and the functions of systems.

The following GLOs have been developed to define expectations related to the Unifying Concepts foundation area.

Unifying Concepts General Learning Outcomes

As a result of their Senior Years science education, students will:

E1 Describe and appreciate the similarity and diversity of forms, functions, and patterns within the natural and constructed world.

E2 Describe and appreciate how the natural and constructed world is made up of systems and how interactions take place within and among these systems.

E3 Recognize that characteristics of materials and systems can remain constant or change over time, and describe the conditions and processes involved.

E4 Recognize that energy, whether transmitted or transformed, is the driving force of both movement and change, and is inherent within materials and in the interactions among them.

Kindergarten to Grade 10 Science Topic Chart

The following table provides a quick reference to the different thematic clusters from Kindergarten to Grade 10 Science. It allows teachers to examine, at a glance, students' previous exposure to scientific knowledge in different areas. The biology-related content clusters are grey-shaded for reference.

	Cluster 0	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Kindergarten	**Overall Skills and Attitudes** (To Be Integrated into Clusters 1 to 4)	Trees	Colours	Paper	——
Grade 1		Characteristics and Needs of Living Things	The Senses	Characteristics of Objects and Materials	Daily and Seasonal Changes
Grade 2		Growth and Changes in Animals	Properties of Solids, Liquids, and Gases	Position and Motion	Air and Water in the Environment
Grade 3		Growth and Changes in Plants	Materials and Structures	Forces That Attract or Repel	Soils in the Environment
Grade 4		Habitats and Communities	Light	Sound	Rocks, Minerals, and Erosion
Grade 5		Maintaining a Healthy Body	Properties of and Changes in Substances	Forces and Simple Machines	Weather
Grade 6		Diversity of Living Things	Flight	Electricity	Exploring the Solar System
Grade 7		Interactions within Ecosystems	Particle Theory of Matter	Forces and Structures	Earth's Crust
Grade 8		Cells and Systems	Optics	Fluids	Water Systems
Grade 9		Reproduction	Atoms and Elements	Nature of Electricity	Exploring the Universe
Grade 10		Dynamics of Ecosystems	Chemistry in Action	In Motion	Weather Dynamics

Notes

Section 2:
Enhancing Student Learning in Grade 11 Biology

ENHANCING STUDENT LEARNING IN GRADE 11 BIOLOGY

Science and the Learning Process

Students are active learners who have individual interests, abilities, and needs. They come to school with various personal and cultural experiences and prior knowledge that generate a range of attitudes and beliefs about science and life.

Students learn most effectively when they are actively engaged in the learning process. Active learning involves the construction of meaning through the interaction of prior knowledge, motivation, purpose, and new experiences. The process of learning varies from one individual to another, and is shaped by many factors, including personal and social influences. Science learning is more meaningful when students

- discover the significance of science in their lives
- appreciate the interrelatedness of science, technology, society, and the environment

Science *knowledge, skills, and attitudes* are interdependent aspects of learning, and need to be integrated in the learning process. Meaningful learning in science requires both depth and breadth of understanding. To achieve the vision of scientific literacy for all, students should become more engaged in the planning, development, and assessment of their own learning experiences.

The Senior Years Student and the Science Learning Environment

Student learning is central to teachers' work. Teachers make decisions regarding course content, learning materials and resources, and instructional and assessment methods on an ongoing basis. Successful learning is more likely to occur if these decisions are informed by teachers' understanding of their students and the ways they learn.

Teachers seeking to learn about their students need to be knowledgeable in various areas, including the following:

- **How people learn:** In recent decades, cognitive psychology, brain-imaging technology, and multiple intelligences theory have transformed our understanding of learning.
- **Ways in which student populations are changing:** The students teachers encounter today are different in many respects from students a generation ago. Students are more sophisticated in their knowledge and use of information and communication technologies, and much of their understanding of the world comes from electronic media. Classrooms are more likely to be ethnically diverse. Students are more likely to be living with a single parent or stepfamily. More students have part-time jobs.
- **Developmental characteristics of students:** The characteristics of adolescent learners have many implications for teachers.

- **The unique qualities of each student:** Family relationships, academic and life experiences, personality, interests, learning styles, socio-economic status, and rate of development all influence a student's ability to learn. Teachers can gain an understanding of the unique qualities of each student through daily interactions, observations, and assessment.

Characteristics of Grade 11 Learners

For many students, Grade 11 is a stable and productive year. Many Grade 11 students have developed a degree of security within their peer group and a sense of belonging in school. They show increasing maturity in dealing with the freedoms and responsibilities of late adolescence: romantic relationships, part-time jobs, and a driver's licence. In Grade 11, most students have a great deal of energy and a growing capacity for abstract and critical thinking. Many are prepared to express themselves with confidence and to take creative and intellectual risks. The stresses and preoccupations of preparing for graduation, post-secondary education, or full-time jobs are still a year away.

For many students, Grade 11 may be the most profitable academic year of the Senior Years. Although many Grade 11 students handle their new responsibilities and the demands on their time with ease, others experience difficulty. External interests may seem more important than school. Because of their increased autonomy, students who previously had problems managing their behaviour at school may now express their difficulties through poor attendance, alcohol and drug use, or other behaviours that place them at risk.

Students struggling to control their lives and circumstances may make choices that seem to teachers to be contrary to their best interests. Communication with the home and awareness of what their students are experiencing outside school continue to be important for Grade 11 teachers. Although the developmental variance evident in previous years has narrowed, students in Grade 11 can still change a great deal in the course of one year or even one semester. Teachers need to be sensitive to the dynamic classroom atmosphere and recognize when shifts in interests, capabilities, and needs are occurring, so they can adjust learning experiences for their students.

The following chart identifies some common characteristics of late adolescence observed in educational studies (Glatthorn; Maxwell and Meiser; Probst) and by Manitoba teachers, and discusses the implications of these characteristics for teachers.

Grade 11 Learners: Implications for Teachers*	
Characteristics of Grade 11 Learners	**Significance for Grade 11 Teachers**
Cognitive Characteristics	
• Most Grade 11 learners are capable of abstract thought and are in the process of revising their former concrete thinking into fuller understanding of principles.	• Teach to the big picture. Help students forge links between what they already know and what they are learning. Be cognizant of individual differences and build bridges for students who think concretely.
• Students are less absolute in their reasoning, more able to consider diverse points of view. They recognize that knowledge may be relative to context.	• Focus on developing problem-solving and critical thinking skills, particularly those related to STSE and decision making.
• Many basic learning processes have become automatic by Grade 11, freeing students to concentrate on complex learning.	• Identify the knowledge, skills, and strategies that students already possess, and build the course around new challenges. Through assessment, identify students who have not mastered learning processes at Grade 11 levels and provide additional assistance and support.
• Students have a clearer self-understanding and have developed specialized interests and expertise. They need to connect what they are learning to the world outside the school. Biology must be seen as valuable and necessary.	• Use strategies that enhance students' metacognition. Encourage students to develop scientific skills through exploring areas of interest. Cultivate classroom experts and invite students with individual interests to enrich the learning experience of the class.
Psychological and Emotional Characteristics	
• It is important for Grade 11 students to see that their autonomy and emerging independence are respected. They need a measure of control over what happens to them in school.	• Provide choice. Allow students to select many of the resources they will explore and the forms they will use to demonstrate their learning. Collaborate with students in assessment. Teach students to be independent learners. Gradually release responsibility to students.
• Students are preparing for senior leadership roles within the school and may be more involved with leadership in their communities.	• Provide students with leadership opportunities within the classroom and with a forum to practise skills in public speaking and group facilitation.
• Students need to understand the purpose and relevance of practices, policies, and processes. They may express their growing independence through a general cynicism about authority and institutions.	• Use students' tendency to question social mores to help them develop critical thinking. Negotiate policies and demonstrate a willingness to make compromises. Use students' questions to fuel classroom inquiry.
• Grade 11 students have a clearer sense of identity than they had previously and are capable of being more reflective and self-aware. Some students are more willing to express themselves and disclose their thoughts and ideas.	• Provide optional and gradual opportunities for self-disclosure. Invite students to explore and express themselves through their work. Celebrate student differences.

(continued)

*Source: Manitoba Education and Training. *Senior 3 English Language Arts: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1999. Section 1, pp. 5–7.

Grade 11 Learners: Implications for Teachers (continued)	
Characteristics of Grade 11 Learners	**Significance for Grade 11 Teachers**
Physical Characteristics	
• Many Grade 11 students have reached adult physical stature. Others, particularly males, are still in a stage of extremely rapid growth and experience a changing body image and self-consciousness.	• Be sensitive to the risk students may feel in public performances and increase expectations gradually. Provide students with positive information about themselves.
• By Grade 11, students are better able to sit still and concentrate on one learning task for longer periods, but they still need interaction and variety. They have a great deal of energy.	• Put physical energy to the service of active learning instead of trying to contain it. Provide variety; change the pace frequently; use kinesthetic learning experiences.
• Grade 11 students still need more sleep than adults do, and may come to school tired as a result of part-time jobs or activity overload.	• Be aware that inertia or indifference may be the result of fatigue. Work with students and families to set goals and plan activities realistically so that school work assumes a higher priority.
Moral and Ethical Characteristics	
• Grade 11 students are working at developing a personal ethic, rather than following a prescribed set of values and code of behaviour.	• Explore the ethical meaning of situations in life and in scientific contexts. Provide opportunities for students to reflect on their thoughts in discussion, writing, or representation.
• Students are sensitive to personal or systemic injustice but are increasingly realistic about the factors affecting social change.	• Explore ways in which decision-making activities can effect social change, and link to the continuum of science, technology, society, and the environment.
• Students are shifting from an egocentric view of the world to one centred in relationships and community. They are able to recognize different points of view and adapt to difficult situations.	• Provide opportunities for students to make and follow through on commitments and to refine their interactive skills.
• Students are becoming realistic about the complexities of adult responsibilities but resist arbitrary authority.	• Explain the purpose of every learning experience. Enlist student collaboration in developing classroom policies. Strive to be consistent.

(continued)

Grade 11 Learners: Implications for Teachers (continued)	
Characteristics of Grade 11 Learners	**Significance for Grade 11 Teachers**
Social Characteristics	
• By Grade 11, certain individuals will take risks in asserting an individual identity. Many students, however, continue to be intensely concerned with how peers view their appearance and behaviour. Much of their sense of self is drawn from peers, with whom they may adopt a “group consciousness,” rather than from making autonomous decisions.	• Ensure that the classroom has an accepting climate. Model respect for each student. Use learning experiences that foster student self-understanding and self-reflection. Challenge students to make personal judgments about situations in life and in their natural environment.
• Adolescents frequently express identification with peer groups through slang, musical choices, clothing, body decoration, and behaviour.	• Foster a classroom identity and culture. Ensure that every student is included and valued. Structure learning so that students can interact with peers, and teach strategies for effective interaction.
• Crises of friendship and romance, and a preoccupation with relationships, can distract students from academics.	• Open doors for students to study personal relationships in science (for example, through biographies of scientists). Respect confidentiality, except where a student’s safety is at risk.
• Students begin to recognize teachers as individuals and welcome a personal connection.	• Nurture and enjoy a relationship with each student. Try to find areas of common interest with each one. Respond with openness, empathy, and warmth.

Student Engagement

The concept of student engagement and its relationship to learning and achievement has become increasingly prominent in educational research and literature in recent years. While there are a number of definitions of student engagement, most contain behavioural, cognitive, and affective dimensions. The *behavioural dimension* refers to student actions related to engagement, such as participating in classroom and school activities, and accepting responsibility for their learning and assignments. The *cognitive dimension* includes student understandings about their own learning—for example, metacognition, and engaging in self-reflection and self-assessment. Student feelings about school, such as developing positive attitudes to school and school subjects, and demonstrating an interest in their learning are part of the *affective dimension*.

Research suggests that when learning activities are more student-directed than teacher-directed and the learning tasks are authentic, involving students in challenging and meaningful inquiry to solve real-life problems, students are more likely to develop positive emotions in the classroom and to become engaged in their learning (Shernoff et al). Greater engagement in classroom activities in high school is a significant predictor of continuing student motivation and commitment, increases the likelihood of successful school completion, and is critical to students’ capacity to be lifelong learners (Levin; Shernoff et al).

Creating a Stimulating Learning Environment

A vital science class grows out of, and is reflected in, a stimulating and inviting learning environment. Teachers develop a positive learning environment by attending to both physical and non-physical components.

Physical components of a positive learning environment may include the following:

- seating arrangements that reflect a student-centred philosophy and that facilitate flexible student groupings
- a classroom library, including science periodicals, newspaper articles, science fiction, files of previous tests and examinations, exemplars or samples of student work (such as projects, lab reports, and posters), reference materials (including dictionaries and encyclopedias of science), and software and CD-ROM titles
- access to electronic media equipment, including overhead/LCD projector, computer with Internet access, television, DVD player/VCR, digital camera/video recorder, and microcomputer-based laboratory (MBL) probeware or calculator-based laboratory (CBL) probeware
- posters, displays, charts, diagrams, plants, animals, fossils, models, and pictures reflecting and displaying student work and stimulating student interest in the current learning focus
- posters, diagrams, and flow charts of learning processes and strategies to encourage students' independent and small-group learning
- regular access to a well-equipped and safe science laboratory to foster the development of lab skills
- student input in classroom design and displays

Non-physical components (Cotton; Marzano; Stronge; Cooper) assist teachers in building a positive learning community and may include the following:

- belief that all students are equally important in the classroom and that each student has unique qualities that contribute to the classroom learning community
- communicating interest in and attention to student interests, problems, and accomplishments
- encouragement of student efforts and development of a sense of responsibility and self-reliance
- high standards of learning for all students and provision of time, instruction, and encouragement for all learners
- development of a safe, risk-free learning environment where failure to meet expectations is not penalized but is an opportunity for improving performance
- student-centred, hands-on learning strategies where students pursue learning with the assistance of the teacher, including student collaboration and cooperation
- definition and recognition of excellence in terms of learning outcomes (criterion-referenced) rather than peer comparisons (norm-referenced)

- clear and focused instruction by providing discussion of learning outcomes and culminating assessment tasks, connections between lessons and larger concepts, and opportunities for guided and independent practice
- frequent descriptive feedback, on both in-class work and assignments, and collaboration with students in developing action plans for success

Planning with the End in Mind

Much of the educational research and literature today is focused on classroom-based assessment. Assessment has a profound impact on student motivation and self-esteem, both of which are critical influences on student learning. Wiggins and McTighe promote a backward design model in which plans for both assessment and instruction stem from a clear understanding of the learning outcomes and the criteria for success that is communicated between the teacher and students. When planning lessons and units, teachers must have a clear conception of the learning outcomes. Then, instruction, assessment, and communication are focused on the learning outcomes (Manitoba Education, Citizenship and Youth, *Communicating Student Learning*).

Wiggins and McTighe suggest the following sequence for planning:

1. Identify the desired results.
2. Determine acceptable evidence.
3. Plan learning experiences and instruction.

When planning with the end in mind, teachers first identify the learning outcomes to be addressed in a given unit or learning experience. Decisions must be made as to what students are to learn. By clarifying the learning goals, teachers are able to focus their instruction and assessment on assisting students to achieve the desired results.

Next, teachers design the culminating summative assessment tasks through which students will demonstrate evidence that they have mastered the learning outcomes. These tasks are planned and communicated to students in advance of their learning so that students have a clear understanding of the learning goals, and the products and performances by which they will demonstrate achievement of their learning. This helps students stay focused on their learning.

Once the learning outcomes are identified and the culminating tasks are designed, teachers can plan the learning experiences. Instruction and formative assessments are developed to prepare students for the culminating tasks. The learning experiences are designed to enable students to build and to practise what they need to demonstrate in the culminating tasks to provide evidence of their learning.

Major Themes in Biology

Grade 11 Biology is driven by specific learning outcomes arranged around the key themes of *wellness* and *homeostasis*. Working with "big ideas" such as these can stimulate student interest and allow for more in-depth inquiry. By organizing learning outcomes around themes, information will be presented in the context of real-world applications.

WP

A recommended tool to help students explore the theme of wellness is the creation of a Wellness Portfolio, which is introduced in Unit 1: Wellness and Homeostasis. A number of possible assignments in a variety of formats can be found in the Suggestions for Instruction and Suggestions for Assessment sections of this document. The intent of the Wellness Portfolio is to have students learn more about their medical histories and how their own bodies work; to collect data on how their bodies are performing; to analyze how well they are taking care of themselves; and to make personal decisions about their own lifestyles to promote their wellness. By completing their portfolios, students personalize the human anatomy and physiology content in the Grade 11 Biology programming.

The theme of homeostasis is explored via an examination of individual human body systems. Learning outcomes related to homeostasis can be found throughout Grade 11 Biology. The final section of the course, Unit 6: Wellness and Homeostatic Changes, is intended to serve as a culminating look at homeostasis from a holistic perspective without being restricted to a particular body system. In this unit students are provided with the opportunity to apply what they have learned throughout Grade 11 Biology.

This curricular design empowers teachers to plan appropriate learning experiences based on the nature of their students, school, and community. Teachers are encouraged to seek their own instructional design with the new curriculum, to share approaches with colleagues, and to use the thematic focus to develop and extend student experiences and understandings in new ways.

Scaffolding and Transfer of Responsibility for Student Learning

Just as scaffolds provide support to a building under construction, scaffolding supports student learning. By providing temporary assistance or frameworks for learning (e.g., graphic organizers, group work), teachers bridge the gap between what students are able to do with the support of others and what they are able to do independently. The scaffolding helps students to advance from their current abilities to the intended goal, and is gradually removed as the students progress.

Associated with scaffolding is the gradual transfer of responsibility for learning. Initially, the teacher takes on most of the responsibility for structuring and leading the learning task, and provides a great deal of guidance to the students. As students' understanding develops, they assume more responsibility for the task by asking questions and attempting more complex applications with greater autonomy (Good and Brophy). The teacher continues to provide coaching and help to students when needed, but steadily reduces the assistance as students' expertise develops. This gradual transfer of responsibility for learning from the teacher to the students helps students to build their confidence by permitting them to demonstrate their growing competence and increases their ability to become independent, self-regulated learners (Frey, Fisher, and Everlove).

Planning Considerations

Biology curricula in the past have focused primarily on presenting a large amount of content deemed essential. While the Grade 11 Biology curriculum continues to be concerned with students gaining the relevant knowledge, it is also concerned with fostering the development of skills (process skills, decision-making skills, problem-solving skills, laboratory skills, research skills, critical thinking skills, independent learning skills) and attitudes (respect, appreciation, reflection). A strong focus of Grade 11 Biology is to link science with students' life experiences through the themes of wellness and homeostasis.

Grade 11 Biology assumes 110 hours of instructional time (including assessment).

Learning Resources

Traditionally, the approach to teaching science in the Senior Years has largely been textbook-based. Research suggests that we should move beyond a single textbook approach and provide students with a variety of information sources. These include human resources, print media, electronic media, field trips, and simulations.

Resource-based learning is a student-centred approach that adapts to student needs, interests, abilities, learning styles, and prior knowledge. An environment that is rich in resources allows students to explore and discover as they learn, and to make personal learning choices that are relevant and meaningful.

As our society continues to change, so do the roles of teachers and learners. A more flexible model of the teaching-learning process in which teachers facilitate the learning process and students make decisions and assume responsibility for their learning is becoming more prevalent in our schools. A resource-based learning approach helps students manage the information overload that typifies today's society, and teaches them how to continue their learning outside the school setting. While the development of fundamental knowledge is still essential in science, students also need the skills to locate, access, and evaluate pertinent information.

> For more information on selecting learning resources for Grades 11 and 12 Biology, see the Manitoba Education website at <www.edu.gov.mb.ca/k12/learnres/bibliographies.html>.

Diversity in the Classroom

Students come from a variety of backgrounds and have distinct learning needs, learning and thinking styles, and prior knowledge and experiences. Their depth of prior knowledge varies, reflecting their experiences inside and outside the classroom. For new learning to occur, it is important for teachers to activate students' prior knowledge, to correct misconceptions, and to encourage students to relate new information to prior experiences.

As a result of Manitoba's cultural diversity, students bring a variety of socially constructed meanings, references, and values to science learning experiences, as well as their unique learning approaches. In addition, cultural influences can affect how students think about science: reasoning by analogy or by strict linear logic; memorization of specific correct responses or generalizations; problem solving by induction or deduction; or needing to learn through hands-on experiences to gain one aspect of a skill before moving on to the next step (Kolodny). Cultural norms vary among societies; for example, values that discourage assertiveness, outspokenness, and competitiveness in some cultures can result in behaviour that may be interpreted in another culture as being indifferent, having nothing to say, or being unable to act decisively (Hoy; National Research Council). As noted in *Senior Years Science Teachers' Handbook*, "to be effective, the classroom must reflect, accommodate, and embrace the cultural diversity of its students" (Manitoba Education and Training 7.13).

Ethical Issues

A fundamental aspect of science learning and teaching (at all grades, but particularly in the Senior Years) is the consideration of controversial issues—issues that involve ethics, principles, beliefs, and values. For example, the technological application of biological principles in areas such as genetic engineering and human reproductive and medical technologies raises questions of ethics and values. Teachers should not avoid controversial issues, as discussion and debate concerning ethical questions serve to motivate students and make learning more personally meaningful.

Students should understand that science provides the background for informed personal and social decisions, and that as informed decision makers, they may have an impact on society and the world. Some students and parents may express concern because the perspectives of science conflict with personal systems of belief. These individuals have a right to expect that science and the public education system will respect those beliefs, although this does not preclude such issues from arising in the classroom. Teachers should explain that science is one way of learning about the universe and our place in it, and that other explanations have been put forth.

Dealing with Controversial Issues

The following guidelines may assist teachers in dealing with controversial issues in the classroom:

- Approach all issues with sensitivity.
- Clearly define the issues.
- Establish a clear purpose for discussions.
- Establish parameters for discussions.
- Ensure that the issues do not become personalized or directed at individual students.
- Protect the interests of individual students by finding out in advance whether any student would be personally affected by the discussion.
- Exercise flexibility by permitting students to choose alternative assignments.
- Accept the fact that there may not be a single "right answer" to a question or issue.
- Respect every student's right to voice opinions or perspectives.
- Help students clarify the distinction between informed opinion and bias.
- Help students seek sufficient and reliable information to support various perspectives.
- Allow time to present all relevant perspectives fairly and to reflect upon their validity.

The Responsible Use of Animals in the Biology Classroom

Biology teachers are encouraged to foster a respect for life and teach about the interrelationships among and interdependency of all living things. Furthermore, a stewardship approach emphasizes that humans must care for the fragile web of life that exists on our planet.

The use of live animals and the dissection of animals is a well-established practice in the teaching of life sciences. Well-constructed learning activities can illustrate important and enduring biological principles. Teachers must, however, carefully consider the educational objectives and available alternatives before using animals in the classroom. Justification on the grounds that "we have always done this" is unacceptable.

Grade 11 Biology does not mandate that dissection (either real or virtual) take place in the classroom. Dissection is one of many instructional strategies that may be used to familiarize students with the structure and function of organs and organ systems. Interactive multimedia materials such as computer simulations, tutorials, and video clips can substitute for the use of animals in the classroom. However, these alternatives must satisfy the objectives of teaching scientific methodology and fundamental biological concepts. If, in the judgment of the teacher, available alternatives do not meet these objectives, dissection may be used, provided that no student is forced to participate in a dissection over his or her objections. In the event that a student chooses not to participate in a dissection, he or she should be provided with an alternate activity of comparable complexity and rigour.

Implementing alternative methods does not mean excluding animals from the classroom. Classroom pets stimulate student interest in the life sciences, and their care can foster a respect for life. Certain instructional strategies allow for the continued use of animals, but with a modified approach. For example, observations of vertebrates in behaviour studies, and experimentation with invertebrates (e.g., fruit flies, planarians) can be used to illustrate important biological principles. In these cases, prudent and responsible use of these animals is essential.

Instruction

Science learning can be enhanced by using a variety of settings both in and outside the school, flexible student groupings, and numerous other instructional strategies.

Active Learning

Well-balanced science programming includes individual, collaborative, and teacher-directed learning experiences and provides students with a variety of conceptual tools and advance organizers.

Effective science instruction includes the use of strategies that promote student inquiry and interaction. These strategies include cooperative and peer learning, laboratory activities, project-based learning, teacher- and student-initiated inquiry, and research.

It is through guided inquiry and interaction that students construct meaning from their individual experiences. Students require opportunities to engage in authentic and relevant scientific issues and events. It is important that these experiences be integral to science learning.

Active learning is encouraged through resource-based and experiential learning. These include laboratory activities, field studies, and the use of information and communication technologies. Effective practices in science actively engage students in scientific inquiry processes such as research, problem solving, and decision making.

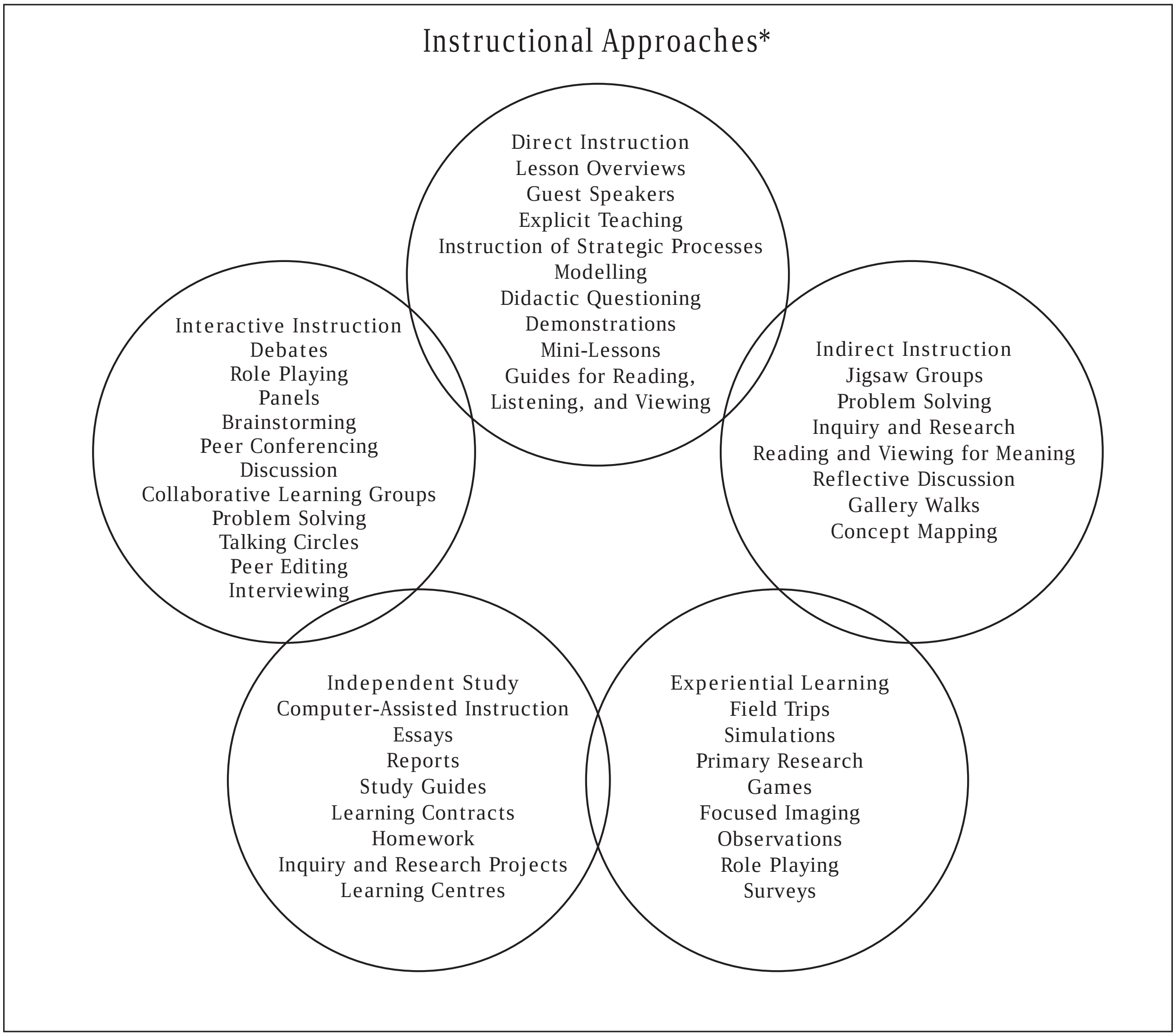
Instructional Approaches

In planning learning experiences, teachers can chose from a variety of instructional approaches and methods and use these in various combinations.

Instructional approaches may be categorized as

- direct instruction
- indirect instruction
- experiential learning
- independent study
- interactive instruction

The following diagram displays these instructional approaches and suggests some examples of methods within each approach. Note that the approaches overlap.



*Source: Saskatchewan Education. *Instructional Approaches: A Framework for Professional Practice*. Regina, SK: Saskatchewan Education, 1991. 20. Adapted by permission.

Teachers consider a number of factors as they select and adapt instructional approaches and methods:

- Will the approach meet the unique learning styles of students?
- Will it assist students in achieving the targeted learning outcomes?
- Will it engage them?
- Do student have the prerequisite knowledge of the content and/or skills to enable them to learn with this approach?
- What are the advantages and disadvantages of this approach?

Some of these considerations are included in the following chart.

Instructional Approaches: Roles, Purposes, and Methods*

Instructional Approaches	Roles	Purposes/Uses	Methods	Advantages/ Limitations
Direct Instruction	• Highly teacher-directed • Teacher uses didactic questioning to elicit student involvement	• Providing information • Developing step-by-step skills and strategies • Introducing other approaches and methods • Teaching active listening and note making	Teachers: • Explicit teaching • Lesson overviews • Guest speakers • Instruction of strategic processes • Lecturing • Didactic questioning • Demonstrating and modelling prior to guided practice • Mini-lessons • Guides for reading, listening, and viewing	• Effective in providing students with knowledge of steps of highly sequenced skills and strategies • Limited use in developing abilities, processes, and attitudes for critical thinking and interpersonal learning • May encourage passive, not active learning
Indirect Instruction	• Mainly student-centred • Teacher's role shifts to facilitator, supporter, resource person • Teacher monitors progress to determine when intervention or another approach is required	• Activating student interest and curiosity • Developing creativity and interpersonal skills and strategies • Exploring diverse possibilities • Forming hypotheses and developing concepts • Solving problems • Drawing inferences	Students: • Observing • Investigating • Inquiring and researching • Jigsaw groups • Problem solving • Reading and viewing for meaning • Reflective discussion • Concept mapping	• Active involvement an effective way for students to learn • High degree of differentiation and pursuit of individual interests possible • Excellent facilitation and organizational skills required of teachers • Some difficulty integrating focused instruction and concepts of content

(continued)

*Source: Manitoba Education and Training. *Senior 3 English Language Arts: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1999. Section 2, pp. 5–6.

Instructional Approaches: Roles, Purposes, and Methods (continued)				
Instructional Approaches	**Roles**	**Purposes/Uses**	**Methods**	**Advantages/ Limitations**
Interactive Instruction	• Student-centred • Teacher forms groups, teaches and guides small-group skills and strategies	• Activating student interest and curiosity • Developing creativity and interpersonal skills and strategies • Exploring diverse possibilities • Forming hypotheses and developing concepts • Solving problems • Drawing inferences	Students participating in: • Discussions • Sharing • Generating alternative ways of thinking and feeling • Decision making • Debates • Role-playing • Panels • Brainstorming • Peer conferencing • Collaborative learning groups • Problem solving • Talking circles • Interviewing • Peer editing	• Increase of student motivation and learning through active involvement in groups • Key to success is teacher's knowledge and skill in forming groups, instructing, and guiding group dynamics • Effective in assisting students' development of life skills in cooperation and collaboration
Experiential Instruction	• Student-centred • Teacher's role may be to design the order and steps of the process	• Focusing on processes of learning rather than on products • Developing students' knowledge and experience • Preparing students for direct instruction	Students participating in: • Learning activities • Field trips • Simulations • Primary research • Games • Focused imaging • Role-playing • Surveys • Sharing observations and reflections • Reflecting critically on experiences • Developing hypotheses and generalizations in new situations	• Increase in student understanding and retention • Additional resources and time required for hands-on learning
Independent Study	• Student-centred • Teacher's role to guide or supervise students' independent study, teach knowledge, skills, and strategies that students require for independent learning, and provide adequate practice	• Accessing and developing student initiative • Developing student responsibility • Developing self-reliance and independence	Students participating in: • Inquiry and research projects • Using a variety of approaches and methods • Computer-assisted instruction • Essays and reports • Study guides • Learning contracts • Homework • Learning centres	• Students grow as independent, lifelong learners • Student maturity, knowledge, skills, and strategies important to success • Student access to resources essential • Approach flexible (may be used with individual students while other students use other approaches)

Phases of Learning*

Teachers find the following three phases of learning helpful when planning learning experiences:

- activating (preparing for learning)
- acquiring (integrating and processing learning)
- applying (consolidating learning)

The instructional strategies suggested in this document are organized into activating and acquiring/applying strategies. While these phases are not entirely linear, they are useful for thinking about and planning learning experiences. A variety of activating, acquiring, and applying strategies are discussed in *Senior Years Science Teachers' Handbook* and *Success for All Learners: A Handbook on Differentiating Instruction* (Manitoba Education and Training).

Activating (Preparing for Learning)

One of the strongest indications of how well students will comprehend new information is their prior knowledge of the subject. Some educators observe that more learning occurs during this activating phase than at any other time. In planning instruction and assessment, teachers develop student learning experiences and select strategies for activating their students' prior knowledge. Using these activating strategies, the learning experiences then provide information about the extent of students' prior knowledge of the topic to be studied, their knowledge of and familiarity with the context in which that knowledge was acquired, and their knowledge of and proficiency in applying skills for learning.

Learning experiences that draw on students' prior knowledge

- help students relate new information, skills, and strategies to what they already know and can do (e.g., if a text includes unfamiliar vocabulary, students may not recognize the connection between what they know and the new material being presented)
- allow teachers to recognize misconceptions that might make learning difficult for students
- allow teachers to augment and strengthen students' knowledge base when students do not possess adequate prior knowledge and experience to engage with new information and ideas
- help students recognize gaps in their knowledge
- stimulate curiosity and initiate the inquiry process that will direct learning

This document contains numerous strategies for activating students' prior knowledge, such as brainstorming, KWL (Know, Want to Know, Learned) guides, demonstrations, and questions to stimulate class discussions.

*Source: Manitoba Education and Training. *Senior 3 English Language Arts: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1999. Section 2, pp. 6–8.

Acquiring (Integrating and Processing Learning)

In the second phase of learning, students engage with new information and integrate it with what they already know, adding to and revising their previous knowledge. Part of the teacher's role in this phase is to present this new information or to help students access it from various resources.

Since learning is an internal process, facilitating learning requires more of teachers than simply presenting information. In the acquiring phase, teachers instruct students in strategies that help them make meaning of information, integrate it with what they already know, and express their new understanding. In addition, teachers monitor these processes to ensure that learning is taking place, using a variety of instruments, tools, and strategies such as observations, conferences, and examination of student work.

In practice, within an actual lesson or unit, the acquiring phase of learning may include a series of steps and strategies, such as

- setting the purpose (e.g., discrepant events, lesson overviews, learning logs, Admit Slips)
- presenting information (e.g., demonstrations, guest speakers, mini-lessons, active reading)
- processing information (e.g., note making, group discussions, journals, visual representations)
- modelling (e.g., role-playing, demonstrations)
- checking for understanding (e.g., quizzes, informal conferences)
- practising (e.g., guided practice, rehearsals)

Applying (Consolidating Learning)

New learning that is not reinforced is soon forgotten. The products and performances by which students demonstrate new learning are not simply required for assessment; they have an essential instructional purpose in providing students with opportunities to demonstrate and consolidate their new knowledge, skills and strategies, and attitudes. Students also need opportunities to reflect on what they have learned and to consider how new learning applies to new situations. By restructuring information, expressing new ideas in another form, or integrating what they have learned in science with concepts from other subject areas, students strengthen and extend their learning.

To ensure that students consolidate new learning, teachers plan various learning experiences involving

- reflection (e.g., journals, Exit Slips)
- closure (e.g., sharing of products, debriefing on processes)
- application (e.g., inquiry, design process, decision making)

Differentiating Instruction

How can Senior Years science teachers meet each student's learning requirements and still make learning experiences challenging and meaningful for all? One way to help all students achieve the identified learning outcomes is to differentiate the instructional strategies.

Through differentiating instruction, teachers can

- activate students' prior knowledge
- accommodate multiple intelligences and the variety of learning and thinking approaches
- help students interpret, apply, and integrate information
- facilitate the transfer of knowledge, skills and strategies, and attitudes to students' daily lives
- challenge students to realize academic and personal progress and achievement

Differentiating instruction does not mean offering different programming to each student. Classroom experiences can be differentiated by offering students choices and by varying instructional and assessment strategies to provide challenging and effective learning experiences for all. Ideas for differentiating instruction are provided in *Senior Years Science Teachers' Handbook* and in *Success for All Learners: A Handbook on Differentiating Instruction* (Manitoba Education and Training).

Assessment

Assessment is integral to instruction and learning. It plays a major role in how students learn, their motivation to learn, and how teachers teach.

Purposes of Assessment

Research indicates that ongoing formative assessment contributes more significantly to learning than the traditional focus on summative assessment (Black and Wiliam). Manitoba Education refers to formative assessment as assessment *for* learning and assessment *as* learning.

Each type of assessment serves a purpose and contributes to student success:

- **Assessment *for* learning** helps teachers to gain insight into what students understand so that they can appropriately plan and differentiate teaching strategies and learning opportunities to help students progress. Students need frequent opportunities to obtain meaningful and relevant feedback. Descriptive feedback that includes analytical questions and constructive comments provides information to students that they may use to adjust their learning processes, and is more helpful to students than a numeric or alphabetic grade.
- **Assessment *as* learning** helps students to develop an awareness of how they learn and to use that awareness to adjust and advance their learning, taking an increased responsibility for their learning. When students have the opportunity to become reflective learners they can synthesize their learning, solve problems, apply their learning in authentic situations, and better understand their learning processes.

- **Assessment *of* learning** serves to confirm whether or not students have met curricular outcomes, and provides evidence of achievement to students, teachers, and parents, as well as to the broader educational community. Assessment *of* learning supports learning when it is used to celebrate success, adjust future instruction, and provide feedback to the learner.

Assessment must be planned with its purpose in mind. Assessment *for*, *as*, and *of* learning all have a role to play in supporting and improving student learning, and must be appropriately balanced. The most important part of assessment is the interpretation and use of the information that is gleaned for its intended purpose.

For more information on assessment, consult *Rethinking Classroom Assessment with Purpose in Mind: Assessment for Learning, Assessment as Learning, Assessment of Learning* (Manitoba Education, Citizenship and Youth).

Assessment in the Phases of Learning

Assessment takes place in each of the three phases of learning (activating, acquiring, and applying) and benefits both students and teachers at each phase.

Assessment at Different Phases of Learning*		
	Students	**Teachers**
Activating Phase	Assessment in the activation stage helps **students** • "set the stage" and mentally plan and prepare for new learning • identify the focus of new learning • identify what they already know about a topic • gain interest in a new topic	Assessment in the activation stage helps **teachers** • identify gaps, strengths, misconceptions, and faulty information in students' prior knowledge • identify student interests • provide a focus for planning instructional strategies and the selection of student learning resources • determine which instructional approaches or resources need to be implemented or adapted
Acquiring Phase	Assessment during the acquisition stage helps **students** • become aware of the progress and the degree of understanding they are achieving • experience and adapt different approaches and strategies that facilitate their learning • identify what further learning they need to undertake • improve as they practise	Assessment during the acquisition stage helps **teachers** • revise learning strategies to meet evolving student needs • monitor student growth and progress, and determine whether students are achieving specific learning outcomes (SLOs) • determine if individual students need additional support or further learning opportunities to achieve SLOs • identify which learning outcomes need to be the focus of subsequent instruction and assessment • gather evidence of student growth, which may be used for reporting
Applying Phase	Assessment during the application stage helps **students** • become aware of their growth and achievement, and celebrate their successes • identify their strengths, as well as areas needing further growth • deepen their understandings as they make connections and reflect on their learning, and apply new ideas in meaningful and authentic ways	Assessment during the application stage helps **teachers** • be fully aware of student understanding and achievement of learning outcomes • identify student strengths and areas needing further learning • provide evidence of student growth and achievement for reporting to parents and administrators • reflect on their teaching practices in order to identify changes and revisions to learning strategies

*Source: Manitoba Education, Citizenship and Youth. *Grade 9 Social Studies: Canada in the Contemporary World: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education, Citizenship and Youth, 2007. Overview, p. 43.

Congruence of Assessment with Learning

There are three types of learning outcomes in science—knowledge, skills, and attitudes—and assessment needs to be congruent with each type of learning.

- **Knowledge:** Science places significant emphasis on the acquisition of knowledge. Students do not gain true understanding of science or meet the goal of scientific literacy if they simply memorize and recall facts. Students must be encouraged to use the knowledge they acquire to synthesize and apply new understandings and to demonstrate evidence of their learning.
- **Skills:** The assessment of science skills and processes requires different tools and strategies than the assessment of knowledge. Because skill development is ongoing, students should practise skills throughout the course. Skills are best assessed by observing students in action, by discussing their learning strategies in conferences and interviews, and by gathering data from student reflections and self-assessments.
- **Attitudes:** Attitudes are implicit in what students do and say, and are not always measurable in the way that knowledge outcomes are measurable. Similar to skills, attitudes are best assessed by observing students in action, looking for behavioural indicators as expressions of student attitudes, and engaging students in critical dialogue.

> Rather than emphasizing the recall of specific, detailed and unrelated “facts,” [assessment in science] should give greater weight to an assessment of a holistic understanding of the major scientific ideas and a critical understanding of science and science reasoning (Millar and Osborne 25).

Assessment Modes, Strategies, and Tools

Assessment is embedded in the learning process. It is deeply interconnected with curriculum and instruction and must be balanced in order to improve learning and achievement for all students. Cooper suggests teachers consider modes, strategies, and tools when developing assessment tasks:

- **Modes** are the ways in which students demonstrate their learning. They include writing, doing, and speaking, and may be used in combination in an assessment task.
- **Strategies** are the tasks in which the students engage. These include tests and quizzes, journals, inquiry projects, laboratory activities, debates, mind maps, multimedia presentations, and diagrams. The type of strategy selected should match the learning being assessed.
- **Tools** are the instruments used to record the assessment data. Examples of assessment tools are marking schemes, rubrics, checklists, and rating scales. The tool must correspond to the strategy that has been chosen. For example, a rubric is used to assess an open-response essay question or an inquiry project, while a marking scheme is used to assess a multiple choice test.

Assessment Tools and Strategies*	
Observations of Skills and Processes	**Tests, Products, and Performances**
Teacher assessment: • checklists and rating scales • anecdotal records • conferences and interviews • review of work in progress Student peer assessment and self-assessment • checklists and rating scales • logs and journals	Teacher assessment: • rubrics and marking scales • conferences • portfolios Student peer assessment and self-assessment • checklists • reflective journals • portfolios

* Source: Manitoba Education, Citizenship and Youth. *Grade 9 Social Studies: Canada in the Contemporary World: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education, Citizenship and Youth, 2007. Adapted from Overview, p. 45.

Characteristics of Effective Assessment**

Effective assessment helps focus effort on implementing strategies to facilitate learning both inside and outside the classroom. Effective assessment is

- congruent with instruction
- ongoing and continuous
- based on authentic tasks
- based on criteria that students know and understand
- a collaborative process involving students
- focused on what students have learned and can do

Effective Assessment Is Congruent with Instruction

Assessment requires teachers and students to be aware continually of the purpose of instruction. How teachers assess depends on what they are assessing—whether it is knowledge, skills, or attitudes. Assessment is intended to inform students of the programming emphases and to help them to focus on important aspects of learning. If teachers assess only the elements that are easiest to measure, students may focus only on those things.

** Source: Manitoba Education and Training. *Senior 3 English Language Arts: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1999. Adapted from Section 2, pp. 10–14.

Effective Assessment Is Ongoing and Continuous

Assessment that is woven into daily instruction offers students frequent opportunities to gain descriptive feedback, to modify their learning approaches and methods, and to observe their progress. Teachers provide assessment for learning by questioning students and offering comments throughout a project or unit of study. They also conduct assessments of learning at the completion of a project or unit of study. Continuous assessment provides ongoing opportunities for teachers to review and revise instruction, content, process emphases, and learning resources, and for students to assess their own knowledge, skills, and learning strategies in order to develop their understanding and to refine their learning strategies.

Effective Assessment Is Based on Authentic Tasks

Assessment tasks in science should be authentic and meaningful—tasks worth doing for their own sake. Through assessment, teachers discover whether students can use knowledge, processes, and resources effectively to achieve worthwhile purposes. Therefore, teachers design tasks that replicate the context in which knowledge will be applied in the world beyond the classroom.

Authentic assessment tasks are tests not only of the information students possess, but also of the way their understanding of a subject has deepened, and of their ability to apply learning. They demonstrate to students the relevance and importance of learning. Performance-based tasks are also a way of consolidating student learning.

Effective Assessment Is Based on Criteria That Students Know and Understand

Assessment criteria must be clearly established and made explicit to students prior to an assignment or test so that students can focus their efforts. Each assessment task should test only those learning outcomes that have been identified to students. This means, for example, that laboratory skills tests need to be devised and marked to gather information about students' laboratory skills, not their ability to express ideas effectively when writing a laboratory report.

Wherever possible, students need to be involved in co-constructing the assessment criteria. Students should also understand clearly what successful accomplishment of each proposed task looks like. Samples of student work from previous years and other exemplars assist students in developing personal learning goals.

Effective Assessment Is a Collaborative Process Involving Students

The ultimate purpose of assessment is to enable students to assess themselves. The gradual increase of student responsibility for assessment is aimed at developing students' autonomy as lifelong learners. Assessment should decrease, rather than foster, students' dependence on teachers' comments for direction in learning and on marks for validation of their accomplishments.

Assessment enhances students' metacognition. It helps them make judgments about their own learning, and provides them with information for goal setting and self-monitoring.

Teachers increase students' responsibility for assessment by

- requiring students to select the products and performances to demonstrate their learning
- involving students in developing assessment criteria whenever possible
- involving students in peer assessment, informally through peer conferences and formally using checklists
- having students use tools for reflection and self-assessment at every opportunity (e.g., self-assessment checklists, journals, identification and selection of goals, self-assessment of portfolio items)
- establishing a protocol for students who wish to challenge a teacher-assigned mark (formal appeals are valuable exercises in persuasive writing, and provide opportunities for students to examine their performance in light of the assessment criteria)

Effective Assessment Is Focused on What Students Have Learned and Can Do

Assessment must be equitable; it must offer opportunities for success to every student. Effective assessment demonstrates the knowledge, skills and strategies, and attitudes of each student and the progress the student is making, rather than simply identifying deficits in learning.

To assess what students have learned and can do, teachers need to use a variety of strategies and approaches, such as the following:

- Use a wide range of instruments to assess the multi-dimensional expressions of each student's learning, avoiding reliance upon rote recall or memorization.
- Provide students with opportunities to learn from feedback and to refine their work, recognizing that not every assignment will be successful, nor will it become part of a summative evaluation.
- Examine several pieces of student work in assessing any particular learning outcome to ensure that data collected are valid bases for making generalizations about student learning.
- Develop complete student profiles by using information from both learning outcome-referenced assessment, which compares a student's performance to predetermined criteria, and self-referenced assessment, which compares a student's performance to her or his prior performance.
- Avoid using assessment for purposes of discipline or classroom control. Ryan, Connell, and Deci found that assessment that is perceived as a tool for controlling student behaviour, meting out rewards and punishments rather than providing feedback on student learning, reduces student motivation.

At times, a common practice was to assign a mark of zero for incomplete student work. However, averaging a zero into the student's mark means the mark no longer communicates accurate information about the student's achievement of science learning outcomes. Unfinished assignments signal personal or motivational problems that need to be addressed in appropriate and alternative ways.

- Allow students, when appropriate and possible, to choose how they will demonstrate their competence.
- Use assessment tools appropriate for assessing individual and unique products, processes, and performances.

For more information regarding assessment, consult *Rethinking Classroom Assessment with Purpose in Mind: Assessment for Learning, Assessment as Learning, Assessment of Learning* and *Communicating Student Learning: Guidelines for Schools* (Manitoba Education, Citizenship and Youth).

NOTES

SECTION 3: DOCUMENT ORGANIZATION

DOCUMENT ORGANIZATION

Document Organization and Format

The suggestions for instruction and assessment contained within *Grade 11 Biology: A Foundation for Implementation* provide teachers with strategies for assisting students in achieving the general and specific learning outcomes identified for this curriculum. The instructional and assessment suggestions offer teachers a range of strategies from which to select appropriate directions with students. Although they are not prescriptive, the strategies presented can be considered starting points from which teachers can include their own initiatives, style, and effective techniques to foster learning.

The topic-related appendices (found at the end of each unit) and the general appendices (found at the end of this document) provide additional information on student learning activities, teacher support materials related to instruction and assessment, and a variety of assessment rubrics. These complementary resources are closely linked to the specific learning outcomes and to the skills and attitudes outcomes, and are designed to support, facilitate, and enhance student learning.

At-a-glance listings of the general learning outcomes, skills and attitudes outcomes, and specific learning outcomes for Grade 11 Biology are provided in Appendix 12.

Guide to Reading the Learning Outcomes and the Document Format

The specific learning outcomes identified for Grade 11 Biology are organized according to six units:

- Unit 1: Wellness and Homeostasis
- Unit 2: Digestion and Nutrition
- Unit 3: Transportation and Respiration
- Unit 4: Excretion and Waste Management
- Unit 5: Protection and Control
- Unit 6: Wellness and Homeostatic Changes

The suggested strategies for implementing the curricular outcomes within each biology unit include the following components:

- **Specific Learning Outcomes (SLOs):** The SLOs, identified at the top of each page within the units, outline the intended learning to be achieved by the student by the end of the course. They include the SLOs related to the particular biology topic, in addition to the learning outcomes related to Cluster 0: Skills and Attitudes, selected to correspond to the Suggestions for Instruction.

- **General Learning Outcome (GLO) Connections:** The GLOs, found in Appendix 12, provide links across the entire scope of the Kindergarten to Grade 12 continuum of learning in science. These GLOs provide connections to the Five Foundations for Scientific Literacy that guide all Manitoba science curricula in all science discipline areas.

- **Suggestions for Instruction:** The instructional strategies relate directly to the achievement of the identified SLOs. In each unit, SLOs may be grouped into related topics.
- **Entry-Level Knowledge:** Students will have prior knowledge in relation to some learning outcomes. Identification of students' entry-level knowledge, where included, links teachers to key areas of the science curriculum from previous years, providing information about where students should be in relation to the present learning outcomes.
- **Background Information:** These notes provide teachers with content background (often beyond what the students are required to know) related to the identified leaning outcomes.
- **Activate:** By activating students' prior knowledge of a topic, teachers can recognize gaps and misconceptions in student knowledge and adjust their instruction appropriately, stimulate student curiosity and initiate the inquiry process, and help students relate new information, skills, and strategies to what they already know and can do. Suggested activating strategies are provided for all groupings of SLOs.
- **Acquire/Apply:** These instructional strategies are designed to assist students in processing, integrating, and consolidating their learning. The examples of teacher-facilitated acquiring and applying strategies presented in this document are designed to be student-centred, engaging the learner directly in some contextual way. The skills linked to the suggested acquiring and applying strategies are provided as well.
- **Teacher Notes:** These notes, incorporated throughout the document, provide teachers with planning hints, cautions, and information on the depth of treatment of certain issues related to the identified learning outcomes.
- **Suggestions for Assessment:** These suggestions offer strategies for assessing students' achievement of the SLOs. As wellness is a major theme throughout the course, a recommended tool to help students explore this theme is the development of a Wellness Portfolio. A number of other assessment tools in a variety of formats are suggested in addition to the portfolio assignments.
- **Resource Links:** The links to websites suggested within the units are intended to provide additional resources to support student learning. They include the websites listed on the following pages.

Note: These websites were accessed in July 2010. Any websites referenced in this document are subject to change. If the sites become inactive, please use a search engine to locate the online resources.

In addition to suggesting online resources, this document refers to various print resources, including the following:

Manitoba Education and Transplant Manitoba. *Life Is a Gift: A Manitoba Grade 11 Biology Resource for Organ Donation and Transplantation.* Winnipeg, MB: Manitoba Education, 2010.

Resource Links

AllRefer Health. "Sickle Cell Anemia." *Diseases & Conditions*. <http://health.allrefer.com/health/sickle-cell-anemia-red-blood-cells-normal.html>.

Berkeley Lab. "The Virtual Frog Dissection Kit." *Computer-Enhanced Science Education: The Whole Frog Project.* <http://froggy.lbl.gov/>.

Burger King Canada. *Menu & Nutrition*. <www.bk.com/en/us/menu-nutrition/full-menu.html>.

Canadian Blood Services. Home Page. <www.bloodservices.ca/>.

Canadian Diabetes Association. Home Page. <www.diabetes.ca/>.

Canadian Fitness and Lifestyle Research Institute. Home Page. <www.cflri.ca/eng>.

Cells Alive. Home Page. <www.cellsalive.com/>.

Dietitians of Canada. "Let's Make a Meal!" *Eat Well, Live Well.* <www.dietitians.ca/public/content/eat_well_live_well/english/menuplanner/overview.asp>.

ECG Library. Home Page. <www.ecglibrary.com/>.

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Fleck, Earl W. "Virtual Pig Dissection." Whitman College Biology Department. <www.whitman.edu/biology/vpd/>.

Health Canada. *Eating Well with Canada's Food Guide*. Ottawa, ON: Health Canada, 2007. Available online at <www.hc-sc.gc.ca/fn-an/food-guide-aliment/index-eng.php>.

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Heart and Stroke Foundation. Home Page. <www.heartandstroke.com/>.

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———. "Statistics." *News.* <www.heartandstroke.com/site/c.ikIQLcMWJtE/b.3483991/k.34A8/Statistics.htm>

Howard Hughes Medical Institute (HHMI). "The Visible Heart." *Cardiovascular: Animations.* <www.hhmi.org/biointeractive/cardiovascular/animations.html>.

International Society for Mountain Medicine. Home Page. <www.ismmed.org>.

Kent State University. "Criteria for Evaluating Web Resources." 22 Mar. 2006. *University Libraries.* <www.library.kent.edu/page/10475>.

The Lung Association, Manitoba. Home Page. <www.mb.lung.ca/>.

———. "Resource Links." *Occupational Lung Monitoring Program.* <www.mb.lung.ca/index.php?pageid=49>.

Manitoba Education. "Bibliographies." *Learning Resources.* <www.edu.gov.mb.ca/k12/learnres/bibliographies.html>.

———. *Information Communication Technology (ICT): Kindergarten to Grade 12.* <www.edu.gov.mb.ca/k12/tech/index.html>.

———. "Professional Learning for Teachers." *Literacy with ICT Across the Curriculum: A Developmental Continuum.* <www.edu.gov.mb.ca/k12/tech/lict/let_me_try/le_teachers.html>.

Manitoba Education and Training. *Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators.* Winnipeg, MB: Manitoba Education and Training, 2000. Available online at <www.edu.gov.mb.ca/k12/docs/support/future/>.

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Manitoba Healthy Living, Youth and Seniors. Home Page. <www.gov.mb.ca/healthyliving/index.html>.

McDonald's Canada. *Nutrition Calculator.* <www.mcdonalds.ca/NutritionCalculator/index_en.html>.

The National Center for Case Study Teaching in Science. *Case Collection.* <http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>.

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SUBWAY. *Nutrition Information.* <www.subway.com/applications/nutritioninfo/index.aspx>.

Timiskaming Health Unit. *Blood Pressure Quiz: Know Your Blood Pressure by Heart.* 27 Aug. 2007. <www.timiskaminghu.com/content.asp?navID=116&parentID=115&lang=en>.

University at Buffalo. *The National Center for Case Study Teaching in Science Case Collection.* <http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>.

University of Manitoba. "Dr. Gordon Giesbrecht." *Health, Leisure, and Human Performance Research Institute.* <http://umanitoba.ca/faculties/physed/research/people/giesbrecht> and <http://umanitoba.ca/faculties/kinrec/research/people/giesbrecht.html>.

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WebQuest.Org. Home Page. <http://webquest.org/>.

Wendy's Canada. *Nutrition Information.* <www.wendys.com/food/pdf/ca/nutrition.pdf>.

Wiley. "Interactive Animations." *Interactive Concepts in Biochemistry*. 2002. <www.wiley.com/legacy/college/boyer/0470003790/animations/animations.htm>.

Sample Two-Page Layout

The following clarification on reading the document format is based on a sample two-page layout from *Grade 11 Biology: A Foundation for Implementation*.

Indicates the biology topic.

Specific learning outcome (SLO) statements define what students are expected to achieve by the end of Grade 11 Biology.

The first alpha-numeric code indicates course (Grade 11 Biology); second digit indicates topic number; and third digit(s) indicate(s) specific learning outcome number.

Suggestions for student learning experiences relate directly to the attainment of the specific learning outcome(s).

Include: Indicates a mandatory component of the specific learning outcome, or a defined set of limitations. (These specific learning outcomes do not contain this component.)

Examples: Provide ideas of what could be included (non-mandatory).

Notes provide teachers with background information, definitions, planning hints, special-interest material, and information on depth of treatment of certain issues. Safety information and cautions are included.

Grade 11 Biology • *Unit 1: Wellness and Homeostasis*

Personal Wellness

Specific Learning Outcomes

B11-1-01: Increase awareness of personal wellness, as well as personal and family health history. (GLO: B3)

B11-1-02: Develop a personal wellness plan. (GLOs: B3, B5)

B11-1-03: Recognize how individual wellness choices affect others. (GLOs: B3, B5)

Examples: community, family...

SLO: B11-1-01
SLO: B11-1-02
SLO: B11-1-03

Suggestions for Instruction

Teacher Note

The instructional strategies suggested in this document follow the constructivist model of learning and are organized into two groups: activate and acquire/apply. By activating students' prior knowledge of a topic, teachers can

- help students relate new information, skills, and strategies to what they already know and can do
- recognize misconceptions and gaps in student knowledge
- stimulate curiosity and initiate the inquiry process

Acquiring and applying strategies are designed to assist students in processing, integrating, and consolidating their learning.

Wellness Portfolio

Wellness is a major theme in Grade 11 Biology. A recommended students explore this theme is the creation of a Wellness Portfol their portfolios, students personalize the human body content i Biology programming. The intent is to have students learn more medical histories and how their body works, to collect data on h performing, to analyze how well they are taking care of themsel decisions about their own lifestyle to promote their wellness.

This portfolio has a number of possible assignments in a variety matched up to an appropriate section of the course. Appendix 1.1: Wellness Portfolio Overview provides a summary of possible Wellness Portfolio activities or assignments. Additional assignments can be added by the teacher.

All students should complete Appendix 1.2: Wellness Checkup (BLM). Other work could be teacher assigned, a combination of teacher assigned and student selected, or all student selected.

The Wellness Portfolio activities and assignments are referenced throughout this document and can be identified by the following graphic:

WP

4 – Wellness and Homeostasis

Skills and attitudes learning outcomes define expectations across all topics in Grade 11 Biology.

GRADE 11 BIOLOGY • *Unit 1: Wellness and Homeostasis*

SKILLS AND ATTITUDES OUTCOMES

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)
Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Code refers to skills and attitudes learning outcome(s).

ACTIVATE

Wellness Checkup

As an introduction to some of the factors that influence wellness, have students complete Appendix 1.2: Wellness Checkup (BLM).

ACQUIRE/APPLY

Once Upon a Time—Microtheme (I4)

Suggested strategies relate directly to assessing student achievement of the specific learning outcome(s).

Microthemes are short writing assignments designed to help students learn the material by looking at it in a different way (Martin). Refer to Appendix 1.3A: Microthemes (Teacher Background) for more information on microthemes, including assessment approaches.

Provide students with the following microtheme assignment:

> **Microtheme**
> Remember a time when you broke your leg sliding into home plate, or how itchy you were that summer vacation when you broke out in chicken pox? What illnesses or injuries have you experienced? Choose one of these incidents to write about. Imagine that you are now a grandparent invited to your grandson's Kindergarten class to talk to students about that illness or injury. Write down what you would tell them. Be sure to include what happened, how you were diagnosed and treated, whether you visited the hospital, and so on. Your account can be dramatic, but it must also be factual.
>
> Option: If you suffer from a chronic disease, you may choose to write about that.

Resource

Resource links indicate the titles, authors, and page references (or URLs) where SLO-related content is treated within the various learning resources.

Life Is a Gift: A Manitoba Grade 11 Biology Resource for Organ Donation and Transplantation (Manitoba Education and Transplant Manitoba) provides a context in which to incorporate the science and issues surrounding organ donation into teaching and learning in each of the six units of the Grade 11 Biology curriculum.

See Organs and Tissues Available for Transplant Lesson Plan in *Life Is a Gift* for learning activities linked to Unit 1: Wellness and Homeostasis.

Suggestion for Assessment

Refer to Appendix 1.3B: Microthemes—First Draft Checklist (BLM) and Appendix 1.3C: Microthemes—Final Draft Assessment (BLM) for assessment tools.

Wellness and Homeostasis – 5

NOTES

Unit 1: Wellness and Homeostasis

Unit 1: Wellness and Homeostasis

Specific Learning Outcomes

B11-1-01: Increase awareness of personal wellness, as well as personal and family health history. (GLO: B3)

B11-1-02: Develop a personal wellness plan. (GLOs: B3, B5)

B11-1-03: Recognize how individual wellness choices affect others. (GLOs: B3, B5)

Examples: community, family...

B11-1-04: Describe how the body attempts to maintain an internal balance called homeostasis, recognizing that the conditions in which life processes can occur are limited. (GLOs: D1, E2, E3)

Include: thermoregulation (maintenance of body temperature), osmoregulation (water balance), and waste management

B11-1-05: Explain the principle of negative feedback and identify how the body stabilizes systems against excessive change. (GLOs: D1, E2, E3)

Include: role of receptors and effectors

B11-1-06: Identify life processes that individual cells, as well as complex organisms, need to manage. (GLOs: D1, E1)

Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, and transport substances

B11-1-07: Explain how cell membranes regulate movement of materials into and out of cells, and recognize the importance of this regulation in managing life processes and maintaining homeostasis. (GLOs: D1, E2, E3)

Include: passive transport, active transport, and endo/exocytosis

B11-1-08: Identify factors that influence movement of substances across a membrane, recognizing that movement of these substances is important for the internal balance of the cell. (GLOs: D1, E2, E3)

Examples: size of molecule, concentration gradient, temperature, polarity of molecule, surface area…

B11-1-09: Explain the role of energy in maintaining an internal balance in the cell. (GLOs: D1, D4, E4)

Include: role of adenosine triphosphate (ATP) in metabolism

PERSONAL WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-1-01: Increase awareness of personal wellness, as well as personal and family health history. (GLO: B3)

B11-1-02: Develop a personal wellness plan. (GLOs: B3, B5)

B11-1-03: Recognize how individual wellness choices affect others. (GLOs: B3, B5)

Examples: community, family...

SLO: B11-1-01
SLO: B11-1-02
SLO: B11-1-03

SUGGESTIONS FOR INSTRUCTION

TEACHER NOTE

The instructional strategies suggested in this document follow the constructivist model of learning and are organized into two groups: activate and acquire/apply. By activating students' prior knowledge of a topic, teachers can

- help students relate new information, skills, and strategies to what they already know and can do
- recognize misconceptions and gaps in student knowledge
- stimulate curiosity and initiate the inquiry process

Acquiring and applying strategies are designed to assist students in processing, integrating, and consolidating their learning.

Wellness Portfolio

Wellness is a major theme in Grade 11 Biology. A recommended tool to help students explore this theme is the creation of a Wellness Portfolio. By completing their portfolios, students personalize the human body content in the Grade 11 Biology programming. The intent is to have students learn more about their medical histories and how their body works, to collect data on how their body is performing, to analyze how well they are taking care of themselves, and to make decisions about their own lifestyle to promote their wellness.

This portfolio has a number of possible assignments in a variety of formats. Each is matched up to an appropriate section of the course. Appendix 1.1: Wellness Portfolio Overview provides a summary of possible Wellness Portfolio activities or assignments. Additional assignments can be added by the teacher.

All students should complete Appendix 1.2: Wellness Checkup (BLM). Other work could be teacher assigned, a combination of teacher assigned and student selected, or all student selected.

The Wellness Portfolio activities and assignments are referenced throughout this document and can be identified by the following graphic:

SKILLS AND ATTITUDES OUTCOMES

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)
Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

ACTIVATE

Wellness Checkup

As an introduction to some of the factors that influence wellness, have students complete Appendix 1.2: Wellness Checkup (BLM).

ACQUIRE/APPLY

Once Upon a Time—Microtheme (I4)

Microthemes are short writing assignments designed to help students learn the material by looking at it in a different way (Martin). Refer to Appendix 1.3A: Microthemes (Teacher Background) for more information on microthemes, including assessment approaches.

Provide students with the following microtheme assignment:

Microtheme
Remember a time when you broke your leg sliding into home plate, or how itchy you were that summer vacation when you broke out in chicken pox? What illnesses or injuries have you experienced? Choose one of these incidents to write about. Imagine that you are now a grandparent invited to your grandson's Kindergarten class to talk to students about that illness or injury. Write down what you would tell them. Be sure to include what happened, how you were diagnosed and treated, whether you visited the hospital, and so on. Your account can be dramatic, but it must also be factual.

Option: If you suffer from a chronic disease, you may choose to write about that.

Resource

Life Is a Gift: A Manitoba Grade 11 Biology Resource for Organ Donation and Transplantation (Manitoba Education and Transplant Manitoba) provides a context in which to incorporate the science and issues surrounding organ donation into teaching and learning in each of the six units of the Grade 11 Biology curriculum.

See Organs and Tissues Available for Transplant Lesson Plan in *Life Is a Gift* for learning activities linked to Unit 1: Wellness and Homeostasis.

Suggestion for Assessment

Refer to Appendix 1.3B: Microthemes—First Draft Checklist (BLM) and Appendix 1.3C: Microthemes—Final Draft Assessment (BLM) for assessment tools.

PERSONAL WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-1-01: Increase awareness of personal wellness, as well as personal and family health history. (GLO: B3)

B11-1-02: Develop a personal wellness plan. (GLOs: B3, B5)

B11-1-03: Recognize how individual wellness choices affect others. (GLOs: B3, B5)

Examples: community, family...

Family Medical History (P2, I1, I4)

Have students conduct research on their family members (immediate and distant) to create a family medical history. Refer to Appendix 1.4: Family Medical History (BLM) for student instructions.

Diseases identified by the individuals in the class can form the basis for research projects that will take place later in the course.

Cautionary Note: While this learning activity provides a tremendous opportunity for students to connect with family members and learn medical information that might prove important to them, teachers will need to be sensitive with regard to students who may not be able to contact family members (e.g., adopted students). An alternative Wellness Portfolio activity could be substituted for anyone not comfortable with this assignment.

Suggestion for Assessment

A sample rubric is provided below. It should be modified, with student input.

Family Medical History Assessment		
1. Interview notes a) indicated individual interviewed, date of interview, and relationship to the student	0 — not done 1 — poor 2 — some information but disorganized or incomplete 3 — lots of information, organized and complete but for one interview only 4 — two excellent interviews	Weighting x 2 = /8
2. Pedigree a) used proper format to indicate relationships b) listed birth and death rates c) listed conditions d) listed cause of death	0 — not done 1 — met one criterion 2 — met two criteria 3 — met three criteria 4 — met four criteria	x 3 = /12
Total		/ 20

Skills and Attitudes Outcomes

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)
Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Alternative: Because of the sensitive nature of this information, this assignment can be ungraded or marked as pass or fail. Another approach for a student or family reluctant to submit sensitive information is to have a parent/guardian* verify that the assignment was completed and not hand in any content to the teacher.

Personal Wellness Reflection (P2)

Have students carry out a Focused Free Writing activity by writing a reflection on personal wellness. The following questions can be used to stimulate thinking:

- What is wellness?
- What is my current level of wellness or health?
- What things do people do to promote wellness?
- What other things could I do to improve my own health?
- How do my personal choices relate to my own health?
- How do they affect others around me (e.g., family, community)?

For more information on Focused Free Writing activities, refer to *Senior Years Science Teachers' Handbook* (Manitoba Education and Training, pp. 13.8–13.13)—hereafter referred to as *SYSTH*.

Throughout Grade 11 Biology, students will be learning more about wellness, culminating with the development of personal wellness goals at the end of the course. Teachers may choose to provide students with the following definition of wellness (or have students create their own).

Definition of Wellness
Wellness is not the same as health. *Health* generally refers only to the physical well-being of an individual, whereas *wellness* refers to the multi-dimensional interrelationship between the physical, emotional, spiritual, intellectual, interpersonal or social, and environmental aspects of life.

* In this document, the term *parents* refers to both parents and guardians, and is used with the recognition that in some cases only one parent may be involved in a child's education.

PERSONAL WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-1-01: Increase awareness of personal wellness, as well as personal and family health history. (GLO: B3)

B11-1-02: Develop a personal wellness plan. (GLOs: B3, B5)

B11-1-03: Recognize how individual wellness choices affect others. (GLOs: B3, B5)

Examples: community, family...

Suggestion for Assessment

This type of Focused Free Writing activity is an opportunity to enter into a dialogue with students. The teacher can respond to what the student wrote with a question, comment, sharing of a personal experience, and so on. A journal or notebook can be used to collect this type of reflective writing and can be assessed periodically. Criteria for assessment at that point might include the following:

- follows guidelines
- relates material to own experiences or expresses opinion of content
- responds critically and reflectively, showing growth and increased understanding of content

Skills and Attitudes Outcomes

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)
Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Notes

INTRODUCTION TO HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-1-04: Describe how the body attempts to maintain an internal balance called homeostasis, recognizing that the conditions in which life processes can occur are limited.
(GLOs: D1, E2, E3)

Include: thermoregulation (maintenance of body temperature), osmoregulation (water balance), and waste management

B11-1-05: Explain the principle of negative feedback and identify how the body stabilizes systems against excessive change.
(GLOs: D1, E2, E3)

Include: role of receptors and effectors

SLO: B11-1-04
SLO: B11-1-05

SUGGESTIONS FOR INSTRUCTION

BACKGROUND INFORMATION

Dr. Gordon Giesbrecht, a professor at the University of Manitoba, has operated a Laboratory for Exercise and Environmental Medicine, where he studied human responses to exercise/work in extreme environments. He has conducted hundreds of cold-water immersion studies that have provided valuable information about cold stress physiology and pre-hospital care for human hypothermia.

Resource Link

Visit the following website for more information:

- University of Manitoba. "Dr. Gordon Giesbrecht." <www.umanitoba.ca/faculties/physed/research/people/giesbrecht/>.

ENTRY-LEVEL KNOWLEDGE

In Grade 8, students studied body systems, what happens when systems are not functioning properly, and the interrelatedness of systems.

ACTIVATE

How Do You Feel?—Class Discussion

Have students describe some of the things they notice happening with their bodies when they are not feeling well (e.g., running a temperature, shivering, sweating, being thirsty). This discussion can be expanded to include more long-term signs of ill health, such as blood pressure and heart rate. Have students try to identify some of the more common "normals" the body attempts to maintain, such as core body temperature and blood pressure.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)
Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)
Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

ACQUIRE/APPLY

Word Splash (U1, U2)

Have students use a Word Splash (Saphier and Haley) to obtain information about homeostasis. Provide each group of students with Appendix 1.5A: Word Splash—Homeostasis (BLM). Have students predict and record thought/concept connections among the words on the BLM. This can be done by drawing lines to connect the words (two or more) and writing on the line the connections. Or, students may choose to write statements that show the connections between words.

Following this learning activity, have students read Appendix 1.5B: Homeostasis—Background Information (BLM) and verify their predictions.

Suggestion for Assessment

Have students use a Concept Organizer Frame such as the Concept Frame or the Concept Overview to summarize learning related to the concept of homeostasis. The type of concept frame used can be determined by the teacher or by individual students. Some students may prefer to use one frame over another. The frames can be handed in and feedback provided by the teacher. As this is intended as a formative assessment to check student understanding, a mark for this learning activity is not required.

INTRODUCTION TO HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-1-04: Describe how the body attempts to maintain an internal balance called homeostasis, recognizing that the conditions in which life processes can occur are limited. (GLOs: D1, E2, E3)

Include: thermoregulation (maintenance of body temperature), osmoregulation (water balance), and waste management

B11-1-05: Explain the principle of negative feedback and identify how the body stabilizes systems against excessive change. (GLOs: D1, E2, E3)

Include: role of receptors and effectors

A summary of the categories used for each frame is provided below. For more details and blackline masters, refer to *SYSTH* (pp. 11.23–11.24, 11.36–11.37).

Concept Frame	Concept Overview
• Concept • Characteristics • Examples • What is it like? • What is it unlike? • Definition • Illustration	• Keyword or concept • Figurative representation • Explanation or definition in own words • Facts • Create questions about the concept • Create an analogy

Negative Feedback (G1, G2, U1)

Have students reread the "A Cold Walk" section of Appendix 1.5B: Homeostasis—Background Information (BLM) and, in small groups, use Appendix 1.6: Negative Feedback Mechanisms (BLM) to describe what is happening to the body. Students will need to use a different BLM for each portion of the story. See the following example.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

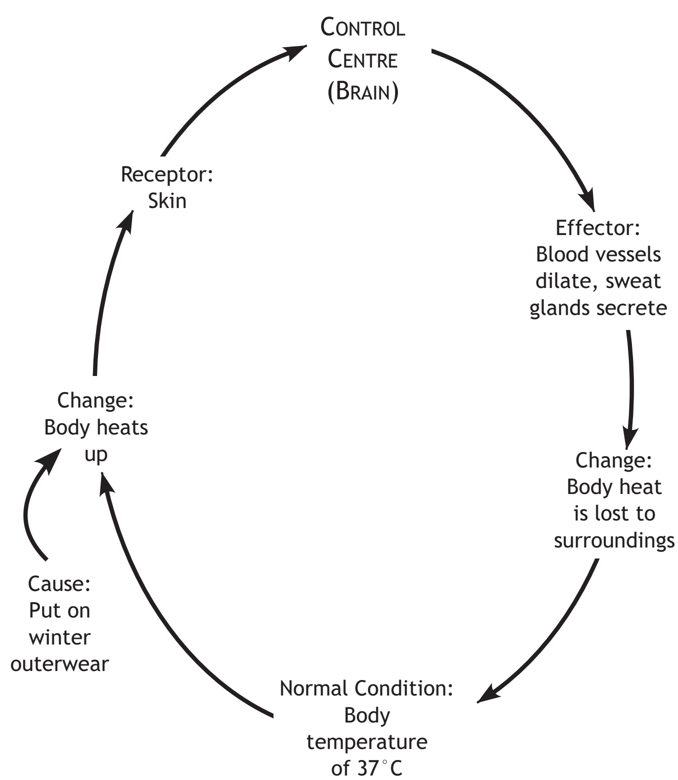
B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Example:



Suggestion for Assessment

Have each group meet with another group to compare their results. Any discrepancies should be discussed and a consensus reached. Each pair of groups can then share any problem areas they encountered and what their final consensus was.

INTRODUCTION TO HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-1-04: Describe how the body attempts to maintain an internal balance called homeostasis, recognizing that the conditions in which life processes can occur are limited. (GLOs: D1, E2, E3)

Include: thermoregulation (maintenance of body temperature), osmoregulation (water balance), and waste management

B11-1-05: Explain the principle of negative feedback and identify how the body stabilizes systems against excessive change. (GLOs: D1, E2, E3)

Include: role of receptors and effectors

Case Study (G1, G2, G3, I4, U2)

Analysis of the case study Appendix 1.7: The Swimming Race allows students to apply what they have been learning about homeostasis.

Suggestions for Assessment

There are a variety of possible assessment focuses for this learning activity.

- Group-work skills can be assessed by the teacher, using observation during the activity.
- Group-work skills can be self-assessed and assessed by peers following the activity.
- The summary can be assessed for both content and effectiveness of communication/presentation. Criteria for assessment should be determined in conjunction with students.
- Students can be asked to demonstrate their understanding of how the body strives to maintain homeostasis by providing their own example. This learning activity could be given to the students one day, and the response could be written individually on another day. This would allow time for research and discussion, with the students ultimately being asked to respond to the question individually.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Notes

Cells and Homeostasis

Specific Learning Outcomes

B11-1-06: Identify life processes that individual cells, as well as complex organisms, need to manage. (GLOs: D1, E1)

Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, and transport substances

B11-1-07: Explain how cell membranes regulate movement of materials into and out of cells, and recognize the importance of this regulation in managing life processes and maintaining homeostasis. (GLOs: D1, E2, E3)

Include: passive transport, active transport, and endo/exocytosis

B11-1-08: Identify factors that influence movement of substances across a membrane, recognizing that movement of these substances is important for the internal balance of the cell. (GLOs: D1, E2, E3)

Examples: size of molecule, concentration gradient, temperature, polarity of molecule, surface area…

SLO: B11-1-06
SLO: B11-1-07
SLO: B11-1-08

Suggestions for Instruction

Entry-Level Knowledge

In Grade 8, students were exposed to the characteristics of living things using the five common characteristics:

- single or multicellular
- reproduce
- grow and develop
- obtain and use energy
- respond to the environment

In Grade 11, this concept should be briefly revisited, with the major learning related to the fact that cells must also manage these same life processes.

In Grade 8, students conducted investigations on the movement of nutrients and wastes across cell membranes, were introduced to the terms *osmosis* and *diffusion*, and explained the importance of transport (SLO 8-1-07). In Grade 11, students are expected to explain the transport of materials across a cell membrane in greater detail.

Teacher Note

Throughout the investigations in this section, emphasize for students that the cell membrane is chiefly responsible for maintaining a balance inside a living cell using different methods to transport molecules in and out of the cell. Too much water can make a cell burst. Too many wastes inside a cell can poison it. The cell cannot tolerate any great variation in conditions. Students may be exposed to the fluid mosaic model in developing their explanations for how substances are transported in and out of the cell, but an in-depth knowledge of this model is not required. It is not necessary to give detailed descriptions of specific protein action in facilitated

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S1: State a testable hypothesis or prediction based on background knowledge or on observed events. (GLO: C2)

B11-0-S2: Plan an experiment to answer a specific scientific question. (GLOs: C1, C2)

Include: materials; independent, dependent, and controlled variables; methods; and safety considerations

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

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diffusion and active transport. A general understanding of the important role of proteins in movement of substances across a membrane is sufficient.

ACTIVATE

Life Processes

Provide students with the following:

Life Processes
Complex organisms need to carry out the following life processes:

- Obtain food.
- Convert energy.
- Eliminate wastes.
- Reproduce.
- Grow and repair.
- Transport substances.

Which of these life processes must also be carried out by individual cells? Justify your answer.

CELLS AND HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-1-06: Identify life processes that individual cells, as well as complex organisms, need to manage. (GLOs: D1, E1)

Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, and transport substances

B11-1-07: Explain how cell membranes regulate movement of materials into and out of cells, and recognize the importance of this regulation in managing life processes and maintaining homeostasis. (GLOs: D1, E2, E3)

Include: passive transport, active transport, and endo/exocytosis

B11-1-08: Identify factors that influence movement of substances across a membrane, recognizing that movement of these substances is important for the internal balance of the cell. (GLOs: D1, E2, E3)

Examples: size of molecule, concentration gradient, temperature, polarity of molecule, surface area…

What Happened?

The following question can be answered by students working individually or in small groups:

What Happened to the Egg?

Place some eggs in vinegar and soak them overnight to dissolve their shell. Give two eggs to each group of students. Have them place one egg in distilled water and one egg in a salt solution. Ask students to compare the eggs at the end of the class as well as on the following day, and have them explain any differences they observe.

Students should see the egg in the distilled water is enlarged, while the egg in the salt solution is shrunken. Lead a class discussion to encourage students to link the explanation for why this happened to what they remember about osmosis and diffusion.

ACQUIRE/APPLY

Transport Mechanisms—Direct Instruction (U1)

Illustrate passive transport, active transport, and endo/exocytosis for students, by using tools such as overheads, labelled diagrams, 3-D paper models, and video and computer animations. Use a note-taking strategy (i.e., the 10 + 2 strategy) where the teacher presents the information on each transport mechanism for 10 minutes, and students have two minutes to summarize the material.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S1: State a testable hypothesis or prediction based on background knowledge or on observed events. (GLO: C2)

B11-0-S2: Plan an experiment to answer a specific scientific question. (GLOs: C1, C2)

Include: materials; independent, dependent, and controlled variables; methods; and safety considerations

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

Laboratory Activities (P1, S1, S2, S3, S4, S6, S8)

Have students investigate factors that influence the movement of substances across a membrane by completing one or more of the labs that follow.

- Appendix 1.9A: Investigating the Movement of Starch, Iodine, and Glucose—Student Handout (BLM) and Appendix 1.9B: Investigating the Movement of Starch, Iodine, and Glucose (Teacher Background). This lab addresses the effect of the size of a molecule on movement across a membrane.
- Appendix 1.10A: Cell Size and Diffusion—Student Handout (BLM) and Appendix 1.10B: Cell Size and Diffusion (Teacher Background). This lab addresses the effect of surface area on movement across a membrane.
- Appendix 1.11A: Effects of Osmosis on Living Tissue—Student Handout (BLM) and Appendix 1.11B: Effects of Osmosis on Living Tissue (Teacher Background). This lab addresses the effect of concentration gradient on movement across a membrane.
- Appendix 1.12A: Concentration and Diffusion—Student Handout (BLM) and Appendix 1.12B: Concentration and Diffusion (Teacher Background). This is a student-designed lab where students choose to investigate either the distance a substance travels or the time it takes to travel a given distance.

CELLS AND HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-1-06: Identify life processes that individual cells, as well as complex organisms, need to manage. (GLOs: D1, E1)

Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, and transport substances

B11-1-07: Explain how cell membranes regulate movement of materials into and out of cells, and recognize the importance of this regulation in managing life processes and maintaining homeostasis. (GLOs: D1, E2, E3)

Include: passive transport, active transport, and endo/exocytosis

B11-1-08: Identify factors that influence movement of substances across a membrane, recognizing that movement of these substances is important for the internal balance of the cell. (GLOs: D1, E2, E3)

Examples: size of molecule, concentration gradient, temperature, polarity of molecule, surface area…

Notes:

- Additional labs may be done to address other factors.
- It is recommended that all students complete Appendix 1.12A: Concentration and Diffusion—Student Handout (BLM). This is a student-designed lab providing an opportunity for students to develop scientific inquiry skills. This lab will be referred to in Unit 3 when students design another investigation.

Suggestions for Assessment

- Refer to Appendix 1.8: Student Lab Skills (Teacher Background) for information on assessing and evaluating student lab skills.
- Refer to Appendix 1.13A: Lab Skills Checklist—General Skills (BLM) and to Appendix 1.13B: Lab Skills Checklist—Thinking Skills (BLM).
- In order to have students apply their learning about osmosis and diffusion, ask them to respond to the following questions:
  - — Why are you thirsty after eating a bag of potato chips?
  - — Why is the grass dead on the side of the road in the spring?
  - — Why do your toes and fingers wrinkle in the bath?

Student responses can be used as a formative assessment to determine the level of student understanding of osmosis and diffusion and to guide further teaching/activity selection (if needed).

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S1: State a testable hypothesis or prediction based on background knowledge or on observed events. (GLO: C2)

B11-0-S2: Plan an experiment to answer a specific scientific question. (GLOs: C1, C2)

Include: materials; independent, dependent, and controlled variables; methods; and safety considerations

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

Analogy (U2)

Review the concept of an analogy and then have students explain the following analogy to describe how the cell membrane functions.

A cell is like a prison.

Endocytosis Investigation (S3, S4, S5, S6)

The *Amoeba proteus* is a larger protozoan. Students can observe these organisms digesting coloured starch granules through endocytosis.

Note: Cultures of *Amoeba proteus* can be purchased from a biological supply company. Place the *Amoeba* into a petri dish. Make a solution of starch, distilled water, and a few drops of blue food colouring. Add a few drops of the food colouring to the petri dish. Leave the *Amoeba* in this solution for a few minutes before students place it on a slide. Use a microscope to observe the *Amoeba* digesting the blue starch granules. At the end of the lab the solution can be safely disposed of down the sink.

Students record their observations by drawing and describing what they saw and relate this to what they know about cell membranes.

CELLS AND HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-1-06: Identify life processes that individual cells, as well as complex organisms, need to manage. (GLOs: D1, E1)

Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, and transport substances

B11-1-07: Explain how cell membranes regulate movement of materials into and out of cells, and recognize the importance of this regulation in managing life processes and maintaining homeostasis. (GLOs: D1, E2, E3)

Include: passive transport, active transport, and endo/exocytosis

B11-1-08: Identify factors that influence movement of substances across a membrane, recognizing that movement of these substances is important for the internal balance of the cell. (GLOs: D1, E2, E3)

Examples: size of molecule, concentration gradient, temperature, polarity of molecule, surface area…

Note: This lab involves using the microscope and creating a biological drawing. Prior to carrying out this lab, students may need to review proper techniques. Microscope diagrams for this purpose can be found in most biology texts. A blackline master can also be found in *Grades 5 to 8 Science: A Foundation for Implementation* (Manitoba Education and Training, BLM 8–A).

A variety of approaches are commonly used for the creation of biological drawings. One approach can be found in Appendix 1.14A: Biological Drawing (BLM).

Suggestions for Assessment

The focus for assessment of this learning experience can be on two skill areas, as well as on the understanding demonstrated by the students' ability to relate observations to the function of a cell membrane. Specify, in advance, what the focus will be. For tools to assess the skills involved, refer to Appendix 1.14B: Rating Scale for Biological Drawing (BLM) and Appendix 1.15: Microscope Skills Checklist (BLM).

Students can be asked to demonstrate their understanding of movement of substances across a cell membrane with the following:

- Using unlabelled diagrams of active transport, diffusion, and osmosis, identify what each represents and explain what is happening.
- Compare and contrast passive and active transport.
- Draw a Concept Map to illustrate how materials move in and out of a cell.
- Explain why the ability to regulate the movement of materials into and out of the cell is important. (Students should make reference to life processes and homeostasis in their response.)

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S1: State a testable hypothesis or prediction based on background knowledge or on observed events. (GLO: C2)

B11-0-S2: Plan an experiment to answer a specific scientific question. (GLOs: C1, C2)

Include: materials; independent, dependent, and controlled variables; methods; and safety considerations

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

Notes

ENERGY

SPECIFIC LEARNING OUTCOMES

B11-1-09: Explain the role of energy in maintaining an internal balance in the cell. (GLOs: D1, D4, E4)

Include: role of adenosine triphosphate (ATP) in metabolism

SLO: B11-1-09

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

In Grade 7, students compared photosynthesis to cellular respiration. The cellular respiration equations used in this grade is:

$$\text{sugar} + \text{oxygen} \longrightarrow \text{water} + \text{carbon dioxide} + \text{energy}$$

ACTIVATE

Where Does the Energy Come From?

Provide students with the following question:

> We've seen in the previous learning experience that the cell uses energy during active transport. Where does this energy come from?

(Hint: Use the formula for cellular respiration to support your answer).

ACQUIRE/APPLY

ATP and Energy—Direct Instruction

Provide students with more detail on the role of ATP as the mechanism for storing energy. Using simplified diagrams, show the breakdown of macromolecules and the release of ATP. A computer animation could also be used to show the breakdown of macromolecules and ATP release.

Resource Link

A variety of websites can be used to help students learn about difficult concepts. For example, the following website provides a series of animations and games students can use to learn difficult biochemical concepts:

- Wiley. "Interactive Animations." *Interactive Concepts in Biochemistry*. 2002. <www.wiley.com/legacy/college/boyer/0470003790/animations/animations.htm>.

Skills and Attitudes Outcomes

11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Microtheme/Case Study (U2, I4)

Provide students with the following microtheme:

> **Microtheme**
> On your family vacation this summer, you drive into a gas station to fill up. Your younger brother asks where all that gas from the last fill-up went. You explain that it is a fuel that gets converted to another kind of energy to power the car. He replies, "How do we get our power?" Explain this to him by referring to food, ATP, and muscle action.

Suggestion for Assessment

Refer to Appendix 1.3B: Microthemes—First Draft Checklist (BLM) and Appendix 1.3C: Microthemes—Final Draft Assessment.

Creative Presentation (U2, I4)

Have students carry out a performance task to bring together their understanding of the concepts presented in the Cells and Homeostasis portion of this unit. This performance task can take on a variety of forms, and students should be given the opportunity to select which form they wish to use to share their understanding. One example is to have students develop a song (which could be performed) or a poem. Refer to Appendix 1.16: Those Magic Membranes (BLM) for a sample song.

Suggestion for Assessment

Develop assessment criteria with students. The criteria should include both content and presentation components and may be similar, regardless of which presentation form students choose. Each criterion could be assigned a point value, or a simple rating scale can be used (e.g., excellent, good, fair, poor) for each.

Notes

Unit 1:
Wellness and Homeostasis

Appendices

Appendix 1.1: Wellness Portfolio Overview

Unit	Assignment
Unit 1: Wellness and Homeostasis	• Wellness Checkup • Once Upon a Time—Microtheme • Family Medical History • Personal Wellness Reflection
Unit 2: Digestion and Nutrition	• Nutrition Labelling—Information and Learning Activities • What Am I Eating? What Is My Lifestyle? • Creating a Meal
Unit 3: Transportation and Respiration	• Debating an Issue • Exercise and Wellness—Reflective Self-Study
Unit 4: Excretion and Waste Management	• Organ Donation—Reflection
Unit 5: Protection and Control	• Personal Records • Concussions Follow-Up
Unit 6: Wellness and Homeostatic Changes	• Blood Sugar Fluctuations • Two Cumulative Assessments • Science Saves the Day!—Reflection

Appendix 1.2: Wellness Checkup (BLM)

Wellness is more than not being ill. Wellness is having a healthy body, mind, and spirit.

Are you monitoring your wellness? Do so by completing this checklist. Put a check mark (✓) beside each statement that applies to you.

General Information	
	I am aware of diseases that run in my family.
	I know what types of illnesses I have had.
	I can explain the types of diagnostic tests I have had.
	I know what types of treatments I have had.
	I know the story of my birth.
	I spend time with people much younger or much older than I am.
	I have supportive family and friends.
	I like school.
	I am involved in extracurricular or community activities.
	I am a lifelong learner.
	I can cope with stress.
	I laugh easily.
	I know how to relax.
	I sleep well.
	I like myself.
	I consider how my actions will affect others.

Digestion and Nutrition	
	I eat a variety of foods.
	I limit my fast-food intake.
	I choose low-fat items in my daily diet (e.g., low-fat dressing, low-fat milk).
	I include high-fibre foods in my diet (e.g., whole wheat breads, fruit with peel).
	I consume at least seven servings of fruit and vegetables per day.
	I consume at least three servings of milk and alternatives per day (e.g., milk, cheese, yogurt).
	I consume at least six servings of grain products per day (e.g., toast, cereal, pasta).
	I consume at least two servings of meat and alternatives per day (e.g., meat, eggs, peanut butter).
	I know what a single serving size is for most food items.
	I limit my junk food intake.

(continued)

Digestion and Nutrition (continued)	
	I taste my food before I add salt.
	I limit my salt intake.
	I limit my sugar intake.
	I make sure that I get enough iron and calcium in my diet.
	I don't drink alcohol.
	I don't go on fad diets.

Transportation and Respiration	
	I maintain a healthy body weight by balancing regular physical activity and healthy eating.
	I get 20 to 30 non-stop minutes of moderately intense exercise three or more times per week.
	If I am unable to do 30 minutes of activity, I am still active for 10 to 15 minutes throughout the day.
	I do activities to make myself more flexible.
	I do activities to make myself stronger.
	I do activities to improve my cardiovascular fitness.
	I know if my blood pressure is in a normal range.
	When I exercise, my heart rate is in the target zone.
	I avoid the dangers of smoking.
	I avoid the dangers of drugs.

Excretion and Waste Management	
	I know the signs of urinary tract infection.
	I drink six to eight glasses of non-caffeinated drinks per day (e.g., water, juice, milk).

(continued)

Protection and Control	
	I stay current on necessary immunizations.
	I do self-examinations (breast and/or testicular).
	I go for regular physical examinations.
	I go for eye examinations.
	I practise abstinence.
	I practise safe sex.
	I follow directions for any medications that I take.
	I wear sunscreen.
	I wear a helmet when riding (e.g., bicycle, motorcycle, snowmobile).
	I wear safety gear when participating in sports.
	I wear a seat belt when in a vehicle.
	I travel only with a sober driver.
	I don't speed when driving.

Other Things I Do to Promote Wellness	

Appendix 1.3A: Microthemes (Teacher Background)

Microthemes are writing assignments designed to help students learn the science material by looking at it in a different way (Martin). This involves more than simply reading the textbook or memorizing notes. Students must examine a particular case study about human biology and interpret what is going on. Afterwards, they express their ideas in a short, written work. Their writing must be concise, detailed, and accurate.

Each microtheme is based on a case study related to the unit of study and poses a question or gives a particular task. A microtheme may require specific thinking skills (e.g., create an analogy, analyze data, write from a particular point of view, examine more than one point of view).

WP Microthemes can be included in students' Wellness Portfolios.

Assessment of microthemes is usually approached differently than assessment of traditional classroom activities. Microtheme tasks require higher-level thinking. It is preferable to have students complete only a few microthemes but to rework them until they have met the standard set. This usually requires a minimum of two drafts. The standard relates to science content, task completion, and communication, and may reflect a particular grade (e.g., 70%). Editing of the first (and subsequent) draft may be done by the teacher or by other students in the class, with the feedback provided being formative in nature.

Students may be given the opportunity to count microthemes for a greater value, and then devalue other categories (i.e., tests, if students exhibit test anxiety). Microthemes might also be given to students who need to be absent for a period of time (e.g., illness, vacations) but still need to work with the material.

Appendix 1.3B: Microthemes—First Draft Checklist (BLM)

(For Teacher or Peer Editing)

Name of Student ____________________ Microtheme ____________________

Science Content ❑ Accurate ❑ Complete/sufficient detail provided ❑ Uses appropriate scientific vocabulary ❑ Uses appropriate examples and/or diagrams – *detail should reflect high-school level* – *use of biological terms enhances the writing (correct use of terms, doesn't detract from flow)*	**Feedback**
Task Completion ❑ Task completed effectively (e.g., explanation given, question answered, argument made, point of view represented) — *last paragraph should provide a concise summary of problem and solution, statement of recommendation, etc.* **Provide additional criteria related to specific microtheme:** ❑ ❑ ❑	**Feedback**
Communication ❑ Communicates effectively (spelling, grammar, flow) ❑ Format or voice appropriate to the task or audience – *clear sentence structure* – *writing is clear and unambiguous* – *no spelling or grammatical errors*	**Feedback**

Appendix 1.3C:
Microthemes—Final Draft Assessment (BLM)

Name of Student ______________________________ Microtheme ______________________________

Science Content ❑ Accurate ❑ Complete/sufficient detail provided ❑ Uses appropriate scientific vocabulary ❑ Uses appropriate examples and/or diagrams – *detail should reflect high-school level* – *use of biological terms enhances the writing (correct use of terms, doesn't detract from flow)*	**Possible Points** 5 — met all criteria 3–4 — met most criteria 1–2 — met few criteria **Score** ________________	**Comments**
Task Completion ❑ Task completed effectively (e.g., explanation given, question answered, argument made, point of view represented) – *last paragraph should provide a concise summary of problem and solution, statement of recommendation, etc.* **Provide additional criteria related to specific microtheme:** ❑ ❑ ❑	**Possible Points** 5 — met all criteria 3–4 — met most criteria 1–2 — met few criteria **Score** ________________	**Comments**
Communication ❑ Communicates effectively (spelling, grammar, flow) ❑ Format or voice appropriate to the task or audience – *clear sentence structure* – *writing is clear and unambiguous* – *no spelling or grammatical errors*	**Possible Points** 5 — met all criteria 3–4 — met most criteria 1–2 — met few criteria **Score** ________________	**Comments**
	Overall **Score** ________________	

Appendix 1.4: Family Medical History (BLM)

When you visit a doctor she or he will ask you if any medical conditions persist in your family. You must be able to answer questions such as these:

- ✓ How long did your longest surviving relative live?
- ✓ Do any conditions persist in your family (e.g., hypertension)?
- ✓ When were your parents and grandparents born?
- ✓ Did they experience any medical conditions during their lifetime (e.g., diabetes)?
- ✓ If they have died, when did that occur? Did any known conditions cause this?
- ✓ Do you have any medical conditions?
- ✓ Have you had any hospital visits? What for?
- ✓ Do you have any allergies? Do these run in your family?

Task

1. Ask these questions of your family members, digging back as far as you can in your family history.
2. Make notes of these interviews and include them in your Wellness Portfolio. Be sure to include at least two interviews.
3. Summarize your work as a medical family tree. Note each person, how the individuals are related, and relevant information about them.

For purposes of genetic history, what you are creating is a medical tool called a *pedigree*. You are doing a basic pedigree with added notes. All information will be considered private.

Assessment

This assignment is intended to give you as complete a picture as you can have. You will be graded on inclusion of interview notes and completeness of the medical family tree. There is no prize for having the family with the most disorders!

Appendix 1.5A: Word Splash—Homeostasis (BLM)

Internal Balance

Fluctuation

Body systems

Blood pH

Death

Blood pressure

Normal range

Body systems

Negative feedback

Thermoregulation

Interaction

Glucose concentrations

Osmoregulation

Waste management

Changes in environment

Appendix 1.5B: Homeostasis—Background Information (BLM)

Introduction

At any given time, our bodies are working to maintain their internal physiological environment in a stable state, or a constant internal balance. The example that comes readily to most people's minds is our relatively constant body temperature. Think about the adjustments your body must make to maintain this constant body temperature during an everyday activity such as walking to school on a brisk winter morning in Manitoba.

A Cold Walk

Before leaving the house you put on your winter outerwear—boots, mitts, hat, scarf, and parka. The increased amount of clothing traps body heat, and you begin to sweat as your body tries to cool down. As you leave the house and enter the cold winter air, your exposed cheeks feel cold. Near the end of the walk you notice your toes and fingers beginning to feel numb. You're late, so you run the rest of the way to school. When you arrive you're glad to find the run has warmed up your fingers and toes; however, as you walk through the hallway to your locker you find yourself beginning to sweat again. You remove your winter outerwear at your locker and head to class. A few minutes later you find yourself becoming cold and you begin to shiver as your body tries to warm up.

This example shows how your body works to maintain one specific aspect of its internal environment—a body temperature of approximately 37°C. In fact, if your body fluctuates too much from this temperature, it could lead to death. Homeostasis is the ability of the body to maintain its internal environment within acceptable ranges despite the changing external environment.

In addition to knowing that a body temperature of about 37°C is relatively constant, you may be familiar with some other body constants. These include a blood pressure of about 160/106 kPa, a blood pH near 7.4, blood glucose concentrations at about 100 mg/mL. While these "normals" do vary, there is a very limited range within which the body can function, and death can result if these normal ranges are exceeded.

To function properly, homeostatic mechanisms must allow the body to

- regulate respiratory gases
- maintain water and salt balance
- regulate energy and nutrient supply
- maintain constant body temperature
- protect against pathogens
- make repairs when injured

Homeostasis depends on the action and interaction of a number of body systems to maintain a range of conditions within which the body can best operate. Because the external environment is constantly changing and homeostatic reactions respond to the change and bring the body back to a given set point, it is often referred to as a *dynamic equilibrium*. A dynamic equilibrium is a condition that remains stable within fluctuating limits. Many homeostatic reactions begin with the body's sensing of changes in the external environment.

Negative Feedback Mechanisms

Negative feedback systems are important mechanisms used to maintain homeostasis, or dynamic equilibrium. There are many examples of negative feedback systems around us. In your home you set the thermostat to the "normal" temperature you would like your house to stay at. If the temperature drops below this temperature, a sensor notes this change and causes the furnace to come back on until the house has heated up to the set temperature. A negative feedback mechanism in your body also makes adjustments to bring things back to within an acceptable range.

Feedback mechanisms have three main components: a sensor, a coordinating centre, and an effector. The sensor is responsible for detecting variation in the set point and will send messages to the coordinating centre, which will then send a message to a specific effector to rectify any variation from a set point.

Example:

- Temperature in house set to 20°C (NORMAL CONDITION)
- Internal house temperature drops to 17°C (CHANGE)
- Thermostat detects drop in temperature (SENSOR)
- Thermostat turns on furnace (COORDINATING CENTRE)
- Furnace starts and begins to warm house (EFFECTOR)
- Temperature returns to 20°C (NORMAL CONDITION)

The coordination and regulation of homeostasis through negative feedback mechanisms in the body are most often achieved by a combination of nervous and hormonal mechanisms.

Homeostatic Systems

Three important homeostatic systems in the human body that depend upon negative feedback mechanisms to maintain equilibrium are:

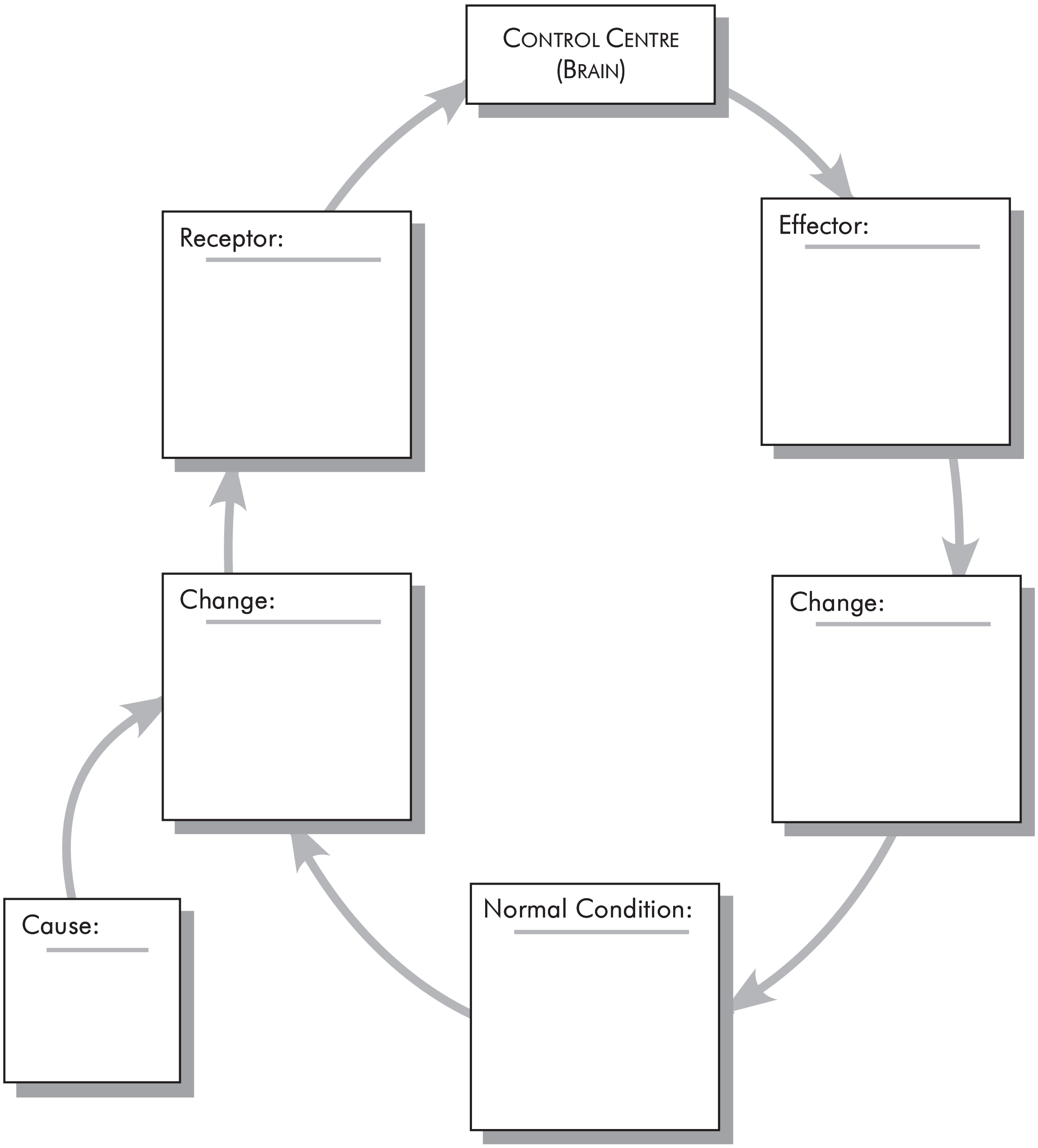
- thermoregulation (the maintenance of body temperature)
- osmoregulation (water balance)
- waste management

Thermoregulation is the ability to maintain a **constant body temperature**. The constant body temperature for humans is 37°C, although there are individual variations. Humans are able to maintain a constant body temperature despite changes in the external environmental temperature (endotherm). The hypothalamus, a part of the human brain, is the coordinating centre for the body's temperature regulation. When there is a change in the external temperature the hypothalamus will release hormones that target specific effectors such as sweat glands.

Osmoregulation is the ability to maintain a constant **water balance**. For the body to maintain water balance, humans must consume fluids daily. A drop in fluid intake by as little as 1% of your body mass will cause thirst, a decrease of 5% will result in extreme pain and collapse, while a decrease of 10% often results in death. The hypothalamus is the coordinating centre for water balance and can detect changes in the fluid concentrations of the blood. When the fluid concentration of the blood decreases (dehydration) the hypothalamus will trigger the release of a hormone to increase water absorption.

Waste management, or the ability of the body to rid itself of harmful wastes, is essential for the maintenance of homeostasis. One example of a harmful waste product is the ammonia produced during the breakdown of proteins. Ammonia is extremely toxic to the body. The liver is the most important organ involved in the elimination of ammonia. Various organs, such as the kidneys, lungs, liver, skin, and stomach are involved in the elimination of various other waste products.

Appendix 1.6:
Negative Feedback Mechanisms (BLM)



Appendix 1.7: The Swimming Race* (BLM)

Case Study

Debra was sitting quietly along the side of the pool. She was anticipating the swimming race that she would be competing in shortly—400 metres of intense physical activity, pushing her body to the very limits of its capabilities. She was calm and relaxed, mentally willing her heart and respiratory rate down. She had done some stretching and warm-up exercises, her heart rate was just 65 beats per minute, and she was breathing 12 breaths per minute. Her body temperature was 37°C. She was well hydrated. Her weight was 65 kg.

➙ That was an hour ago. Now, she was standing on the lane 4 starting block ready to go. She could see two swimmers to her left and three to her right. The swimmers all looked bigger than she, but then they always did. The starter on the pool deck was saying something over the loudspeaker but Debra wasn't paying attention. These last few seconds before the race were the most stressful—you could feel the tension in the air. She was sweating, although the air was cool. Her heart rate was now 85 beats per minute and she was breathing 18 breaths per minute. She felt a nervous excitement.

"Take your mark," the starter announced, and with the sound of the horn the swimmers dove into the water.

After a short glide through the water, Debra surfaced stroking at maximum power. She was putting all her strength into each stroke.

➙ Thirty seconds later, she had travelled just over 50 metres. Debra was completely focused on shutting out the external distractions and concentrating on keeping the power up. She was giving each stroke about 80% of her maximum power. Her heart rate was 201 beats per minute. Her respiratory rate was also up slightly. Her body temperature was 37.5°C.

At the end of that first minute, Debra's heart rate was 180 beats per minute. She was taking breaths every six strokes, fast and forced. Her body temperature was 38°C.

With 100 metres to go to the finish line, Debra had been swimming for just over three minutes. Debra could see she was even with the swimmer in lane 2. Debra knew she needed to push herself if she wanted to win. She focused completely on the placement and pull of each stroke. She was breathing faster, one breath every three strokes. Her heart rate was 195 beats per minute and her body temperature was 38.5°C.

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* Source: Strong, Nathan. "The 2000-Meter Row: A Case in Homeostasis." <www.sciencecases.org/crew/crew.asp>. Adapted by permission of the National Center for Case Study Teaching in Science, University at Buffalo, State University of New York.

➙The winner of this race was going to be whoever touched the wall first. As Debra touched the edge of the pool, four minutes and 15 seconds after starting and one-tenth of a second behind the swimmer from lane 2, her heart rate was 208 beats per minute. She slumped over the lane marker, breathing nearly 60 times per minute but still not feeling like she could get enough air. It felt like her arms and legs were on fire. She felt light-headed. Her body temperature was 39°C.

➙Ten minutes later after a cool-down, Debra's heart rate and respiratory rate were almost back to normal. She weighed 64 kg. Her body temperature was still half a degree above normal. She felt drained of energy. She was thirsty. She had allowed herself only small sips of water during the cool-down.

Instructions to Students

1. Working in assigned study groups, each group will describe what is going on in Debra's body during each of the moments highlighted by an arrow (➙). Specifically, what conditions are changing as a result of the race? What responses are made by the body to try to maintain homeostasis? What are the *results* of those responses? You should concentrate on changes in the *nervous* system, the *respiratory* system, the *cardiovascular* system, and the *urinary* system.

2. One suggestion would be for each student to take one or two body systems and report to the group on the activities of those systems throughout the course of the race. Another approach would be for each student to take one of the moments highlighted by an arrow (➙) and describe the stresses encountered and the responses made.

   Note: Ensure that the answers to these questions are included in your report. Your report should not consist only of the answers to these questions.

   Study Questions

   a) On the starting block, what is responsible for raising Debra's heart and respiratory rate and for stimulating sweating before the race?
   b) Thirty seconds after the start, swimming hard is putting new demands on Debra's body. What are these new demands and how does the body respond to them?
   c) At the finish, Debra has stopped swimming and her muscles are now at rest. Why are her heart and breathing rates still so high?
   d) What changes have occurred in the last 10 minutes after a cool-down to allow Debra's heart and respiratory rates to come down?

3. Prepare a summary of your group's findings to present to the class. This presentation can take on any form you select that is agreed upon by the teacher.

Appendix 1.8: Student Lab Skills (Teacher Background)

Students' lab skills consist of two parts: students' actions in the lab and the report that they produce. All too often, teachers have put more energy into evaluating the latter rather than assessing student thinking and actions during the lab. Do students understand why they are conducting the lab? Are they getting the results they expected? Do they trust their lab technique when they see others getting different results? Consider the following suggestions when designing your assessment approach for student lab work.

Pre-lab

Traditionally, teachers outline purpose, procedure, methods of data collection, and safety considerations during the pre-lab talk. They also pose questions to the group to check comprehension. Do the students know what they are to do and why that approach is being used? Addressing the whole group continues to be the most appropriate approach for an introduction.

During the Lab

At this point, you may have an opportunity to do individual student assessment. General lab skills, such as recording observations or using equipment properly, could be marked on a checklist. You could also interview students between procedures, to check the depth of their understanding. This could be done by posing a series of questions to the individual. How does this lab relate to what you have studied in class? What was the rationale behind your hypothesis? Are you getting the results you expected? Have you had any difficulties with the procedure?

This type of assessment may seem very time-consuming but can be alleviated by using checklists and choosing to meet with a limited number of students during each lab. By using the same checklist for each student throughout the course, you could note improvements each time you evaluate.

Post-lab

You would conduct your traditional post-lab activity. Most of the analysis would be discussed by the larger group before students did their individual write-ups. You would lead the group to an understanding of the big picture and support this with details from the group experience. After this, you might consider posing questions to certain students to check comprehension. What can you conclude from your results? Give me a specific piece of evidence to support this. What sources of error occurred in your case? What would you do differently next time?

Although these questions may be written in the lab report, taking the time to discuss these with individuals allows you to probe and draw out more understanding. Again, perhaps only certain students would be questioned on a rotational basis.

Redoing the Lab

Students are often asked to identify possible sources of error. Rarely are they given the opportunity to tighten up their control variables and repeat the lab. Perhaps they want to change their approach to solving the initial problem completely and re-test. Consider the possibility of having your students do one less new lab during the course and redoing a lab they have already tried. Students need to test their analytical skills by doing more than one trial. Don't we always tell them that a bigger sample size is more accurate?

A Variety of Products

Students can summarize their experience in a lab report. You might also consider using lab frames or lab notebooks. Lab frames allow the teacher to draw out very specific responses. Lab notebooks allow students to record their work as they conduct the lab, which reflects more of the process than the product. Analysis, answering questions, and drawing conclusions can be done after the post-lab.

The following table provides a general suggestion for a lab report. There are numerous alternative formats that could also be used. Refer to *SYSTH* (pp. 11.26–11.29 and 14.11–14.12) or other resources for more ideas.

Lab Report Format (Sample)	
Introduction	• purpose or question • hypothesis or prediction—may be supported by a rationale (What do you think will be found, and why?)
Methodology	• materials • methods/procedures Note: In many labs this information will be provided. In student-designed labs this section increases in importance and is developed by the student.
Results	• general observations—may include the following: — data tables — graphs and calculations
Analysis	Include any of the following items that are appropriate to the lab: • interpretation/discussion of results • indication of whether hypothesis was supported • implications of results • linking of results to prior knowledge • answers to questions • error analysis/sources of error • summary

Appendix 1.9A: Investigating the Movement of Starch, Iodine, and Glucose—Student Handout (BLM)

Purpose

To determine which substances are capable of moving across a cell membrane.

Method

- Test #1: Cut a piece of dialysis tubing of approximately 20 cm in length. Tie one end of the tubing and fill it with a mixture of water and molasses. Tie the other end of the tubing and place it into a beaker of water.
- Test #2: Cut another piece of dialysis tubing and tie one end. This time, pour water into the tubing. Tie the other end of the tubing and place it into a beaker containing a mixture of water and molasses.
- Test #3: Place a dilute iodine solution into a piece of dialysis tubing. Tie the other end of the tubing and place it into a beaker containing a starch and water mixture.
- Test #4: Pour a starch and water mixture into a piece of dialysis tubing. Place the tubing into a beaker containing a dilute iodine solution.
- Test #5: Pour a glucose solution into a piece of dialysis tubing. At the end of the class, place a glucose test strip into a beaker containing water to test for the presence of glucose. Repeat this test the following day.

Results

Describe the appearance of each solution or mixture before the procedure. Record detailed observations at the end of the class as well as the following day. Your results can be recorded in a table such as the following.

Observations	**Test #1** Molasses and water in tubing, water in beaker	**Test #2** Water in tubing, molasses and water in beaker	**Test #3** Iodine solution in tubing, starch and water in beaker	**Test #4** Starch and water in tubing, iodine solution in beaker	**Test #5** Glucose solution in tubing, water in beaker
Initial					
End of Class					
Following Day					

Analysis

For each of the procedures, indicate which molecules cross the membranes and which molecules do not. Explain how you came to this conclusion. Use the following terms to explain why each type of molecule is capable or incapable of crossing the membrane and how the movement takes place:

- semi-permeable membrane
- concentration
- hypertonic
- isotonic

Conclusion

Under the heading Conclusion, write an interpretation of your results.

Appendix 1.9B: Investigating the Movement of Starch, Iodine, and Glucose (Teacher Background)

In this investigation, students will observe osmosis and diffusion. They should be able to determine which substances are and which are not able to cross a cell membrane. Students should record this investigation using a lab report, lab notebook, or lab frame. To help students develop an in-depth explanation of what they see happening in this lab, have them use the following terms:

- semi-permeable membrane
- concentration
- hypertonic
- isotonic

Note: Students may need to do some research to explain the movement of molecules in this investigation.

Dialysis tubing and glucose test strips can be purchased from a biological supply company. Plastic sandwich bags can be used instead of the tubing.

Results

The following are some general descriptions of what students should observe for each test.

- Test #1: The amount of liquid in the tubing gradually increases. The mixture in the tubing becomes paler.
- Test # 2: The amount of liquid in the dialysis tubing gradually decreases. The mixture in the tubing becomes darker.
- Test #3: The mixture in the beaker turns black and the solution in the dialysis tubing gradually becomes paler.
- Test #4: The mixture in the dialysis tubing turns black and the solution in the beaker gradually becomes paler.
- Test #5: The glucose test strips change colour to indicate the presence of glucose. The glucose concentration should slowly increase.

Analysis

- Test #1: Molasses molecules are too big to cross the membrane, but water molecules can cross freely. The water and molasses mixture is hypertonic; therefore, water molecules will migrate from an area of higher concentration (water in the beaker) to an area of lower concentration (dialysis tubing). This movement will continue until the two systems are isotonic.
- Test #2: The water and molasses mixture is hypertonic. Water molecules will migrate from an area of higher concentration (dialysis tubing) to an area of lower concentration (molasses and water mixture in the beaker).
- Test #3: When iodine and starch interact, the iodine turns black. The starch molecules stay in the beaker because they are too big to cross a membrane. Iodine molecules can cross freely because they are small. They will move from an area of higher concentration (dialysis tubing) to an area of lower concentration (beaker).
- Test #4: The starch molecules stay in the dialysis tubing. Because the iodine molecules can cross the membrane, they will move from an area of higher concentration (beaker) to an area of lower concentration (dialysis tubing).
- Test #5: The glucose test strips indicate a slow increase of glucose concentration. Glucose molecules cross the membrane slowly, moving from a higher concentration (dialysis tubing) to a lower concentration (beaker).

Conclusion

When cells grow to a certain size, their rate of growth slows down until they stop growing entirely. When they have reached their size limit, one of these larger cells divides into two smaller cells. The rate of growth in these small cells again increases.

Materials needed for cell activity and growth must in some way gain entrance into the cell, and waste products must leave.

Appendix 1.10A: Cell Size and Diffusion— Student Handout (BLM)

The following two questions will be explored in this dry lab situation:

1. What is the relationship between the surface area and the volume of a cell?
2. How does this relationship affect the rate of diffusion?

Purpose

To investigate the mathematical relationship between diffusion and the size of a cell.

Material

- 27 sugar cubes
- metric ruler
- calculator

Method

Part 1

1. Obtain 27 sugar cubes and assume that their dimensions are 1.0 cm per side. These cubes will be combined in different arrangements to represent cells.
2. a) Arrange the cubes in the following manner:
   3 x 3 cube (27 sugar cubes in total)

   b) Calculate the volume, total surface area, and surface area to volume ratio of the arrangement. Express all ratios in their simplest form (e.g., 3:1 and not as 9:3.)
3. Repeat step 2 for the following arrangements (each arrangement contains a total of 27 sugar cubes—sugar cubes will need to be cut for one arrangement):
   3 x 9 rectangle
   1 x 27 rectangle
   2 x 13.5 rectangle

Part 2

4. a) Using 8 sugar cubes, build a cell that is a 2 x 2 cube.
   b) Calculate the volume, total surface area, and surface area to volume ratio of the arrangement.
5. Divide this cell in half; this will simulate cell division. Calculate the volume, surface area, and surface area to volume ratio for this "baby cell."

Analysis

1. What advantage is gained by a cell having a rectangular shape instead of a cuboidal shape?
2. What happens to the surface area to volume ratio when a cell undergoes division?
3. From the point of view of diffusion, is there an advantage for cells to divide?
4. What happens to the surface area to volume ratio of a cell as the cell grows?
5. Propose a hypothesis to explain why the growth rate of a cell slows down as it gets larger.
6. Based on what you have learned in this lab, explain why cells must remain small to survive.
7. Write a statement(s) summarizing your findings in this lab.

Appendix 1.10B: Cell Size and Diffusion (Teacher Background)

Purpose

To investigate the mathematical relationship between diffusion and the size of a cell.

Method

Part 1

Sample student data table:

Cube Dimensions	Total Surface Area (cm^2)	Volume (cm^3)	Ratio (SA:V)
3 x 3 cube	54	27	2:1
3 x 9 rectangle	84	27	3:1
1 x 27 rectangle	110	27	4:1
2 x 13.5 rectangle	85	27	3:1

Part 2

Sample student data:

Cell Types	Surface Area (cm^2)	Volume (cm^3)	Ratio (SA:V)
original	24	8	3:1
"baby"	16	4	4:1

Analysis

1. What advantage is gained by a cell having a rectangular shape instead of a cuboidal shape?

   The surface area increases.

2. What happens to the surface area to volume ratio when a cell undergoes division?

   It increases.

3. From the point of view of diffusion, is there an advantage for cells to divide?

   Yes. Dividing increases SA:V ratio and improves movement of molecules in and out of the cell.

4. What happens to the surface area to volume ratio of a cell as the cell grows?

   It decreases.

5. Propose a hypothesis to explain why the growth rate of a cell slows down as it gets larger.

   It becomes more difficult to exchange waste products and required molecules.

6. Based on what you have learned in this lab, explain why cells must remain small to survive.

   If a cell grows too large, its surface area gets smaller. The cell cannot take in the nutrients it needs to survive.

7. Write a statement(s) summarizing your findings in this lab.

   As cells grow, their increased size reduces their ability to exchange required molecules and waste products. Dividing increases the SA:V ratio and increases the ability to complete the needed exchanges.

Appendix 1.11A: Effects of Osmosis on Living Tissue— Student Handout (BLM)

Purpose

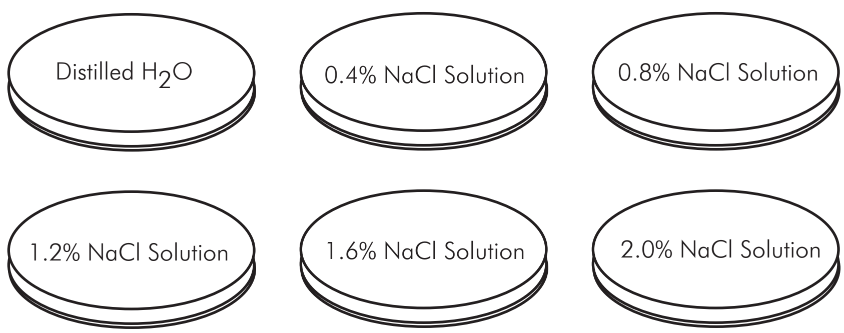
To measure the effect of osmosis on celery tissue and use this data to estimate the concentration of dissolved substances in the cytoplasm of a cell.

Method

Work as a team. One member should do steps 1 and 2 while the other is doing steps 3 to 6.

Material

- 3 petri dishes
- marking pencil
- distilled H_2O
- 0.4% NaCl solution
- 0.8% NaCL solution
- 1.2% NaCl solution
- 1.6% NaCl solution
- 2.0% NaCl solution
- metric ruler
- scalpel
- razor blade
- fresh celery stalks (100 mm length)



Method

1. Obtain 3 petri dishes. Label the bases and lids (6 separate pieces) as follows: distilled water; 0.4% NaCl; 0.8% NaCl; 1.2% NaCl; 1.6% NaCl; 2.0% NaCl.

2. Add enough of the appropriate liquids to nearly fill each of the petri dishes.

3. Obtain one or two fresh celery stalks at least 100 mm in length. Examine the cut end of the celery stalk. Note the concave and convex surfaces. Just inside the convex epidermis you will find a series of darker green circles, the vascular bundles. The vascular bundles run lengthwise in the celery stalk and are composed of rigid, thick-walled cells forming tough "strings."

Caution: Use extreme care when cutting with a razor blade or scalpel.

4. Place the stalk, concave side down, on a cutting surface (not the table surface). Use a dissecting razor blade or scalpel to cut the stalk lengthwise into at least six strips about 3 mm thick.

5. Select six strips of celery tissue. Lay them on their side. Then, cutting lengthwise, carefully remove the outer epidermis (skin) and vascular tissue (darker green “string”) if present. The remaining tissue is composed of parenchyma cells, thin-walled and flexible.
6. Trim each strip to a width of 2 to 3 mm, if necessary. Attempt to keep the strips as uniform as possible.
7. Angle cut one end of each strip to a point.
8. Measuring from the tapered end, *carefully and precisely* angle cut each strip to a length of 70 mm so that both “points” are on the same side of the strip.
9. Place one measured celery tissue strip into each of the prepared petri dishes. Leave them undisturbed for a minimum of 25 minutes.
10. After 25 minutes, remove the strips of celery, one at a time, immediately measuring the length (mm) of each.
11. Record any variations in the rigidity of the strips relative to the concentration of the solutions. Compare with the strips before they were placed in the solutions. Use “more,” “similar,” and “less” to describe the condition.

Results

1. Create a data table in your notebook to record the initial length (l_i) of the celery strips, the final length, and observations on the rigidity of the strips, for each solution.
2. Calculate and record the change in length (Δl) of each strip in millimetres.

$$\Delta l = l_f - l_i$$

   Indicate an increase in length with a positive (+) sign and a decrease with a negative (–) sign.

3. a) Graph your own results by plotting the change in length against the concentration of the solution.

   b) Plot the class averages on the same graph. It will be necessary to draw a “zero” line halfway up the paper in order to plot points indicating an increase (+) or a decrease (–) in length.

   c) Identify the manipulated (independent) variable and the responding (dependent) variable in the title of the graph.

   d) Draw a straight line through the points.

   e) Record the points (concentration) at which each line intersects the zero axis.

   f) Answer the question: *What information is provided by the points along the zero axis?*

Analysis

1. Which of the six solutions used has the highest percentage of water? the lowest? Explain.
2. From your investigation, is there supporting evidence to suggest that water has entered or left the celery cells? Explain.
3. How can osmosis account for the changes in length of the celery tissue?
4. What term is given to a solution that has the same concentration as the cytoplasm of a cell?
5. Which would provide the more reliable information, the class average graph or your own data graph? Explain your reasoning.
6. Predict what would happen to a plant cell placed in a 1% salt solution. Justify your prediction.

Appendix 1.11B: Effects of Osmosis on Living Tissue (Teacher Background)

Purpose

To measure the effect of osmosis on celery tissue and use this data to estimate the concentration of dissolved substances in the cytoplasm of a cell.

Pre-lab Suggestions

Before proceeding with this investigation, help students become familiar with the scientific terms used to describe activities or conditions associated with living membranes. Use text and reference books.

Have students clearly define each of the following terms:

- permeable
- semi-permeable
- non-permeable
- diffusion
- isotonic
- hypertonic
- hypotonic

Encourage students to use these terms during the investigation.

Results

Specifics of student data will vary, but students should find that the higher the salt concentrations in the water, the greater the decrease in length will be.

The graph should include responses to the following questions:

- Which is the manipulated (independent) variable?

  Concentration of NaCl

- Which is the responding (dependent) variable?

  Change in length

- What information is provided by the intersection points in (j)?

  No change in the cell length

Analysis

1. Which of the six solutions used has the highest percentage of water? the lowest? Explain.

   Highest percentage of water: Distilled H_20

   Lowest percentage of water: 2.0% NaCl solution

2. From your investigation, is there supporting evidence to suggest that water has entered or left the celery cells? Explain.

   Yes. Cells changed in length – some expanded and some shrank.

3. How can osmosis account for the changes in length of the celery tissue?

   Water flows in and the cell is stretched (increases in tonicity); when water flows out, tonicity decreases.

4. What term is given to a solution that has the same concentration as the cytoplasm of a cell?

   Isotonic

5. Which would provide the more reliable information, the class average graph or your own data graph? Explain your reasoning.

   Class average graph – more data improves reliability, cancellation of errors is possible.

6. Predict what would happen to a plant cell placed in a 1% salt solution. Justify your prediction.

   Cell should shrink. Base answer on graphical interpolation.

Appendix 1.12A: Concentration and Diffusion— Student Handout (BLM)

Introduction

This lab investigation presents a problem. Your task is to plan and conduct an experiment to solve the problem. A list of materials is provided, but you must determine which variables you will study, the procedure you will follow, as well as what observations you will record and how you will record them.

Problem

Diffusion is a process by which substances enter and leave cells across a semi-permeable membrane. Your problem is to design an experiment to study the effects of concentration on either the distance that potassium permanganate diffuses into potato cubes OR the time that potassium permanganate takes to diffuse into potato cubes.

Material

- 2 firm potatoes
- metric ruler (30 cm)
- 1%, 5%, and 10% solutions of potassium permanganate ($KMnO_4$) (in beakers)
- paper towels
- waste container
- stopwatch/clock
- 3 small beakers (approximately 150 mL)
- forceps
- scalpel
- experiment display sheet
- graph paper

Procedure

1. **Beginning ideas:** State the question that you want to answer during this investigation. Predict what will be the effects of concentration on the distance that potassium permanganate diffuses into potato cubes or on the time that potassium permanganate takes to diffuse into potato cubes. Explain reasons for your prediction.

2. **Tests:** What will you do to help answer your question? List, in order, the steps you will use to solve the problem. You may include a diagram to help illustrate your plans for the experiment. Include *safety procedures* you will follow. Perform the experiment by following the steps outlined in your procedure.

3. **Observations:** Record your observations and measurements for the experiment. What did you see when you were performing your experiment? Use written statements, descriptive paragraphs, tables of data, and/or graphs, where appropriate.

4. **Claims and evidence:** Write an interpretation of your results. Explain what you have concluded and support it with evidence that helped you come to that conclusion. (What is your claim? What is the evidence to support your claim? How do you know? Why are you making this claim? How do your findings compare with your prediction?)

5. **Reflection:** Compare your results and interpretation of results with those of other groups. How do your ideas compare with the ideas of other students? Compare your results with information about concentration and diffusion from a textbook. Have your ideas changed after comparing your results and interpretations?

Appendix 1.12B: Concentration and Diffusion (Teacher Background)

This lab investigation presents a more student-centred approach. Students will be provided with a list of materials, but they must determine which variables they will study—the effect of concentration on distance of diffusion or the effect of concentration on time of diffusion—as well as the procedure they will follow. Teachers may choose to give students either distance or time to study, or have half the class study one variable, while the other half studies the second variable.

The lab report suggested for this investigation is different than the traditional format. It uses a tool called the *science writing heuristic*, which focuses on helping students make connections between questions, procedures, data, claims, and evidence (support for the claims). Students are also encouraged to verify their explanations with other students as well as with textbooks or other sources of information, in order to develop their conceptual understanding.

Encourage students to construct graphs (if they are not doing so already) as part of recording and interpreting data. The graph will present the relationship between either the distance $KMnO_4$ moved into the potatoes and the concentration of the $KMnO_4$ solution or the relationship between the time it took for $KMnO_4$ to move into the potatoes and the concentration of the $KMnO_4$ solution.

Many scientific inquiry skills are targeted in this inquiry. Students must develop a procedure in order to test this hypothesis, control variables, and determine how their observations will be recorded and displayed. Because students develop their own procedure, results may vary greatly from group to group. Discussions with other groups is a good way for students to understand that there is no set procedure for conducting a scientific investigation and that ideas based on evidence can change and be refined through discussion and debate.

References

Hand, B., and C. W. Keys. "Inquiry Investigation: A New Approach to Lab Reports." *The Science Teacher* 66.4 (1999): 27–29.

Keys, Carolyn W., et al. "Using the Science Writing Heuristic as a Tool for Learning from Lab Investigations in Secondary Science." *Journal of Research in Science Teaching* 36.10 (1999): 1065–1084.

Appendix 1.13A: Lab Skills Checklist—General Skills (BLM)

General Skills	Expectations	Not Yet Meeting Expectations	Meeting Expectations
Is prepared to conduct the lab	Reads lab outline ahead, creates tables, asks questions that clarify the task, instead of asking "What do I do next?"		
Sets and uses equipment properly	Chooses the correct equipment, sets up properly (e.g., ring height on ring stand), and uses equipment properly (e.g., lighting a Bunsen burner or anaesthetizing fruit flies)		
Follows safety procedures	Demonstrates general safety procedures as well as specifics outlined in pre-lab		
Records observations	Records own observations as the action is occurring, uses quantitative and qualitative approaches as directed, records in an organized fashion (e.g., uses a table or key)		
Works independently (individual labs) or works cooperatively (group labs)	Knows task and gets right to work or shares tasks and observations, is a good listener, and is receptive to the other student's point of view		
Manages time efficiently	Divides and orders tasks to meet deadlines		
Cleans up adequately	Leaves table and sink clean, puts away all equipment, washes table top, washes hands		

Appendix 1.13B:
Lab Skills Checklist—Thinking Skills (BLM)

Thinking Skills	Questions	Understanding of Lab		
		Limited	General	Specific
Knowledge/ Comprehension	• What is the purpose of doing this lab? • How does this relate to what you are studying in class? • What is the rationale for your hypothesis? • Why do you need special safety considerations for this lab? • What chemical disposal guidelines have you been given?			
Application/ Analysis	• How did you decide on this procedure? • Are you having any difficulties with this procedure? • Are you getting the results that you expected? • How would you set up a graph, diagram, or flowchart to depict these results? • Do you see a pattern in your data? • Do any data points not follow the pattern?			
Synthesis/ Evaluation	• What can you conclude from your results? • Give a specific piece of evidence to support your conclusion. • What sources of error occurred in this trial? • What would you do differently in a second trial? What would you do the same? • How do your two trial results compare?			

Appendix 1.14A: Biological Drawing (BLM)

Making a Biological Drawing

1. What to Use
   a) Use a sharp pencil.
   b) Use a clean sheet of unlined paper.
2. What to Draw
   a) Draw only what you see.
   b) Draw only what is necessary.
3. How to Draw
   a) Centre your diagram.
   b) Draw a large enough diagram to show details clearly (approximately one-half page).
   c) Make your proportions accurate.
4. Showing Depth
   a) Do not shade.
   b) Show depth with stippling.
5. Label Your Drawing
   a) In your title, include the name of the slide, the total magnification, the date observed, the field diameter, and the size of the object.
   b) Label specific information. Labels should be printed, written horizontally, and placed to the right of the drawing.
   c) Use a ruler to draw labelling lines and do not cross the lines.

Appendix 1.14B:
Rating Scale for Biological Drawing (BLM)

Title of Drawing or Lab ____

	Possible Points	Self-Assessment	Teacher Assessment
1. Tools/Material (What to Use) a) Used sharp pencil. b) Used clean sheet of unlined paper.			
2. Content (What to Draw) a) Drawing includes only what was observed. b) Drawing includes only what is necessary.			
3. Approach (How to Draw) a) Diagram is centred. b) Diagram is large enough to show details clearly. c) Proportions are accurate.			
4. Showing Depth a) Did not shade. b) Used stippling to show depth .			
5. Labelling (Label Your Drawing) a) Title includes the name of the slide, the total magnification, the date observed, the field diameter, and the size of the object. b) Specifics on diagram are labelled. c) Labelling lines are drawn with a ruler and do not cross the lines.			
Totals			

Comments

Appendix 1.15: Microscope Skills Checklist (BLM)

Teacher Notes: Use one page per student and use throughout the entire course. Either a check mark or a date reference can be placed in the appropriate column to indicate whether the student is meeting or not yet meeting expectations. Anecdotal comments can be recorded in the space provided below the table (be sure to include a date with the comment).

While these skills could be assessed through a Pencil-and-Paper Task, that approach would not provide feedback on the *skill level* of students in performing the required tasks. It would only provide information as to a student's *knowledge* of what the steps/procedures are. Performance tasks and observational assessments should be used whenever possible.

Name ______________________ Date ______________________

Skills	Not Yet Meeting Expectations	Meeting Expectations
1. General Microscope Skills a) Handles and cares for microscope properly. b) Selects proper magnification to see the object (i.e., cell or tissue). c) Uses only fine focus on medium and high power. d) Watches from the side when bringing object and lens together. e) Uses diaphragm and/or mirror to adjust light properly.		
2. Proper Technique to Focus Object under Various Magnifications (i.e., parfocal) a) Starts on low power with coarse adjustment. b) Centres object. c) Adjusts fine focus. d) Moves up to medium or high power using only fine focus.		
3. Preparing a Wet Mount Slide a) Places specimen and drops of water on slide. b) Lowers cover slip at a 45° angle.		
4. Staining a Wet Mount Slide a) Prepares the wet mount slide. b) Places a drop of stain on one side of the cover slip. c) Draws through with a paper towel.		
5. Oil Immersion Technique (Optional) a) Properly focuses slide on high power. b) Swings lens to the side. c) Puts drops of oil on slide. d) Positions oil immersion lens and focus.		
6. Technical Skills a) Determines total magnification. b) Determines object size.		
Comments (include date)		

Appendix 1.16: Those Magic Membranes* (BLM)

(Short version—the one recorded)
by Arthur W. Siebens, Ph.D., Copyright 1995
(to the tune of "La Bamba" by Richie Valens and "Twist and Shout," by Medley and Russell)

How do things get into cells?
How do things get out?
Transport across cell membranes
Is what this song's about.

Diffusion, osmosis
Active transport, too.
To make your cells and organs work right
The right solutes must get through.

CHORUS
Oh, those magic membranes
In each and every cell
Differences between solutes may be small
But membrane transporters can tell.

Oh those magic membranes!

They let the good stuff in
Get the bad stuff out
Through transporters made of protein
There's lots of different routes.

Membranes are mainly made of lipid
Most solutes can't penetrate
Proteins transport specific solutes
Many change their shape (conformational state).

Facilitated diffusion
(From) high concentration to low.
In co-transport a solute going "downhill"
Moves another "uphill" as it goes (secondary active transport).

There's also (primary) active transport
And that takes energy
Solutes are moved uphill
Energy from ATP.

CHORUS

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*Source: Siebens, Arthur W. "Those Magic Membranes." *Bio-Rhythms I* (1995): <www.biosongs.com/4.htm>. Reproduced by permission.

If solutes can't cross a membrane
But water can diffuse
It will cross 'til equilibrium (the water concentration is the same)
Osmosis is when water moves (across cell membranes).

CHORUS

Oh those magic membranes! Yeah!

Unit 2:
Digestion and Nutrition

Unit 2: Digestion and Nutrition

Specific Learning Outcomes

B11-2-01: Identify major structures and functions of the human digestive system from a diagram, model, or specimen. (GLO: D1)

Include: tongue, teeth, salivary glands, epiglottis, esophagus, pharynx, sphincters, stomach, small intestine, large intestine, rectum, anus, appendix, liver, gallbladder, pancreas, and uvula

B11-2-02: Describe the processes of mechanical digestion that take place at various sites along the alimentary canal. (GLO: D1)

Include: chewing in the mouth, peristalsis along the tract, muscle contractions in the stomach, and emulsification by bile in the small intestine

B11-2-03: Identify functions of secretions along the digestive tract. (GLO: D1)

Include: to lubricate and to protect

B11-2-04: Identify sites of chemical digestion along the alimentary canal, as well as the type of nutrient being digested. (GLO: D1)

Include: starch in the mouth; proteins in the stomach; and carbohydrates, lipids, and proteins in the small intestine

B11-2-05: Explain the role of enzymes in the chemical digestion of nutrients and identify factors that influence their action. (GLOs: D1, E2)

Examples: pH, temperature, coenzymes, inhibitors, surface area…

B11-2-06: Describe the processes of absorption that take place at various sites along the alimentary canal. (GLO: D1)

Include: uptake of nutrients by villi in the small intestine and uptake of water in the large intestine

B11-2-07: Describe the homeostatic role of the liver with respect to the regulation of nutrient levels in the blood and nutrient storage. (GLOs: D1, E2, E3)

Include: carbohydrate metabolism

B11-2-08: Describe the functions of each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

Include: ATP production, construction/repair, and regulating

B11-2-09: Identify dietary sources for each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

B11-2-10: Evaluate personal food intake and related food decisions. (GLOs: B3, C4, C8)

Examples: percentage of daily values of nutrients, portion size, nutrient labels, balance between lifestyle and consumption...

B11-2-11: Investigate and describe conditions/disorders that affect the digestive process. (GLOs: B3, C6, D1)

B11-2-12: Use the decision-making process to investigate an issue related to digestion and nutrition. (GLOs: B3, C4, C5, C8)

DIGESTION

SPECIFIC LEARNING OUTCOMES

B11-2-01: Identify major structures and functions of the human digestive system from a diagram, model, or specimen. (GLO: D1)

Include: tongue, teeth, salivary glands, epiglottis, esophagus, pharynx, sphincters, stomach, small intestine, large intestine, rectum, anus, appendix, liver, gallbladder, pancreas, and uvula

SLO: B11-2-01

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

In Grade 5, students identified the following structures of the digestive system: teeth, mouth, esophagus, stomach, and intestines. In Grade 8, students compared the structure of digestive organs in a variety of organisms.

ACTIVATE

Do You Remember?

Have students draw from memory an outline of the digestive system that includes the following: tongue, teeth, salivary glands, epiglottis, esophagus, stomach, small intestine, large intestine, rectum, anus, appendix, liver, gallbladder, pancreas, and uvula.

ACQUIRE/APPLY

Surfing for the Stomach (I1)

The Internet is an excellent way for students to explore the digestive system in an interactive manner. Have students complete an Internet Scavenger Hunt to answer questions provided by the teacher or developed by students.

Example:

What is the function of the epiglottis?

Websites can be identified in advance by the teacher.

An alternative would be for students to use specific websites to develop their own questions for other students to answer.

Suggestion for Assessment

Depending on the approach taken, either the teacher or students would identify the "correct" answers. Teachers may also choose to have some of the questions/answers form part of student notes on the digestive system, which can be incorporated into an assessment at a later point in the unit.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: C2, C5)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

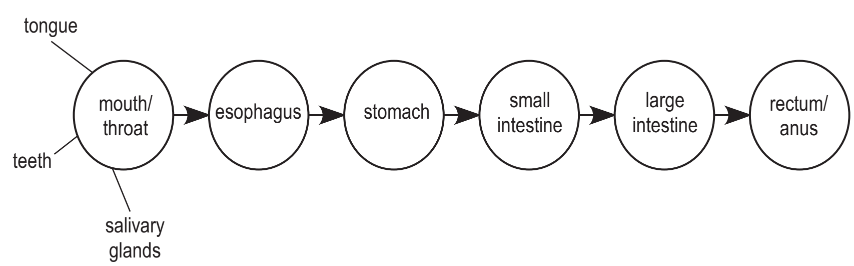
Include: biological drawings

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

Alimentary Canal—Concept Map (U1)

Have students use a Chain Concept Map (flow chart) to illustrate the main components of the alimentary canal and the process of digestion. The base structure in Appendix 2.1: Concept Map of the Digestive System (BLM) is provided and contains six main components: mouth/throat, esophagus, stomach, small intestine, large intestine, and rectum/anus. To each of these main areas students should add more details related to specific components (see sample below). Refer to SLO B11-2-01 for a list.



Suggestion for Assessment

Additions will be made to this base Concept Map at various stages throughout the unit. It will serve as an important visual organizer and will be a useful tool for teachers to monitor student understanding of the digestive system (formative assessment) and to adjust teaching to address any difficulties. The Concept Map can also be used as a summative assessment tool at the end of the unit.

DIGESTION

SPECIFIC LEARNING OUTCOMES

B11-2-01: Identify major structures and functions of the human digestive system from a diagram, model, or specimen. (GLO: D1)

Include: tongue, teeth, salivary glands, epiglottis, esophagus, pharynx, sphincters, stomach, small intestine, large intestine, rectum, anus, appendix, liver, gallbladder, pancreas, and uvula

What Am I? (U1)

Review the function of each of the parts listed in the SLO B11-2-01. Have students create a table including the digestive system structure and explaining its function. Write all the parts of the human digestive system on self-stick notes. Stick a self-stick note on the back of each student. Have them ask each other yes/no questions to figure out the structure posted on their back.

Suggestion for Assessment

An Exit Slip is a quick assessment tool that helps gain information about what students viewed as important during a particular lesson. The process for an Exit Slip is to pose a question at the end of the lesson and give students five minutes to respond. Suggested questions include the following:

- Describe what you thought was the most important point made during this lesson.
- What did you learn during this lesson?
- What questions do you still have about this lesson?

Virtual or Real Dissection (S3, S4, S5, S6, I1 OR S5, I1)

Provide students with the opportunity to identify components of a “real” digestive system through either a dissection specimen or a virtual specimen.

As indicated in Section 2 of this document, Grade 11 Biology does not mandate that dissection (either real or virtual) take place in the classroom. Dissection is one of many instructional strategies that may be used to familiarize students with the structure and function of organs and organ systems. Interactive multimedia materials such as computer simulations, tutorials, and video clips can substitute for the use of animals in the classroom. However, these alternatives must satisfy the objectives of teaching scientific methodology and fundamental biological concepts. If, in the judgment of the teacher, available alternatives do not meet these objectives, dissection may be used, provided that no student is forced to participate in a dissection over his or her objections. In the event that a student chooses not to participate in a dissection, he or she should be provided with an alternate activity of comparable complexity and rigour.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: C2, C5)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

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Resource Links

The following websites provide virtual dissections:

- Berkeley Lab. "The Virtual Frog Dissection Kit." *Computer-Enhanced Science Education: The Whole Frog Project*. <http://froggy.lbl.gov/>.
- Fleck, Earl W. "Virtual Pig Dissection." Whitman College Biology Department. <www.whitman.edu/biology/vpd/>.
- U.S. National Library of Medicine. *The Visible Human Project*. 11 Sept. 2003. <www.nlm.nih.gov/research/visible/visible_human.html>.

  This project is the creation of three-dimensional representations of the normal male and female bodies. A sample of images and animations is available online.

For more ideas about integrating information and communication technologies across the curriculum, see

- Manitoba Education. *Information Communication Technology (ICT): Kindergarten to Grade 12*. <www.edu.gov.mb.ca/k12/tech/index.html>.

For additional information on topics such as plagiarism, evaluating web content, and making a bibliography, see

- Manitoba Education. "Professional Learning for Teachers." *Literacy with ICT Across the Curriculum: A Developmental Continuum.* <www.edu.gov.mb.ca/k12/tech/lict/let_me_try/le_teachers.html>.

DIGESTION

SPECIFIC LEARNING OUTCOMES

B11-2-01: Identify major structures and functions of the human digestive system from a diagram, model, or specimen. (GLO: D1)

Include: tongue, teeth, salivary glands, epiglottis, esophagus, pharynx, sphincters, stomach, small intestine, large intestine, rectum, anus, appendix, liver, gallbladder, pancreas, and uvula

Suggestion for Assessment

Establish with students a list of expectations for good dissection skills. Conduct a performance-based assessment by circulating throughout the classroom and assessing dissection skills using a checklist or rating scale.

The following are suggestions to include in the list of dissection skills criteria:

- Secures specimen to the dissection pan.
- Uses care while using scalpel.
- Cuts tissue without damaging organs.
- Moves or removes organs that obstruct a view of deeper organs.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: C2, C5)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

NOTES

INTRODUCTION TO MECHANICAL AND CHEMICAL DIGESTION

SPECIFIC LEARNING OUTCOMES

B11-2-02: Describe the processes of mechanical digestion that take place at various sites along the alimentary canal. (GLO: D1)
Include: chewing in the mouth, peristalsis along the tract, muscle contractions in the stomach, and emulsification by bile in the small intestine

B11-2-03: Identify functions of secretions along the digestive tract. (GLO: D1)
Include: to lubricate and to protect

B11-2-04: Identify sites of chemical digestion along the alimentary canal, as well as the type of nutrient being digested. (GLO: D1)
Include: starch in the mouth; proteins in the stomach; and carbohydrates, lipids, and proteins in the small intestine

SLO: B11-2-02
SLO: B11-2-03
SLO: B11-2-04

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Mechanical Digestion—The First Step

Begin a discussion with students by asking:

> What could you do to help your digestive system if you had a broken jaw?

Have students brainstorm some solutions and justify their explanations. This discussion will help activate students' thinking about the first step in the breakdown of food.

Increasing the Surface Area

Take a piece of chalk and break it in half. Break one of the halves up into smaller pieces. Have students predict which half of the chalk will dissolve more quickly in a jar of vinegar. Place the pieces of chalk into the vinegar and observe during class time. Relate the dissolution and the size of chalk particles to the need for mechanical digestion.

ACQUIRE/APPLY

Mechanical Digestion—Concept Map (U1)

Using information gained from direct teaching or text material, have students refer to their Concept Map of the Digestive System (Appendix 2.1) and label the locations where mechanical digestion takes place with the process that takes place there. This labelling could be done in a particular colour, with future labelling of details related to chemical digestion done in a different colour.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames …

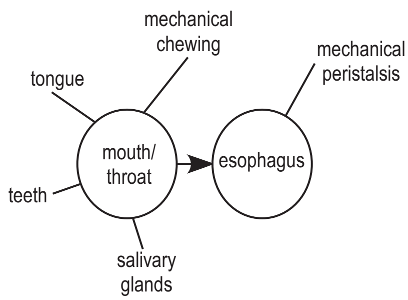
B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

Example:



Secretion Models—Demonstration (I1, S6)

Use models to demonstrate to students the functions of secretions along the digestive tract.

- **Lubricant—Rubber Tubing and Marble**

  Demonstrate the ease with which the marble passes along a rubber tube if oil is added. Relate this to the role of lubricants in moving the bolus along the digestive tract.

- **Protection—Leaf and Petroleum Jelly**

  Cover the surface of one leaf with petroleum jelly and leave another leaf bare. Add a drop of mild acid to each leaf and have students observe what happens (the leaf with the petroleum jelly is protected from the acid). Relate this to the function of the mucus lining the stomach.

Students should record information from the demonstrations in their science notebooks, including a description of the model and the link between the model and the digestive system.

INTRODUCTION TO MECHANICAL AND CHEMICAL DIGESTION

SPECIFIC LEARNING OUTCOMES

B11-2-02: Describe the processes of mechanical digestion that take place at various sites along the alimentary canal. (GLO: D1)

Include: chewing in the mouth, peristalsis along the tract, muscle contractions in the stomach, and emulsification by bile in the small intestine

B11-2-03: Identify functions of secretions along the digestive tract. (GLO: D1)

Include: to lubricate and to protect

B11-2-04: Identify sites of chemical digestion along the alimentary canal, as well as the type of nutrient being digested. (GLO: D1)

Include: starch in the mouth; proteins in the stomach; and carbohydrates, lipids, and proteins in the small intestine

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Suggestion for Assessment

Have students respond to the following questions:

- What would happen to the process of digestion if your salivary gland stopped producing saliva?
- What would happen to the process of digestion if your stomach could not produce any more mucus?

Mixing It Up—Demonstration (U1)

Add a small amount of oil to a test tube of water and have students record what happens. Shake it and have students record what happens. Repeat the demonstration but add liquid detergent to simulate bile. Have students discuss the role of the detergent.

When detergent is added, the oil separates into small droplets and can stay suspended in the water. Relate this to the action of bile in the digestive system. Bile will separate fats into small particles, which can then be chemically digested.

Chemical Digestion—Concept Map (U1)

Use a text resource and/or explicit teaching to address the concept of chemical digestion. This should include the sites of chemical digestion and the type of nutrient being digested (e.g., starch, carbohydrates, lipids, proteins). This information should be added to the Concept Map created earlier.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames …

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

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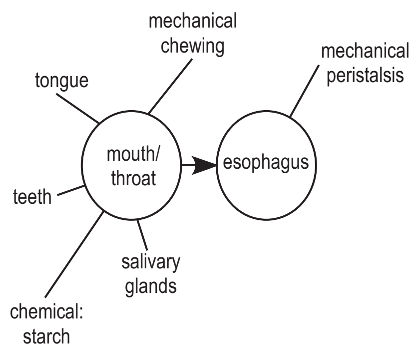
Example:



Cumulative Assessment

Have students create, from memory, the Concept Map that they developed during the previous learning activities. This would include creating the initial diagram of the six main components of the alimentary canal, some details related to each component, and the sites of mechanical and chemical digestion. This can be used as a formative assessment to determine the level of students' understanding of the digestive system to this point. If needed, reviewing and/or re-teaching may be carried out. This activity can also be used as a summative assessment to make a judgment about student achievement to this point.

ENZYMES AND CHEMICAL DIGESTION

SPECIFIC LEARNING OUTCOMES

B11-2-05: Explain the role of enzymes in the chemical digestion of nutrients and identify factors that influence their action. (GLOs: D1, E2)

Examples: pH, temperature, coenzymes, inhibitors, surface area…

SLO: B11-2-05

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Enzyme Reaction—Demonstration

Prepare fresh pineapple juice by cutting up a pineapple and putting it into a blender until it is puréed. Obtain the juice by straining the purée through cheesecloth. Make some gelatin (any type will do, but it is helpful if it is of a dark colour). Cut the gelatin into cubes and place the cubes in petri dishes. Have students observe what happens when the pineapple juice is poured over the gelatin. Have students relate their observations to the role of enzymes in digestion.

Note: Pineapple belongs to a group of plants called *bromeliads*. Kiwi, papaya, and figs are other types of bromeliads. The enzyme in pineapple juice that is responsible for the breakdown of collagen is *bromelain*. Canned pineapple will not work in this demonstration; the canning process denatures the bromelain, rendering it incapable of catalyzing the breakdown of gelatin.

What's the Key?

Bring a series of locks and keys into the classroom. Have students determine which key fits into which lock. Explain to students that enzymes work in a similar fashion.

ACQUIRE/APPLY

Enzymatic Factors in the Digestion of Lipids—Lab (P1, S3, S4, S6, S8)

Have students perform a lab to demonstrate the action of an enzyme on food particles. Refer to Appendix 2.2A: Enzymatic Factors in the Digestion of Lipids—Student Handout (BLM) and Appendix 2.2B: Enzymatic Factors in the Digestion of Lipids (Teacher Background). This lab will also allow students to see the effect of factors such as temperatures and coenzymes on enzymatic action.

Suggestion for Assessment

Refer to Appendix 1.8: Student Lab Skills (Teacher Background) in Unit 1 for information on assessing and evaluating student lab skills.

SKILLS AND ATTITUDES OUTCOMES

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

NOTES

ABSORPTION

SPECIFIC LEARNING OUTCOMES

B11-2-06: Describe the processes of absorption that take place at various sites along the alimentary canal. (GLO: D1)

Include: uptake of nutrients by villi in the small intestine and uptake of water in the large intestine

SLO: B11-2-06

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

It's All in the Folds

Provide each group of students with a piece of paper and have them

1. calculate the surface area of a sheet of paper (one side only)
2. roll the paper into a tube and secure it
3. fold additional pieces of paper; insert them into the tube to try to increase the surface area of the tube (as much as possible); and record the new surface area
4. share their maximum surface area with the class

Tell students that their tube is a model of the villi in the small intestine, and have them discuss why an increased surface area in the small intestine would be important.

ACQUIRE/APPLY

Reconstructing Text (U1)

Provide students with an article or notes from a textbook explaining the process of absorption and the movement of food particles through the alimentary canal. Cut up the reading into paragraphs and have students reconstruct it. Students identify the sites where absorption occurs and describe to their neighbour how absorption occurs at different sites.

Suggestion for Assessment

Have students complete a Cloze exercise (insert missing words to text related to the process of absorption).

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

Absorption—Concept Map (U1)

Students identify the sites along the alimentary canal where absorption occurs, using the Concept Map they created earlier—marking the sites in a different colour.

Comparing Conditions (U2)

Have students use their understanding of absorption to explain what happens in two common conditions: diarrhea and constipation (explanations should refer to water uptake).

Suggestion for Assessment

Have students answer the following questions:

In a condition known as microvillus inclusion disease the microvilli fold inwards and, therefore, have no contact with the intestinal lining.

- How do you think this condition affects the health of an individual?
- What might need to be done to treat this condition? Justify your response.

Written responses could be assessed using the following criteria:

- clarity of response
- completeness of response
- presentation of logical response
- use of unit knowledge to justify response

Student responses do not need to be "correct"; however, they must be clear and justified and include knowledge gained in this unit.

Note: Children with microvillus inclusion disease cannot absorb any nutrients and must be fed intravenously. In order to survive, the children must receive an intestinal transplant, which is quite rare.

THE LIVER

SPECIFIC LEARNING OUTCOMES

B11-2-07: Describe the homeostatic role of the liver with respect to the regulation of nutrient levels in the blood and nutrient storage. (GLOs: D1, E2, E3)

Include: carbohydrate metabolism

SLO: B11-2-07

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Relating to the Real World

Ask students:

> What do we do to our ripe garden tomatoes in order to eat them throughout the year?

Note: Excess tomatoes need to be modified and stored to preserve their nutrients and to be able to access them throughout the year. Relate this concept to the transformation and storage of carbohydrates by the liver.

ACQUIRE/APPLY

Regulatory Systems (U1)

As an introduction to hormones as one of the body's key regulatory systems, have students read Appendix 2.3: Regulatory Systems (BLM) and answer the questions provided.

Liver Functions (U2)

Have students read Appendix 2.4A: The Role of the Liver in Homeostasis (BLM) and develop one or two questions about the reading (this can be done individually or in small groups). These questions can then be compiled and given back to the students as a short quiz or written assignment.

Suggestion for Assessment

Have students complete an Exit Slip on which they describe the homeostatic adjustment that would occur for a person who has consumed a significant quantity of carbohydrates in the past hour. The result should look similar to the "answer" provided in Appendix 2.4B: The Liver and Negative Feedback (BLM).

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Liver Job Application (I4)

Have students write a resumé for the liver. The resumé should include important qualities and abilities, such as decision-making skills (homeostasis), storage capabilities, and regulation of nutrient levels.

Resource

See Liver Transplant Lesson Plan in *Life Is a Gift* (Manitoba Education and Transplant Manitoba) for activities related to Unit 2: Digestion and Nutrition.

Suggestion for Assessment

Develop criteria with the students and have them peer-evaluate each other's resumés. (Does the liver get the job?)

Examples:

- Address—location in the human body
- Previous Experience—some past challenges to the liver
- Abilities—storage and decision-making capabilities

NUTRITION

SPECIFIC LEARNING OUTCOMES

B11-2-08: Describe the functions of each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

Include: ATP production, construction/repair, and regulating

B11-2-09: Identify dietary sources for each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

SLO: B11-1-08
SLO: B11-1-09

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

In Grade 5, students examined the nutritional content of a variety of food sources and read food labels for nutrient content. They focused on carbohydrates, proteins, fats, vitamins, and minerals. In Grade 10 Physical Education/Health Education, students analyzed and monitored their food intake over a period of time.

ACTIVATE

Graffiti Brainstorm

Have students participate in a Rotational Cooperative Graffiti (Kagan) learning experience. Provide each group with a sheet of poster paper and a heading. Examples of possible headings are carbohydrates, lipids, proteins, vitamins and minerals, and water.

Each group must have a different heading and a different colour of marker. Predetermine a period of time in which students will brainstorm as many ideas as they have about each topic—anything that comes to mind. Have students circulate the posters until each group has placed their response on each sheet. Once individual groups have received their original posters, they work together to summarize what has been written and share their summary with the class.

For more details on this strategy, refer to *SYSTH* (p. 3.15).

ACQUIRE/APPLY

Nutrients—Reading for Information (I1, I2)

Part 1

Have groups of students read current information on nutrients that identifies the types of nutrients, their functions, and related dietary sources. Give each group different information sources (e.g., pamphlets, posters, information from the Internet). Students record key information in their notebooks, using the strategy of their choice (e.g., mapping, outlining), and comment on the quality of the information (e.g., accuracy, reliability, currency).

SKILLS AND ATTITUDES OUTCOMES

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens …

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S7: Evaluate the relevance, reliability, and adequacy of data and data collection methods. (GLOs: C2, C4, C5, C8)

Include: discrepancies in data or observations and sources of error

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

For more information on strategies available for reading scientific information and note-taking, refer to *SYSTH* (Chapter 12).

Part 2

Have each group share their information with another group and continue the process until everyone has had the opportunity to hear all the groups. After the sharing, have students analyze whether or not they obtained the same information and, if not, discuss reasons for the differences. They should also talk about the format of their information source and what traits of the information piece make it easier or more difficult to obtain information from it, as well as the quality of various information sources.

Suggestion for Assessment

Have students complete an Exit Slip. Ask them to comment specifically on what type of information source they found easiest to get information from, and what characteristics of the source they liked. For example, students may indicate they like information from a poster, as it has many headings, short sections, pictures, and simple vocabulary. They should also comment on the quality of information sources.

NUTRITION

SPECIFIC LEARNING OUTCOMES

B11-2-08: Describe the functions of each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

Include: ATP production, construction/repair, and regulating

B11-2-09: Identify dietary sources for each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

Testing for Nutrients—Labs (P1, S3, S4, S6, S7, S8)

Have students conduct lab activities to identify the nutrients present in different food samples. Refer to Appendix 2.5A: Testing for Carbohydrates—Student Handout (BLM), Appendix 2.5B: Testing for Carbohydrates (Teacher Background), Appendix 2.6A: Testing for Proteins—Student Handout (BLM), and Appendix 2.6B: Testing for Proteins (Teacher Background).

Suggestions for Assessment

Refer to Appendix 1.8: Student Lab Skills (Teacher Background) in Unit 1 for information on assessing and evaluating student lab skills.

Refer to Appendix 1.13A: Lab Skills Checklist—General Skills (BLM) and Appendix 1.13B: Lab Skills Checklist—Thinking Skills (BLM) in Unit 1 for templates on assessing general lab skills and thinking skills.

What's in It? (I1)

Students examine various convenience foods or meal replacements to determine what types of basic nutrients they contain (e.g., drinks, bars, powders and shakes, frozen dinners, fast food) and in what amounts.

Suggestion for Assessment

Have students do a reflection in their science notebooks. The following questions may be used to stimulate thinking about this learning activity:

- What surprised you?
- What questions came to your mind?

SKILLS AND ATTITUDES OUTCOMES

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens …

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S7: Evaluate the relevance, reliability, and adequacy of data and data collection methods. (GLOs: C2, C4, C5, C8)

Include: discrepancies in data or observations and sources of error

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B110-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

Nutrient Lunches (I1, G1, G2)

Conduct a series of Nutrient Lunches for which groups of students bring snacks of a certain type to class (e.g., for Monday, the assigned group will bring a lipid snack). Before consuming the snack, students work in small groups to identify which snack has the highest amount of the day's nutrient.

Examples:

- lipid lunch = french fries
- protein lunch = cheese, tuna, egg
- carbohydrate lunch = chocolate bar

Suggestion for Assessment

Use an observational checklist to monitor student participation and knowledge.

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-2-10: Evaluate personal food intake and related food decisions. (GLOs: B3, C4, C8)

Examples: percentage of daily values of nutrients, portion size, nutrient labels, balance between lifestyle and consumption...

SLO: B11-2-10

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

In Grade 10 Physical Education/Health Education, students examined the nutritional value of a variety of foods, using *Eating Well with Canada's Food Guide* and other resources (SLO K.5.S2.C.1a).

ACTIVATE

KWL

Have students fill out the first column of a KWL (Know, Want to Know, Learned) chart or another similar chart indicating what they already know about information provided on food labels and what they would like to know.

You Are What You Eat

Have the class watch a video or film about nutrition, such as those listed below. After the viewing, have students reflect on the video or film from a health and nutrition perspective.

Resources

- *Nutrition in a Box: The Video Food Quiz*. Learning Seed Company, 1991. Videocassette. (Available from the Instructional Resources Unit library.)
- *Super Size Me: A Film of Epic Portions.* Dir. and Prod. Morgan Spurlock. Samuel Goldwyn Films, 2004. Film.

ACQUIRE/APPLY

Nutrition Labelling—Information and Learning Activities (P2, P3)

WP

Nutrition facts and ingredient lists are the foundation of food labels since they provide an overview of what is in the food. They are present on most prepackaged foods. Nutrition claims are not always provided. When they are, they are highly visible and can highlight a specific aspect of the food that may be of interest to consumers.

SKILLS AND ATTITUDES OUTCOMES

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)
Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)
Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Health Canada's *Food and Nutrition* website (see <www.hc-sc.gc.ca/fn-an/index-eng.php>) contains information for various groups:

- **Consumers:** The Interactive Nutrition Label and Quiz can be used to help students understand and learn how to use nutrition information on food labels.
- **Educators:** A variety of multimedia resources can be used for introducing students to the nutrition information on food labels and teaching them about how it can support healthy eating choices. Included are a ready-to-use presentation on nutrition labelling and a collection of ready-to-use articles and fact sheets.
- **First Nations, Inuit, and Métis:** *Eating Well with Canada's Food Guide: First Nations, Inuit and Métis* is a new food guide that includes both traditional foods and store-bought foods. A ready-to-use presentation about this new *Food Guide* is available on the website.

Teachers can select which components of this material to share with students and which learning activities to carry out. The goal is to have students understand what information is provided on food labels and how to use this information to make healthy food choices.

As a culminating activity, have students write a piece for inclusion in their Wellness Portfolio. This piece could take the form of a letter to themselves identifying what (one or more things) they would like to do to improve their food choices, based on what they have learned.

Suggestion for Assessment

Depending on the particular components of the Health Canada website that are used with students, a variety of assessments can be used. One suggestion is to use real food labels and have students determine which food choice would be best for someone in a particular situation.

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-2-10: Evaluate personal food intake and related food decisions. (GLOs: B3, C4, C8)

Examples: percentage of daily values of nutrients, portion size, nutrient labels, balance between lifestyle and consumption ...

What Am I Eating? What Is My Lifestyle? (P2, P3, S6, S8, I1, I4)

Have students monitor and record their own eating habits for a three-day period. Students collect the food labels or food information for all the food items they consume and evaluate their eating habits using *Eating Well with Canada's Food Guide* (Health Canada). Students can use *FoodFocus* (Prowse) software to evaluate their food intake (available from the Instructional Resources Unit library).

For this same time period, students could also keep track of their physical activity (e.g., walk to school).

Students write a summary report in which they draw conclusions about their diet and suggest changes they could make. They also reflect on their activity level and what this lifestyle might mean to their overall health. They could suggest how they could improve their lifestyle as well. Students' reports can be included in their Wellness Portfolios.

Suggestion for Assessment

Have students select another student with whom to share their report. Have the selected student carry out a peer assessment of the suggestions made.

- Were the suggested improvements to diet practical? Would they be effective? If not, why not? Other suggestions?
- Were the suggested improvements to activity level practical? Would they be effective? If not, why not? Other suggestions?

Creating a Meal (P2, P3)

Have students assess their ability to plan a healthy meal by completing a learning activity from a website such as the following. Students could include their work from this learning activity in their Wellness Portfolios.

Resource Link

- Dietitians of Canada. "Let's Make a Meal!" *Eat Well, Live Well*. <www.dietitians.ca/public/content/eat_well_live_well/english/menuplanner/overview.asp>.

SKILLS AND ATTITUDES OUTCOMES

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

NOTES

DISORDERS

SPECIFIC LEARNING OUTCOMES

B11-2-11: Investigate and describe conditions/disorders that affect the digestive process. (GLOs: B3, C6, D1)

SLO: B11-2-11

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

What Do You Think?

Begin a discussion with the class by asking:

What would happen to you if you could not absorb nutrients efficiently or if you could not absorb them at all?

ACQUIRE/APPLY

Coping with a Disorder (W1, P4)

Invite a guest speaker to speak to students about a disorder, either from a medical perspective (e.g., a doctor) or a personal perspective (e.g., someone suffering from the disorder). Have students prepare questions in advance to address both the medical aspects and the treatment aspects of the disorder. Several guest speakers can be brought in throughout the course. Ensure that the speakers represent a diversity of cultural perspectives and approaches to treating illness (e.g., traditional medicines, homeopathy). Encourage students to develop an understanding of and a respect for this diversity.

Suggestion for Assessment

Have students reflect on questions such as the following:

- What surprised you?
- What did you find interesting?
- What do you question?

Unravelling the Enigma of Vitamin D (I1, W2)

The article in Appendix 2.7A: Unravelling the Enigma of Vitamin D (BLM) contains a historical look at the development of our understanding about vitamins, and Vitamin D in particular, as scientists first attempted to understand rickets and other diseases. There are a variety of possible approaches to this assignment. Whether students read the article individually or in small groups, they should be encouraged to use effective reading strategies to acquire new knowledge from the lengthy text. This includes activating prior knowledge before the reading, taking some form of notes

SKILLS AND ATTITUDES OUTCOMES

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models …

B110-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. (GLO: B4)

B11-0-W2: Appreciate the contributions of scientists, including Canadians, to the field of human biology. (GLOs: A4, B4)

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during the reading, and having an opportunity to discuss/reflect on what they read following the reading. The questions provided in Appendix 2.7B: Unravelling the Enigma of Vitamin D—Student Questionnaire can help with this last step. They can be answered individually or in small groups.

Suggestion for Assessment

Whatever the form of assessment used, students should be made aware of the criteria beforehand. "Answers" to the questions provided in Appendix 2.7C: Unravelling the Enigma of Vitamin D (Teacher Background) can be assessed by the teacher, or shared and debated with other groups, to create an agreed-upon class answer. One or more of the questions could be used in a formal written assessment with established criteria (e.g., uses full sentences, includes examples).

DISORDERS

SPECIFIC LEARNING OUTCOMES

B11-2-11: Investigate and describe conditions/disorders that affect the digestive process. (GLOs: B3, C6, D1)

Share the Information (I1, I2, I3, U2)

Students research a specific problem or condition associated with the digestive system. Students may be given the option of sharing this information in the format of their choice (e.g., oral presentation, informational brochure, essay). Regardless of the format selected, student work must contain the following information:

- causes of the problem or condition
- symptoms
- treatments (include a range of treatments, including non-Western, if possible)
- prevention
- indication of whether the condition constitutes a problem with mechanical digestion, chemical digestion, or absorption

Alternative: Similar assignments appear throughout the course related to different body systems. At this point in the course, students may be asked to select one body system for a research project. These projects become due as each of the body systems is addressed throughout the course. For more details, refer to Appendix 2.8: Human Disorders Assignment (BLM).

Suggestion for Assessment

Develop assessment criteria with the students. The list above can form the basis of the "content" section of the assessment. Additional criteria can relate to the effectiveness of the presentation.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models …

B110-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. (GLO: B4)

B11-0-W2: Appreciate the contributions of scientists, including Canadians, to the field of human biology. (GLOs: A4, B4)

What's My Diagnosis? (G1, G2, G3, U2)

Set up a series of stations for groups of students to diagnose problems that affect the digestive process and develop treatment plans. Refer to Appendix 2.9: What's My Diagnosis? (Teacher Background).

Suggestion for Assessment

Once groups of students have diagnosed and treated all patients in the What's My Diagnosis? learning activity, they bring their sheet to the teacher to be checked. If students have misdiagnosed any patients, they are sent back to re-examine them. Assess groups on suggested treatments. A variation of this learning activity can be used as an end-of-unit assessment component where students are given a similar task and asked to provide the diagnosis.

DECISION MAKING

SPECIFIC LEARNING OUTCOMES

B11-2-12: Use the decision-making process to investigate an issue related to digestion and nutrition. (GLOs: B3, C4, C5, C8)

SLO: B11-2-12

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Brainstorming

Have the class carry out a brainstorming session to identify current issues that relate to nutrition and health. The suggestions from the class can be compiled and then grouped according to given criteria (e.g., whom the issue affects, level of importance).

Note: Students may use this brainstormed list to decide what issue they (or the class) want to investigate in the decision-making learning activity to follow.

ACQUIRE/APPLY

Decision Making (D1, D2, D3, D4, D5, D6)

Give students the opportunity to investigate real-life issues related to nutrition and wellness. This investigation should include some type of decision-making process. The type of decision can vary greatly. For example, it could be

- a very personal/individual decision on a particular topic for inclusion in the Wellness Portfolio (e.g., How should I go about losing weight? What should I do about a friend who I think is anorexic?)
- a school or community decision (e.g., Should pop/chip machines be removed from schools?)
- a far-reaching decision (e.g., Should milk cost the same throughout the province?)

A number of approaches can be used to simulate a real-life context or to promote interaction between students (e.g., a town-hall meeting, a formal debate). For more details, refer to Appendix 2.10: Decision Making (Teacher Background).

Note: Unit 3 provides information on a debating strategy called Creative Controversy (Baloche, et al.). For more details, see *Senior 2 English Language Arts: A Foundation for Implementation* (Manitoba Education and Training, Senior 2, p. 34).

SKILLS AND ATTITUDES OUTCOMES

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-D6: Evaluate the process used by self or others to arrive at a decision. (GLOs: C4, C5)

Suggestions for Assessment

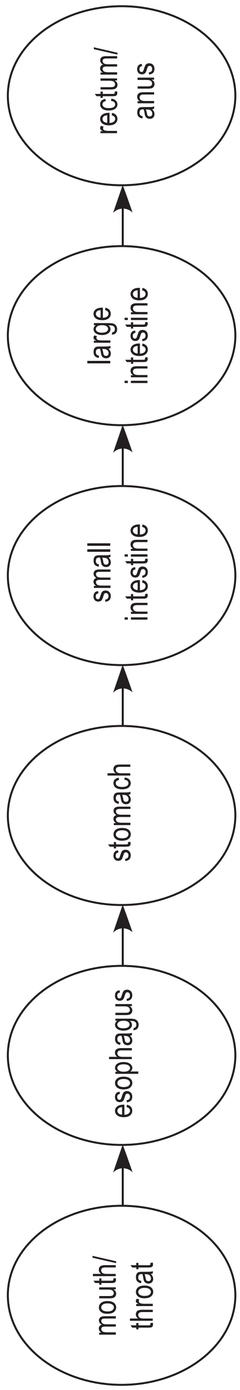
The type of assessment used will vary, depending on the approach taken, but it should focus on the student's ability to demonstrate the skills outlined in Cluster 0.

NOTES

UNIT 2:
DIGESTION AND NUTRITION

APPENDICES

Appendix 2.1:
Concept Map of the Digestive System (BLM)



Appendix 2.2A: Enzymatic Factors in the Digestion of Lipids—Student Handout (BLM)

Purpose

To investigate the role of enzymes in lipid digestion.

Material and Procedure

1. Obtain five test tubes and mark them #1 to #5.
2. For each test tube, measure and add the materials specified in the table below according to the test tube number. Place test tubes requiring a water bath in the one provided.
3. Once all the solutions have been created, wait 15 minutes.
4. Record observations and note the colour of each solution at the bottom of the table below.

Note: Phenol red is an indicator for pH. The colour red indicates a solution is a base. Yellow indicates the solution is an acid. pH 6.5 (yellow); pH 7.0 (orange); pH 8.2 (red)

	Test Tube #1	**Test Tube #2**	**Test Tube #3**	**Test Tube #4**	**Test Tube #5**
Water (mL)	5	5	5	5	5
Fresh cream (mL)	5	5	5	5	5
Phenol red (drops)	4	4	4	4	4
Bile salts		Pinch	Pinch		Pinch
Pancreatin (mL)			5	5	5
Water bath (37°C)	X	X	X	X	
Results					
Observations					
Colour					

Analysis

1. What is the role of the substances in each of the test tubes: fresh cream, bile salts, and pancreatin?
2. What is the function of Test Tube #1? Explain your response.
3. Compare the contents of Test Tubes #1 and #2. What do the results obtained indicate?
4. Compare the results of Test Tubes #1 and #2 with Test Tubes #3, #4, and #5. What do the results obtained indicate?
5. Both Test Tubes #3 and #5 changed colour. Did you notice any difference in how quickly the colour change took place? What is a possible explanation for this difference?
6. Both Test Tubes #3 and #4 changed colour. Did you notice any difference in how quickly the colour change took place? What is a possible explanation for this difference?
7. Create a summary list of the factors that increased the rate of digestion.

Conclusion

Under the heading "Conclusion," write an interpretation of your results, identify sources of error, and so on.

Appendix 2.2B: Enzymatic Factors in the Digestion of Lipids (Teacher Background)

Objective

To investigate the role of enzymes in lipid digestion.

Background Information

Lipids include fats, such as butterfat and oils. Lipids are digested by pancreatic lipase in the small intestine, a process described by the following two reactions:

1. fat $\longrightarrow$ fat droplets (bile emulsifier)
2. fat droplets + water $\longrightarrow$ glycerol + fatty acids (lipase enzyme)

The first reaction is not enzymatic. It is an emulsification reaction in which fat is physically dispersed by the emulsifier (bile) into small droplets. The small droplets provide a greater surface area for enzyme attack. Lipids are hydrophobic and therefore insoluble, so they are hydrolyzed slowly unless an emulsifier is used. As a result, when the fat droplets are exposed to an enzyme and broken down into glycerol and fatty acids, the pH of the solution will go down.

Material and Procedure

You can purchase pancreatin as a salt from a science supply company and then create your own solution by mixing 5 g of pancreatin with 100 mL of distilled water. Bile salts and phenol red can also be purchased from a science supply company.

Results

Students should find results similar to the ones included in the following table. This is an imprecise type of lab, and observations will vary. However, Test Tubes #1 and #2 should show no change and Test Tubes #3, #4, and #5 should have a change. Students should also observe that the change took place most quickly in Test Tube #3, which contained bile salts and was placed in a water bath. The impact of bile salts (increasing surface area) and temperature as factors affecting enzymatic action is discussed in the Analysis questions.

	Test Tube #1	Test Tube #2	Test Tube #3	Test Tube #4	Test Tube #5
Water (mL)	5	5	5	5	5
Fresh cream (mL)	5	5	5	5	5
Phenol red (drops)	4	4	4	4	4
Bile salts		Pinch	Pinch		Pinch
Pancreatin (mL)			5	5	5
Water bath (37°C)	X	X	X	X	
Results					
Observations	*No change*	*No change*	*Change took place quickly*		
Colour	*Red/ Orange*	*Red/ Orange*	*Yellow*	*Yellow*	*Yellow*

Analysis

1. What is the role of the substances in each of the test tubes: fresh cream, bile salts, and pancreatin?

   The fresh cream is the source of a lipid, the bile salts are the emulsifier necessary to break down the lipids in the cream, and the pancreatin is the enzyme necessary to break the fat droplets into fatty acids.

2. What is the function of Test Tube #1? Explain your response.

   Test tube #1 is the control for the experiment to demonstrate what happens when no emulsifiers or enzymes are added to the solution.

3. Compare the contents of Test Tubes #1 and #2. What do the results obtained indicate?

   Both test tubes contain water, fresh cream, and phenol red, and are placed in a water bath. Neither contains pancreatin. Only Test Tube #2 contains bile salts. There is no change of colour in either test tube, indicating that without pancreatin digestion does not take place. Also, the presence of bile salts was not a factor.

4. Compare the results of Test Tubes #1 and #2 with Test Tubes #3, #4, and #5. What do the results obtained indicate?

   Test Tubes #1 and #2 had no change. A colour change took place in Test Tubes #3, #4, and #5. This indicates that digestion took place in #3, #4, and #5 and can be linked to the presence of pancreatin.

5. Both Test Tubes #3 and #5 changed colour. Did you notice any difference in how quickly the colour change took place? What is a possible explanation for this difference?

   Test Tube #3 changed colour more quickly. The only difference between the two test tubes is that Test Tube #3 was placed in a water bath. This would seem to indicate that temperature accelerates enzymatic activity.

6. Both Test Tubes #3 and #4 changed colour. Did you notice any difference in how quickly the colour change took place? What is a possible explanation for this difference?

   Test Tube #3 changed colour more quickly. The only difference between the two test tubes is that Test Tube #3 contained bile salts. This would seem to indicate that the presence of bile salts accelerates enzymatic activity by increasing surface area.

7. Create a summary list of the factors that increased the rate of digestion.

   Increased temperature, increased surface area (caused by emulsification)

Conclusion

Students should state clearly that enzymes are necessary for digestion of lipids to take place. They may also discuss factors that increase the rate of digestion (presence of bile salts—increasing surface area, increase in temperature). However, this evidence was subjective or qualitative and students should recognize this weakness.

Appendix 2.3: Regulatory Systems (BLM)

The human body has two major systems that help the body detect and respond to environmental change and maintain homeostasis: the nervous and endocrine systems. These systems may work either independently or in a coordinated manner.

Nervous Regulatory System

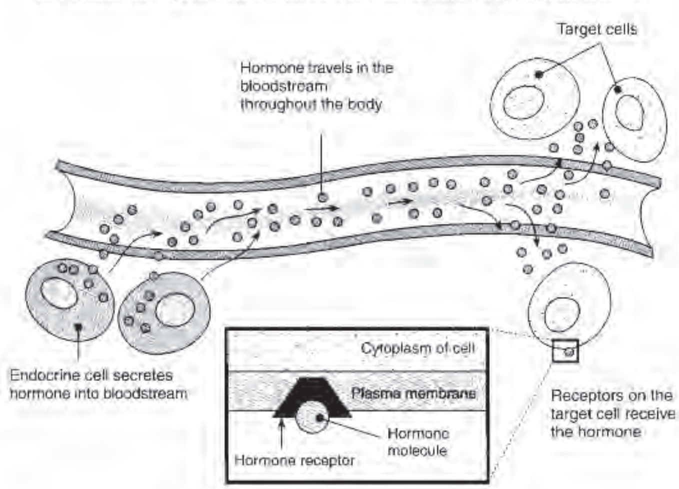
The nervous system contains specialized nerve cells that transmit information in the form of electrochemical impulses along branches that can carry information directly to and from specific target tissues. These impulses can be transmitted over considerable distances and the response is very precise and rapid. More will be learned about the nervous system in a later unit of study.

Hormonal Regulatory Systems*

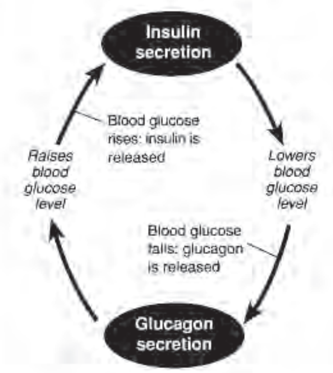
The endocrine system regulates the body's processes by releasing chemical messengers (hormones) into the bloodstream. Hormones are potent chemical regulators: they are produced in minute quantities yet can have a large effect on metabolism. The endocrine system comprises endocrine cells (organized into endocrine glands), and the hormones they produce. Unlike exocrine glands (e.g., sweat and salivary glands), endocrine glands are ductless glands, secreting hormones directly into the bloodstream rather than through a duct or tube. Some organs (e.g., the pancreas) have both endocrine and exocrine regions, but these are structurally and functionally distinct. The basis of hormonal control and the role of negative feedback mechanisms in regulating hormone levels are described below.

The Mechanism of Hormone Action

Endocrine cells produce hormones (chemical messengers) and secrete them into the bloodstream where they are distributed throughout the body. Although hormones are broadcast throughout the body, they affect only specific target cells. These target cells have receptors on the plasma membrane which recognize and bind the hormone (see inset, below right). The binding of hormone and receptor triggers the response in the target cell. Cells are unresponsive to a hormone if they do not have the appropriate receptors.



Antagonistic Hormones



The effects of one hormone are often counteracted by an opposing hormone. Feedback mechanisms adjust the balance of the two hormones to maintain a physiological function. Example: insulin decreases blood glucose and glucagon raises it.

(continued)

*Source: Allan, Richard, and Tracey Greenwood. "Hormonal Regulatory Systems." *Senior Biology 2, 2004. Student Resource and Activity Manual (2003)*: 252. Reproduced by permission of Biozone International.

1. a) Explain what is meant by a **hormone**: ______________________

   ____

   b) Explain what is meant by **antagonistic hormones** and provide an example of two such hormones:

   ____

   Example: ______________________

   c) Explain the role of feedback mechanisms in adjusting hormone levels (explain using an example if this is helpful):

   ____

   ____

2. Explain how a hormone can bring about a response in target cells even though all cells may receive the hormone:

   ____

   ____

3. Explain why hormonal control differs from nervous system control with respect to the following:

   a) The speed of hormonal responses is slower: ______________________

   ____

   b) Hormonal responses are generally longer lasting: ______________________

   ____

Appendix 2.4A: The Role of the Liver in Homeostasis (BLM)

The liver has many important functions. Almost all the blood circulating from the intestines to the heart passes through the liver. Therefore, everything you eat that gets into the bloodstream passes through your liver. The liver then either stores nutrients or breaks them down even more. The liver transforms nutrients into proteins, fats, and cholesterol. It also stores vitamins (A, D, K, and B12), minerals, and carbohydrates.

The liver also plays the role of a filtering system. Toxic substances, including alcohol, are transformed into less harmful substances.

As you have seen in Unit 1, glucose is necessary for cells to produce ATP, the molecule that stores energy. The amount of ATP that the body needs at any one time changes; therefore, the body needs to be able to store glucose when it is not needed, but release glucose when it is needed.

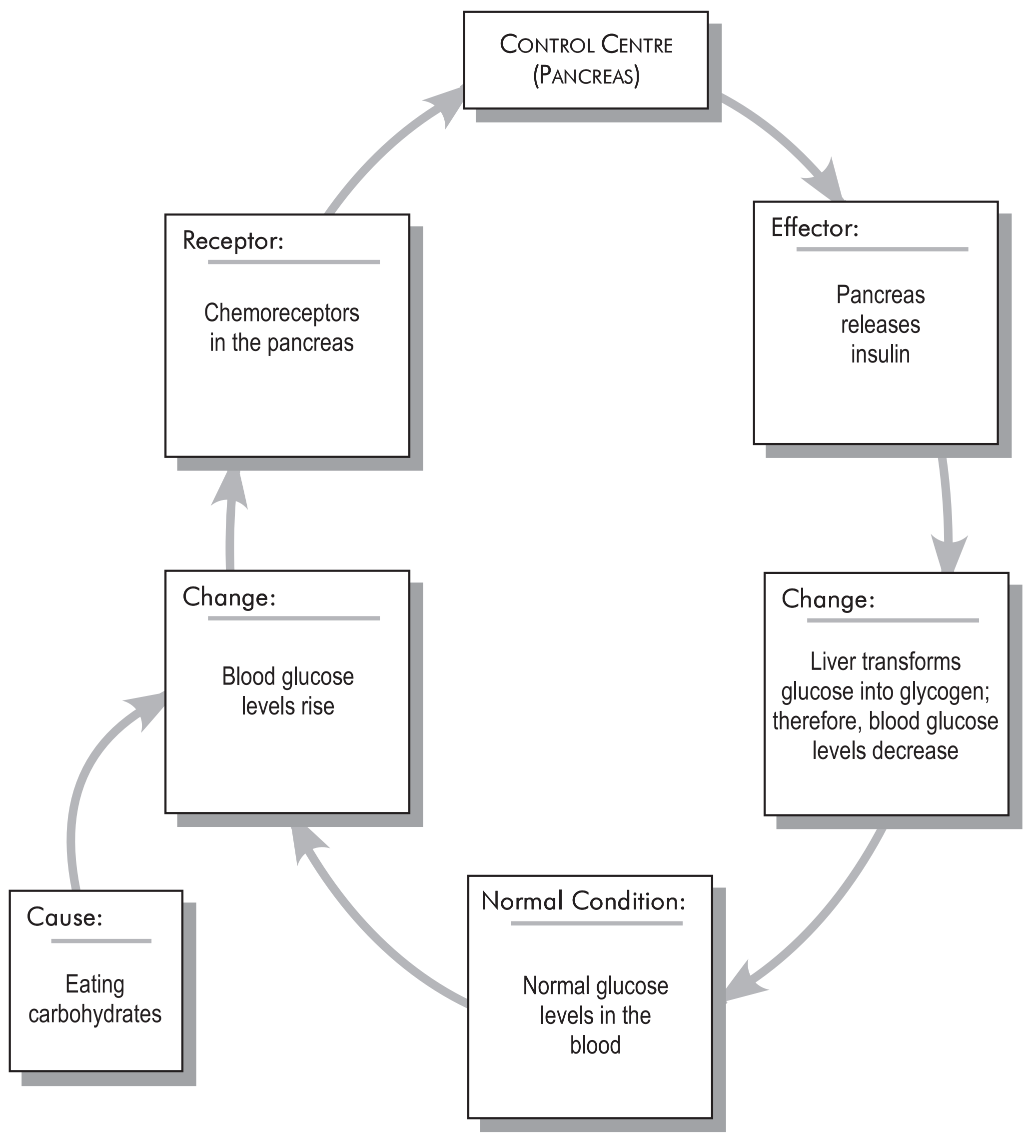
Two hormones responsible for controlling the concentration of glucose in the blood are insulin and glucagon, which are produced in the pancreas. The liver also plays an important role in blood glucose control. It is here that excess glucose is stored in the form of glycogen.

When you eat a meal, blood glucose levels start to rise. When they reach a certain concentration, receptors in the pancreas stimulate the production of insulin. This hormone reaches the liver, which then converts blood glucose into glycogen. Blood glucose levels drop and return to a normal level.

If blood glucose levels drop below a certain level, receptors in the pancreas stimulate the production of glucagon. This hormone reaches the liver, which then converts glycogen into glucose. Glucose is released into the bloodstream and blood glucose levels rise until they return to a normal level.

Appendix 2.4B: The Liver and Negative Feedback (BLM)

Negative Feedback Pathways—Liver and Pancreas



Appendix 2.5A: Testing for Carbohydrates— Student Handout (BLM)

Introduction

One of the major functions of carbohydrates is to provide living cells with a source of energy. Carbohydrates are composed of molecular building blocks known as *monosaccharides*, or *simple sugars*. Glucose is the most well-known simple sugar.

The type of carbohydrate formed is determined by three factors:

- the number of monosaccharide units
- the type of monosaccharide units
- the physical arrangement of these units

Benedict's solution produces a range of colours, depending upon the concentration of monosaccharide (simple sugar) in the sample:

- green—low concentration
- yellow—low to medium concentration
- orange—medium concentration
- reddish/orange—medium to high concentration
- brick red—high concentration

Purpose

To become familiar with a test to indicate the presence of reducing sugars and to classify substances accordingly.

Materials and Samples

Materials	Suggested Samples
two test tubes	milk
hot water bath	potato
eyedropper	apple
goggles	bread
Benedict's solution	apple juice
apron	unsalted cracker
gloves	banana
	plain yogourt
	clear, non-diet pop

Procedure

CAUTION

DO NOT SPILL CHEMICALS ON SKIN OR CLOTHES.

ALL GLASSWARE MUST BE CLEANED
BEFORE AND AFTER EACH TEST.

1. Obtain two test tubes. Mark one **T** (for test) and the other **C** (for control).
2. To both test tubes add a single eyedropperful of Benedict's solution.
3. To the **T** test tube add one eyedropperful of sample to be tested, and to the **C** test tube add an eyedropperful of water.
4. Place both test tubes in the community hot water bath for four minutes. Create a table to record the initial and final colours.
5. Repeat for all other samples assigned.

Analysis

1. From your tested samples identify the sample that had the highest concentration of sugar and the sample that had the lowest concentration.
2. Differentiate between the structure of a molecule of glucose and a molecule of sucrose and record differences in the table below.

Sucrose	Parameter	Glucose
	Number of atoms	
	Relative size	

3. List the samples that you tested where sugar was present.
4. When testing a sample with Benedict's solution, the colour changes from blue to violet. Is a sugar present? Explain.
5. Specify the process on the planet that creates carbohydrates.
6. What is the purpose of the control test tube?
7. Why must the glassware be clean in biochemical testing?

Appendix 2.5B: Testing for Carbohydrates (Teacher Background)

Introduction

An important function of carbohydrates is to provide living cells with a source of energy. Carbohydrates are composed of molecular building blocks known as *monosaccharides*, or *simple sugars*. Glucose is the most well-known simple sugar.

The type of carbohydrate formed is determined by three factors:

- the number of monosaccharide units
- the type of monosaccharide units
- the physical arrangement of these units

Benedict's solution produces a range of colours, depending upon the concentration of monosaccharides (simple sugar) in the sample:

- green—low concentration
- yellow—low to medium concentration
- orange—medium concentration
- reddish/orange—medium to high concentration
- brick red—high concentration

Note: Benedict's solution is used to test urine for glucose in diagnosing diabetes. Be sure to test the pop you plan to use in advance as some brands may work better than others.

Purpose

To become familiar with a test to indicate the presence of reducing sugars and to classify substances accordingly.

Materials and Samples

Materials	Suggested Samples
two test tubes	milk
hot water bath	potato
eyedroper	apple
goggles	bread
Benedict's solution	apple juice
apron	unsalted cracker
gloves	banana
	plain yogourt
	clear, non-diet pop

Procedure

CAUTION

DO NOT SPILL CHEMICALS ON SKIN OR CLOTHES.

ALL GLASSWARE MUST BE CLEANED
BEFORE AND AFTER EACH TEST.

1. Obtain two test tubes. Mark one **T** (for test) and the other **C** (for control).
2. To both test tubes add a single eyedropperful of Benedict's solution.
3. To the **T** test tube add one eyedropperful of sample to be tested and to the **C** test tube add an eyedropperful of water.
4. Place both test tubes in the community hot water bath for four minutes. Create a table to record the initial and final colours.
5. Repeat for all other samples assigned.

Note: Have students record their findings in a data table similar to the one below.

Samples	Initial Colour	Final Colour

Analysis

1. From your tested samples identify the sample that had the highest concentration of sugar and the sample that had the lowest concentration.

   Results will vary, depending on the particular samples tested. Apples, apple juice, bananas, and non-diet pop are generally higher in concentration of monosaccharides, whereas milk, potatoes, breads, unsalted crackers, and plain yogourt are lower.

2. Differentiate between the structure of a molecule of glucose and a molecule of sucrose and record differences in the table below.

Sucrose	Parameter	Glucose
46	Number of atoms	*24*
Larger	Relative size	*Small*

3. List the samples that you tested where sugar was present.

   Answers will vary, depending on samples used.

4. When testing a sample with Benedict's solution, the colour changes from blue to violet. Is a sugar present? Explain.

   No. Violet is not in the colour range for a positive Benedict's test.

5. Specify the process on the planet that creates carbohydrates.

   Photosynthesis

6. What is the purpose of the control test tube?

   It is meant as a comparison to eliminate the temperature variable.

7. Why must the glassware be clean in biochemical testing?

   To prevent contamination and invalidation of a test.

Appendix 2.6A:
Testing for Proteins—Student Handout (BLM)

Introduction

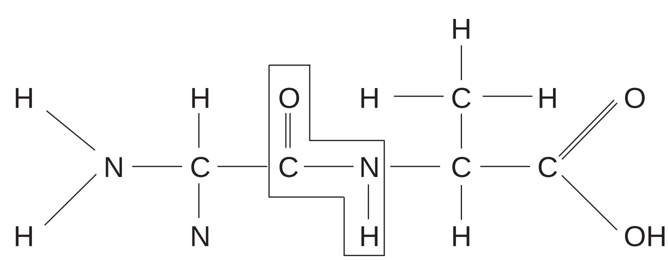
Proteins are massive molecules containing thousands of atoms.

The molecules are composed of subunits called *amino acids.* These amino acids, of which there are 22 different kinds, all contain an amino group (NH_2) and a carboxyl group (–COOH). In a protein molecule the amino acids are joined together by a carbon-nitrogen bond called a *peptide bond.*

The peptide bond links the carboxyl group of one amino acid to the amino group of another (see the figure below).

All proteins contain these elements:

Carbon
Oxygen
Hydrogen
Nitrogen



Purpose

To test samples for the presence of amino acids.

Materials and Samples

Materials	Suggested Samples
goggles	milk
apron	egg white
gloves	gelatin
eyedropper	tofu
two test tubes	apple
test tube rack	unsalted cracker
biuret reagent	potato

Biuret reagent reacts with certain amino acids to produce a striking colour change. The presence of a *violet* or *purple* colour indicates a positive test; any other colour is a negative result.

Procedure

1. Add one eyedropperful of water into one test tube, and to the other test tube add a comparable amount of the sample to be tested.
2. To each test tube add the following: one eyedropperful of biuret reagent.
3. Agitate the system for a couple of minutes and then observe the colours. Record the colours in the table that follows.
4. Clean your test tubes well and repeat the test with the other samples that are provided.

Results

Sample	Post-Reaction Colour	Protein Present (+ or –)

Analysis

1. Why must the test tubes be cleaned after each test?
2. The test tube with the water acts as a control for the biochemical testing procedure. What is the value of this control?
3. Differentiate between proteins and carbohydrates under the following topics:

Topic	Carbohydrates	Proteins
Elements present		
Relative size		
Chemical test for...		
Building block (subunit)		
Uses	1.	1.
	2.	2.

4. Why are important molecules such as enzymes and antibodies composed of proteins and not of carbohydrates?

Appendix 2.6B: Testing for Proteins (Teacher Background)

Introduction

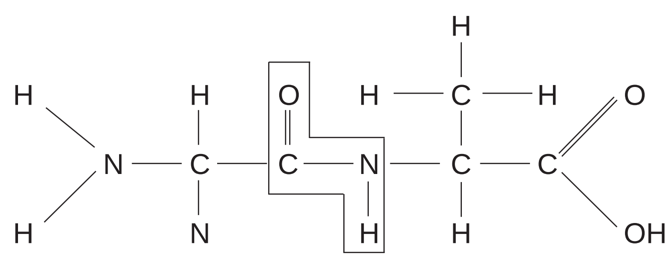
Proteins are massive molecules containing thousands of atoms.

The molecules are composed of subunits called *amino acids.* These amino acids, of which there are 22 different kinds, all contain an amino group (NH_2) and a carboxyl group (–COOH). In a protein molecule the amino acids are joined together by a carbon-nitrogen bond called a *peptide bond.*

The peptide bond links the carboxyl group of one amino acid to the amino group of another (see the figure below).

All proteins contain these elements:

Carbon
Oxygen
Hydrogen
Nitrogen



Purpose

To test samples for the presence of amino acids.

Materials and Samples

Materials	Suggested Samples
goggles	milk
apron	egg white
gloves	gelatin
eyedropper	tofu
two test tubes	apple
test tube rack	unsalted cracker
biuret reagent	potato

Biuret reagent reacts with certain amino acids to produce a striking colour change. The presence of a *violet* or *purple* colour indicates a positive test; any other colour is a negative result.

Procedure

1. Add one eyedropperful of water into one test tube, and to the other test tube add a comparable amount of the sample to be tested.
2. To each test tube add the following: one eyedropperful of biuret reagent.
3. Agitate the system for a couple of minutes and then observe the colours. Record the colours in the table that follows.
4. Clean your test tubes well and repeat the test with the other samples that are provided.

Results

Results will vary, depending on the samples used. The table below provides an example of what student data might look like.

Sample	Post-Reaction Colour	Protein Present (+ or –)
milk	*No change*	–
egg white	*Purple*	+
gelatin	*Purple*	+
tofu	*Purple*	+
apple	*No change*	–
unsalted cracker	*No change*	–
potato	*No change*	–

Analysis

1. Why must the test tubes be cleaned after each test?

   The test tubes must be cleaned because there may be protein residue in the test tubes, which would result in an incorrect conclusion.

2. The test tube with the water acts as a control for the biochemical testing procedure. What is the value of this control?

   This test tube demonstrates what would occur without the presence of a protein and can be used for reference. It checks whether the reagents/solutions are also contaminated and provides a basis for comparison.

3. Differentiate between proteins and carbohydrates under the following topics:

Topic	Carbohydrates	Proteins
Elements present	*C/H/O*	*C/H/O/N*
Relative size	*Smaller*	*Larger*
Chemical test for...	*Benedict's solution*	*Biuret reagent*
Building block (subunit)	*Monosaccharide*	*Amino acid*
Uses	*1. Structural*	*1. Enzymes*
	2. Energy	*2. Hormones*

4. Why are important molecules such as enzymes and antibodies composed of proteins and not of carbohydrates?

   Carbohydrate structure is fixed. In proteins the structure can vary and, therefore, accommodate the needs of the cell.

Appendix 2.7A: Unravelling the Enigma of Vitamin D* (BLM)

by Roberta Conlan and Elizabeth Sherman, with the assistance of David R. Fraser, Mark R. Haussler, Michael F. Holick, Robert Neer, Anthony W. Norman, and Munro Peacock

Summary

Rickets was a common disease afflicting children in the eighteenth century. However, the cause for it was not well understood, and many children died because there was no cure (see Tracing the Cause of Disease). As physicians began investigating other diseases such as beriberi, they realized that there were factors in food other than proteins and salts which were essential to health. Research into these "accessory food factors" led scientists to demonstrate the existence of vitamins (see "A Substance Different from Protein and Salts ..."). As scientists turned their attention to rickets again, they found that exposure to sunlight seemed to be an effective treatment. Physicians also were attempting to isolate nutrients in food that might help and found that an unknown nutrient in cod-liver oil was effective against rickets. Following the designation of vitamins in alphabetic order, they dubbed this new nutrient vitamin D.

Scientists explored the relationship between nutrition and irradiation of foods and found that irradiated foods contained the nutrient that seemed to fight rickets (see Closing in on Rickets). But scientists still knew nothing of what this nutrient was and how it worked to cure rickets. The search continued for the exact substance in food and skin that was activated by ultraviolet radiation. Through extensive research, scientists isolated 3 forms of vitamin D, which made it possible to synthesize the vitamin in large quantities (see Animal, Vegetable, or Mineral?). Research continued to determine how vitamin D worked in the body and scientists were able to determine the process by which vitamin D regulates the amount of calcium in the body (see Vitamin D's Connection to Calcium Control). Further investigations have shown that vitamin D plays many roles beyond maintaining the body's calcium levels (see More Than Just a Way to Regulate Calcium).

Introduction

Most of us know that to maintain good health we need to eat a balanced diet that includes fruits, vegetables, grains, protein, and some fat. In this age of fast food and missed meals, however, many of us also take supplements to ensure that we're getting the minimum daily requirement of essential vitamins and minerals—nutrients necessary only in very small quantities to prevent disease and to keep us optimally healthy.

The first of these so-called micronutrients was discovered a little over a century ago, with investigations into the causes of such diseases as scurvy, beriberi, and rickets. The following article focuses on the twists and turns leading to the discovery and understanding of one such nutrient: vitamin D, a substance that occurs naturally in only a few foods and that is

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*Source: "Unravelling the Enigma of Vitamin D." <www.beyonddiscovery.org/content/view.txt.asp?a=414>. Reproduced by permission of the National Academies of Sciences.

also manufactured in the skin when a precursor interacts with the short ultraviolet rays of the sun. Without adequate levels of 1,25-dihydroxyvitamin D3—the active metabolite of vitamin D—in the blood, the body cannot absorb and use the dietary calcium essential for such vital functions as the electrochemical signalling between brain cells. When dietary calcium and the mineral phosphorus are not properly absorbed through the intestine, the body also cannot build strong bones. In children, vitamin D deficiency results in the once common disease known as rickets, which leaves its lifelong mark of bowed legs and deformed ribs. In adults, the result is the bone disease osteoporosis.

Today, as growing numbers of Baby Boomers celebrate their fiftieth-plus birthdays, concerns about the brittle bones and fractures associated with advanced age are focusing renewed attention on vitamin D. Increasingly, researchers are learning that vitamin D is essential in maintaining health and preventing disease not just during the crucial growing years of childhood but throughout life. Recent studies show that vitamin D insufficiency may even be, in one researcher's words, "an unrecognized epidemic" among both women and men who are middle aged and older. In addition to affecting bone growth, scientists are finding that vitamin D and calcium may affect diseases and disorders as disparate as colon cancer, multiple sclerosis, premenstrual syndrome, psoriasis, high blood pressure, and depression.

A Case of Mistaken Identity

One of the reasons vitamin D was a puzzle to scientists for so many years was that it was initially misidentified as a true vitamin, that is, an essential substance that our bodies cannot manufacture and which, therefore, can only be obtained from our food. But, unlike essential dietary trace elements, such as vitamins A, B, and C, which humans must get directly from food, vitamin D can be produced in the body through a photosynthetic reaction when the skin is exposed to sunlight. The resulting substance is only a precursor, however, which must then undergo two transformations—first in the liver and then in the kidney—to become the biologically active substance the body uses. This active form of vitamin D is a hormone, chemically akin to familiar steroid hormones, such as the sex regulators testosterone and estrogen and the stress regulator cortisol.

Arriving at a clear understanding of the multifaceted nature of vitamin D and its role in the body—especially its relationship to calcium—was the culmination of three different avenues of research. The earliest investigators were interested in the causes and prevention of particular diseases, such as scurvy, beriberi, and rickets. On a separate track, scientists were examining how the known primary constituents of food (proteins, fats, carbohydrates, salts, and water) affected health and growth. Work along these two fronts dovetailed to yield the concept of vitamins—an essential micronutrient in food—and to establish that vitamin deficiencies can lead to disease. This allowed a lack of vitamin D to be identified as the cause of rickets. But many aspects of this "vitamin" remained baffling, since it was actually a hormone whose active form is produced in our bodies in response to regulatory signals. Understanding of the vitamin D hormone and its roles in human physiology would require the knowledge and tools of a third line of research that had been developed by organic chemists studying sterols—the steroid alcohols (such as cholesterol) that occur in both animal and plant fats. Just as a tapestry image emerges from the weaving of many threads, clues from each line of inquiry eventually formed a pattern that solved the enigma of vitamin D.

Tracing the Cause of Disease

The first solid hint that a specific dietary deficiency could lead to disease came in 1754. In that year the Scottish naval surgeon James Lind showed that scurvy—the painful and sometimes fatal bane of mariners on long ocean voyages—could not only be cured but also prevented with the juice of oranges, lemons, and limes. By the late eighteenth century, British sailors (soon nicknamed "Limeys") were reaping the benefit of Lind's discovery.

Meanwhile, the advent of the Industrial Revolution in Britain in the late 1700s brought with it a different scourge: rickets. The disease itself had first been described by physicians in the mid 1600s, but it was then relatively rare. By the nineteenth century, however, as more and more families left the outdoor life of the farm for factory work in the smoggy air of industrial cities, rickets had become a plague all over Europe. Symptoms of the disease were unmistakable. The bones of afflicted infants remained soft, like cartilage, and the babies were slow to sit, crawl, and walk. As the children grew, their soft bones bent under the additional weight, leaving the children with rickets' telltale pigeon breast, bowed legs, or knock-knees. Rachitic children (that is, children with rickets) also suffered from tetany: painful spasms of the hands, feet, and larynx, along with difficulty in breathing, nausea, and convulsions. This condition, later found to be symptomatic of insufficient calcium, was often so severe that children died.

Throughout the nineteenth century, sporadic reports of cures for rickets surfaced, but with little effect. In 1822, for example, a Polish physician observed that children in Warsaw suffered severely from rickets, whereas the disease was virtually unknown in the city's rural outskirts. After experimenting with the two groups, he concluded that sunbathing cured rickets. Five years later, a French researcher reported cures among those given the home remedy cod-liver oil. Neither treatment gained widespread attention, in part because the prevailing medical wisdom was that people needed only to get adequate amounts of the so-called macronutrients—proteins, fats, and carbohydrates—in order to maintain health. However, researchers looking into the causes of such diseases as pellagra and beriberi began to suspect that the macronutrients might not be the whole story—that, in fact, there was more to ordinary food than met the eye.

"A Substance Different from Protein and Salts . . ."

In the late 1880s Dutch physician Christiaan Eijkman was sent to the East Indies (now Indonesia) to investigate why beriberi was so widespread in the region. Eijkman observed that hens in his Jakarta laboratory suffered symptoms of nerve disease (polyneuritis) that were strikingly similar to those for beriberi—including muscle weakness, nerve degeneration, and paralysis. He then began a series of experiments to try to find a culprit organism, which he assumed was the cause. (Like most of his contemporaries, Eijkman was influenced by the work of Louis Pasteur and believed that a bacterium caused beriberi.)

Eijkman failed in this effort, but in 1897 he did succeed in establishing something more significant. He showed that the hens contracted the beriberi-like polyneuritis soon after their feed was changed to polished rice—that is, rice whose outer husk had been removed. He also proved that by adding rice bran (the parts removed in polishing) to the hens' food, the disease could be cured.

Eijkman and his successor, Gerrit Grijns, later used water or ethanol to extract the mysterious antineuritic factor from rice hulls. "There is present in rice polishings a substance different from protein and salts," the two researchers wrote in 1906, "which is indispensable to health and the lack of which causes nutritional polyneuritis."

In 1926 B. C. P. Jansen and W. Donath, two Dutch chemists working in Eijkman's old laboratory in Jakarta, crystallized the water-soluble antineuritic factor—now called vitamin B1, or thiamine—from rice bran.

Another researcher soon after the turn of the century also came to believe in the existence of certain "accessory food factors." English biologist Sir Frederick Gowland Hopkins developed this concept in the course of work that began with his discovery in 1901 of the amino acid tryptophan. Building on techniques developed in this research, Hopkins went on to perform a series of now classic experiments demonstrating that whole foods (as opposed to purified forms of proteins, fats, and carbohydrates) contain certain unknown constituents essential to health and growth.

Biochemist Casimir Funk, whose own work led him to believe these factors were amines (compounds derived from ammonia), suggested they be called "vital amines" or "vitamines" for short. The "e" was later dropped when scientists realized that these various nutrients have different chemical properties and functions and that many contain no amines at all. Hopkins and Christiaan Eijkman—in belated recognition of his seminal work with beriberi—would later share the 1929 Nobel Prize for Physiology or Medicine for the discovery of essential nutrient factors.

At about the same time that Hopkins was demonstrating the existence of vitamins, other researchers were investigating the effects of different diets on the health of experimental animals. Over the next two decades, they would identify a number of vitamins, demonstrating again and again that these essential nutrients are not equally distributed in the foods we eat.

In 1913, for example, Wisconsin researchers Elmer McCollum and Marguerite Davis discovered a fat-soluble accessory substance. By feeding rats diets of different foods and observing the effects on the animals' growth and health, McCollum and Davis found that the new substance is present in egg yolk and butter fat but absent from lard and other fats. They called the nutrient "fat-soluble vitamin A." These scientists were further able to show that vitamin A in the diet prevents night blindness and the eye disease xerophthalmia. The team of L. B. Mendel and T. B. Osborne independently published similar results within weeks.

Closing in on Rickets

By this time, a number of studies had focused attention again on rickets, which was still a severe problem in Scotland and in parts of northern Europe. A few investigators approaching the question from another direction had picked up the nearly forgotten clue about the effectiveness of sunlight. In 1892, British scientist T. A. Palm found a relationship between the geographic distribution of rickets and the amount of sunlight in the region. In 1913, University of Wisconsin's H. Steenbock and E. B. Hart made a more direct link, showing that lactating goats kept indoors lose a great deal of their skeletal calcium, whereas those kept outdoors do not. Six years later, in 1919, the German researcher K. Huldschinsky carried out a remarkably innovative experiment and cured children of rickets using artificially produced ultraviolet light. Two years after that, researchers Alfred F. Hess and L. F. Unger of Columbia University showed that by simply exposing rachitic children to sunlight, they were able to cure them of the disease.

On the nutritional front, in the meantime, British physician Sir Edward Mellanby, still searching for a dietary deficiency as the cause of rickets, decided in 1918 to test porridge, the staple food of Scotland, by feeding dogs exclusively on oats. Inadvertently, he also kept the animals indoors throughout the experiment, thereby inducing rickets. When he cured the dogs of the disease by feeding them cod-liver oil, Mellanby naturally credited the oil's recently identified vitamin A with the cure.

On learning of Mellanby's experiments, McCollum, who had since moved from Wisconsin to Johns Hopkins University in Baltimore, decided to pursue them further. From his own work on isolating vitamin A, McCollum had found that certain foods may contain more than one accessory food substance. He thus designed a series of ingenious experiments to follow up on Mellanby's findings and discover what else, if anything, cod-liver oil might have to offer. He began by heating and aerating the oil to destroy its vitamin A. As expected, the treated oil no longer cured night blindness. But, to everyone's surprise, it did remain effective against rickets. Clearly, an unknown essential nutrient was responsible. In his 1922 publication of these experiments, McCollum followed the designations of vitamins in alphabetic order; since vitamins B and C had recently been named, he dubbed the new miracle worker "vitamin D."

By the early 1920s, then, it appeared that the world had two cures for rickets: cod-liver oil and irradiation—that is, exposure to sunlight or ultraviolet light. Despite this promise, the disease remained intractable. Although physicians knew that sunlight was essential for young bones, the streets of industrial cities were as smoky and sunless as ever. And changing people's dietary habits to include prescriptive doses of cod-liver oil was no easy matter.

Then came a series of experiments that tied together the nutritional research and the findings concerning irradiation, offering a solution to this critical piece of the vitamin D puzzle and paving the way for a widely available cure for rickets. During the course of extensive nutritional research, Harry Goldblatt and Katherine Soames, working in London, discovered that the livers from irradiated rats, when fed to other rats, were growth promoting, whereas the livers from unirradiated rats were not. In the early 1920s, two teams of researchers—H. Steenbock and A. Black, and Alfred Hess and Mildred Weinstock—followed up on this strand of research, as well as Huldschinsky's lead, by further experimenting with the effect of ultraviolet light on foods fed to rats.

Independently, the two teams of researchers irradiated excised skin as well as such food substances as vegetable oils, egg yolk, milk, lettuce, or rat chow and found that irradiation produced a substance that seemed to work on rickets much as the vitamin D in cod-liver oil did. Rats that were fed irradiated foods or irradiated skin were protected against rickets, whereas those fed unirradiated foods or skin were not. Recognizing that simply irradiating certain foods that were common in most people's diets could spare large numbers of children from the bone disease, Steenbock patented the food irradiation process using ultraviolet light in 1924, donating all future proceeds to support research at the University of Wisconsin.

Animal, Vegetable, or Mineral?

By 1924, the practical side of the battle against rickets had been won. Across the United States, children began consuming irradiated milk and bread and, seemingly overnight, the imminent threat of epidemic disease dwindled to a half-forgotten historical event. But the quest to understand vitamin D was only just beginning, for scientists still knew almost nothing of what it was or how it worked.

The search continued for the exact substance in food and skin that was activated by ultraviolet irradiation. Several teams of researchers—Wisconsin's Steenbock and Black; Columbia University's Hess, Weinstock, and F. Dorothy Helman; and O. Rosenheim and T. A. Webster of the National Institute for Medical Research in London—confirmed that the substance is present in animal and vegetable fats. Moreover, they proved that it is localized in the fraction of fats known to contain sterol molecules. The researchers found that purified cholesterol (a major animal sterol) and phytosterols (vegetable sterols), both of which otherwise have no antirachitic properties, are rendered antirachitic by ultraviolet irradiation.

Up to this point, researchers investigating vitamin D had to be content with characterizing the elusive substance on the basis of its physiological effects. As it happened, however, the work of organic chemist Adolf Windaus, in Göttingen, Germany, would produce chemical tools that would finally help pinpoint the molecular identity of vitamin D. Early in the century, Windaus had embarked on his study of cholesterol and related sterols, about which virtually nothing was known at the time. From the very start, he believed that sterols, which occur in every cell, must be considered as the parent substance of other groups of natural substances, and he was convinced that investigations into the structure of these molecules would yield unexpected results.

By 1925, Windaus was recognized as the leading expert on sterols, and Hess invited him to come to New York to work on antirachitic vitamins. Windaus also was collaborating with Rosenheim and Webster in London at the time, and in 1927 both teams, using a series of clever chemical transformations and comparisons with known compounds, deduced that ergosterol was the likely parent substance of vitamin D in food. Back in his own laboratory in Göttingen the following year, Windaus isolated three forms of the vitamin: two derived from irradiated plant sterols, which he called D1 and D2, and one derived from irradiated skin, which he called D3. F. A. Askew's British team followed up in 1931, successfully defining the chemical makeup of D2—the form of vitamin D found in irradiated foods (now called ergocalciferol)—which was derived from the precursor molecule ergosterol. Five years later, in 1936, Windaus synthesized the molecule 7-dehydrocholesterol and then converted it by irradiation to vitamin D3, now known as cholecalciferol. Although it was assumed that vitamin D was photosynthesized in the skin from 7-dehydrocholesterol, the final proof did not emerge until more than three decades later. A Wisconsin team led by R. P. Esvelt and one led by Michael F. Holick at the Endocrine Unit of Massachusetts General Hospital then independently demonstrated that vitamin D3 is, in fact, what is produced in the skin through irradiation.

Because of these discoveries, it became possible to synthesize the vitamin in large quantities. Synthesizing the vitamin costs a fraction of what it costs to irradiate foods and does not destroy or change food flavours, as irradiation sometimes does. Synthesized vitamin D provided the capstone of the public health campaign to eradicate rickets. For his "research into the constitution of the sterols and their connection with the vitamins," Windaus was awarded the Nobel Prize for Chemistry in 1928.

Vitamin D's Connection to Calcium Control

With rickets under control, scientists now concentrated on finding out how the miracle bone builder worked. Over the next forty years, a number of research teams teased out vitamin D's metabolic pathway in the body. One of the confusing initial findings was that the metabolic by-products of vitamin D all seemed to be biologically inactive. How, then, did vitamin D build bone and cure rickets?

Scientists did not have the tools to follow this complicated process in living subjects until the advent, in the mid 1960s, of new techniques using radioactively labelled substances. Between 1968 and 1971, researchers made great progress in understanding the metabolic processing of vitamin D and its physiological activity. In 1968 a team headed by Hector F. DeLuca at the University of Wisconsin isolated an active substance identified as 25-hydroxyvitamin D3, which the team later proved to be produced in the liver. During the next two years, the Wisconsin team, Anthony W. Norman and colleagues at the University of California-Riverside, and E. Kodicek and co-workers at Cambridge University in England independently reported the existence of a second active metabolite. Kodicek and David R. Fraser showed that this second metabolite is produced in the kidney. Finally, in 1971 all three research groups published papers in which they reported the chemical/molecular structure of this metabolite, which was identified as 1,25-dihydroxyvitamin D3. It was now clear that the liver changes vitamin D3 to 25-hydroxyvitamin D3, the major circulating form of the vitamin. The kidneys then convert 25-hydroxyvitamin D3 to 1,25-dihydroxyvitamin D3, the active form of the vitamin.

But how does all of this affect calcium deposition to build strong bones? Since the 1950s, scientists had been puzzling over the implications of two findings related to this question. In the early part of that decade, the Swedish researcher Arvid Carlsson made the startling discovery that vitamin D can actually remove calcium from bones when it is needed by the body. At about the same time, the Norwegian biochemist R. Nicolaysen, who had been testing different diets on animals for years, concluded that the uptake of calcium from food is guided by some unknown "endogenous factor" that alerts the intestines to the body's calcium needs. Answers began to emerge with the experiments tracing the activation of vitamin D.

An important result of those experiments was that 1,25-dihydroxyvitamin D3, the active form of vitamin D, was reclassified as a hormone that controlled calcium metabolism. A hormone is a chemical substance produced by one organ and then transported in the bloodstream to a target organ, where it causes a specific biological action. Evidence for reclassifying the active form of vitamin D came with the realization that 1,25-dihydroxyvitamin D3 is produced by the kidneys and that its secretion by the kidneys is followed by its buildup in cell nuclei of the intestine, where it regulates calcium metabolism. By 1975, Mark R. Haussler at the University of Arizona confirmed the discovery of a protein receptor that binds the active vitamin D metabolite to the nucleus of cells in the intestine.

With vitamin D now linked to the intestine, scientists were zeroing in on the mechanism of calcium control. Researchers noted that as the level of calcium in the diet rises, the amount of active vitamin D hormone in the body falls and vice versa—a feedback-loop pattern that clearly pointed to the vitamin D hormone as Nicolaysen's calcium-regulating "endogenous factor." Many research teams, including those at the University of Wisconsin and Cambridge University, now focused on tracing the relationship of vitamin D hormone to the rest of the body's endocrine system. They found that a hormone produced by the parathyroid gland is critical to maintaining adequate levels of vitamin D hormone in the blood. When calcium is needed, the parathyroid gland sends the parathyroid hormone to the kidneys to trigger production of vitamin D hormone. That hormone, in turn, prompts the intestines to transfer calcium from food to the blood. When calcium intake is too small to support normal functions, both vitamin D and the parathyroid hormone trigger a process in which stored calcium is mobilized from the bones (confirming the Swedish finding nearly twenty years earlier).

Regulating blood calcium levels is important. When there is too little calcium in the blood, soft-tissue cells—especially nerves and muscle—shut down, sending the body into convulsions; when there is too much calcium in the blood, organs calcify and eventually cease to work. For human patients who had lost their parathyroid glands or their kidneys and could no longer regulate the level of calcium in their blood, the newly synthesized vitamin D hormone, when given with plenty of calcium, had a dramatic effect, curing them of convulsions and chronic bone disease.

More Than Just a Way to Regulate Calcium

Now that its role in calcium uptake had been sketched out, researchers in the 1970s began investigating vitamin D in greater detail—and with surprising results. Several groups managed to find the vitamin D hormone in the nucleus of cells that were not part of the classical calcium maintenance system including the brain, lymphocytes (infection-fighting white blood cells), skin, and malignant tissues. What business would vitamin D have in these places?

In the early 1980s, Japanese researcher Tatsuo Suda made the exciting discovery that adding the hormone to immature malignant leukemia cells caused the cells to differentiate, mature, and stop growing. The amount of vitamin D hormone needed to stop the runaway growth of tumours and cancers has so far proved too toxic for human use, but Suda's discovery suggested that this fascinating hormone had roles beyond the part it played in maintaining the body's calcium levels. This finding spurred on a new era in vitamin D research.

In the mid 1980s, a group of researchers led by S. C. Manolagas found that vitamin D hormone also seemed to play a part in modulating the immune system. In 1993, S. Yang and other researchers in DeLuca's laboratory found that rats given a large dose of vitamin D hormone were protected from the inflammation normally associated with wounds and chemical irritants. This unexpected immunosuppressant function for vitamin D hormone suggested a whole new range of possibilities—including its use in the control of autoimmune diseases.

More developed is vitamin D hormone's effect on psoriasis, a disfiguring skin disorder that affects some 50 million people worldwide. For reasons unknown, psoriasis causes skin cells to multiply uncontrollably. Failing to differentiate and develop normally, the skin cells clump in unsightly rashes, scales, and scars. In the 1980s, a Japanese research team demonstrated that 1,25-dihydroxyvitamin D3 can inhibit skin cell growth. A team of scientists at Boston University School of Medicine, led by Michael F. Holick, investigated this inhibition further and reasoned that it could be used for the treatment of psoriasis.

Initial experiments by Holick and co-workers with vitamin D hormone have shown that topical applications of the hormone are remarkably effective. After two months, the lesions of 96.5 percent of the patients treated with a topical calcitriol (vitamin D hormone) preparation had improved with no noticeable side effects, as compared with 15.5 percent of the controls treated with petroleum alone. In 1994 the U.S. Food and Drug Administration approved a vitamin D-based topical treatment for psoriasis, called calcipotriol.

As we enter the twenty-first century, we recognize that the basic scientific research done in the previous two centuries has not only untangled the workings of the elusive vitamin D hormone, but also has given us ways to protect the health of both adults and children. Researchers are pursuing many new applications for vitamin D, but its role in building and maintaining bone continues to be an important health issue, especially among middle-aged and older adults.

Credits

"Unravelling the Enigma of Vitamin D" was written by science writers Roberta Conlan and Elizabeth Sherman, with the assistance of Drs. David R. Fraser, Mark R. Haussler, Michael F. Holick, Robert Neer, Anthony W. Norman, and Munro Peacock for Beyond Discovery(TM) The Path from Research to Human Benefit, a project of the National Academy of Sciences.

Timeline

- 1600—In the mid 1600s, rickets is first described.
- 1900—In the early 1900s, Sir Frederick Gowland Hopkins demonstrates that whole foods (as opposed to purified proteins, fats, and carbohydrates) contain certain unknown constituents essential to health and growth.
- 1906—Christiaan Eijkman and Gerrit Grijns extract the antineuritic factor from rice hulls, later shown to be vitamin B1.
- 1918—Sir Edward Mellanby induces rickets in dogs and then cures the disease by feeding the animals cod-liver oil.
- 1919—K. Huldschinsky cures children of rickets using artificially produced ultraviolet light.
- 1920—In the early 1920s, Harry Goldblatt and Katherine Soames, H. Steenbock and A. Black, and Alfred Hess and Mildred Weinstock independently discover that irradiating certain foodstuffs with ultraviolet light renders those foods antirachitic.
- 1922—Elmer V. McCollum destroys vitamin A in cod-liver oil and shows that the separate antirachitic substance remains. He calls the newly identified substance "vitamin D."
- 1927—Adolf Windaus, O. Rosenheim, and T. A. Webster deduce that ergosterol is the likely parent substance of vitamin D in food.
- 1931—F. A. Askew defines the chemical makeup of the form of vitamin D found in irradiated foods (now called ergocalciferol), derived from the precursor molecule ergosterol.
- 1936—Windaus deduces the chemical structure of vitamin D3 produced in the skin (now known as cholecalciferol) and identifies the structure of its parent molecule, 7-dehydrocholesterol.

- 1968—Hector F. DeLuca and colleagues isolate an active vitamin D metabolite and identify it as 25-hydroxyvitamin D3. They later prove that the substance is produced in the liver.
- 1968— Between 1968 and 1970, the existence of a second active metabolite produced from 25-hydroxyvitamin D3 is reported by Anthony W. Norman, Mark R. Haussler, and J. F. Myrtle; by E. Kodicek, D. E. M. Lawson, and P. W. Wilson; and by DeLuca and co-workers.
- 1970—In the 1970s, researchers discover the relationship of vitamin D to the body's endocrine system and calcium regulation.
- 1971—Three research groups identify the chemical/molecular structure of the final active form of vitamin D as 1,25-dihydroxyvitamin D3, which is soon reclassified as a hormone controlling calcium metabolism.
- 1975—Haussler confirms the discovery of a protein receptor that binds the active vitamin D metabolite to the nucleus of cells in the intestine.
- 1980—In the 1980s, a Japanese research team and, independently, Michael F. Holick and co-workers show that vitamin D hormone inhibits skin cell growth. Holick and colleagues demonstrate that topical applications of the vitamin D hormone are a remarkably effective treatment of psoriasis.
- 1980—In the mid-1980s, researchers find that vitamin D hormone seems to play a part in modulating the immune system.
- 1994—The U.S. Food and Drug Administration approves a vitamin D-based topical treatment for psoriasis, called calcipotriol.

Appendix 2.7B: Unravelling the Enigma of Vitamin D— Student Questionnaire

Questions

After you have read the article, "Unravelling the Enigma of Vitamin D," answer the following questions:

1. Outline the symptoms of, the causes of, and the treatments for rickets.
2. With a better understanding of the operation of vitamin D as a calcium regulator, its active form, 1,25-dihydroxyvitamin D3, had its classification changed from vitamin to hormone. Explain how vitamin D is involved in the regulation of calcium in our bodies.
3. Low levels of calcium in the blood result in the shutdown of soft tissue cells such as muscle and nerve cells. Use this information to explain why rickets became a common condition at the time of the Industrial Revolution in Europe, and to explain the symptoms of rickets.
4. Scientific discoveries often arise as the result of work done by many different scientists, over a period of time, on unrelated topics. Describe how this is true for the discovery and use of vitamin D.

Appendix 2.7C: Unravelling the Enigma of Vitamin D (Teacher Background)

1. Outline the symptoms of, the causes of, and the treatments for rickets.

   Symptoms of Rickets

   - bones of developing children remain soft, like cartilage
   - babies slow to sit, crawl, and walk
   - as children grow, weight on soft bones results in pigeon breast, bowed legs, and knock-knees
   - tetany: painful spasms in feet, hands, and larynx
   - problems breathing, nausea, and convulsions

   Causes of Rickets

   - lack of ultraviolet (UV) light
   - lack of 1,25-dihydroxyvitamin D3

   Treatments for Rickets

   - sunlight
   - cod-liver oil
   - irradiated food
   - vitamin D supplement

2. With a better understanding of the operation of vitamin D as a calcium regulator, its active form, 1,25-dihydroxyvitamin D3, had its classification changed from vitamin to hormone. Explain how vitamin D is involved in the regulation of calcium in our bodies.

   When calcium level is low

   - the parathyroid gland secretes a hormone to kidneys
   - kidneys convert 25-hydroxyvitamin D3 (from the liver) to the active form 1,25-dihydroxyvitamin D (25-hydroxyvitamin D3 produced by irradiation of skin on 7-dehydrocholesterol)
   - 1,25-dihydroxyvitamin D3 prompts intestines to transfer calcium from food to blood
   - calcium stored in bone is released to blood (if calcium intake in food is too low)

3. Low levels of calcium in the blood result in the shutdown of soft tissue cells such as muscle and nerve cells. Use this information to explain why rickets became a common condition at the time of the Industrial Revolution in Europe, and to explain the symptoms of rickets.

   Reasons rickets became a common condition during the Industrial Revolution in England

   - towns covered in smog and people working in factories resulted in lack of UV light exposure
   - without UV light, people could not produce vitamin D3
   - without vitamin D3, people could not control uptake of calcium from diet
   - less calcium for bones and muscles resulted in problems such as spasms and tetany

4. Scientific discoveries often arise as the result of work done by many different scientists, over a period of time, on unrelated topics. Describe how this is true for the discovery and use of vitamin D.

   Examples of key discoveries by different scientists that students can use to demonstrate how the discovery and use of vitamin D came about:

   early 1800s—Hopkins shows whole foods contain specific unknown parts necessary for health and growth.

   1906—Eijkman and Grijns extract antineuritic chemical from rice hulls.

   1918—Mellanby cures rickets in dogs with cod-liver oil.

   1919—Huldschinsky cures rickets in children using UV light.

   early 1920s—Goldblatt and Soames, Steenbock and Black, and Hess and Weinstock independently show that eating certain foods irradiated with UV light can be used to cure rickets.

   1922—McCollum destroys vitamin A in cod-liver oil and shows oil still contains chemical that can cure rickets (terms it vitamin D).

   1927—Windaus, Rosenheim, and Webster deduce that ergosterol is the likely parent substance of vitamin D in food.

   1931—Askew defines chemical makeup of the type of vitamin D found in irradiated food.

   1936—Windaus deduces the chemical structure of vitamin D3 produced in skin.

   1968—DeLuca et al. identify vitamin D metabolite produced in liver.

   1968–70—Second vitamin D metabolite is discovered by several labs.

   1971—Three separate groups discover the chemical/molecular structure of the active form of vitamin D.

   1970s—Researchers discover the relationship between vitamin D and calcium regulation.

   1980s—Separate researchers show that vitamin D hormone inhibits skin cell growth, and that topical applications treat psoriasis.

   mid 1980s—Vitamin D hormone is discovered to play a part in the immune system.

   1994—The U.S. Food and Drug Administration approves topical vitamin D cream to treat psoriasis.

Appendix 2.8: Human Disorders Assignment (BLM)

The human body is a very efficient machine. Most of the time it works well, adjusting to changes in the environment, resisting infections, and adapting to meet a host of potential dangers. However, the body is not perfect; it cannot always cope with a particular infection or its own systems may fail and result in sickness.

This assignment will give you an understanding of one disorder by researching it in detail. It should make you aware of sources of information about human disorders, or the many support programs that are available for some diseases. It should also give you a greater understanding of the problems faced by someone who is disabled or afflicted by a disorder.

Format

Discuss the final format of this research project with the teacher.

Due Date

The assignment is due the last week of class discussion on a specific body system. During this same week, you will be required to make a short presentation of your topic to the class.

Components

In your project, consider including

- a brief description of the disorder (introduction)
- the cause or causes of the disorder
- the symptoms
- the treatments
- any side effects or associated problems
- an explanation of the problem, if known
- prognosis and possible future treatments
- other relevant factors

A bibliography of at least three sources must be included.

Topic

To add interest to the topic, consider selecting a disorder with which you are familiar, either directly or indirectly. Perhaps you, or members of your family, have suffered from a particular disorder and you could usefully learn more about the disease. Or you might consider visiting a person suffering from arthritis (or another ailment) and conduct an interview discussing how that person copes with difficulties, or how the disorder has affected his or her lifestyle. If you approach such a person, remember to be considerate and sensitive to feelings. The individual may be quite willing to talk about his or her disorder and you may gain some special insights to problems.

Choose a topic from the list below, or another one approved by your teacher.

Digestive System

anorexia nervosa/bulimia	malabsorption
ulcers	diabetes
appendicitis	cancer of stomach/bowel
dysentery	liver cirrhosis

Respiratory System

emphysema	smoking and lung cancer
tuberculosis	pneumonia
sudden infant death syndrome (SIDS)	asthma

Transport System

heart attack	arteriosclerosis
anemia	hemorrhoids
hypertension	angina pectoris
hemophilia	Rh disease

Excretory System

nephritis	kidney stones
kidney dialysis	kidney transplants
lupus	

Nervous System

stroke	epilepsy
meningitis	Parkinson’s disease
multiple sclerosis	concussion
spina bifida	psoriasis
Alzheimer’s disease	mental illness
cataracts	cerebral palsy
Lyme disease	polio

Appendix 2.9: What's My Diagnosis? (Teacher Background)

Setting Up

- This learning activity requires cutting 10 patient profiles (see attached) and pasting them onto cards (e.g., large file cards).
- Larger station cards, numbered 1 through 10, need to be set up around the room, with the patient profile cards placed at the respective stations (laminated large colour sheets with station numbers come in handy for all sorts of labs/activities including this one).
- To set the mood, you may choose to wear a lab coat, a stethoscope, and a surgical cap or mask, and/or play music, such as the theme song for a hospital show.

Getting Started

- Group students into teams (groups of three work well).
- Assign one student on each team as the head doctor, one as the consulting or assisting doctor, and one as the nurse.
- Instruct the nurses to read a patient profile card to the doctors and provide their opinions on the problem.
- The doctors then discuss the problem and decide on a diagnosis—if there is a disagreement, it is understood that the head doctor will make the final decision.
- Treatment is then decided on by all three team members, as they record both the diagnosis and the treatment on a piece of paper by station number.
- Since the state of affairs in Canadian medicine dictates that doctors must work quickly in order to earn high salaries, the teams work as quickly as they can, visiting all 10 patients (in any order). Once they have diagnosed and treated all patients, they bring their sheet to the teacher to be checked. If they've misdiagnosed any patients, they are sent back to re-examine them.

Assessment

- Collect sheets from teams and assign a mark out of 10.
- Prizes for the most successful team include NOT receiving a malpractice lawsuit, along with a "treat."

Diagnosis	Treatment
1. Anorexia nervosa	seek counselling
2. Heartburn	avoid caffeine and eating before bed
3. Appendicitis	obtain prompt medical attention (surgery?)
4. Hemorrhoids	use ointment, and perhaps laxatives until healed
5. Cirrhosis of liver	stop drinking
6. Malnutrition	change diet
7. Perhaps cancer/tumour	obtain prompt medical attention (scope/biopsy/surgery/chemo/radiation?)
8. Lactose intolerance (no milk on weekends)	change diet, use lactase
9. Ulcer	use antibiotics for *H. Pylori*, evaluate aggravating diet
10. Gallbladder/bile problem	change diet, consider surgery

Station #1

Erin is 15 years old. She is a very high achiever who maintains a 90+ average in school. She is involved in the band and a variety of sports. Recently her parents have noticed that she excuses herself from family meals whenever possible. They have also noticed that she has become obsessed with exercising and seems to be losing weight. They are quite concerned, so they visit their family doctor.

Station #2

George is a middle-aged man (45 years old). He has recently been experiencing some pain in the centre of his chest. He is concerned about his heart. He notices that his pain is often worse when he drinks a lot of coffee, and also when he eats right before bed.

Station #3

Ashley is 12 years old, and very active. She has not been feeling well for the past couple of days. She has been staying home from school due to a fever, chills, and dizziness. Her parents think it is the flu, but when she starts to complain of terrible pain in her lower right side they rush her to the doctor's office.

Station #4

Mary has a two-year-old daughter, and has given birth to a beautiful baby boy five days ago. She has terrible pain and itchiness on her bottom, and is experiencing severe pain whenever she has a bowel movement. Although a little embarrassed, she visits her doctor with the problem.

Station #5

Bob has been a heavy drinker for the past 20 years. He has been feeling unwell for the past couple of months and has noticed his skin colour is slightly off. He finally decides to visit his doctor when he experiences some pain in his upper abdomen.

Station #6

Amanda is a busy woman with four children and a career. Although she attempts to take time for herself, and tries to live a healthy lifestyle, she is often too caught up in her busy schedule to eat properly. She starts to notice that she is unusually tired, her hair is falling out (more than normal), and her gums are bleeding quite frequently. She visits her doctor for a check-up.

Station #7

Sam is an elderly gentleman who has always been fairly healthy—no problems other than the frequent heartburn he has suffered throughout his life. Over the past couple of months he has lost a bit of weight and has noticed a lump in his throat when he swallows. Since it has been getting worse, he is worried and finally visits his doctor.

Station #8

Doug is a young boy who frequently experiences cramping, bloating, and diarrhea. His parents are puzzled that the condition seems to be worse during the week than it is on the weekend, since they always drink pop and eat poorly most weekends. Doug eats a perfectly balanced diet on weekdays, yet this is when he feels the worst. They visit the doctor in an attempt to help him.

Station #9

Shannon has been experiencing mild pain in her upper abdomen for a couple of weeks. Recently her pain has increased a great deal, and she often finds herself doubled over in pain, unable to find any relief. She decides to see her doctor right away.

Station #10

Grant has always enjoyed fast food. Over the past few months he has noticed that every time he eats fast food, he experiences pain and discomfort throughout his digestive system. He doesn't experience this problem when he isn't eating greasy food. He makes an appointment with his doctor in an effort to figure out the problem.

Appendix 2.10:
Decision Making (Teacher Background)

The decision-making process is an approach for analyzing issues and making a choice among different courses of action. Issues are often complex, with no one right answer. They can also be controversial, as they deal with individual and group values. To make an informed decision, students must understand scientific concepts involved in an issue and must be aware of the values that guide a decision. The process involves a series of steps, which may include

- identifying and clarifying the issue
- being aware of the different viewpoints and/or stakeholders involved in the issue
- critically evaluating the available research
- determining possible alternatives or positions related to an issue
- evaluating the implications of possible alternatives or positions related to an issue
- being aware of the values that may guide a decision
- making a thoughtful decision and providing justification
- acting on a decision
- reflecting on the decision-making process

In Grade 9 Science, students were introduced to the decision-making process. Most of the issues in Grade 11 Biology are personal decisions related to health and wellness, but there are also issues with a societal focus. If students don't have a lot of experience with the decision-making process, teachers can start the process with more guidance, giving students a chance to use this approach in a structured environment. This could be done by giving them a specific scenario or issue to study. Students would eventually become active participants in this process by choosing their own issues, doing their own research, making their own decisions, and acting on those decisions.

The decision-making process can be approached in a variety of ways. For instance, students can play the role of different stakeholders involved in an issue, work in small groups to discuss issues, or make a decision based on their own research and personal values. Students can be asked to take a stand and debate issues, or be placed in situations where they have to reach a consensus. Students should not always defend a point of view that they agree with. They should be asked to put themselves in someone else's mindset and speak from his or her point of view.

Regardless of the approach used, the following questions can guide students in the decision-making process:

- What is the issue?
- What important scientific information is needed to understand this issue? Where do I find this information?
- Who has a stake in this issue, and why?
- What are the possible options?
- What are the pros and cons for each of the possible options?
- What is my decision?
- What criteria were used to make this decision?

Assessment

Because there are so many different ways of approaching an issue, a variety of products or culminating events can result from a decision-making process, such as a town hall meeting, a round table discussion, a conference, a debate, a case study, a position paper, a class presentation, a class discussion, and so on. Regardless of what those products or events are, the assessment should focus on the skills outlined in Cluster 0: Biology Skills and Attitudes.

For role-playing activities such as town hall meetings, round table discussions, or conferences, assessment criteria should be related to how students are able to put themselves in the position of their stakeholder. The assessment criteria could include the following:

- position is clearly stated
- evidence is presented to support arguments
- answers to questions are clear and aligned with the position of the stakeholder
- presentation is clear and organized
- position of stakeholder is accurately represented
- personal biases are absent

Unit 3: Transportation and Respiration

Unit 3: Transportation and Respiration

Specific Learning Outcomes

B11-3-01: Design and execute an experiment to investigate an aspect of the transportation or respiratory system. (GLOs: C2, D1, E2)

Examples: the effect of exercise on heart and/or respiratory rate; the effect of adrenalin on blood pressure; carbon dioxide production as an indicator of metabolism…

B11-3-02: Compare the characteristics of blood components in terms of appearance, origin, numbers, relative size, and function in the body. (GLO: D1)

Include: plasma, erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (platelets)

B11-3-03: Compare and contrast the characteristics of different blood groups. (GLO: D1)

Include: ABO and Rh factor

B11-3-04: Predict the physiological consequences of blood transfusions involving different blood groups. (GLOs: D1, E2)

B11-3-05: Describe the blood donation process and investigate related issues. (GLOs: B3, C4, C5, C6, C8)

Examples: compatible blood groups, screening procedure, frequency of donation, use of donated blood products, blood-borne diseases…

B11-3-06: Compare the structure and function of blood vessels. (GLOs: D1, E1)

Examples: diameter, elasticity, muscle layers, valves, what they transport...

B11-3-07: Identify the materials transported between cells and capillaries. (GLO: D1)

Include: carbon dioxide, oxygen, hormones, nutrients, and nitrogenous wastes

B11-3-08: Describe the cardiac cycle. (GLO: D1)

Include: systole and diastole

B11-3-09: Describe, in general terms, the nervous and chemical control of heartbeat. (GLOs: D1, E2)

B11-3-10: Explain the meaning of blood pressure readings and identify the normal range. (GLOs: B3, D1)

Include: given as a ratio of systolic over diastolic

B11-3-11: Identify factors that affect blood pressure or cardiac function and describe their effects. (GLOs: B3, D1)

Examples of factors: exercise, caffeine, nicotine, shock, beta blockers, diuretics, hormones, stress...
Examples of effects: low blood pressure, high blood pressure, increased heart rate…

B11-3-12: Explain how transport systems help to maintain homeostasis in the body. (GLOs: D1, E2)

Include: transport nutrients, oxygen, carbon dioxide, wastes, and hormones; help maintain fluid balance; regulate body temperature; and assist in the defence of the body against invading organisms

B11-3-13: Distinguish between cellular respiration, internal respiration, and external respiration. (GLO: D1)

B11-3-14: Identify major structures and functions of the human respiratory system from a diagram, model, or specimen. (GLO: D1)

Include: lungs, pleura, nasal cavity, epiglottis, bronchi and bronchioles, alveoli, pulmonary capillaries, diaphragm, pharynx, larynx, trachea, uvula, ribs, and intercostal muscles

B11-3-15: Describe how breathing is controlled to help maintain homeostasis in the human body. (GLOs: D1, E2)

Include: chemoreceptor and medulla oblongata

B11-3-16: Investigate and describe conditions/disorders associated with transportation and/or respiration in the human body. (GLOs: B3, C6, D1)

Examples: cardiovascular diseases...

B11-3-17: Identify personal lifestyle choices that contribute to cardiovascular and respiratory wellness. (GLOs: B3, C4, D1)

Examples: active lifestyle, not smoking…

INVESTIGATION OF THE TRANSPORT AND RESPIRATORY SYSTEMS

SPECIFIC LEARNING OUTCOMES

B11-3-01: Design and execute an experiment to investigate an aspect of the transportation or respiratory system. (GLOs: C2, D1, E2)

Examples: the effect of exercise on heart and/or respiratory rate; the effect of adrenalin on blood pressure; carbon dioxide production as an indicator of metabolism…

SLO: B11-3-01

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

In Grade 8, students conducted investigations associated with the relationship between exercise and heart and respiratory rate, and discussed how the relationship is affected by health (SLO 8-1-15). In Grade 11, students are expected to design their own investigation.

ACTIVATE

Reflection on Student-Designed Experiment

Have students reflect on the student-designed experiment they completed in Unit 1, Appendix 1.12A: Concentration and Diffusion—Student Handout (BLM), by answering the following questions in their journals or by discussing them in class:

- What did you like most about designing your own experiment?
- What did you like the least about designing your own experiment?
- What were some difficulties you encountered when designing your own experiment? How did you solve these difficulties?

ACQUIRE/APPLY

Design Your Own Experiment (P1, S1, S2, S3, S4, S5, S6, S7, S8, I4)

In this learning activity, student pairs use their scientific inquiry skills to investigate a question they may have about the transportation or respiration system. A key component of this lab activity is the creation of a good testable question. Students can refer to Appendix 3.1: Scientific Inquiry (BLM) to ensure they understand how to develop testable questions and to ensure a fair test.

SKILLS AND ATTITUDES OUTCOMES

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S1: State a testable hypothesis or prediction based on background knowledge or on observed events. (GLO: C2)

B11-0-S2: Plan an experiment to answer a specific scientific question. (GLOs: C1, C2)

Include: materials; independent, dependent, and controlled variables; methods; and safety considerations

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S7: Evaluate the relevance, reliability, and adequacy of data and data collection methods. (GLOs: C2, C4, C5, C8)

Include: discrepancies in data or observations and sources of error

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Before having students begin the lab activity, verify students' questions to make sure they are, indeed, testable.

Students should be able to come up with their own questions, such as the following:

- How does exercise affect blood pressure?
- How does body position affect blood pressure?
- How does exercise affect heart rate?

Ask students to list the steps they will use to answer their question. They should include safety procedures that they need to follow. See Appendix 1.8: Student Lab Skills (Teacher Background) and Appendix 1.12B: Concentration and Diffusion (Teacher Background) in Unit 1, or refer to *SYSTH* (pp. 11.26–11.29 and 14.11–14.12) for different ways of writing a lab report.

INVESTIGATION OF THE TRANSPORT AND RESPIRATORY SYSTEMS

SPECIFIC LEARNING OUTCOMES

B11-3-01: Design and execute an experiment to investigate an aspect of the transportation or respiratory system.
(GLOs: C2, D1, E2)

Examples: the effect of exercise on heart and/or respiratory rate; the effect of adrenalin on blood pressure; carbon dioxide production as an indicator of metabolism…

Students can conduct their experiments after having received comments and suggestions from their written submissions. Appendix 3.2: Feedback Form for Designing an Experiment (Plan) contains a feedback form for experimental design. Following the experiment, students can write a written report and present their findings to the class using a poster presentation, or some other format.

Resource

See Giving the Breath of Life Lesson Plan in *Life Is a Gift* (Manitoba Education and Transplant Manitoba) for learning activities related to Unit 3: Transportation and Respiration.

Suggestions for Assessment

To provide feedback to students on their experimental design and written report, refer to Appendix 3.3: Rating Scale for Experimental Design and Report (BLM).

Develop assessment criteria for the presentation of findings to the class with students. The criteria should include both content and presentation components such as the following:

- Poster is neat, colourful, and informative.
- All members of the group share equally in presenting the information.
- Relevant scientific vocabulary is used (e.g., dependent variable, independent variable, controls, hypothesis).

Note: Often when scientists want to present their research at a conference they develop posters.

Students could work on this learning activity throughout the unit. Teachers can then monitor students' understanding of experimental design and provide feedback when necessary.

SKILLS AND ATTITUDES OUTCOMES

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-S1: State a testable hypothesis or prediction based on background knowledge or on observed events. (GLO: C2)

B11-0-S2: Plan an experiment to answer a specific scientific question. (GLOs: C1, C2)

Include: materials; independent, dependent, and controlled variables; methods; and safety considerations

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S7: Evaluate the relevance, reliability, and adequacy of data and data collection methods. (GLOs: C2, C4, C5, C8)

Include: discrepancies in data or observations and sources of error

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

NOTES

BLOOD COMPONENTS

SPECIFIC LEARNING OUTCOMES

B11-3-02: Compare the characteristics of blood components in terms of appearance, origin, numbers, relative size, and function in the body. (GLO: D1)
Include: plasma, erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (platelets)

SLO: B11-3-02

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

In Grade 8, students identified red and white blood cells, platelets, and plasma, and described the function of each (SLO 8-1-13). In Grade 11, students explore the distribution and roles of the components of blood in order to make decisions about blood health.

ACTIVATE

Reconstructing Blood

Show unlabelled pictures of blood components to students and have them try to identify the pictures.

Resource Links

Many websites, such as the following, include pictures of cells. Use pictures that are acceptable for educational purposes.

- Cells Alive. Home Page. <www.cellsalive.com/>.
- AllRefer Health. "Sickle Cell Anemia." *Diseases & Conditions.* <http://health.allrefer.com/health/sickle-cell-anemia-red-blood-cells-normal.html>.

ACQUIRE/APPLY

Viewing Blood Components—Microscope Activity (S3, S4, S5, S6, S8)

Have students examine prepared slides or electronic images of human blood under a microscope and identify blood components. Have students create a chart to summarize the following for each of the different blood components found in the human body:

- appearance (biological drawing as well as written description)
- origin
- numbers
- relative size
- function

SKILLS AND ATTITUDES OUTCOMES

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity towards, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

Suggestion for Assessment

Assess students' charts for completeness and accuracy. Refer to Appendix 1.14A: Biological Drawing (BLM) to assess biological drawings and to Appendix 1.15: Microscope Skills Checklist (BLM) to assess microscope skills.

Blood Tests (S5, S8)

Have students investigate how blood tests can be used to detect conditions such as diabetes, anemia, leukemia, cholesterol levels, kidney function, and so on. For example, use of hematocrits is one type of commonly used test.

Suggestion for Assessment

Have students complete a personal reflection on an experience they have had or someone close to them has had with blood tests (e.g., what the blood test was for, what impact the results may have had on treatment). An alternative could be to have students reflect on why someone may not allow a blood test to be done.

BLOOD GROUPS

SPECIFIC LEARNING OUTCOMES

B11-3-03: Compare and contrast the characteristics of different blood groups. (GLO: D1)

Include: ABO and Rh factor

B11-3-04: Predict the physiological consequences of blood transfusions involving different blood groups. (GLOs: D1, E2)

B11-3-05: Describe the blood donation process and investigate related issues. (GLOs: B3, C4, C5, C6, C8)

Examples: compatible blood groups, screening procedure, frequency of donation, use of donated blood products, blood-borne diseases…

SLO: B11-3-03
SLO: B11-3-04
SLO: B11-3-05

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

What's Your Type?

Ask students if they know their own blood type and whether or not it is important to know this information.

Excluding Donors

Discuss situations in which you would need a blood donation and reasons for donating blood. Ask students why certain people are not allowed to donate blood (e.g., piercings, tattoos, travelled to certain areas of the world, lived in the UK during the 1990s).

ACQUIRE/APPLY

Antigens, Antibodies, and Blood Cells (U2)

Use visuals to illustrate interactions between antigens, antibodies, and blood cells as a starting point for the creation of a chart of blood group antigens and antibodies, and donor-recipient relationships. Students may need to conduct additional research to complete the chart.

Sample Chart:

Blood Groups	Antigens	Antibodies	Possible Donors	Possible Recipients

Suggestion for Assessment

Review the chart with students, as a formative assessment, to determine the level of students' understanding of blood groups and blood transfusions, and re-teach if necessary.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B110-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. GLO: B4)

Blood Transfusions—Laboratory Activity (S3, S4, S6, S8)

Have students complete a fake blood lab (commercial kits are available for this type of activity) in order to explore the physiological consequences of blood transfusions between different blood types.

Blood Transfusions—Case Studies (U2)

Present a variety of case studies involving the transfusion of different blood types and have students predict the effects. Refer to Appendix 3.4: Blood Transfusion Case Studies (Teacher Background). Discuss the concept of a universal donor and a universal recipient, as well as the Rh factor.

BLOOD GROUPS

SPECIFIC LEARNING OUTCOMES

B11-3-03: Compare and contrast the characteristics of different blood groups. (GLO: D1)
Include: ABO and Rh factor

B11-3-04: Predict the physiological consequences of blood transfusions involving different blood groups. (GLOs: D1, E2)

B11-3-05: Describe the blood donation process and investigate related issues. (GLOs: B3, C4, C5, C6, C8)
Examples: compatible blood groups, screening procedure, frequency of donation, use of donated blood products, blood-borne diseases…

Suggestion for Assessment

Have students write a short paragraph on the importance of typing blood before it is used for a transfusion. Have students peer assess the paragraphs of other students based on the following criteria:

- Clearly identifies the Rh factor as well as blood groups.
- Describes the physiological consequences for each blood type of not typing blood before transfusion.

The Blood-Donation Process (U2, P4, I1, I2, I4)

Have students investigate the blood donation process and issues related to blood transfusions, including instances where someone might refuse a blood transfusion. To promote understanding of and respect for diversity of perspectives, discuss the issue of personal beliefs that do not support the use of blood transfusions in a sensitive manner. Acknowledge that there is more to personal decision making than what medical science says.

Approaches to the investigation could include the following:

- Research the use of various blood components by Canadian Blood Services.
- Create a timeline of the history of blood transfusions, including the risks and the successes.
- Compare the benefits and risks of artificial blood transfusions.
- Examine the impact of certain disorders on blood safety (e.g., Creutzfeldt-Jakob disease, West Nile virus, bovine spongiform encephalopathy [BSE], hepatitis, HIV).
- Discuss instances where blood transfusions may be refused.

The class can determine the format of this assignment (e.g., debate, discussion, oral presentation), as well as the timelines.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B110-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. GLO: B4)

Suggestion for Assessment

Develop assessment criteria with students. The criteria should address content as well as presentation components and may be similar, regardless of which form of presentation students choose. Each criterion could be assigned a point value, or a simple rating scale can be used (e.g., excellent, good, fair, poor).

BLOOD GROUPS

SPECIFIC LEARNING OUTCOMES

B11-3-03: Compare and contrast the characteristics of different blood groups. (GLO: D1)

Include: ABO and Rh factor

B11-3-04: Predict the physiological consequences of blood transfusions involving different blood groups. (GLOs: D1, E2)

B11-3-05: Describe the blood donation process and investigate related issues. (GLOs: B3, C4, C5, C6, C8)

Examples: compatible blood groups, screening procedure, frequency of donation, use of donated blood products, blood-borne diseases…

Blood Donor Clinic (U1, I1)

To allow students to experience (or simply observe) the blood donation process, visit a local blood donor clinic or invite Canadian Blood Services to the school for a clinic. The class could choose to be involved in promoting the event with posters and announcements and use Canadian Blood Services brochures and blood donor questionnaires as resources. During the visit to a clinic, encourage students to ask questions about the blood donation process (e.g., What happens at the actual clinic? What happens to the donated blood after the clinic?).

Suggestion for Assessment

Have students prepare a written summary of the donation process, in whatever form they choose (e.g., paragraph, Concept Map, point form, flow chart). Assessment questions from the next learning activity could also be used.

Guest Speaker (I1, W1)

Invite a guest speaker from Canadian Blood Services to talk to the class about the donation process and blood typing. For more information, visit their website at <www.bloodservices.ca/>.

Note: This is also a good opportunity to have students explore related careers. Students could be asked to prepare questions for the presenters, or presenters could be asked to provide information about careers in their field to students.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B110-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. GLO: B4)

Suggestion for Assessment

Have students answer questions such as the following in their science notebooks:

- Give some reasons why people would not want to donate blood, and explain what you might tell these people to convince them otherwise.
- Are there certain times of the year when there is more need for blood? Explain.
- Why would certain people not be allowed to donate blood?
- Why does everyone get a doughnut or a cookie after giving blood?

BLOOD VESSELS

SPECIFIC LEARNING OUTCOMES

B11-3-06: Compare the structure and function of blood vessels. (GLOs: D1, E1)

Examples: diameter, elasticity, muscle layers, valves, what they transport...

B11-3-07: Identify the materials transported between cells and capillaries. (GLO: D1)

Include: carbon dioxide, oxygen, hormones, nutrients, and nitrogenous wastes

SLO: B11-3-06
SLO: B11-3-07

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

In Grade 8, students compared and contrasted the structure and function of arteries, veins, and capillaries. In Grade 11, students are expected to extend their knowledge of vessel structure and apply this knowledge in making decisions about vessel health.

ACTIVATE

Representations of Blood Vessels

Show students three tubes of different diameter and wall thickness. Ask students to select which would represent a vein, an artery, or a capillary. Have them explain their selections.

ACQUIRE/APPLY

Vessel Structure Slides—Microscope Activity (S3, S4, S6)

Have students examine prepared microscope slides of blood vessels and compare vessel structure under a microscope. Ask them to create biological drawings of the vessel structure.

Suggestions for Assessment

Refer to Appendix 1.14A: Biological Drawing (BLM), Appendix 1.14B: Rating Scale for Biological Drawing (BLM), and Appendix 1.15: Microscope Skills Checklist (BLM) in Unit 1 for information on expectations for biological drawings and assessment of microscope skills.

Arteries Versus Veins (U1)

Demonstrate how valves work in the veins of the arm. For example, demonstrate how a backup valve works by inflating a beach ball (that has a backup valve to prevent the air from flowing out when you require more breath). Ask students why the beach ball doesn't deflate when you take your mouth off the valve. Have students complete a Compare and Contrast frame on veins and arteries (see *SYSTH*, p. 10.16).

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

Suggestion for Assessment

Ask groups to speculate on the following:

What would happen if…

- there were no valves in the veins
- the arteries had the same structure as veins
- capillaries had muscular walls

Vessel Structure and Function—Chart (U1)

Refer to Appendix 3.5: Comparing Vessels (BLM). Have students fill out the chart to compare the structure and the function of different blood vessels.

Suggestion for Assessment

Review the completed charts with students, as a formative assessment, to determine the level of students' understanding of vessel structure and function, and re-teach if necessary.

Cumulative Assessment

Have students prepare a Category Concept Map (see *SYSTH*, p. 11.11) representing the different types of blood vessels in the human body. This Concept Map could contain information such as

- type of vessel
- elasticity
- presence or absence of valves
- condition of blood transported (oxygenated or not)

This assessment could be done at the end of the unit.

BLOOD VESSELS

SPECIFIC LEARNING OUTCOMES

B11-3-06: Compare the structure and function of blood vessels. (GLOs: D1, E1)

Examples: diameter, elasticity, muscle layers, valves, what they transport...

B11-3-07: Identify the materials transported between cells and capillaries. (GLO: D1)

Include: carbon dioxide, oxygen, hormones, nutrients, and nitrogenous wastes

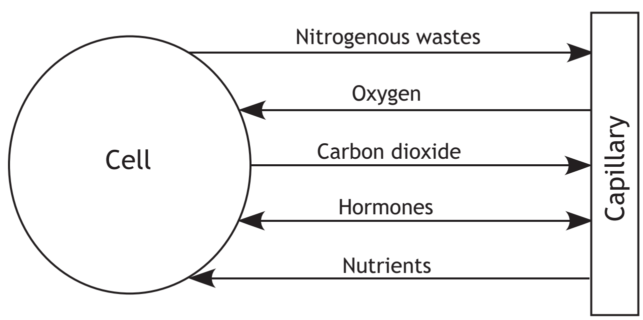
Pressure—Direct Instruction (U1)

Review diffusion and active transport. Use direct instruction to explain the pressure difference between the arteriole end and the venule end of a capillary bed.

Suggestion for Assessment

Have students draw a diagram of a cell and of a capillary with materials transported between the two. Students can then add arrows to indicate the direction in which materials move.

Example:



Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

Notes

HEART FUNCTION AND CONTROL

SPECIFIC LEARNING OUTCOMES

B11-3-08: Describe the cardiac cycle. (GLO: D1)
Include: systole and diastole

B11-3-09: Describe, in general terms, the nervous and chemical control of heartbeat. (GLOs: D1, E2)

SLO: B11-3-08
SLO: B11-3-09

SUGGESTIONS FOR INSTRUCTION

ENTRY-LEVEL KNOWLEDGE

Grade 8 students explored the structure and function of the heart and the path of blood to and from the heart through its four chambers. In Grade 11, students are expected to apply this information to their understanding of heart health.

ACTIVATE

Grade 8 Review

Review from Grade 8 the heart parts and blood flow through the heart. Have students label a diagram of the heart and blood flow.

Have students identify the diastole and systole events of the cardiac cycle.

Are We in Control?

Question students about their understanding of heartbeats. Can they control their own heartbeat? What factors affect heart rate? Have them record their responses to these questions in their journals.

ACQUIRE/APPLY

Electrocardiograms (I1)

Have students interpret printouts of electrocardiograms (ECGs). Refer to Appendix 3.6: Interpreting the Electrocardiogram (BLM) and Appendix 3.7: Comparing Electrocardiograms (BLM) for samples, or ask students to create their own ECGs, using *probeware*. Students draw pictures of the heart at each stage of the ECG.

Ask students to answer the following question:

> Why might an individual need an artificial pacemaker?

Extension: Have students compare ECGs available from the ECG Library at <www.ecglibrary.com>.

Suggestion for Assessment

Provide students with an abnormal ECG and have them overwrite it showing what a normal ECG would look like.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

Nervous and Chemical Control of Heartbeat—Direct Instruction (I1, U1)

Use diagrams, videos, and/or computer animation to illustrate and discuss the control of heartbeat. Emphasize that the heart is composed of cardiac muscle tissue, which has the ability to contract without external nerve stimulation and will continue to beat (for a short time) when removed from the body. Outline the role of the sinoatrial (SA) node, atrioventricular (AV) node, bundle of His, and Purkinje fibres in controlling heartbeat. Explain the effects of hormones such as adrenalin and noradrenalin on heart rate. Relate this effect to fight-or-flight response situations. The Note Frame strategy (see *SYSTH*, p. 11.32) or the Divided Notebook strategy (see *SYSTH*, p. 13.16) can be used to help students follow the presentation.

Suggestion for Assessment

Have students complete a Compare and Contrast frame for nervous and chemical control of heartbeat (see *SYSTH*, p. 10.15) or complete a Concept Map about the cardiac cycle and the control of heartbeat.

BLOOD PRESSURE

SPECIFIC LEARNING OUTCOMES

B11-3-10: Explain the meaning of blood pressure readings and identify the normal range. (GLOs: B3, D1)

Include: given as a ratio of systolic over diastolic

B11-3-11: Identify factors that affect blood pressure or cardiac function and describe their effects. (GLOs: B3, D1)

Examples of factors: exercise, caffeine, nicotine, shock, beta blockers, diuretics, hormones, stress...
Examples of effects: low blood pressure, high blood pressure, increased heart rate…

B11-3-12: Explain how transport systems help to maintain homeostasis in the body. (GLOs: D1, E2)

Include: transport nutrients, oxygen, carbon dioxide, wastes, and hormones; help maintain fluid balance; regulate body temperature; and assist in the defence of the body against invading organisms

SLO: B11-3-10
SLO: B11-3-11
SLO: B11-3-12

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Blood Pressure Quiz

Ask students to answer the following question:

What comes to mind when you hear the term *blood pressure* or *120/80*?

Have students complete Appendix 3.8: Blood Pressure Quiz: Know Your Blood Pressure by Heart.

What's Your Blood Pressure?

Have students use a sphygmomanometer to measure their own blood pressure and collect blood pressure data on the class. If a sphygmomanometer is not available, contact a public health nurse or visit a local pharmacy to obtain this device. Have students respond to questions such as the following:

- What is the mean blood pressure for each group?
- How does this value compare to norms for the general population? (The average blood pressure is 120/80. An acceptable blood pressure is 140 or less for the systolic reading and 90 or less for the diastolic reading.)
- Why is it important to know if your blood pressure is within the normal range?

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

ACQUIRE/APPLY

Understanding Blood Pressure (U1)

Part 1

Have students listen to their own heartbeat using a stethoscope and describe the sounds they hear (e.g., "lubb-dubb").

Part 2

Have students visit the Heart and Stroke Foundation website or review pamphlets or fact sheets to learn more about blood pressure, and identify the relationship of the sounds of the heart from Part 1 to systole, diastole, and the specific action of heart valves and the control of heartbeat. They should also link the cardiac cycle to heart sounds and blood pressure reading (120 systole/ 80 diastole). The description of what blood pressure is all about can be summarized using a Concept Map (see *SYSTH*, p. 9.6)

Resource Link

The following website offers comprehensive information about blood pressure:

- Heart and Stroke Foundation. Home Page. <www.heartandstroke.com/>.

Suggestions for Assessment

Review the completed Concept Maps, as a formative assessment, to determine the level of students' understanding of blood pressure, and re-teach if necessary.

The question of how the sounds of a heartbeat (the lubb-dubb) relate to the functioning of the heart could be used as a summative assessment question at the conclusion of the unit.

BLOOD PRESSURE

SPECIFIC LEARNING OUTCOMES

B11-3-10: Explain the meaning of blood pressure readings and identify the normal range. (GLOs: B3, D1)

Include: given as a ratio of systolic over diastolic

B11-3-11: Identify factors that affect blood pressure or cardiac function and describe their effects. (GLOs: B3, D1)

Examples of factors: exercise, caffeine, nicotine, shock, beta blockers, diuretics, hormones, stress...
Examples of effects: low blood pressure, high blood pressure, increased heart rate…

B11-3-12: Explain how transport systems help to maintain homeostasis in the body. (GLOs: D1, E2)

Include: transport nutrients, oxygen, carbon dioxide, wastes, and hormones; help maintain fluid balance; regulate body temperature; and assist in the defence of the body against invading organisms

Factors That Affect Blood Pressure (U1, U2)

Part 1

Demonstrate the constriction of capillaries in the skin (vasodilation) using cold water or air. Ask a volunteer to help demonstrate the vasodilation of capillaries of skin after exercise, such as running laps. Have students discuss how meditation or relaxation techniques can help reduce blood pressure.

Part 2

Explain to students that high blood pressure affects approximately 22 percent of Canadian adults (Heart and Stroke Foundation, "Statistics") and that the risk increases with age. Show pictures of people in various activities and have students predict the effect of the activities on blood pressure.

Suggestions for Assessment

Have students apply their understanding of factors that affect blood pressure by answering questions such as the following:

- Why do soldiers faint after standing at attention for a long period of time?
- Why are blood donors told not to smoke for a few hours prior to donating their blood?

These questions can be used as a formative type of assessment to judge the level of student understanding of blood pressure and to help plan future lessons. They can also serve as a summative type of assessment using criteria for success such as the following:

- Response is complete and accurate, includes appropriate scientific vocabulary, and demonstrates an in-depth understanding of blood pressure.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Transport Systems and Homeostasis—Direct Instruction (U1, U2)

Explain the importance of the circulatory system in the maintenance of homeostasis. This system transports hormones, which are key substances in the negative feedback mechanisms of the body, to target cells. It also transports nutrients and oxygen to cells, carbon dioxide to the lungs, and nitrogenous wastes to the kidneys, in order for them to be removed from the body.

Suggestion for Assessment

Have students complete a Concept Overview frame to describe the role of the circulatory system in maintaining homeostasis (see *SYSTH*, pp. 11.23–11.25).

Bloodletting and Homeostasis—Microtheme (U2, I4)

Provide students with the following microtheme assignment:

Microtheme
The practice of bloodletting or phlebotomy was very popular until the mid-nineteenth century. It was believed that by removing “bad blood,” illnesses such as fevers, coughs, headaches, inflammations, and even hemorrhage could be successfully treated. Doctors thought that the drained blood could be replaced within a few hours by new, healthy blood. In 1799, George Washington (the first U.S. president) was treated for a throat infection by the removal of five litres of blood from his body within 24 hours. He died following this treatment.

With the knowledge you have about blood pressure, transport systems and homeostasis, explain why this treatment caused George Washington’s death instead of curing him.

Suggestion for Assessment

Refer to Appendix 1.3B: Microthemes—First Draft Checklist (BLM), and Appendix 1.3C: Microthemes—Final Draft Assessment (BLM) from Unit 1 for assessment tools.

RESPIRATION

SPECIFIC LEARNING OUTCOMES

B11-3-13: Distinguish between cellular respiration, internal respiration, and external respiration. (GLO: D1)

B11-3-14: Identify major structures and functions of the human respiratory system from a diagram, model, or specimen. (GLO: D1)

Include: lungs, pleura, nasal cavity, epiglottis, bronchi and bronchioles, alveoli, pulmonary capillaries, diaphragm, pharynx, larynx, trachea, uvula, ribs, and intercostal muscles

B11-3-15: Describe how breathing is controlled to help maintain homeostasis in the human body. (GLOs: D1, E2)

Include: chemoreceptor and medulla oblongata

SLO: B11-3-13
SLO: B11-3-14
SLO: B11-3-15

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Breathe Easy

Ask students to brainstorm answers to the following questions:

- Why do we need to breathe?
- How does O_2 get into body cells?
- How is CO_2 removed from the lungs?

The Breathing Challenge

To maximize gas exchange, athletes will often train themselves to inhale and exhale through the nose and the mouth at the same time. Challenge students at the beginning of the class to try breathing like an athlete. Discuss with students how people in other occupations (e.g., musicians) that require efficient gas exchange may train their breathing to maximize gas exchange.

ACQUIRE/APPLY

Cellular Respiration (U1)

Conduct a teacher-led discussion on the need for cellular, internal, and external respiration. Have students examine explanations of cellular, internal, and external respiration and represent these in a variety of ways—in word equations, in chemical equations, and verbally. Have students create a flow chart that summarizes the pathways of air as it moves into and out of the respiratory system.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

Suggestions for Assessment

Students can use the Three-Point Approach strategy (see *SYSTH*, p. 10.9) to distinguish between cellular respiration and internal respiration.

Students' flow charts can be collected to provide feedback on completeness.

Structures of the Respiratory System (U1)

Give each student an outline of the human body. Have students draw, from memory, the nose, the trachea, and the lungs. With the help of resources such as textbooks or websites, have students draw and label the pleura, epiglottis, bronchi and bronchioles, alveoli, pulmonary capillaries, diaphragm, pharynx, larynx, uvula, ribs, and intercostal muscles.

Suggestion for Assessment

Review students' diagrams to ensure their accuracy. To check for understanding, use Entrance or Exit Slips over a period of days, requiring students to label a number of components.

RESPIRATION

SPECIFIC LEARNING OUTCOMES

B11-3-13: Distinguish between cellular respiration, internal respiration, and external respiration. (GLO: D1)

B11-3-14: Identify major structures and functions of the human respiratory system from a diagram, model, or specimen. (GLO: D1)

Include: lungs, pleura, nasal cavity, epiglottis, bronchi and bronchioles, alveoli, pulmonary capillaries, diaphragm, pharynx, larynx, trachea, uvula, ribs, and intercostal muscles

B11-3-15: Describe how breathing is controlled to help maintain homeostasis in the human body. (GLOs: D1, E2)

Include: chemoreceptor and medulla oblongata

Dissection (S3, S4, S5)

Provide students with the opportunity to identify components of a "real" respiratory system through the examination of a pluck (lungs, bronchi, and trachea, all in one piece) or through a real dissection specimen or a virtual specimen. If a pluck is used, demonstrate the expansion of the lungs as air is blown in.

Resource Links

The following websites provide virtual dissections:

- Berkeley Lab. "The Virtual Frog Dissection Kit." *Computer-Enhanced Science Education: The Whole Frog Project*. <http://froggy.lbl.gov/>.
- Fleck, Earl W. "Virtual Pig Dissection." Whitman College Biology Department. <www.whitman.edu/biology/vpd/>.

Suggestion for Assessment

Establish with students a list of expectations for good dissection skills. Conduct a performance-based assessment by circulating throughout the classroom and assessing dissection skills, using a checklist or a rating scale.

Dissection skills criteria could include the following:

- Secures specimen to the dissection pan.
- Takes care while using scalpel.
- Cuts tissue without damaging organs.
- Identifies parts of the respiratory system correctly.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

Modelling Breathing Mechanics (U2, I4)

To help students understand the functioning of the lungs, conduct a teacher-led demonstration using a bell jar or have students construct their own model.

- **Demonstration:** Conduct a teacher-led demonstration on air pressure and volume relationships to illustrate the action of the lungs.
  - Construct a model of the lungs by using a bell jar or a 2 L clear plastic pop bottle with the bottom cut off.
  - Place a cork or rubber stopper with a hole in the middle in the mouth of the jar or bottle.
  - Place a piece of Y-tube through the hole and attach a balloon at the end of each tube.
  - Tape a piece of balloon or rubber over the large opening at the bottom of the jar or bottle.
  - When the piece of balloon or rubber (diaphragm) is pulled down, volume inside the jar or bottle increases; therefore, air pressure inside drops and the “lungs” inflate. When the “diaphragm” is pushed up, the “lungs” deflate.

- **Student models:** Have students design and construct a model of the respiratory system using recyclable material. Have them use their model to explain the mechanics of breathing.

RESPIRATION

SPECIFIC LEARNING OUTCOMES

B11-3-13: Distinguish between cellular respiration, internal respiration, and external respiration. (GLO: D1)

B11-3-14: Identify major structures and functions of the human respiratory system from a diagram, model, or specimen. (GLO: D1)

Include: lungs, pleura, nasal cavity, epiglottis, bronchi and bronchioles, alveoli, pulmonary capillaries, diaphragm, pharynx, larynx, trachea, uvula, ribs, and intercostal muscles

B11-3-15: Describe how breathing is controlled to help maintain homeostasis in the human body. (GLOs: D1, E2)

Include: chemoreceptor and medulla oblongata

Suggestions for Assessment

- **Demonstration:** Have students explain (in written form, with a diagram, or orally) what they saw during the demonstration and how it relates to the action of the lungs.
- **Student models:** Together with students, develop assessment criteria, and have students use these criteria to assess each other's work. The assessment should be based on the strength of the model's ability to illustrate correct functioning of the lungs.

Extension: Effects of Altitude on Breathing (U2)

Discuss the effects of altitude on breathing.

Resource Links

For information on the physiology involved in climbing, refer to websites such as the following:

- International Society for Mountain Medicine (ISMM). Home Page. <www.ismmed.org/>.
- Public Broadcasting Service (PBS) Online. *Everest*. Apr. 1999. <www.pbs.org/wgbh/nova/everest/>.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

Breathing and Homeostasis—Direct Instruction (U1)

Provide students with information about the role of chemoreceptors and the medulla oblongata in the control of breathing. Have students use the negative feedback mechanisms information and chart provided in Appendix 1.5B: Homeostatis—Background Information (BLM) and Appendix 1.6: Negative Feedback Mechanisms (BLM) of Unit 1 to describe the control of breathing during intense physical activity.

Suggestion for Assessment

Have students form groups and compare their results from the learning activity. Any discrepancies should be discussed and a consensus reached. Each group can then share any problem areas they encountered and what their final consensus was. An example of a negative feedback mechanism chart is found on the following page.

RESPIRATION

SPECIFIC LEARNING OUTCOMES

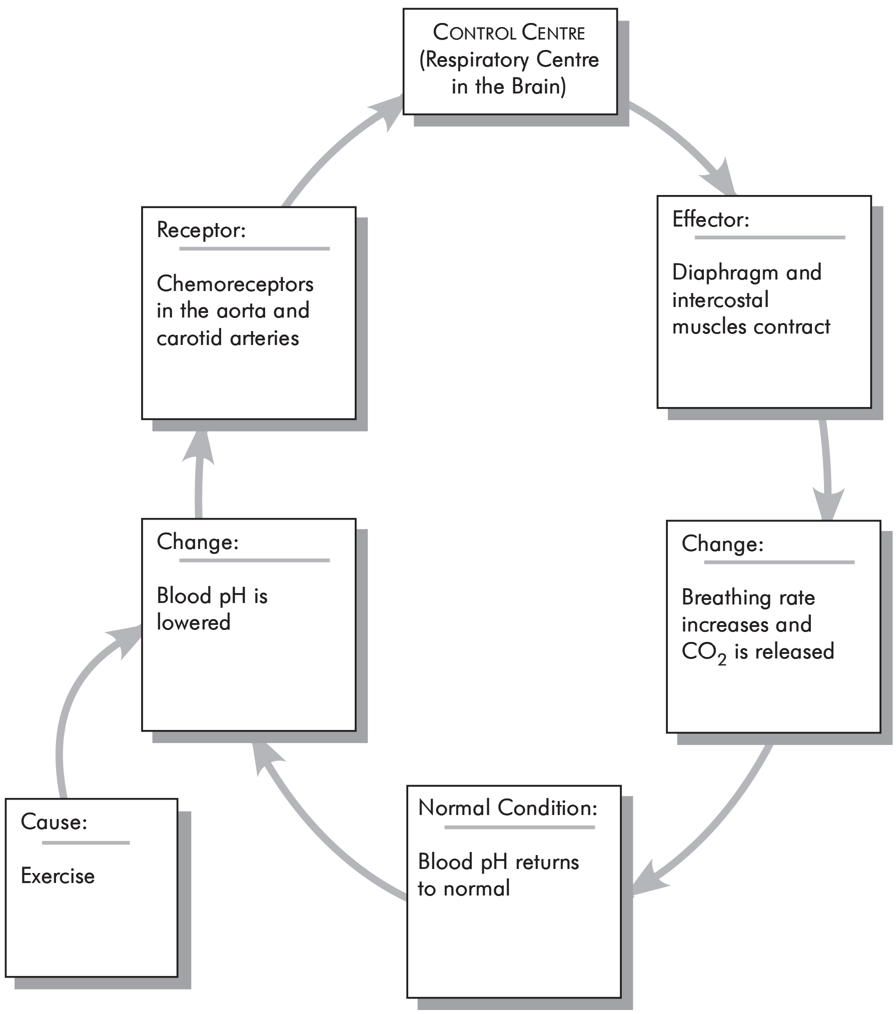
B11-3-13: Distinguish between cellular respiration, internal respiration, and external respiration. (GLO: D1)

B11-3-14: Identify major structures and functions of the human respiratory system from a diagram, model, or specimen. (GLO: D1)

Include: lungs, pleura, nasal cavity, epiglottis, bronchi and bronchioles, alveoli, pulmonary capillaries, diaphragm, pharynx, larynx, trachea, uvula, ribs, and intercostal muscles

B11-3-15: Describe how breathing is controlled to help maintain homeostasis in the human body. (GLOs: D1, E2)

Include: chemoreceptor and medulla oblongata



Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

Notes

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-3-16: Investigate and describe conditions/disorders associated with transportation and/or respiration in the human body. (GLOs: B3, C6, D1)

Examples: cardiovascular diseases...

B11-3-17: Identify personal lifestyle choices that contribute to cardiovascular and respiratory wellness. (GLOs: B3, C4, D1)

Examples: active lifestyle, not smoking…

SLO: B11-3-16
SLO: B11-3-17

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Cardiovascular Problems

Ask students to talk about people they know who have cardiovascular problems. Are they smokers? Do they exercise regularly?

Reflecting on Cardiovascular and Respiratory Wellness

Have students revisit their Wellness Checkup (see Appendix 1.2 in Unit 1) and identify personal issues related to cardiovascular and respiratory wellness.

ACQUIRE/APPLY

Cardiovascular and Respiratory Conditions and Disorders—Research and Presentation (U2, I1, I2, I3, I4)

Have students choose a condition or disorder associated with transportation or respiration in the human body and conduct research into their selected topic. The results can be displayed in poster format. Develop, with students, the assessment criteria for the display. The criteria should include both content and presentation components. The content criteria should include the use of key terms and understandings from the unit.

Students can pair up and visit displays located around the room. Students observe the displays carefully, discuss them with their partners, and record the important information.

Suggestion for Assessment

Student displays can be self- and peer-assessed with the help of criteria developed by the class.

Resource Link

The following website may be useful for student research on lung disease:

- The Lung Association, Manitoba. "Resource Links." *Occupational Lung Monitoring Program*. <www.mb.lung.ca/index.php?pageid=49>.

Skills and Attitudes Outcomes

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Debating an Issue (P1, P3, D1, D2, I1, I4, G1, G2, G3)

Structure a class debate on lifestyle choices related to cardiovascular health. Some suggestions for initiating statements are:

- Physical education should be mandatory for all grades across Canada.
- Manitoba should repeal the province-wide smoking ban.
- There should be more public funding of community centres to ensure that everyone has access to recreational opportunities.

Following the debate, have students complete a reflective piece on what they heard. It could include responses to questions such as the following:

- What did you learn that you didn’t know before?
- What surprised you?
- Was it easy to see a “right and wrong” side to the debate? Why or why not?
- What is your personal opinion on the issue? What impact might this have on your lifestyle choices?

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-3-16: Investigate and describe conditions/disorders associated with transportation and/or respiration in the human body. (GLOs: B3, C6, D1)

Examples: cardiovascular diseases...

B11-3-17: Identify personal lifestyle choices that contribute to cardiovascular and respiratory wellness. (GLOs: B3, C4, D1)

Examples: active lifestyle, not smoking…

Suggestion for Assessment

Refer to Appendix 4.2: Debating Skills Rubric.

Senior 2 English Language Arts: A Foundation for Implementation (Manitoba Education and Training) suggests using the Creative Controversy debating strategy (Batoche et al. 43–48) to help students gather arguments so they can switch sides in a debate, and then move to consensus (see Senior 2, p. 34).

Resource Links

The following online resources could help students gather information about their selected issue:

- Canadian Fitness and Lifestyle Research Institute. Home Page.
  <www.cflri.ca/eng/>.
  This site has information about fitness and lifestyle.

- Health Canada. "Tobacco." *Health Concerns.*
  <www.hc-sc.gc.ca/hc-ps/tobac-tabac/index-eng.php>.
  This site has information on the effects of smoking, including the Canadian Tobacco Use Monitoring Survey, and statistics on the use of tobacco by youth.

- Manitoba Healthy Living, Youth and Seniors. Home Page.
  <www.gov.mb.ca/healthyliving/index.html>.
  This site has tips for healthy living.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

To Smoke or Not to Smoke—Microtheme (U2, I4)

Have students respond to the following microtheme:

> **Microtheme**
> Statistics show that mothers are the last to know that their children smoke. Your task is to convince yourself or a friend to stop smoking before Mom finds out.

Suggestion for Assessment

Refer to Appendix 1.3A: Microthemes (Teacher Background) and Appendix 1.3B: Microthemes—First Draft Checklist (BLM) in Unit 1 for additional information on the purpose, procedure, and assessment of microthemes.

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-3-16: Investigate and describe conditions/disorders associated with transportation and/or respiration in the human body. (GLOs: B3, C6, D1)

Examples: cardiovascular diseases...

B11-3-17: Identify personal lifestyle choices that contribute to cardiovascular and respiratory wellness. (GLOs: B3, C4, D1)

Examples: active lifestyle, not smoking…

Wake-up Call (U2, I1, I4)

The case study "Wake-up Call" developed by Lisa M. Rubin and Clyde Freeman Herreid incorporates circulatory and respiratory issues in a case related to cardiovascular disease. (See Appendix 3.9 for the full case study.)

Resource Link

Case Study Teaching Notes and Answer Keys are available at the following website:

- National Center for Case Study Teaching in Science. *Case Collection.* <http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>.

To access some of these resources, you are required to register for a password (available free of charge).

Suggestions for Assessment

There are questions associated with each step of the case study, which teachers could assess using criteria such as the following:

- The response clearly answers the question.
- The response uses evidence to identify issues referred to in the question.
- The response justifies suggested diagnosis or course of action using evidence.

The performance-based products in this case study, such as a pamphlet or a brochure, could be assessed using a rubric. Teachers can discuss with students the criteria to be used for this assessment.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Exercise and Wellness—Reflective Self-Study (P2, P3)

WP

Have students review the information about exercise habits in their Wellness Checkup (see Appendix 1.2 in Unit 1) to reflect on what they could improve. Have students propose an exercise plan that incorporates suggestions for improvement. This plan could include

- ways to improve their strength, flexibility, and cardiovascular endurance
- realistic suggestions (Will students be able to practise what they suggest?)

Suggestion for Assessment

Assess students’ exercise plans according to the identified criteria or using other criteria developed with student input.

Notes

Unit 3:
Transportation and Respiration

Appendices

Appendix 3.1: Scientific Inquiry (BLM)

Science plays an important role in daily life. Whether you investigate how changing the angles of a skateboard ramp affect the height of your jump or which type of skin cream you should buy to clear up acne, science is important to you. Learning more about how science works will enable you to use it more effectively.

People have always tried to understand the world around them. To answer questions people may have, scientists conduct experiments or investigations that involve imagination, creativity, and perseverance. Scientists do not follow a fixed step-by-step approach when investigating a question. The type of question asked will often determine the approach taken to answer it. Some investigations can be mainly observational in nature, while others are more experimental. The following aspects of scientific inquiry can help you construct your own experimental investigation.

Asking a Question

A good *testable question* will often take the form of "How does ____ affect ____?" It will focus your testing to only one factor (e.g., How does the amount of sunlight affect the growth of plants? instead of What affects the growth of plants?). It will allow you to make predictions, create a plan, conduct a fair test, and make meaningful observations and conclusions.

Consider another example of a testable question: How does the application of heat affect the viscosity of a fluid? This question includes the cause (the application of heat) and the effect (viscosity of a fluid). These two portions of the testable question are called variables. *Variables* are factors that can affect an event or a process in some way. The *independent variable* is the one variable you choose to change. The *dependent variable* changes as a result of or in response to the change in the independent variable.

Making a Hypothesis

A *hypothesis* is a suggested answer of how one variable affects the other. The hypothesis should describe the relationship between the independent and dependent variables. Often it follows an *if-then* pattern:

If the *amount of heat added* increases, then the *viscosity* will decrease.

independent variable   dependent variable

Designing the Experiment

Ensuring a Fair Test

To conduct a fair test, you must ensure that factors that could affect the outcome of the experiment are controlled or kept the same. The variables that are not changed are called *controlled variables.* For example, in an experiment to determine which sponge absorbs the most liquid, the size of the sponge used is a variable you would want to control. Samples of each of the different types of sponges to be tested could be cut to the same size. The amount of liquid each sponge absorbs could be compared fairly, with the results attributed to the type of sponge and not the size of the sponge.

Creating a Plan

The next step is to create a plan to test the hypothesis. First, you determine what materials are needed to conduct the test. Then you create and record a plan or method. The test should be done several times to continue the concept of a fair test. This is intended to ensure that results do not happen by chance or by fluke, but are accurate and dependable.

Conducting the Experiment

During the experiment, it is important to follow your plan, to take accurate measurements, and to make careful observations. Your own safety and that of others should always be on your mind. To increase the accuracy and reliability of the experiment, measurements should be repeated.

Observing and Recording Data

Observations can be recorded in any of the following ways:

- written sentences
- graphs
- point-form notes
- diagrams
- charts
- lists
- spreadsheets

Organizing and Analyzing Results

Your conclusion should explain the relationship between the independent variable and the dependent variable. Here is an example of a conclusion on an experiment that involved sunlight and plant growth.

> *In our experiment, all variables, other than the amount of sunlight, were kept constant. The geranium plants that received additional sunlight grew more than the plants that were only given limited amounts of sunlight. In the 32 days that we ran the experiment, the plants that received an additional 10 hours of sunlight a day grew an average of 3 cm, while the plants that received only limited sunlight grew an average of 1 cm. Our results support our hypothesis.*

In addition to revisiting the hypothesis, the conclusion should include the sources of error in the experiment. These would be factors that may impede the accuracy of the data. In the reflections on the process component of the conclusion, you may want to suggest ways to improve the experiment.

Implications and applications for daily use: Include an additional component to the conclusion that deals with how the experiment or concept applies to everyday living.

Appendix 3.2: Feedback Form for Designing an Experiment (Plan) (BLM)

Name ____

Proposed Experiment Title ________________________________

Criteria	Yes/No	Comments
The experimental design tests the hypothesis.		
The statement of the problem justifies the need for the experiment.		
The procedures are complete, clear, and described sequentially.		
An independent variable is clearly identified.		
The plan controls and measures the independent variable accurately.		
A dependent variable is clearly identified.		
The design ensures the dependent variable is measured accurately.		
A complete list of required materials is provided.		
The experiment includes proper controls.		
An appropriate strategy to use repeated trials and measurements is described.		
Experimental design includes appropriate safety concerns.		
Instructions are provided for proper cleanup and disposal of wastes.		

Appendix 3.3: Rating Scale for Experimental Design and Report (BLM)

Name ______________________________

Experiment Title ______________________________

Level 1: Not Meeting Expectations
Level 2: Approaching Expectations
Level 3: Meeting Expectations
Level 4: Exceeding Expectations

Criteria	**Level**			
	1	**2**	**3**	**4**
The experimental design tests the hypothesis.				
The statement of the problem justifies the need for the experiment.				
The procedures are complete, clear, and described sequentially.				
The plan controls and measures the independent variable accurately.				
The design ensures the dependent variable is measured accurately.				
A complete list of required materials is provided.				
The experiment includes proper controls.				
A margin of "error" is noted, and a thoughtful discussion for reducing error is included.				
An appropriate strategy to use repeated trials and measurements is described.				
Experimental design includes appropriate safety concerns.				
The report is neat, clear, and well-organized.				
Appropriate vocabulary, mechanics, and complete sentences are used.				

Appendix 3.4: Blood Transfusion Case Studies (Teacher Background)

Case Studies

Station #1 Quinn has been extremely tired lately and unable to do much physical labour. As her doctor, you diagnose her with anemia and suggest a blood transfusion. Quinn's blood type is O^+. Her sister's is B^+ and her brother's is O^-. Who can donate blood to Quinn?	**Station #2** Lester just went through a difficult surgery and his hemoglobin count is low. As his doctor, you recommend a blood transfusion. Lester's blood type is B^-. What blood type(s) can Lester be given?

Station #3 Meagan was in a car accident and, due to an injury to her spleen, she was bleeding internally. As her doctor, you are able to control the internal bleeding but must replace the blood with a transfusion. Meagan's blood type is A^-. What blood type(s) can Meagan be given?	**Station #4** Reagan, whose blood type is AB^+, is suffering from severe heart disease. As her doctor, you suggest Reagan have a blood transfusion to increase the oxygen flow throughout her body. What blood type(s) can Reagan be given?

Station #5 Gilles has a cancer that has affected his ability to produce enough red blood cells. As his doctor, you want Gilles, whose blood type is AB^-, to have a blood transfusion. What blood type(s) can Gilles be given?	**Station #6** Donald is being prepared for a long heart surgery. However, his hemoglobin count is too low. As his doctor, you recommend a blood transfusion before surgery. Donald's blood type is A^+. What blood type(s) can Donald be given?

Station #7 Reg has hemophilia and needs clotting factors found in plasma. Reg's blood type is AB^-. As his doctor, you need to decide from what blood type(s) Reg can receive the plasma/clotting factor.	**Station #8** Stacey has sickle cell anemia and requires a blood transfusion to help transport more oxygen to her tissues. Her blood type is O^-. From what blood type(s) could Stacey receive a transfusion?
Station #9 Hilda has breast cancer and undergoes chemotherapy. The chemo has affected her red blood cell count and she needs a transfusion. Hilda's blood type is B^+. What blood type(s) can be used for Hilda's transfusion?	**Station #10** Bill has an immunodeficiency disorder that weakens his body's ability to fight off infection. As his doctor, you suggest a blood transfusion. Bill's blood type is A^+. What blood type(s) can Bill be given?

Answers

1. Brother
2. B–, O–
3. A–, O–
4. AB+, AB–
5. AB–, A–, B–, O–
6. A–, A+, O+, O–
7. AB–
8. O–
9. B+, B–, O+, O–
10. A+, A–, O–, O+

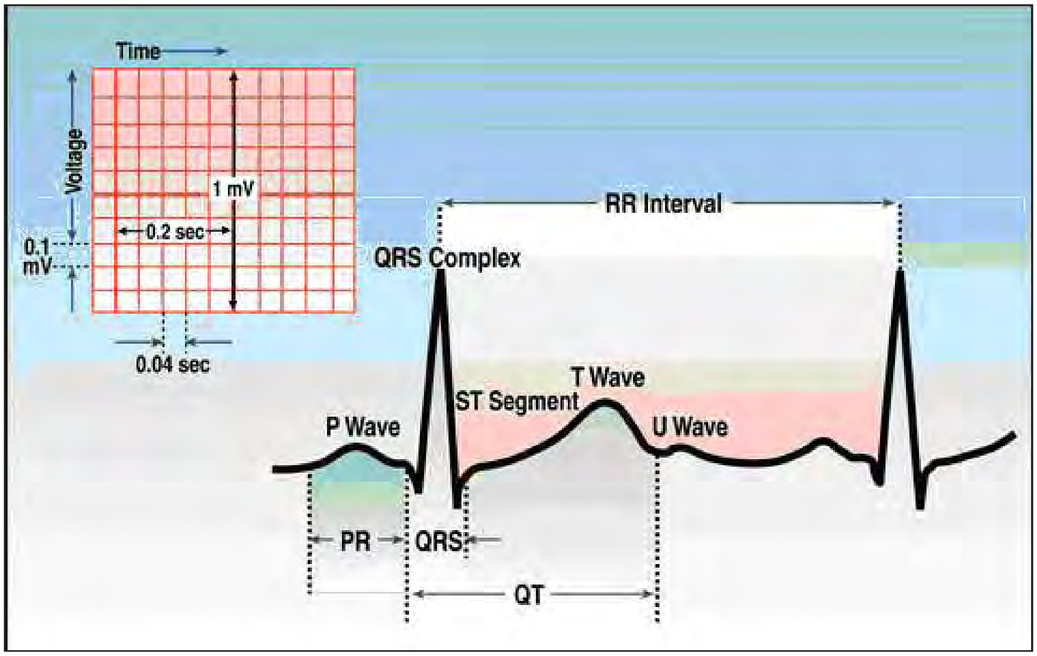
Appendix 3.5:
Comparing Vessels (BLM)

Name ______________________________

	Artery	Vein	Capillary
Direction of Flow			
Inner Wall			
Smooth Muscle			
Connective Tissue			
Gas and Nutrient Exchange			
Blood Pressure			
Valves Present			
Fluid Moved By			
Oxygen Content			
Carbon Dioxide Content			
Type of Blood Flow			

Appendix 3.6:
Interpreting the Electrocardiogram (BLM)

ECG Intervals and Waves—KH*



The P wave represents atrial activation; the PR interval is the time from onset of atrial activation to onset of ventricular activation. The QRS complex represents ventricular activation; the QRS duration is the duration of ventricular activation. The ST-T wave represents ventricular repolarization. The QT interval is the duration of ventricular activation and recovery. The U wave probably represents "afterdepolarizations" in the ventricles.

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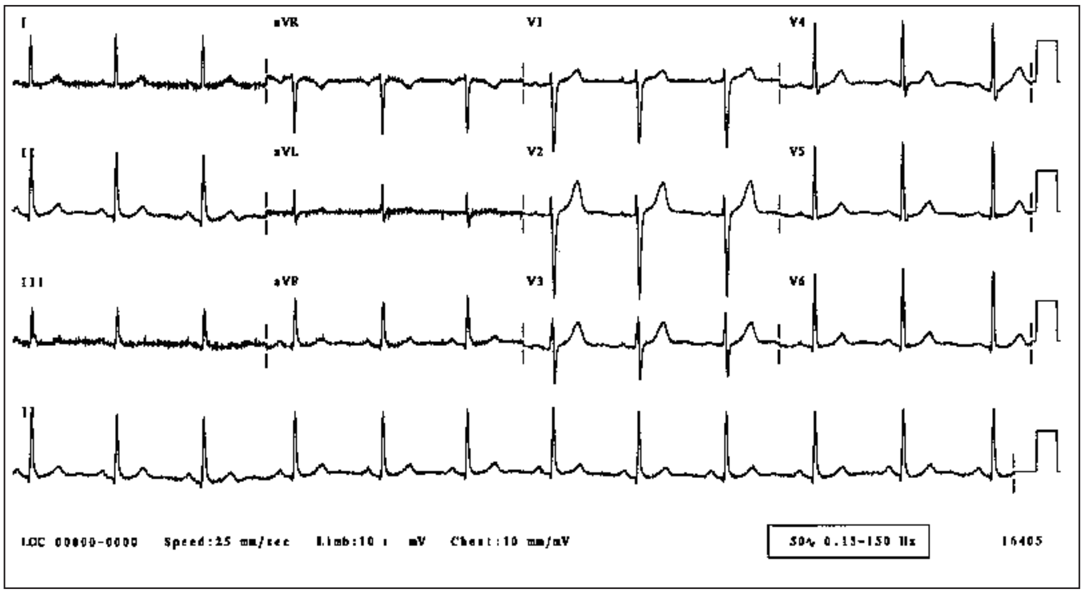
*Source: Frank G. Yanowitz, M.D., copyright 1997. <http://library.med.utah.edu/kw/ecg/mml/ecg_533.html>.

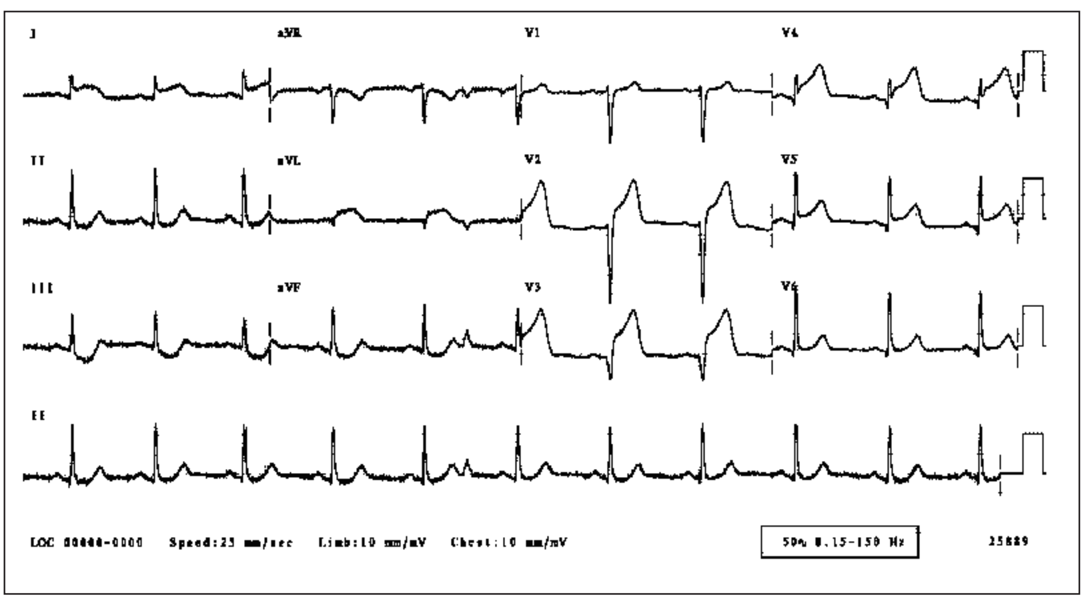
Appendix 3.7: Comparing Electrocardiograms (BLM)

Using the following electrocardiograms, compare the P wave and the QRS complex in normal patients to those with heart disease.

A normal adult electrocardiogram (ECG)*

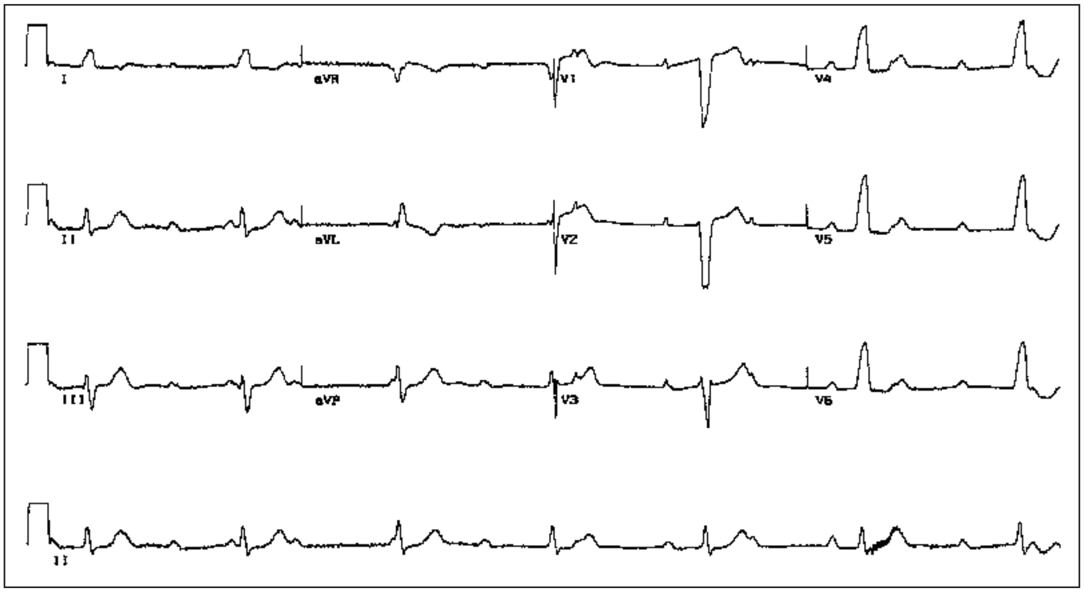


Electrocardiogram of 63-year-old woman with 10 hours of chest pain and sweating*



*Source: Jenkins, Dean, and Stephen Gerred. *ECG library*. © 1995–2009. <www.ecglibrary.com/ecghome.html>. Reproduced with permission.

Electrocardiogram of 70-year-old man with complete heart blockage*



*Source: Jenkins, Dean, and Stephen Gerred. *ECG library*. © 1995–2009. <www.ecglibrary.com/ecghome.html>. Reproduced with permission.

Appendix 3.8:
Blood Pressure Quiz:
Know Your Blood Pressure by Heart* (BLM)

What Do You Know about Blood Pressure?

Take this short quiz by circling either **T** for TRUE or **F** for FALSE for each of the following statements about blood pressure.

1. Blood pressure begins with a heartbeat.	T	F
2. Blood pressure stays the same all day, every day.	T	F
3. Blood pressure helps the blood flow to all parts of the body.	T	F
4. A blood pressure reading has two numbers.	T	F
5. You can tell what your blood pressure is by the way you feel.	T	F
6. A healthy person could have a blood pressure of around 120/80.	T	F
7. Blood pressure should be checked every five years.	T	F
8. You can only tell what your blood pressure is by having it measured.	T	F
9. Being overweight can lower blood pressure.	T	F
10. Eating large amounts of food high in salt (sodium) can cause blood pressure to rise.	T	F
11. Regular exercise will help keep your blood pressure healthy.	T	F
12. Only a relaxed and easygoing person can have normal blood pressure.	T	F

*Source: Timiskaming Health Unit. *Blood Pressure Quiz: Know Your Blood Pressure by Heart*. <www.timiskaminghu.com/content.asp?navID=116&parentID=115&lang=en>. Used with permission.

Answers to Blood Pressure Quiz

1. True.
2. False.
3. True.
4. True.
5. False.
6. True.
7. False.
8. True.
9. False.
10. True.
11. True.
12. False.

Resource Link

Heart and Stroke Foundation. *Get Your Blood Pressure under Control.* Ottawa, ON: Heart and Stroke Foundation, n.d. Available online at <www.heartandstroke.com/atf/cf/%7B99452D8B-E7F1-4BD6-A57D-B136CE6C95BF%7D/Get-your-blood-pressure-under-control-en.pdf>.

Appendix 3.9: Wake-up Call* (BLM)

by Lisa M. Rubin and Clyde Freeman Herreid
University at Buffalo, State University of New York

Part I—"Panic!"

It was 4:36 a.m. She was in a cold sweat and having difficulty breathing. She felt as though she had run a marathon. Fear swept through her—something terrible was going to happen. Panic-stricken, she woke her husband, Jeremy.

"Denise, what is it? Is it a nightmare?"

"No, it's like I'm having an asthma attack. I feel lightheaded and I can't catch my breath. My heart feels like it's beating a thousand times a minute."

Afraid to upset her husband further, Denise didn't tell him that an immense feeling of apprehension suddenly overcame her. She got up to drink some water and waited for the anxiety to subside. Her mind was racing. Jeremy had a family history of heart disease. This couldn't be happening to her. It was his problem. A few months earlier Jeremy was diagnosed with coronary artery disease. He was only 48 years old, the same age as Denise. The scare had encouraged him to gradually end years of chain smoking and adopt a healthier lifestyle. He was currently working on giving up the occasional cigarette for good.

"No," Denise thought to herself. *"There's no way this was a sign of heart troubles. I didn't have a pain in my chest, I'm physically fit, and I have no family history. There's just no way."*

After assuring herself of this, Denise was somehow able to fall back asleep.

Questions:

1. How likely is this to be a heart problem? Asthma? Panic attack? Or...?
2. Why do you say this? What are the symptoms that are consistent with your preliminary diagnosis? Is there anything unusual?

---

*Source: Rubin, Lisa M., and Clyde Freeman Herreid. "Wake-up Call." Parts I–VI. <www.sciencecases.org/heart/heart.asp>. Reproduced by permission of the National Center for Case Study Teaching in Science, University at Buffalo, State University of New York.

Part II—"A Voice from Within"

The next day at work, Denise was having a hard time focusing. Maybe the stress of her job was finally catching up with her. Managing a catering business was no easy task. On top of that, her only daughter, Emily, had left for college this fall and, being the overprotective parent that she was, Denise found herself constantly worrying about how her daughter was faring in a different city, away from the comforts of home. Also, Denise was starting to go through the early stages of menopause. The hormonal changes, combined with fatigue, stress, and her general worrisome nature, were catching up to her. Not only that, she couldn't get last night's scary episode out of her thoughts. Was it just part of the whole perimenopause thing or was it more? Her body was trying to tell her something, but Denise wasn't sure she was ready to hear.

> *"I wonder if Denise realizes how all those years of second-hand smoke have taken a toll on her lungs and on ME, her heart! All that tobacco inhalation has constricted her coronary arteries. Sure, Denise tries to stay physically active but genetics and her food choices have brought her blood cholesterol up pretty high to 245 mg/dl. She could be headed for heart disease. A person's total cholesterol level shouldn't get above 200 mg/dl. That's right. I ought to know! Denise has hypercholesterolemia, a major contributor to heart disease. Geesh. Get with it, Denise.*
>
> *"That was a major warning last night. I'm oxygen-starved! Luckily, only a small area of my left ventricle had a big decrease in blood flow and oxygen supply (cardiac ischemia). Thank goodness. If nothing else happens, my body will start growing some new collateral vessels (bypass channels) and I can get some repair work done. Denise didn't experience chest pain (angina pectoris). But her rapid heartbeat and shortness of breath sure got her attention. She had better shape up because I don't know if I can handle much more oxygen deprivation. And, hey, all this unstable plaque lurking around is not a good sign either. No indeed. Who knows when it may rupture? I don't like the looks of this at all."*

Questions:

1. Draw a sketch of the heart and show where the coronary blood vessels lie.
2. List in order the blood vessels that a drop of blood would follow as it makes a complete journey around the body starting as it enters the right atrium until it returns to the right atrium.
3. What are the characteristics of Denise's lifestyle that might lead to a heart problem?
4. Has Denise suffered a heart attack?
5. Define these terms: **cholesterol**, **hypercholesterolemia**, **cardiac ischemia**, **collateral vessels**, **angina pectoris**, and **plaque**.

Part III—"Heart Attack Basics"

It appears that Denise has suffered mild heart trauma, which may lead to a more severe heart attack if not treated. But wait ... isn't a heart attack when the heart stops beating? Not exactly.

Cardiac arrest is the term used when the heart muscle literally stops pumping blood. A heart attack, also known as a **myocardial infarction**, may lead to cardiac arrest, but it's defined as a sudden event where at least one of the **three major coronary arteries** (right coronary artery, left anterior descending coronary artery, and left circumflex artery) becomes partially or totally blocked, usually by a blood clot (**thrombus**). A more rare cause of coronary occlusion is an artery spasm that shuts down blood flow to the heart. This can occur with cocaine use and severe emotional stress. Other rare causes of heart attack include sickle cell crisis, allergic reactions, carbon monoxide poisoning, extreme hypoxia, and an unmet increased need for blood flow to the heart such as may occur during extreme physical exertion, shock, or hemorrhage.

Heart cells can live for about 20 minutes without oxygen. The loss of oxygen-rich blood to the heart cells during a heart attack leads to cell damage, which may be permanent and lead to **cell necrosis** (death), depending on the severity of the attack and the amount of heart tissue that the blocked artery supplies. **The area of infarction** is where cell necrosis occurs, if it does. Surrounding it is the **area of injury**, which may or may not suffer permanent damage. The outermost affected area is the **zone of ischemia**, which is weakened but regains function within two to three weeks.

Besides the possibility of cardiac arrest, other possible complications include the following: **cardiogenic shock** (where the heart is too weak to adequately pump blood), **pulmonary edema** (where a weakened heart causes blood backup and leakage of plasma into the lungs), irregular heart rhythm (**arrhythmia**), rupture of a heart wall or valve, or death.

It is a misconception that having a heart attack leads to chronic **coronary artery disease (CAD)**. In reality, CAD and accompanying **atherosclerosis** (hardened, narrowed arteries) is the number one cause of heart attacks. What causes CAD? The main culprit is **arteriosclerosis**, or plaque buildup in the coronary arteries. **Plaque** is a material composed mainly of lipids, cholesterol (lipoproteins), and calcium. **Cholesterol** (a type of lipid necessary for synthesis of hormones, vitamin D, and bile) is carried through the bloodstream by two main types of **lipoproteins: high-density lipoproteins (HDLs) or "good" cholesterol, and low-density lipoproteins (LDLs) or "bad" cholesterol.** Studies by the American Heart Association and the well-known NHLBI-supported Framingham Heart Study show that HDLs help prevent heart disease by transporting lipids and cholesterol from the arteries to the liver. LDLs, which contain more fat and less protein, are unstable and stick to artery walls to help contribute to plaque formation.

LDLs (**cholesterol-handling system**) produce toxins that form tiny lesions on the inner walls of arteries. These lesions attract triglycerides and other substances in the bloodstream. White blood cells (**inflammatory system**) rush to the injury site, but cause the inner wall to become stickier and thus attract more LDLs. Platelets (**blood-clotting system**) collect at the lesion site, only to trap more lipids and white blood cells. Plaque build-up slowly occurs. (Note that cholesterol is not the sole cause of plaque formation.) Over time, some of the plaque can develop a thick, hard, calcified fibrous cap and is called **stable plaque**, yet causes the arteries to become narrower and harder (atherosclerosis). Other plaque can develop a large lipid and macrophage core, decreased smooth muscle cell content, and a thinner, softer, more unpredictable fibrous cap (due to increased metalloproteinase enzyme activity). This can rupture, producing a **thrombosis** (artery blockage), **cardiac ischemia**, and a heart attack can ensue.

Part IV—"Call 911!"

It was March. Emily was home for spring break and Denise was enjoying having her 19-year-old daughter around. Unfortunately, it was going to be hard to spend much time with her because it was that time of the year when weddings and other catered events were picking up again after the post-New Year's lull. Denise was feeling the pressure pile up again. She constantly felt fatigued and out of breath, but she attributed these to perimenopause.

Emily could sense that her mother was tense and out of sorts, so she planned a relaxing evening for her parents and offered to cook mushroom lasagna, her mother's favourite dish. All was going well until dessert, when Emily noticed her mother's face growing paler by the minute. Suddenly, just like that night back in October, Denise began to have severe trouble breathing and her heart began racing. The room began to spin and, without warning, she fainted on the dining room floor.

"Oh my God! Dad, call 911!"

> *"Uh oh. Oh! Oh no! Denise. Denise! Do you read me? I'm in the middle of a heart attack!! I know it. I can feel it! That plaque in your left anterior descending coronary artery just ruptured. Now everything is going crazy. Everyone in the whole body seems to be swimming by. High levels of fibrinogen, C-reactive protein (CRP), and interleukin-18 (IL-18-inflammatory markers present in the bloodstream when there's unstable plaque) are combining with your high blood serum cholesterol. BAD things are happening, Denise. Really, really BAD!*
>
> *"Plaque ruptures. Platelets stick to the exposed lipid core at the site of rupture. The blood clot grows...too big. Oh, too big. Is it going to break? Say it isn't going to break. Not thrombosis, please....*

"…. It's been 10 minutes since my heart cells supplied by the blocked artery have been without oxygen. If something isn't done soon, my cells are going to die. Necrosis! I never thought I could say that word. They say a heart attack can take over four to six hours. This first hour is horrible – the most critical period. Parts of the blood clot may break loose, travel in the blood, and stick in some tiny little blood vessel. My God, it could get in a coronary artery or the brain! An embolism. I need help! Now... NOW. HELP!!

"I've got to get myself in hand. It's the only way in a crisis. Right? Right! Why didn't Denise go to her doctor to complain about her chronic breathlessness, fatigue, and nausea? All this stress elevated her blood pressure and further increased her risk for a heart attack. Alright, so she didn't know that she had a mutation in her LDL receptor gene. How could she know that LDL was not being efficiently removed from her blood? Whatever. At least she should have known her LDL blood levels were very high. So were her levels of lipoprotein (LP a). This stuff increases heart disease risk. Why didn't anyone warn her?

"Sure, I know I'm involved. I'm taking it personally. Wouldn't you? But maybe, just maybe, if Denise had been more aware of the symptoms of heart disease she would have sought help. I happen to know that heart attacks are the number one cause of death in the U.S. More people die from cardiovascular disease (including heart attacks, atherosclerosis, and hypertension) each year than the next six leading causes of death combined, including cancer and automobile accidents. It's an epidemic that people need to be educated about. So get it. I'm here to tell you. Denise. If you won't listen to me, who will you listen to?"

Questions:

1. Why is the first hour of a heart attack the most critical?
2. What do fibrinogen, C-reactive protein (CRP), and interleukin-18 (IL-18) indicate?
3. What is the cause of Denise's breathlessness, fatigue, and nausea?
4. What are platelets and what do they have to do with Denise's heart problem?
5. What is an embolism and what is its connection to thrombosis?
6. What does LDL have to do with heart attacks?
7. How does hypertension develop and what does it have to do with a high risk of heart attacks?

Part V—"Emergency Room"

The doctor spoke calmly to Jeremy in the waiting room. "Mr. Belmore, your wife is in no immediate danger but she has suffered a heart attack to her left ventricle. She's in the emergency room right now, with the aid of an oxygen mask. We noticed some scar tissue, meaning that some prior heart trauma occurred as well. Is this your wife's first attack?"

"Yeah. I'm actually the one who has been diagnosed with heart disease in the house, and I'm the one with a family history. I don't understand. Where did this come from? Denise is conscious of her weight, and she's healthier than I am. She's the one who usually looks out for me and my daughter."

"Well, from her records, your wife hasn't had her blood pressure and cholesterol tested in a few years. Unfortunately, they were highly elevated, which greatly increased her risk of heart disease. Although she looked fit on the outside, blood work would have revealed hidden dangers. Tell me, had your wife been feeling out of sorts these past few months?"

"She has always been an on-the-go person and tends to worry a lot. Her job is pretty stressful. I did notice that these past few months she seemed more tired than usual and acted almost asthmatic. But, don't heart attack victims experience chest pain? Denise has never complained of that."

"That's a good question. The simple answer is that women's heart disease symptoms can be subtler than men's and are often overlooked. Take a look at the charts on the wall over there and you'll see what I mean. Patients may experience all, some, or none of those symptoms. It is even possible to have a silent heart attack."

Women's Symptoms	**Men's Symptoms**
Angina (chest pain may radiate into jaw and down left shoulder and arm) **B**reathlessness (especially at night) **C**hronic fatigue (usually overwhelming) **D**izziness or even blackouts **E**dema or swelling, especially in the ankles **F**luttering (rapid heartbeat) and pallor **G**astric upset (nausea) and sweating	1. Sudden immense pressure or pain in the chest centre (may persist or occur on and off) 2. Pain that radiates from chest centre to neck, shoulders, and arms 3. Dizziness, nausea, sweating 4. Sudden onset of rapid heartbeat

The doctor continued, “This is a pamphlet that gives you some background on cardiovascular disease and the factors that go into them. You’ll notice that some of these are things you can’t change. We call them ‘non-modifiable.’ They include your gender, age, and your hereditary background; we’re all stuck with these. Then there are the ‘modifiable’ factors, things like smoking, stress, and a high fat diet. When more than one factor is present, risk further increases. Once Denise is better I think you both need some time together to consider how you might change your lifestyle.”

Part VI—”The Aftermath”

“Well, it’s been four hours since the chaos began here in Denise’s heart. I’m pooped! Here’s the way I see it. A bunch of my cells are dead. So now there’s an inflammatory response of neutrophils and monocytes and an elevated body temperature. Enzyme levels in the bloodstream are up. I don’t know one enzyme from the other. They’re all just proteins to me. But here’s what I heard the doctors say – I mean it, they really use these big words: Creatine phosphokinase (CPK) has become elevated and will peak within 12 to 24 hours since the attack and with luck it’ll return to normal within 48 to 72 hours. Its isoenzyme, CK-MB, is also elevated. CK-MB2 undergoes a change to CK-MB when released into the bloodstream. The ratio of CK-MB2 to CK-MB1 is more than 1.5 for heart attack patients, which is a benchmark doctors use to diagnose myocardial infarction within 6 hours of symptom onset. The blood level of aspartate aminotransferase (AST or GOT) has become elevated due to cell injury, will peak in 24 to 48 hours, and will return to normal in five days. In contrast to the rapid rise and decline of these enzymes, lactate dehydrogenase (LDH) will begin to elevate within a day of the attack onset and will persist at high levels for 10 to 20 days.

“Cardiac troponins T and I (which help me contract) will remain elevated in the blood for 10 to 15 days after myocardial injury. This means that if the doctors find that the troponins levels are up, they can really be sure the heart has been injured. Well, that’s sure to be what happened to me. So now what have I got to look forward to? Some rest and healing time. With luck, four to six weeks from now, Denise’s body will have deposited collagen fibres and scar tissue at the plaque rupture site. Some more collateral vessels will have been built. But for me, things will never be the same. Any of my heart tissue that died from oxygen starvation will be lost and replaced with scar tissue ... unless doctors can find a way to regenerate it. Geesh, I never thought this would happen to me. Denise is so young....”

Assignment

Denise is back home and on cholesterol-lowering medication and is learning how to better handle stress. Your assignment is to help Denise and her family research the key measures in preventing heart disease, or in Denise's case, another heart attack. Answer the following questions briefly and directly. You may include a table if desired. The sources cited in the References for this case are good sites to utilize.

1. Heart-Healthy Diet
   a) What foods/nutrients should be limited and specifically what foods/nutrients are beneficial and why? (Example: What are the benefits of folic acid, monounsaturated fats, omega 3 fats, etc.? Why are saturated fats bad?)
2. Lifestyle Changes
   a) What activities are hazardous to heart health and what are some solutions? (Example: handle stress with stress management, not overeating.)
   b) What are the benefits of exercise concerning heart health?
3. Aspirin
   a) How can Aspirin help in preventing heart disease?
4. Draw a diagram of the changes in blood enzyme and troponin levels that occur before, during, and after a heart attack.
5. Create a pamphlet that the doctor could give to Denise about altering her lifestyle. It should include information on smoking, cholesterol, blood pressure, obesity, diabetes, physical activity, diet, and stress.

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Unit 4: Excretion and Waste Management

Unit 4: Excretion and Waste Management

Specific Learning Outcomes

B11-4-01: Identify the primary metabolic wastes produced in the human body and the source of each. (GLO: D1)

Include: ammonia, urea, mineral salts, carbon dioxide, and water

B11-4-02: Describe the roles of the major excretory structures in eliminating wastes and helping the body maintain homeostasis. (GLOs: D1, E2)

Include: kidneys, lungs, skin, and intestines

B11-4-03: Describe the important role of the liver in the process of excretion and the maintenance of homeostasis. (GLOs: D1, E2)

B11-4-04: Identify structures of the human urinary system from a diagram, model, or specimen, and describe the function of each. (GLO: D1)

Include: kidneys, renal cortex, renal medulla, renal pelvis, renal arteries and veins, ureters, urinary bladder, urethra, and urinary sphincters

B11-4-05: Explain the processes of filtration, reabsorption, and secretion in the nephron. (GLO: D1)

B11-4-06: Describe the feedback mechanisms associated with water and salt balance and their role in the maintenance of homeostasis in the human body. (GLOs: D1, E2)

Include: antidiuretic hormone (ADH) and aldosterone

B11-4-07: Describe what types of information can be gained through urinalysis. (GLOs: B3, D1)

Examples: performance-enhancing drugs, diabetes, recreational drugs, pregnancy, infections, kidney failure or damage…

B11-4-08: Investigate and describe issues related to kidney failure and treatment options available. (GLOs: B3, C6, C8, D1)

Examples: organ transplant, personal lifestyle, dialysis...

METABOLIC WASTES

SPECIFIC LEARNING OUTCOMES

B11-4-01: Identify the primary metabolic wastes produced in the human body and the source of each. (GLO: D1)

Include: ammonia, urea, mineral salts, carbon dioxide, and water

B11-4-02: Describe the roles of the major excretory structures in eliminating wastes and helping the body maintain homeostasis. (GLOs: D1, E2)

Include: kidneys, lungs, skin, and intestines

B11-4-03: Describe the important role of the liver in the process of excretion and the maintenance of homeostasis. (GLOs: D1, E2)

SLO: B11-4-01
SLO: B11-4-02
SLO: B11-4-03

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

What Are Waste Products?

Ask students the following questions and record their responses.

- What would happen if you never threw out your garbage or leftover food?
- Why do we sweat?
- Why do we urinate?

Have students list as many waste products of the human body as possible.

ACQUIRE/APPLY

Charting Waste (U1)

Explain to students that *excretion* is the removal of the waste products of cellular metabolism from the body. Ammonia, one of the products of cellular metabolism, is very toxic. This is why it is converted to urea (which is much less toxic than ammonia) in the liver before being released into the bloodstream. With the use of resources such as texts or the Internet, have students acquire information to create a chart that links metabolic waste products with the organ that excretes this product.

Example:

Waste Product	Origin of Waste Product	Excretory Organ
Ammonia	*breakdown of amino acids in the liver*	*kidneys*
Urea	*conversion of ammonia in the liver*	*kidneys, skin*
Carbon dioxide	*cellular respiration (breakdown of glucose in cells)*	*lungs, intestines, skin*
Water	*cellular respiration (breakdown of glucose in cells)*	*kidneys, lungs, intestines, skin*
Mineral salts	*food and water*	*kidneys, skin*

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

Have students answer the following question:

- Why is excrement not included in the list of metabolic wastes?
  (Excrement is not a product of cellular metabolism. It is a "leftover" after the body absorbs what nutrients it needs from the small intestine.)

Suggestions for Assessment

Review the completed charts with students to check for comprehension, and re-teach if necessary (formative assessment).

Have students complete a Concept Frame or a Concept Overview for the process of excretion (see *SYSTH*, pp. 11.23–11.25).

Have students answer the following questions:

- What is the liver's role in excretion?
- Why is the liver not considered an excretory organ?

Cumulative Assessment

Have students create a Concept Map illustrating the liver's role in various body systems (e.g., digestion, excretion).

URINARY SYSTEM

SPECIFIC LEARNING OUTCOMES

B11-4-04: Identify structures of the human urinary system from a diagram, model, or specimen, and describe the function of each. (GLO: D1)

Include: kidneys, renal cortex, renal medulla, renal pelvis, renal arteries and veins, ureters, urinary bladder, urethra, and urinary sphincters

SLO: B11-4-04

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Kidney Size

Have students make two fists and place them on their backs just above the hips. Discuss the size and location of their kidneys. Students brainstorm the role of the kidney.

ACQUIRE/APPLY

Charting the Urinary System (S3, S4, S5, S6)

Have students label a diagram of the urinary system while dissecting a specimen or examining models. Using information from texts or the Internet, have students place arrows on the diagram to indicate the direction of the flow of fluids through the system, as well as construct a chart listing the structures of the urinary system and their functions.

Suggestion for Assessment

The diagrams and charts can be used as a formative assessment to determine the level of students' understanding of urinary system structures and their functions.

SKILLS AND ATTITUDES OUTCOMES

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5: Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs: B5, C1)

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

NOTES

SPECIFIC LEARNING OUTCOMES

B11-4-05: Explain the processes of filtration, reabsorption, and secretion in the nephron. (GLO: D1)

PROCESSES

SLO: B11-4-05

SUGGESTIONS FOR INSTRUCTION

BACKGROUND INFORMATION

The kidneys filter about 125 millilitres of blood every minute, which adds up to about 180 litres per day. We obviously don't excrete 180 litres of urine per day, so most of the water filtered out of the blood is returned to the circulatory system. The body excretes only about two litres of urine every day.

Water isn't the only substance that is reabsorbed into the circulatory system. All the glucose that is filtered out of the blood is reabsorbed. This important nutrient necessary for the production of ATP is actively transported back into the circulatory system so that it reaches the cells. Salt concentration in the blood also needs to remain constant. The amount of salt excreted and reabsorbed into the blood depends on how much salt we get from the foods we eat. If we take in a lot of salt, some is reabsorbed into the bloodstream, and more is excreted into the urine.

ACTIVATE

The Formation of Urine

Have students discuss the following question:

Where does your urine come from and how is it formed?

ACQUIRE/APPLY

Filtration, Reabsorption, and Secretion—Direct Instruction (U1)

Use visuals to show the location of the nephron. Provide students with a variety of views of the parts of the nephron (e.g., micrograph, phase contrast slide). Explain the processes of filtration, reabsorption, and secretion. Have students complete one of the following activities to consolidate their understanding of the nephron and its activities.

- Have students create a labelled diagram of a nephron and place arrows on the diagram to indicate
  - the direction of water and solute movement at the locations of filtration
  - reabsorption and secretion through the nephron to the collecting duct
  - the filtration and reabsorption mechanisms
- Have students use a Chain Concept Map to illustrate
  - the main parts of the nephron
  - the direction of water and solute movement in each part

SKILLS AND ATTITUDES OUTCOMES

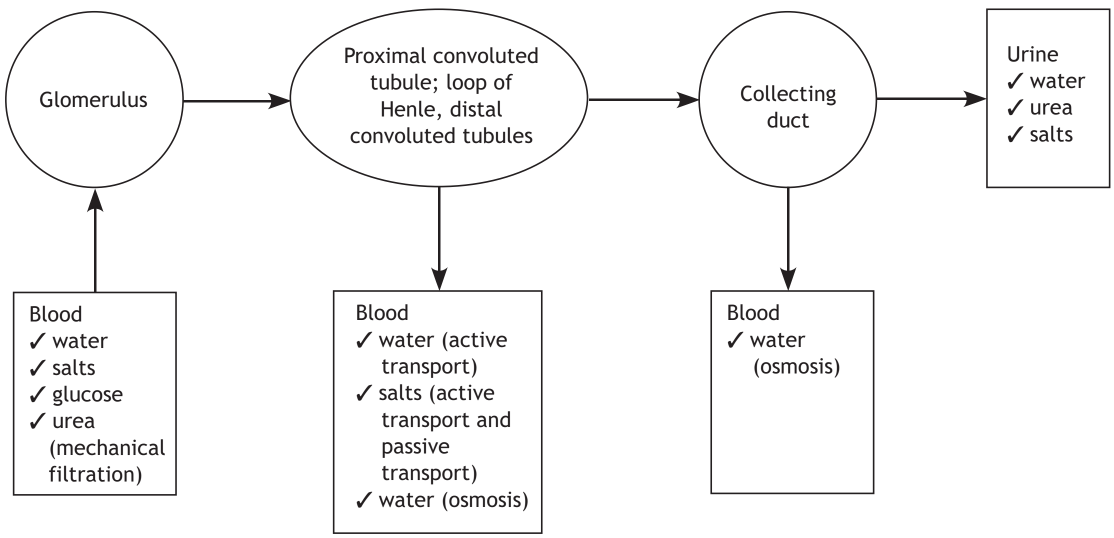
B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

Example:



Suggestion for Assessment

Have students answer the following questions:

- Why do we need to drink regularly?
- How would organisms adapt to an environment such as a desert?

SPECIFIC LEARNING OUTCOMES

B11-4-05: Explain the processes of filtration, reabsorption, and secretion in the nephron. (GLO: D1)

PROCESSES

Kidney Analogies (U2)

Have groups of students create an analogy of the kidney or one of its parts. Students must include the following in their analogy:

- description of the structure (biological concept)
- identification of a familiar object (analogy) that shares some similar characteristics
- identification of the shared characteristics of the structure (biological concept) and the analogy
- indication of where the analogy breaks down

(Glynn, "The Teaching with Analogies Model"; Glynn, Duit, and Thiele)

Suggestion for Assessment

Kidney analogies can be shared with the class and discussed in order to arrive at a consensus as to whether or not the analogy is helpful. The following criteria can help determine the effectiveness of an analogy:

- A familiar analogy is selected.
- Similarities between the analogy and the structure are clear and help explain the structure and/or function of the structure.
- Differences between the analogy and the structure are clear.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

NOTES

FEEDBACK

SPECIFIC LEARNING OUTCOMES

B11-4-06: Describe the feedback mechanisms associated with water and salt balance and their role in the maintenance of homeostasis in the human body. (GLOs: D1, E2)

Include: antidiuretic hormone (ADH) and aldosterone

SLO: B11-4-06

SUGGESTIONS FOR INSTRUCTION

BACKGROUND INFORMATION

The amount of water and salt in the body needs to remain constant. Fluid excreted by the body must, therefore, balance out fluid taken in by the body. The kidneys, acting with hormones named ADH (antidiuretic hormone) and aldosterone, maintain the balance of blood volume and composition through negative feedback mechanisms. Receptors in the hypothalamus sense when the body's fluid intake is low, when blood volume decreases, and when the sodium concentration in blood increases. ADH is then released from the pituitary gland and increases the permeability of the nephron to water. More water is, therefore, reabsorbed into the circulatory system. Aldosterone also helps to regulate water balance. This hormone is released by the adrenal cortex. Factors that cause its release are low blood volume and pressure, which put in motion a complex series of events that start with the release of a hormone called rennin in the kidney. Aldosterone causes the reabsorption of sodium into the circulatory system. Water follows the sodium, and blood volume and pressure are restored.

ACTIVATE

Control of Excretion

Have students discuss the following questions:

- Why do we sometimes excrete a lot of urine and sometimes hardly any?
- Why do we sometimes feel so thirsty we can hardly get enough to drink, but sometimes we don't want to drink anything at all?

ACQUIRE/APPLY

Water Balance and Hormonal Control—Direct Instruction (U1)

Describe the release of ADH and the relationship to osmotic concentration in terms of a negative feedback mechanism. Have students fill in the Negative Feedback Mechanisms BLM (see Appendix 1.6 in Unit 1) to illustrate the process involved in osmoregulation. The Concept Map of this process could look similar to the following:

Skills and Attitudes Outcomes

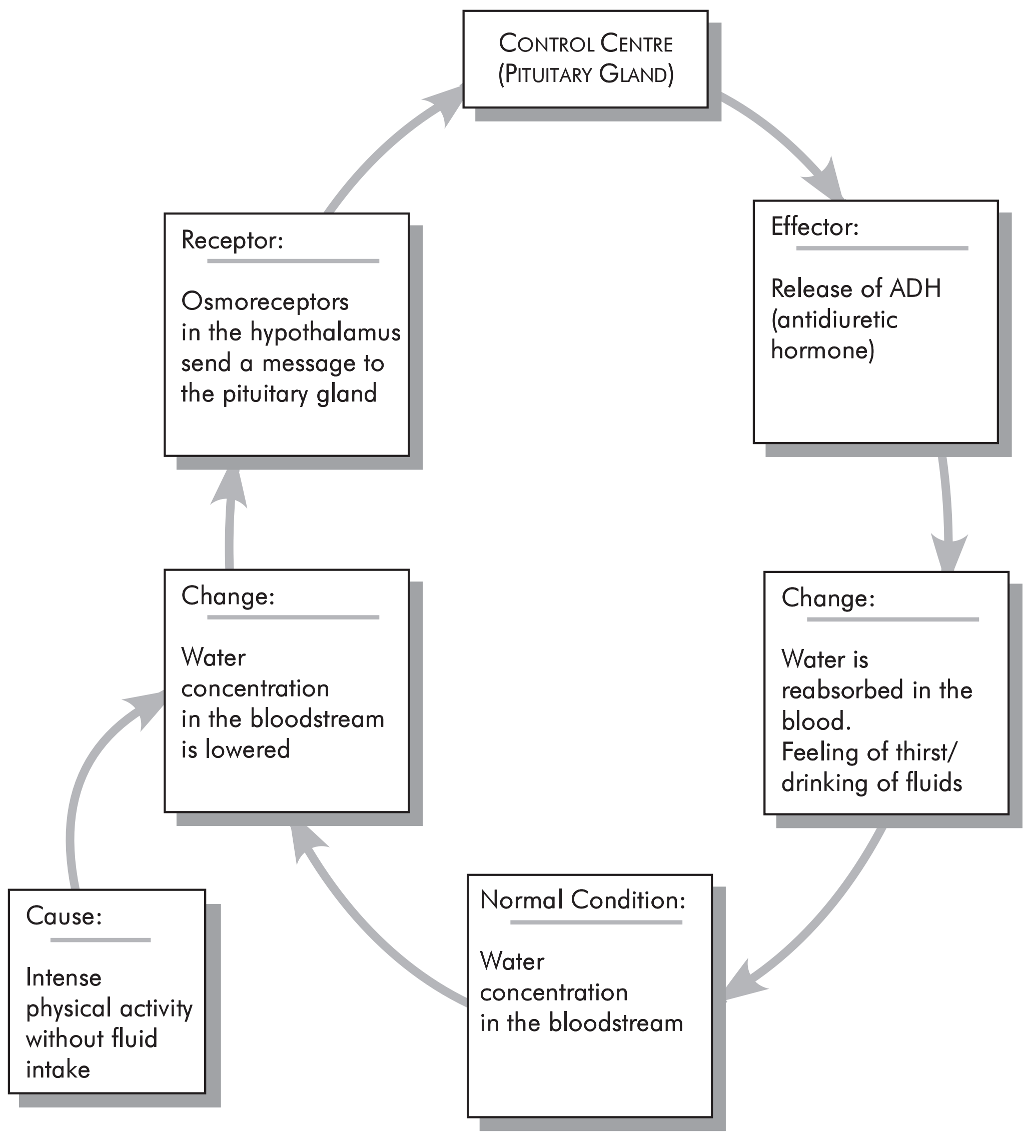
B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLO: C5, C6)



FEEDBACK

SPECIFIC LEARNING OUTCOMES

B11-4-06: Describe the feedback mechanisms associated with water and salt balance and their role in the maintenance of homeostasis in the human body. (GLOs: D1, E2)
Include: antidiuretic hormone (ADH) and aldosterone

Suggestions for Assessment

Review students' responses with the class to check for understanding (formative assessment).

Have students complete a second blackline master, this time to illustrate the negative feedback mechanism involved with a high fluid intake by the body. Have students meet in small groups to compare their results. Any discrepancies should be discussed and a consensus reached.

Have students answer the following questions:

- Alcohol inhibits the secretion of ADH. What would be the effect of ingesting alcohol on the process of excretion?
- What causes a hangover?
- Caffeine increases glomerular blood pressure and decreases the reabsorption of sodium. What would be the effect of ingesting caffeine on the process of excretion?
- If you drank a large pop at the beginning of a movie, you would probably have to urinate before the end of the movie. Explain what would happen if you ate salty popcorn with your large pop.

Water as a Need—Microtheme (U2, I4)

Provide students with the following information and questions.

> "Water, water, everywhere
>
> Nor any drop to drink."
>
> — Samuel Taylor Coleridge (1798)

In modern English, this phrase from the famous poem "The Rime of the Ancient Mariner" can be read as "Water, water, everywhere but not a drop to drink." Samuel Coleridge tells the sad tale of survivors of shipwrecks, even though they float on a vast body of water teeming with life.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLO: C5, C6)

Students work in groups to develop responses to the following questions:

- Why can't we drink seawater?
- What will happen to our bodies if we do?
- What systems in the body are most affected?
- What needs to be done to the seawater to make it drinkable?
- How can this be done?
- What does dehydration do to the human body?

Following the discussions, have students write a microtheme about what they could do to conserve their body's water, if they were in a survival situation where drinkable water is unavailable.

> "And every tongue, through utter drought,
> Was withered at the root;
> We could not speak, no more than if
> We had been choked with soot."
>
> — Samuel Taylor Coleridge (1798)

Suggestion for Assessment

Refer to Appendix 1.3B: Microthemes—First Draft Checklist (BLM) and Appendix 1.3C: Microthemes—Final Draft Assessment (BLM) from Unit 1 for assessment tools.

Urinalysis

Specific Learning Outcomes

B11-4-07: Describe what types of information can be gained through urinalysis. (GLOs: B3, D1)

Examples: performance-enhancing drugs, diabetes, recreational drugs, pregnancy, infections, kidney failure or damage…

SLO: B11-4-07

Suggestions for Instruction

Activate

Thinking about Urine Tests

Pose the following questions to the class:

- Why do we give urine samples when we visit the doctor for a physical examination?
- What kinds of things can doctors detect with a urine test?
- Why do athletes get their urine tested?

Have students discuss the issue using a Think-Pair-Share strategy (see *SYSTH*, p. 3.10).

Acquire/Apply

Fake Urine—Laboratory (S3, S4, S6, S7, S8)

Have students complete a urinalysis laboratory activity using synthetic urine. They analyze results to determine potential disorders (i.e., clarity of urine—opaque sample may indicate yeast). See Appendix 4.1A: Urinalysis Lab—Student Handout (BLM) and Appendix 4.1B: Urinalysis Lab (Teacher Background).

Note: Students are not permitted to use samples of actual human fluid or tissue in the classroom. Refer to *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions* (Manitoba Education and Training) for more information on safety procedures.

Suggestions for Assessment

Refer to Appendix 1.8: Student Lab Skills (Teacher Background) in Unit 1 for information on assessing and evaluating student lab skills.

Refer to Appendix 1.13A: Lab Skills Checklist—General Skills and Appendix 1.13B: Lab Skills Checklist in Unit 1 for templates on assessing general lab skills and thinking skills.

SKILLS AND ATTITUDES OUTCOMES

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S7: Evaluate the relevance, reliability, and adequacy of data and data collection methods. (GLOs: C2, C4, C5, C8)

Include: discrepancies in data or observations and sources of error

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Researching Urine Tests (I1, I2, I3, I4)

Have students research how a commercial pregnancy test kit works, or conduct research about one specific type of urine test, and possible diseases or illnesses that can be detected with this test. Students may also choose to investigate urine tests used with high-performance athletes. As part of this research process, have students evaluate information sources and the quality of the information, to identify potential problems with scientific accuracy, bias, and so on, that may be present, especially in materials promoting the sale of commercial products.

Suggestion for Assessment

Develop assessment criteria with students. Criteria might include

- a description of how the urine test works
- a description of the condition that the urine test can detect
- use of appropriate vocabulary
- minimal evidence of spelling or grammatical errors
- evaluation of the sources and the information contained within them

URINALYSIS

SPECIFIC LEARNING OUTCOMES

B11-4-07: Describe what types of information can be gained through urinalysis. (GLOs: B3, D1)

Examples: performance-enhancing drugs, diabetes, recreational drugs, pregnancy, infections, kidney failure or damage…

Mandatory Testing Debate (I1, I2, I4, G1, G2, G3)

Have students debate whether urinalysis should be mandatory at all athletic competitions. Have them create a Fact and Opinion Recording Sheet while conducting research in preparation for the debate. To create such a sheet, students fold a sheet of paper in half and label one half "Fact" and the other half "Opinion." During the course of their research, students document statements that are either Facts or Opinions. If no opinions are stated in a given article, students can add their own opinions.

Senior 2 English Language Arts: A Foundation for Implementation (Manitoba Education and Training) suggests a debating strategy called Creative Controversy (see Senior 2, p. 34). This debating strategy requires students to gather arguments so that they can switch sides in a debate, and then move to consensus.

Suggestion for Assessment

Collect students' Fact and Opinion Recording Sheets and assess them based on accuracy of categorized statements. Establish performance criteria with the class before a debate and use the classroom-based criteria to create a rubric. Use an assessment tool such as Appendix 4.2: Debating Skills Rubric (BLM).

SKILLS AND ATTITUDES OUTCOMES

B11-0-S3: Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4: Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S6: Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S7: Evaluate the relevance, reliability, and adequacy of data and data collection methods. (GLOs: C2, C4, C5, C8)

Include: discrepancies in data or observations and sources of error

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

NOTES

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-4-08: Investigate and describe issues related to kidney failure and treatment options available. (GLOs: B3, C6, C8, D1)

Examples: organ transplant, personal lifestyle, dialysis...

SLO: B11-4-08

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Kidney Disease

Have students brainstorm what could cause kidney failure, malfunction, and disease.

Ask students whether they have signed a donor card and discuss reasons for deciding to sign or not to sign.

ACQUIRE/APPLY

The Kidney Dilemma

See The Kidney Dilemma Lesson Plan in *Life Is a Gift* (Manitoba Education and Transplant Manitoba) for learning activities related to Unit 4: Excretion and Waste Management.

Suggestions for Assessment

Depending on the learning activities completed, a range of approaches can be used to assess student understanding (e.g., Concept Maps, notes summarizing key information, questions from the activities included on unit tests). Students should be expected to link this new understanding of organ and tissue transplant with the knowledge acquired throughout this course (e.g., functioning of the kidney, compatible blood types.)

Renal Failure—Research Project (U1, U2, S8, D2, D3, I1, I4)

Another approach to the topic of organ donation is to personalize and contextualize it, similarly to what is done in a microtheme. This can be achieved by providing students with a scenario and the associated questions, such as the following (or brainstorming questions with students).

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLO: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths, and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-D6: Evaluate the process used by self or others to arrive at a decision. (GLOs: C4, C5)

Scenario

Imagine that your father has been showing signs of renal failure. Hemodialysis or kidney transplant are the realistic treatments that he will need very soon. Research the impact of hemodialysis treatments on your family's lifestyle. How will your lives change? Examine the current state of organ donation in Canada. What are organ availabilities in Canada? What steps are taken to get access to organs and to harvest them? As a teenager, how can you make your wishes regarding transplantation known? What will influence the likelihood of your father getting a transplant?

Suggestion for Assessment

This research project can be assessed using the microtheme tools provided in Appendix 1.3B: Microthemes—First Draft Checklist (BLM) and Appendix 1.3C: Microthemes—Final Draft Assessment (BLM) in Unit 1.

SPECIFIC LEARNING OUTCOMES

B11-4-08: Investigate and describe issues related to kidney failure and treatment options available. (GLOs: B3, C6, C8, D1)

Examples: organ transplant, personal lifestyle, dialysis...

WELLNESS

Kidney Failure and Treatment Options—Performance Tasks

The following performance tasks can be used in addition to, or instead of, the previous activities in this section. It involves both factual information gathering and decision making.

In these performance tasks, students are expected to develop and apply their knowledge of kidney functioning and treatment options within a context that forces them to take on the role of the doctor (Part 1) and the role of a patient (Part 2). Part 2 is intended to emphasize the personal nature of decision making related to personal health and to help students recognize that there is seldom a “right” decision that would apply to everyone.

You Are a Doctor—Performance Task, Part 1 (U2, I1, I4, G1, G2)

Give students the following scenario:

Imagine you are a new doctor who has received test results for a patient showing signs of renal failure. Your task is to prepare an explanation for the patient on what the problem is, within the context of what normal kidney function looks like, and what the treatment options are (dialysis and transplant). You must describe the options in detail, including pros and cons. Your preparation will take the form of written notes, which will be shared with other doctors to confirm your information.

Suggestion for Assessment

Students must prepare a written submission, which will be assessed by the teacher and shared in small groups. Develop criteria for the written piece, as well as for the oral sharing. Assessment criteria could include

- clear and complete explanation of kidney function
- use of appropriate terminology
- diagrams
- accurate explanation of the consequences of renal failure
- clear, concise, and accurate description of treatment options (understandable by patient, including pros and cons)
- sharing ideas with the group
- listening when others talk
- providing constructive feedback to others

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLO: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths, and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-D6: Evaluate the process used by self or others to arrive at a decision. (GLOs: C4, C5)

You Are the Patient—Performance Task, Part 2 (D1, D2, D3, D4, D5, D6)

Give students the following scenario:

You have just been told that you are experiencing renal failure. You must decide which treatment option to use.

Give different patient scenarios to different students, using Appendix 4.3: Patient Profiles (Teacher Background). Students with the same patient profile can meet to discuss treatment options, but the final decision is made individually, and then shared with a group of students who have different patient profiles. A written decision-making sheet will be submitted to the teacher, along with a reflection about the decision-making process.

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-4-08: Investigate and describe issues related to kidney failure and treatment options available. (GLOs: B3, C6, C8, D1)
Examples: organ transplant, personal lifestyle, dialysis...

The following questions can help guide students:

- What is the issue?
- What are my alternatives?
- What are the risks and benefits for each alternative?
- What is my decision?
- Why have I made this decision?
- Did the people in my group all make the same decision?
- Why would people make different decisions in a similar situation?

Suggestion for Assessment

Establish an assessment rubric for the decision-making sheet and for the reflection. Assessment criteria could include the following:

- The issue is clearly stated.
- The risks and benefits for each alternative are included.
- The decision is justified with supporting details related to the patient profile.
- The reflection shows an understanding of different factors that can affect a decision (e.g., values) and an awareness that there isn't one right answer.

Organ Donation—Reflection (D3)

WP

Have students write a short reflection for inclusion in their Wellness Portfolio. Ask them to reflect on what their views on organ donation were when they began this section of the unit (see suggested activating strategy) and how their views have further developed, or perhaps even changed, upon completion of the learning activities in this section. Specific reference should be made to whether or not they have signed or will sign permission for organ donation.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLO: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths, and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-D6: Evaluate the process used by self or others to arrive at a decision. (GLOs: C4, C5)

Notes

NOTES

UNIT 4:
EXCRETION AND WASTE MANAGEMENT

APPENDICES

Appendix 4.1A: Urinalysis Lab—Student Handout (BLM)

Objectives

- Conduct various tests on two known urine samples to identify the characteristics of urine.
- Identify the characteristics of an unknown urine sample.

Procedure

Design a table for your results. The table should have space to record your data and drawings for the following six tests on two known urine samples and a test for one unknown sample.

Part A: Analysis of Known Urine Samples

1. **Making Initial Examination of Urine**
   a) Examine each urine sample for odour. Describe the odour.
   b) Comment on the colour of the sample. Use terminology such as yellow, amber, dark, pale, and so on.
   c) Describe the clarity of the sample. Use terminology such as clear, cloudy, and so on.

2. **Determining Specific Gravity**
   a) Remove the hydrometer from its cylinder and empty the water from the cylinder into the sink. Fill the hydrometer cylinder three-quarters full with the urine sample.
   b) With a spinning motion, float the hydrometer in the urine. Be sure that the hydrometer stays suspended in the urine and does not adhere to the sides of the cylinder.
   c) When the hydrometer has stopped spinning and is not touching the sides of the cylinder, read the specific gravity of each sample at the bottom of the meniscus formed at the hydrometer column. Record the specific gravity.
   d) Pour the urine sample from the hydrometer cylinder into a test tube for Tests 3 and 4 of this laboratory activity. Pour any remaining urine back into the sample container.
   e) Rinse and repeat with each sample.
   f) Rinse and fill the hydrometer cylinder with water and place the hydrometer into the water.

3. **Testing for pH**
   a) Use pHydrion (pH) testing paper to test the sample.
   b) Compare with the coloured pH scale provided.
   c) Record the pH in the table.
   d) Repeat with each sample.

4. Analyzing Sediment

a) In this test, you will be looking for blood cells, crystals, and phosphate granules in the urine sample. The presence of blood cells in the urine may be indicative of an abnormal condition, while the crystals may indicate the presence of drugs.

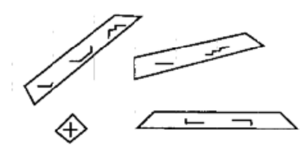
b) Fill one small test tube with the urine sample.

c) Set the tube in the centrifuge opposite someone else's sample and spin for five minutes. (Please check with the teacher that your setup is correct before you turn on the centrifuge.)

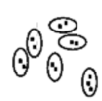
d) After centrifuging, pour off the liquid or supernatant and place it into a clean test tube. Place the test tube to the side for use in Test 5.

What You May See in the Urine Sample

Amorphous phosphates (normal)



Oxalate crystals (normal)



Red blood cells (may indicate disease)

Acetylsalicylic acid crystals (Aspirin present)

e) Shake the test tube to re-suspend the sediment in the small amount of urine left in the test tube. Pour this onto a slide and prepare a wet mount to observe under the microscope.

f) Describe the sediment you observe under the microscope. (Remember to include any blood cells, phosphate granules, or crystals you observe.)

g) Repeat for each sample.

5. **Testing for Presence of Albumin (Protein)**
   a) Observe and record the clarity of the supernatant.
   b) Separate the supernatant into two parts. Place one part to the side for use in Test 6.
   c) Pour the second part of the supernatant into a test tube and place the test tube in a hot water bath.
   d) Compare the cloudiness of the heated supernatant with the unheated portion of the supernatant. If cloudiness increases in the heated sample, then protein is present.
   e) Repeat with each sample.
6. **Testing for Presence of Glucose**
   a) Add 10 drops of Benedict's solution to the unheated portion of the supernatant from Test 5.
   b) Fill a second test tube one-quarter full of water and add 10 drops of Benedict's solution (this is the control).
   c) Boil both test tubes for 4 to 5 minutes and then allow the test tubes to cool.
   d) An orange precipitate will form when glucose is present.
   e) Repeat with each sample.

Part B: Analysis of an Unknown Urine Sample

You will be required to complete an analysis of an unknown urine sample using the procedures you have learned in Part A.

1. Obtain 50 mL of one of the unknown urine samples.
2. Perform the urine analysis procedure on your unknown sample and compare the results to the known samples.
3. Check your results with the teacher's key.

Analysis

1. Research to determine the normal ranges of the tests you have completed for human urine.
2. Pick one specific test and research the possible diseases or medical illnesses that can occur if a person exceeds the normal range.

Appendix 4.1B: Urinalysis Lab (Teacher Background)

Suggestions for Instruction

The following concepts may be developed in this lab:

- kidney function and disease
- chemical reactions

Review/discuss kidney function and the formation of urine. Include a look at conditions and diseases that might be tested for with a urinalysis.

Procedure

Part A: Analysis of Known Urine Samples

1. **Making Initial Examination of Urine**

   Students make a visual examination of the odour and colour of the urine sample. Although the urine is synthetic, it may take some time for students to "settle down" with the idea of working with urine. It is important for them to consider the samples as "real" and perform the procedures accordingly. This means that they should keep their equipment clean and be aware of potential health concerns if they spill their samples.

2. **Determining Specific Gravity**

   Some time may be needed to show the class the proper use of a hydrometer and how it is used to determine specific gravity. Students should understand that having a change in the specific gravity of urine could indicate a medical problem.

3. **Testing for pH**

   To determine the pH of urine, pH paper is used.

4. **Analyzing Sediment**

   Analysis of sediment can provide clues such as an abnormal condition of blood in the urine or the presence of crystals in the urine that may indicate drug use. Provide students with diagrams to assist in identification.

5. **Testing for Presence of Albumin (Protein)**

   Using part of the supernatant, students heat the liquid. If protein is present, it will denature and make the solution cloudy.

6. **Testing for Presence of Glucose**

   Testing for sugar may give an indication of diseases such as diabetes. Students will need to use care when working with Benedict's solution and a hot plate.

Part B: Analysis of an Unknown Urine Sample (Practice)

Provide students with urine samples to choose from and ask them to determine the composition of the urine by performing the various tests. Each sample has a different set of conditions based on how you prepare the sample. You may choose to make up your own samples or you may choose to follow a sample preparation key.

Materials

- stock and sample urine solutions
- hydrometers
- pH testing paper
- centrifuge
- microscope (including slides and cover slips)
- test tubes
- beakers
- hot plate
- Benedict's solution
- water
- clock or watch

Preparation of Urine Samples

Basic Stock Solution

To 1 L of distilled water add:

- 3 g sodium chloride (NaCl)
- 3 g ammonium oxalate
- 3 g potassium phosphate

For Tests 1 to 6 of the urine analysis activity, make the following solution:

To the 1 L Basic Stock Solution, add:

- 2 drops of 1M HCl
- 1 acetylsalicylic acid (ASA) tablet
- 1 g glucose
- 1 g albumin powder
- 5 g urea
- blood cells (obtain fresh meat from butcher or meat department)

Sample Solutions

To a 1 L Basic Stock Solution for each sample, add the following:

Sample #1

- 24 mL 0.1M NH_3
- 1 g glucose

Sample #2

- 5 g urea
- 1 g albumin powder

Sample #3

- 1 g glucose
- 1 g albumin powder
- blood cells

Sample #4

- 1 ASA tablet
- 2 drops of 3M HCl

Note

- Solutions will keep for about a week in the fridge.
- Adjust pH as required.
- Fresh blood cells should be added to appropriate sample(s) each time the sample is used, as they tend to lyse in solution.
- Blood obtained from a butcher or a meat department usually contains few whole blood cells. Centrifuge blood and pour off liquid. Re-suspend cells in a small portion of "urine" and add to sample.

Sample Preparation Key

Sample #	pH	Protein (Albumin)	Glucose	Sediment			Specific Gravity
				Amorphous Phosphate	Crystals	Blood	
1	8	–	+	+	Oxalate	–	Varies
2	6	+	–	+	Oxalate	–	Varies
3	6	+	+	+	Oxalate	+	Varies
4	2/3	–	+	+	Oxalate, ASA tablet	–	Varies

Appendix 4.2: Debating Skills Rubric (BLM)

Debating Rubric	Exemplary 4	Accomplished 3	Developing 2	Beginning 1
Organization of Opening Statement	always maintains focus on the topic	maintains focus on the topic, with few exceptions	does not consistently maintain focus on the topic	does not maintain focus on the topic
Use of Evidence to Support Claims	always uses evidence to support claims	usually uses evidence to support claims	rarely uses evidence to support claims	does not use evidence to support claims
Persuasiveness	arguments are always clear and convincing	arguments are generally clear and convincing	arguments are sometimes clear and convincing	arguments are not clear or not convincing
Teamwork	always uses team members effectively	generally uses team members equally effectively	sometime uses team members equally effectively	team members are not used effectively
Organization of Closing Statement	always responds with points that are specific to the topic	usually responds with points that are specific to the topic	sometimes responds with points that are specific to the topic	does not respond with points specific to the topic

Appendix 4.3:
Patient Profiles (Teacher Background)

- ✓ 15-year-old who has had kidney disease since the age of three
- ✓ 23-year-old who received a kidney transplant five years ago, but the kidney was rejected
- ✓ 45-year-old recovering alcoholic who was diagnosed with kidney failure three years ago due to the medications he was taking
- ✓ 61-year-old woman with years of high blood pressure, which probably caused her kidneys to fail
- ✓ 26-year-old male who has a rare kidney disease
- ✓ 55-year-old female, smoker, with type 2 diabetes, who does not exercise regularly
- ✓ 65-year-old male with atherosclerosis, who has a heart condition and suffered a stroke one year ago
- ✓ 70-year-old female from a remote northern community

Unit 5: Protection and Control

Unit 5: Protection and Control

Specific Learning Outcomes

B11-5-01: Describe the body's defence mechanisms for protection from foreign agents. (GLO: D1)

Include: non-specific and specific defences

B11-5-02: Describe the body's response to allergens, vaccines, and viruses/bacteria. (GLO: D1)

Include: inflammatory response and immune response

B11-5-03: Explain the role of the lymphatic system in protecting the human body. (GLO: D1)

Include: lymph vessels, lymph nodes, and lymph

B11-5-04: Investigate issues related to the immune system and the protection of public health. (GLOs: B3, C4, C5, C6, C8, D1)

Examples: immunization policies, travel bans and advisories, epidemics…

B11-5-05: Describe the major organization of the nervous system. (GLO: D1)

Include: central nervous system and peripheral nervous system (autonomic and somatic)

B11-5-06: Identify the functional regions of the brain. (GLO: D1)

Examples: general anatomy such as cerebellum, specific regions responsible for speech and other functions, left-brain/right-brain concept…

B11-5-07: Explain how a nerve impulse travels a particular pathway using chemical and electrical signals. (GLO: D1)

Include: synapse

B11-5-08: Compare the general roles of nervous and hormonal controls, recognizing that the nervous and endocrine systems interact to maintain homeostasis in the human body. (GLOs: D1, E2, E3)

Include: communication, speed, duration, target pathway, and action

B11-5-09: Explain the effects of a concussion on brain function and the implications of multiple concussions. (GLOs: B3, C8, D1)

Include: second impact syndrome

B11-5-10: Describe how personal lifestyle choices can influence the functioning of protection and/or control systems. (GLOs: B3, D1)

Examples: impact of recreational drugs, use of anabolic steroids, lack of sleep, poor diet, non-use of protective equipment…

B11-5-11: Investigate and describe conditions/disorders that affect protection and/or control in the human body. (GLOs: B3, C6, D1)

Immune System

Specific Learning Outcomes

B11-5-01: Describe the body's defence mechanisms for protection from foreign agents. (GLO: D1)
Include: non-specific and specific defences

B11-5-02: Describe the body's response to allergens, vaccines, and viruses/bacteria. (GLO: D1)
Include: inflammatory response and immune response

B11-5-03: Explain the role of the lymphatic system in protecting the human body. (GLO: D1)
Include: lymph vessels, lymph nodes, and lymph

SLO: B11-5-01
SLO: B11-5-02
SLO: B11-5-03

Suggestions for Instruction

Entry-Level Knowledge

In Grade 8, students examined the human body's defence mechanisms and technologies related to defence mechanisms, such as vaccines and antibiotics.

Activate

Mapping out Protection

Have groups of students create a Concept Map that outlines all the systems they think are involved in protecting the body.

Acquire/Apply

Three Lines of Defence—Direct Instruction (U1)

Using multimedia software or overhead projections, describe the body's non-specific and specific responses to foreign agents (e.g., skin and mucous membranes, the inflammatory response, the immune system). Students then refer to their original Concept Map and describe in a paragraph how they would change their initial Concept Map to reflect the information in their notes.

Suggestion for Assessment

Have students create a Concept Frame on the body's defence mechanisms (see *SYSTH*, p. 11.36).

Poster Presentation (U1, I1, I4)

Divide students into groups of two or three. With the help of textbooks or other resources, groups must construct posters to represent the response mechanism assigned to them. Assign the inflammatory response to half the groups, and the immune response to the other half. All posters should include

- the steps involved in the body's response
- illustrations representing the body's response to enhance the written component

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Suggestions for Assessment

The following tool can be used to assess the posters.

Poster Presentation Assessment			
	3	**2**	**1–0**
Organization	The information is clear and well-organized.	The information is sometimes confusing and/or disorganized.	The information is confusing and disorganized.
	5–4	**3–2**	**1–0**
Required Information	The description of the body's response is well-developed and contains the required details.	The description of the body's response contains most of the required details.	The description of the body's response lacks required details.
	8–7	**6–5–4–3**	**2–1–0**
Quality of the Illustrations	The illustrations are visually appealing and enhance the comprehension of the written information.	The illustrations are adequate and complement the written information somewhat.	The illustrations are confusing and don't enhance the comprehension of the written information.
	4	**3–2**	**1–0**
Presentation	There are no spelling or grammatical errors.	There are a few minor spelling or grammatical errors.	There are numerous spelling or grammatical errors that detract from the message.

IMMUNE SYSTEM

SPECIFIC LEARNING OUTCOMES

B11-5-01: Describe the body's defence mechanisms for protection from foreign agents. (GLO: D1)

Include: non-specific and specific defences

B11-5-02: Describe the body's response to allergens, vaccines, and viruses/bacteria. (GLO: D1)

Include: inflammatory response and immune response

B11-5-03: Explain the role of the lymphatic system in protecting the human body. (GLO: D1)

Include: lymph vessels, lymph nodes, and lymph

Once the posters are assessed, have students use them to construct a Chain Concept Map (see *SYSTH*, p. 11.14) or some other note-taking method to illustrate each response.

Allergens, Vaccines, Viruses, and Bacteria (U1)

Have students complete Appendix 5.1: Concept Frame (BLM) to illustrate the similarities and differences between allergens, vaccines, viruses, and bacteria.

Suggestion for Assessment

The completed Concept Frames can be used as a formative assessment to determine the level of students' understanding of the body's reaction to allergens, vaccines, viruses, and bacteria. If needed, reviewing and/or re-teaching may be carried out.

Cumulative Assessment

Have students complete a Compare and Contrast Frame (see *SYSTH*, pp. 10.15, 10.24) to compare allergens, vaccines, viruses, and bacteria.

To Vaccinate or Not to Vaccinate—Case Study (D1, D2, I1)

Have students examine Appendix 5.2: To Vaccinate, or Not to Vaccinate: That Is the Question (BLM) and answer the questions associated with the case study.

Resource Link

Case Study Teaching Notes and Answer Keys are available on the following website. To access some of these resources, you are required to register for a password (available free of charge).

- University at Buffalo. *The National Center for Case Study Teaching in Science Case Collection*. <http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Suggestion for Assessment

Brainstorm with students to determine what criteria should be used to assess their responses to the questions.

Personal Records (P2, P3)

Students research their personal vaccinations and immunization records and assess their own immunity to certain diseases. Students research additional immunizations they would need to travel to a different part of the world (e.g., immunization against typhoid, cholera, hepatitis A, malaria). Students may include these records in their Wellness Portfolio.

The Lymphatic System and Immunity—Direct Instruction (U1)

Discuss how the lymphatic system contributes to immunity. Then have students locate and label the lymph nodes and organs on a diagram of the human body. Have students complete a Concept Overview Frame about the lymphatic system's role in immunity (see *SYSTH*, pp. 11.23, 11.37).

Suggestion for Assessment

The Concept Overview Frame can be used as a formative assessment to determine the level of students' understanding of the lymphatic system's role in immunity. If needed, reviewing and/or re-teaching may be carried out.

IMMUNE SYSTEM

SPECIFIC LEARNING OUTCOMES

B11-5-01: Describe the body's defence mechanisms for protection from foreign agents. (GLO: D1)
Include: non-specific and specific defences

B11-5-02: Describe the body's response to allergens, vaccines, and viruses/bacteria. (GLO: D1)
Include: inflammatory response and immune response

B11-5-03: Explain the role of the lymphatic system in protecting the human body. (GLO: D1)
Include: lymph vessels, lymph nodes, and lymph

Write a Story (U2, I4)

Have students write an adventure story about a foreign substance trying to invade the body.

Suggestion for Assessment

Prepare guidelines for the task and develop assessment criteria with students. The criteria should address scientific content as well as creative writing components. Each criterion could be assigned a point value, or a simple rating scale can be used (e.g., excellent, good, fair, poor) for each criterion.

Cumulative Assessment

The above can be used as a cumulative assessment to assess the level of students' understanding of the immune system.

Defence Analogies (U2, I4)

Have students develop analogies for the three lines of defence in the body. For example, a castle:

1. The outer wall serves as the first line of defence.
2. Guards rush to a scene inside the castle.
3. The head of the guards coordinates a search for other infiltrators.

Other examples of possible analogies are computers, homes, and countries.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Students should include the following in their analogies:

- description of the structure (biological concept)
- identification of a familiar object (analogy) that shares some similar characteristics
- identification of the shared characteristics of the structure (biological concept) and the analogy
- indication of where the analogy breaks down

(Glynn, "The Teaching with Analogies Model"; Glynn, Duit, and Thiele)

Resource

See Organ Transplant Rejection Lesson Plan in *Life Is a Gift* (Manitoba Education and Transplant Manitoba) for learning activities related to Unit 5: Protection and Control.

Suggestion for Assessment

Defence analogies can be shared with the class and discussed in order to arrive at a consensus as to whether or not the analogy is helpful. The following criteria can help determine the effectiveness of an analogy:

- A familiar analogy is selected.
- Similarities between the analogy and the structure are clear and help explain the structure and/or function of the structure.
- Differences between the analogy and the structure are clear.

ISSUES ANALYSIS

SPECIFIC LEARNING OUTCOMES

B11-5-04: Investigate issues related to the immune system and the protection of public health. (GLOs: B3, C4, C5, C6, C8, D1)

Examples: immunization policies, travel bans and advisories, epidemics…

SLO: B11-5-04

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Current Events

Have students brainstorm a current news item related to the topic, such as an influenza outbreak, and the actions taken to prevent its spread. Have students share what they know about the issue and identify questions they have.

ACQUIRE/APPLY

Outbreak Scenario (P1, D1, D2, D3, D4, D5, D6, I1, G1, G2, G3)

Have students participate in a simulation/case study, such as those found on the following website, which also contains links to other sources of case study ideas:

- University at Buffalo. *The National Center for Case Study Teaching in Science. Case Collection*. <http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>.

For example, in "The 1st New Disease of the 21st Century" by Otto Sanchez, students participate in a role-playing scenario based on the severe acute respiratory syndrome (SARS) outbreak in China, learning about the disease and arguing from the perspective of different health professionals on a plan of action for dealing with its consequences.

Students take on one of the following roles:

- health professionals working in Hong Kong, China
- health professionals working in Toronto, Canada
- World Health Organization officers in Geneva, Switzerland
- Centers for Disease Control officers in Atlanta, Georgia

Suggestion for Assessment

Assessment will depend on the type of activity undertaken. It could focus on a number of areas such as group work and decision making, and involve self-assessment, peer assessment, as well as a written reflection, summary, and so on.

Skills and Attitudes Outcomes

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-D6: Evaluate the process used by self or others to arrive at a decision. (GLOs: C4, C5)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Internet Research (D1, I2, I3)

A good way to investigate a current event or issue is to conduct research on the Internet. Have students select from the list of current events they generated earlier and design a research project to gather information about an issue. In addition to exploring a current issue, students need to develop skills in analyzing sources of information on the Internet.

Resource Links

The following websites provide guidelines and tools for analyzing and evaluating information sources:

- Kent State University. “Criteria for Evaluating Web Resources.” 22 Mar. 2006. *University Libraries*. <www.library.kent.edu/page/10475>.
- Manitoba Education. “Professional Learning for Teachers.” *Literacy with ICT Across the Curriculum: A Developmental Continuum.* <www.edu.gov.mb.ca/k12/tech/lict/let_me_try/le_teachers.html>.
- Schrock, Kathleen. “The Five W’s of Web Site Evaluation.” 2001–2009. *The ABC’s of Web Site Evaluation.* <http://kathyschrock.net/abceval/5ws.pdf>.
- ———. “Web Site Evaluation & Internet Lesson Plan Guide.” 2002. *The ABC’s of Web Site Evaluation.* <http://kathyschrock.net/abceval/teacherwebeval.pdf>.

ISSUES ANALYSIS

SPECIFIC LEARNING OUTCOMES

B11-5-04: Investigate issues related to the immune system and the protection of public health. (GLOs: B3, C4, C5, C6, C8, D1)

Examples: immunization policies, travel bans and advisories, epidemics…

Suggestion for Assessment

Develop assessment criteria with students. Ensure an emphasis on the evaluation of information sources.

Skills and Attitudes Outcomes

B11-0-P1: Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-D6: Evaluate the process used by self or others to arrive at a decision. (GLOs: C4, C5)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Notes

NERVOUS SYSTEM

SPECIFIC LEARNING OUTCOMES

B11-5-05: Describe the major organization of the nervous system. (GLO: D1)

Include: central nervous system and peripheral nervous system (autonomic and somatic)

B11-5-06: Identify the functional regions of the brain. (GLO: D1)

Examples: general anatomy such as cerebellum, specific regions responsible for speech and other functions, left-brain/right-brain concept…

B11-5-07: Explain how a nerve impulse travels a particular pathway using chemical and electrical signals. (GLO: D1)

Include: synapse

SLO: B11-5-05
SLO: B11-5-06
SLO: B11-5-07

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Nervous System Functions

Have students brainstorm components and functions of the nervous system. This could become part of a KWL strategy.

Fooling Your Senses

Conduct demonstrations with students that illustrate the importance of our five senses and how they can be fooled.

Examples:

- Have students smell mint while eating something else. Ask them what they taste.
- Have students close their eyes, and then cross their middle and index fingers and move them along the edge of a table. Students should feel two parallel edges instead of one.
- Have students close their eyes, and then cross their middle and index fingers and rub a pencil in the space between the two fingers. Students should feel two pencils instead of one. If they open their eyes, they will only feel one pencil.
- Have students read the following colours as fast as they can: **Yellow Brown Green Red Blue Black**. Show the same words, but each of them written in a colour other than the word (e.g., **Yellow** written in red). Have students state the colour in which the words are written as quickly as possible.

ACQUIRE/APPLY

Organizing the Nervous System (U1)

With the use of their text or another resource, have students create a flow chart or functional hierarchy to show the organization of the central and peripheral nervous systems.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Suggestions for Assessment

Review the completed flow charts with students to check for comprehension, and re-teach if necessary (formative assessment).

Have students complete an Exit Slip (see *SYSTH*, p. 13.9) at the end of the lesson. The following questions can help get them started:

- What do you know now that you didn't know when you walked into class today?
- What did you already know?
- What further question(s) do you still have?

The Parts of the Brain (U2)

Have students create and label their own models of the brain using modelling clay, toothpicks, and paper labels. Together with students, develop assessment criteria for the models, such as the following:

- All the required parts of the brain are clearly identified.
- Relative sizes of the parts of the brain are appropriate.

Suggestion for Assessment

Assess students' models using the assessment criteria developed with students.

NERVOUS SYSTEM

SPECIFIC LEARNING OUTCOMES

B11-5-05: Describe the major organization of the nervous system. (GLO: D1)

Include: central nervous system and peripheral nervous system (autonomic and somatic)

B11-5-06: Identify the functional regions of the brain. (GLO: D1)

Examples: general anatomy such as cerebellum, specific regions responsible for speech and other functions, left-brain/right-brain concept…

B11-5-07: Explain how a nerve impulse travels a particular pathway using chemical and electrical signals. (GLO: D1)

Include: synapse

Split My Brain: A Case Study of Seizure Disorder and Brain Function (U2, S8, D2, D3, D4, D5)

The case study "Split My Brain" developed by Julia Omarzu incorporates the effects of seizures on brain function (see Appendix 5.3 for the full case study).

Resource Link

Case Study Teaching Notes and Answer Keys are available on the following website. To access some of these resources, you are required to register for a password (available free of charge).

- University at Buffalo. *The National Center for Case Study Teaching in Science Case Collection.* <http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>.

Suggestion for Assessment

Teachers could assess the questions associated with both parts of the case study using criteria such as the following:

- Response clearly answers the question.
- Response uses evidence to identify issues referred to in the question.
- Response justifies suggested diagnosis or course of action using evidence.

Student Presentation—Performance Task (U2, I4)

Have students carry out a performance task to demonstrate concepts related to the functional regions of the brain, such as the cerebellum, the medulla oblongata, the different lobes, the left brain versus the right brain, the effects that strokes can have on different parts of the brain, and so on. This performance task can take on a variety of forms, and students should be given the opportunity to select which form they wish to use to share their understanding. For example, students could prepare a skit or a multimedia presentation.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Suggestion for Assessment

Develop assessment criteria with students. The criteria should include both content and presentation components and may be similar, regardless of which presentation format students choose. Each criterion could be assigned a point value, or a simple rating scale can be used (e.g., excellent, good, fair, poor) for each criterion.

Demonstrating Impulse Transmission (U1)

Use Appendix 5.4: Impulse Transmission Demonstration (BLM) to describe how a nervous impulse travels through a neuron and how neurotransmitters carry this impulse to the next neuron.

Suggestion for Assessment

Have students use a Three-Point Approach strategy (see *SYSTH*, p. 10.9) to represent impulse transmission in a neuron and impulse transmission through a synapse.

NERVOUS SYSTEM

SPECIFIC LEARNING OUTCOMES

B11-5-05: Describe the major organization of the nervous system. (GLO: D1)

Include: central nervous system and peripheral nervous system (autonomic and somatic)

B11-5-06: Identify the functional regions of the brain. (GLO: D1)

Examples: general anatomy such as cerebellum, specific regions responsible for speech and other functions, left-brain/right-brain concept…

B11-5-07: Explain how a nerve impulse travels a particular pathway using chemical and electrical signals. (GLO: D1)

Include: synapse

Chemicals and Synaptic Transmission (I1, U2)

Have students research and give a presentation on the effects various chemicals have on synaptic transmission and use a demonstration device to explain what is happening. Possible discussion topics could include chemicals that impede transmission such as cyanide, which prevents neurotransmitters from forming at the synapse, or the cocaine/dopamine relationship. Develop assessment criteria with students, such as the following:

- The effect of the chemical on synaptic transmission is clearly explained.
- Appropriate vocabulary is used.
- The presentation follows a logical pattern.
- A demonstration device is used to enhance explanations.

Suggestion for Assessment

Assess presentations using the criteria developed with students.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-S8: Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

NOTES

HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-5-08: Compare the general roles of nervous and hormonal controls, recognizing that the nervous and endocrine systems interact to maintain homeostasis in the human body. (GLOs: D1, E2, E3)

Include: communication, speed, duration, target pathway, and action

SLO: B11-5-08

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Brainstorming

Have students discuss questions such as the following:

- Has your stomach ever felt queasy before an examination? Why?
- Why would your heart beat faster if you stepped off a curb and a car, rushing toward you, blared its horn?
- What happens when you are driving along a road and a car pulls into the road directly in front of you?
- Why do you get goosebumps?
- What happens when you accidentally place your hand on a hot stove?

ACQUIRE/APPLY

Concept Map

Have students watch a video, such as *Osmosis Jones*, and create a Concept Map of how the endocrine and nervous systems maintain homeostasis.

Suggestion for Assessment

Use the completed Concept Maps to determine students' current level of understanding of how the endocrine and nervous systems maintain homeostasis.

Reflexes and Homeostasis (U1)

With the help of a text or other resources, have students create a flow chart describing what happens when a hand is placed on a hot surface. Students must use the following terms in their flow chart: *receptor*, *control centre*, and *effector*. Have them indicate which part(s) of the nervous system are involved in reflexes.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

Suggestions for Assessment

Have students create a flow chart for what happens in another situation, such as an object being thrown toward someone's face.

Have students answer the following question in their scientific journals:

- How do reflexes help maintain homeostasis?

Interaction between the Nervous and Endocrine Systems—Direct Instruction (U1)

Explain to students that many of our homeostatic responses involve the nervous system and the endocrine system. Have students revisit the concept of thermoregulation, which they studied in Unit 1.

Thermoregulation
The autonomic nervous system and the endocrine system are both involved in the body's response to a change in temperature. Receptors in the skin detect external temperature and receptors in the hypothalamus detect the temperature of the blood. When the body is exposed to heat, receptors send a nervous message to the hypothalamus. The hypothalamus sends messages to muscles in arterioles, which constrict to decrease blood flow to extremities and, therefore, decrease heat loss. Nervous messages are sent to muscles in the skin, which cause goosebumps. This erects the tiny hairs on our skin to trap heat. Messages are also sent to our skeletal muscles, which contract and relax quickly to cause shivering. The endocrine system also gets involved in thermoregulation. The hypothalamus sends a message to the pituitary gland in the brain. The pituitary releases a thyroid-stimulating hormone (TSH) in the blood, which causes the release of the hormone thyroxine by the thyroid gland. Thyroxine increases the body's metabolic rate.

Suggestion for Assessment

Have students complete a Negative Feedback Mechanism BLM (see Appendix 1.6 in Unit 1), providing information about the body's response to a change in temperature.

HOMEOSTASIS

SPECIFIC LEARNING OUTCOMES

B11-5-08: Compare the general roles of nervous and hormonal controls, recognizing that the nervous and endocrine systems interact to maintain homeostasis in the human body. (GLOs: D1, E2, E3)

Include: communication, speed, duration, target pathway, and action

The Fight-or-Flight Response (U1)

The fight-or-flight response is another type of response that can be presented to students to illustrate the role of the nervous system in maintaining homeostasis.

Fight-or-Flight Response
The fight-or-flight response is the autonomic nervous system's swift reaction to stress or danger. It causes pupils to dilate and increases respiratory rate and heart rate. It causes the liver to release glucose into the bloodstream, and the adrenal glands to secrete adrenalin. The parasympathetic division of the autonomic nervous system brings the body back to a state of relaxation.

Suggestion for Assessment

Have students create a narrative story that uses descriptive language to describe the biological occurrences during the fight-or-flight scenario.

Why Do We Need Two Systems to Coordinate Homeostasis? (U1)

With the help of text or other resources, have students compare the nervous and endocrine systems by completing Appendix 5.5: Comparing Two Systems (BLM). Students should understand that both these systems are essential in the maintenance of homeostasis. The nervous system acts very quickly, but its effects are short-lived. The endocrine system reacts more slowly to a change in the body, but its effects last longer.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

Suggestion for Assessment

Review the completed Comparing Two Systems charts with students to verify their comprehension, and re-teach if necessary (formative assessment). The chart should contain the following:

Comparing Two Systems		
	Nervous System	**Endocrine System**
Communication	impulses across synapses	hormones in the blood
Response Speed	responds very rapidly (within a few milliseconds)	responds relatively slowly (over minutes, hours, or longer)
Duration	short-term and reversible effects	longer lasting effects
Target Pathway	signal runs through nerves to specific cells	hormones broadcast to target cells everywhere
Action	causes glands to secrete or muscles to contract	causes changes in metabolic activity

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-5-09: Explain the effects of a concussion on brain function and the implications of multiple concussions. (GLOs: B3, C8, D1)
Include: second impact syndrome

B11-5-10: Describe how personal lifestyle choices can influence the functioning of protection and/or control systems. (GLOs: B3, D1)
Examples: impact of recreational drugs, use of anabolic steroids, lack of sleep, poor diet, non-use of protective equipment…

B11-5-11: Investigate and describe conditions/disorders that affect protection and/or control in the human body. (GLOs: B3, C6, D1)

SLO: B11-5-09
SLO: B11-5-10
SLO: B11-5-11

SUGGESTIONS FOR INSTRUCTION

BACKGROUND INFORMATION—CONCUSSIONS

Sports injuries that affect the central and peripheral nervous systems are responsible for thousands of deaths or permanent peripheral damage in Canadian youth. A concussion is caused by the brain being subjected to a trauma where it may be twisted. Often both brain cells and blood vessels that feed the brain are affected, and the injury could disrupt the chemicals responsible for brain functions. Blood flow to the brain is restricted by the increase in pressure due to swelling and an insurgence of free calcium ions that constricts blood vessels. The result is an "energy crisis" in the brain that can last for weeks. If a second concussion occurs before the brain recovers from the first one, the energy-starved cells in the brain are likely to die, and individuals may experience a life-threatening swelling of the brain, referred to as second impact syndrome (SIS). Half the individuals with SIS die, and it is most common in male adolescents and young adults. The long-term effects of concussions vary from negligible to cognitive and behavioural impairments, and may depend on the number of concussions.

ACTIVATE

Anticipation Guide

Have students complete an Anticipation Guide (see *SYSTH*, pp. 9.20, 9.26) on the topic of concussions. Here are some possible statements to elicit students' initial reaction to the topic:

- Bodychecking should be banned in youth hockey.
- To decrease concussions, coaches should train players to bodycheck properly.
- Helmets should be mandatory on all skating rinks.
- Better equipment would reduce the incidence of concussions in hockey.
- After having suffered a concussion, a hockey player should be sidelined for the rest of the season.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

S3B-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Should You Wear a Helmet?

Ask students whether they wear a helmet during sporting or recreational activities such as skateboarding, rollerblading, playing hockey, or riding a bike or a scooter. Initiating a discussion about wearing helmets can be a starting point to elicit students' initial interest in the after-effects of head trauma.

ACQUIRE/APPLY

Analyze an Article (U1)

Have students read and analyze the following article:

Marchie, Anthony, and Michael D. Cusimano. "Bodychecking and Concussions in Ice Hockey: Should Our Youth Pay the Price?" *Canadian Medical Association Journal* 169.2 (22 July 2003): 124–128. Available online at <www.cmaj.ca/cgi/content/full/169/2/124>.

After students have read the article, ask them to complete Appendix 5.6: Article Analysis Frame (BLM).

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-5-09: Explain the effects of a concussion on brain function and the implications of multiple concussions. (GLOs: B3, C8, D1)

Include: second impact syndrome

B11-5-10: Describe how personal lifestyle choices can influence the functioning of protection and/or control systems. (GLOs: B3, D1)

Examples: impact of recreational drugs, use of anabolic steroids, lack of sleep, poor diet, non-use of protective equipment…

B11-5-11: Investigate and describe conditions/disorders that affect protection and/or control in the human body. (GLOs: B3, C6, D1)

Suggestion for Assessment

Assess students' analysis of the article using criteria such as the following:

- The issue is clearly stated.
- The main ideas in the article are summarized.
- The author's opinion is presented with evidence to support it.
- The student's opinion is clearly stated and supported with evidence.
- Questions about the article are included.

Concussions Follow-Up (P2, P3)

WP

Have students review their *initial* responses to the topic of concussions and explain whether their responses have changed, completing the *after* responses of the Anticipation Guide. Students can pair up and discuss their responses with their partners. They can then share their responses with the whole class.

Suggestion for Assessment

Have students write a personal reflection explaining whether or not their opinion on wearing helmets has changed. This reflection can be included in their Wellness Portfolios.

Sledding Injuries (P3, I1, I4)

Have students read the data in Appendix 5.7: A Profile of Sledding Injuries (BLM) prepared by the Public Health Agency of Canada. The questions that follow ask students to interpret the data provided, and then use the data to support information in a letter to a young child about the potential hazards of sledding.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

S3B-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Suggestion for Assessment

Responses to the questions and/or the letter can be used for assessment purposes. Students should be provided with (or help develop) criteria for what an effective letter would look like.

Should You Cram before an Exam?—Microtheme (U2)

Provide students with the following information:

> **Microtheme**
> Your sister is in her first year of university and is writing exams all week. She is staying up very late every night to study and is drinking a lot of coffee to stay awake. She is also eating a lot of junk food because she says she has no time to cook. Using what you know about the impact of factors such as lack of sleep and diet on protection and control systems, convince your sister that a good night's sleep and a balanced diet are just as important as studying, in order to perform well on her exams.

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-5-09: Explain the effects of a concussion on brain function and the implications of multiple concussions. (GLOs: B3, C8, D1)
Include: second impact syndrome

B11-5-10: Describe how personal lifestyle choices can influence the functioning of protection and/or control systems. (GLOs: B3, D1)
Examples: impact of recreational drugs, use of anabolic steroids, lack of sleep, poor diet, non-use of protective equipment…

B11-5-11: Investigate and describe conditions/disorders that affect protection and/or control in the human body. (GLOs: B3, C6, D1)

Suggestion for Assessment

Refer to Appendix 1.3B: Microthemes—First Draft Checklist (BLM) and Appendix 1.3C: Microthemes—Final Draft Assessment (BLM) from Unit 1 for assessment tools.

Note: This microtheme deals with several key factors (e.g., lack of sleep, caffeine, poor diet) that can affect protection and control systems. Students' microthemes should address all these factors.

Personal Reflection (P2, P3)

Have students answer the following questions in their science journals:

- What things am I doing now in the area of protection and control that could be negatively affecting my health?
- What is one thing I could change?

Student Research/Report (I1, I2, I3, I4)

Have students choose a condition or a disorder associated with protection or control in the human body. Students may be given the option of sharing this information in the format of their choice (e.g., oral presentation, informational brochure, essay). Regardless of the format chosen, student work must contain the following information:

- causes
- symptoms
- treatment (a range of treatments, including non-Western, if possible)
- prevention

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

S3B-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Suggested Topics:

- allergies
- HIV/AIDS
- lupus
- diabetes
- arthritis
- West Nile virus
- Alzheimer's disease
- Parkinson's disease
- Huntington's disease
- cerebral palsy
- epilepsy
- stroke
- Creutzfeldt-Jacob disease
- encephalitis
- others

WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-5-09: Explain the effects of a concussion on brain function and the implications of multiple concussions. (GLOs: B3, C8, D1)

Include: second impact syndrome

B11-5-10: Describe how personal lifestyle choices can influence the functioning of protection and/or control systems. (GLOs: B3, D1)

Examples: impact of recreational drugs, use of anabolic steroids, lack of sleep, poor diet, non-use of protective equipment…

B11-5-11: Investigate and describe conditions/disorders that affect protection and/or control in the human body. (GLOs: B3, C6, D1)

Suggestion for Assessment

Develop assessment criteria with students. The criteria should include both content and presentation components. The list on the previous page can form the basis of the "content" section of the assessment. Student products can be self-assessed and peer-assessed with the help of criteria developed by the class.

A Need for Needles: Acupuncture—Does It Really Work?—Case Study (P4, G1, G2, G3)

The case study in Appendix 5.8: A Need for Needles: Acupuncture—Does It Really Work? (BLM) looks at the effectiveness of alternative treatments for a protection disorder. Students are expected to gather evidence for or against acupuncture and then reach a consensus within a small group about the use of this treatment.

Resource Link

Case Study Teaching Notes and Answer Keys are available on the following website. To access some of these resources, you are required to register for a password (available free of charge).

- University at Buffalo. *The National Center for Case Study Teaching in Science Case Collection.* <http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm>.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P2: Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-P4: Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion…

B11-0-I3: Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

S3B-0-G3: Evaluate individual and group processes used. (GLOs: C2, C4, C7)

Suggestions for Assessment

See Appendix 5.9: Assessment—Collaborative Process (BLM) for a peer-assessment of the group process.

Observe students using a checklist such as the following:

The student

- presents evidence to support arguments
- uses appropriate language
- clarifies and summarizes his or her ideas
- gives reasons for not agreeing with opposing claims
- listens actively

NOTES

Unit 5: Protection and Control

Appendices

Appendix 5.1: Concept Frame (BLM)

Concept	Explanation

Examples

Like	Unlike

Appendix 5.2: To Vaccinate, or Not to Vaccinate: That Is the Question* (BLM)

by Caren Shapiro
Department of Mathematics and Natural Sciences
D'Youville College, Buffalo, NY

Paula Highsmith was quite distraught. She had returned from a routine checkup for her four-week-old daughter Jennifer. The pediatrician, Dr. Feiller, had informed Paula that he would begin giving Jennifer her DTP shots at her next appointment in a month.

Paula phoned her mother, Marion Johnson. "Oh, Mother, I don't know what to do."

"You were vaccinated as a child and you didn't have any problems," replied Mrs. Johnson.

"You know my friend Julie? Her oldest son Sam had a seizure after getting the DTP shot when he was Jennifer's age. And what about that couple on television that said the rubella vaccine was responsible for their son's autism?"

"I don't know about that couple," replied Mrs. Johnson, "but Sam was vaccinated ten years ago. If the vaccine was really the problem, I'm sure they would have a different vaccine now."

"But now there are so many shots and, besides, the diseases they prevent have practically disappeared, so why do I have to have Jennifer vaccinated?"

"Jennifer will be required to show evidence of vaccination before she'll be allowed to go to school and perhaps even some daycare centres. Don't you remember the article in the *Buffalo News* about the couple whose son wasn't allowed to register for school because he hadn't had his vaccinations? His parents said they had refused to have him vaccinated for religious reasons."

This case presents many of the issues facing parents when they need to begin the vaccination series for their child. Paula wants to do what is best for her child and she wants to make her decision based on scientific fact not emotional rhetoric.

* Source: Shapiro, Caren. "To Vaccinate, or Not to Vaccinate: That Is the Question." <www.sciencecases.org/vaccination/vaccination.asp>. Reproduced by permission of the National Center for Case Study Teaching in Science, University at Buffalo, State University of New York.

What are the issues raised about vaccination by this case study and what kind of information will help Paula make an informed decision about vaccinating her daughter?

1. Is vaccination necessary? What are the consequences of natural infection?
   - Do micro-organisms cause asymptomatic infections or disease?
   - What are the symptoms of the major vaccine preventable diseases?
   - What are the possible sequelae of the infections?
   - What groups of individuals are particularly susceptible to serious disease consequences?
   - How are infections transmitted?
2. What kinds of vaccines are available?
3. a) What are the advantages (e.g., efficacy and duration of immunity) of the different kinds of vaccines?
   b) What are the disadvantages (e.g., side effects) of the different kinds of vaccines?
4. What is the purpose of vaccination (i.e., prevent infection and/or disease)?
5. Are there reasons for not being vaccinated?
   - Are there beneficial effects of acquiring an infection naturally?
   - Are religious concerns justifiable?

Assignment

In order to address the general questions posed by this case study, you will individually research information on the disease(s) caused by a particular microbe and the vaccine that is used for it. Address the following questions for the microbe and vaccine that you have been assigned:

1. a) Describe the typical symptoms of the disease(s) caused by the agent.
   b) What are the serious sequelae (complications) caused by the agent and how common are they?
   c) Is serious disease primarily a problem only in certain individuals? Explain.
2. a) What kind of vaccine preparation is used (live attenuated; killed or inactivated; toxoid)?
   b) Are there different kinds of vaccine preparations available?
   c) How long has the current vaccine been available?

3. a) What side effects are associated with the vaccine and what is the reported frequency for these side effects?

   b) What is the reported efficacy of the vaccine?

   - What proportion of vaccinated persons are protected from infection (or disease)?
   - What proportion of vaccinated persons are protected from serious disease?

   c) What is the duration of immunity? Are booster shots necessary?

   d) How does the latest number of reported cases compare with the number before the vaccine was available?

4. a) Does the vaccine prevent infection?

   b) Does the vaccine prevent the usual symptoms of disease or primarily the more serious complications of infection?

Appendix 5.3:
Split My Brain: A Case Study of Seizure Disorder and Brain Function (BLM)

by Julia Omarzu
Department of Psychology
Loras College, Dubuque, Iowa

Part I—Jerrod and Jump

Jerrod Hamilton is seven years old. He is an only child and much loved by his parents, Karen and Jeff, and by his extended family of grandparents, aunts, uncles, and cousins. Jerrod has always been a very active boy. He loves hockey, baseball, swimming at the local pool, climbing trees, and playing with his golden retriever, Jump. Making friends has never been a problem for Jerrod. He has several good friends he plays ball with whenever he can. He also does fairly well in school, although he is not as interested in the classroom as he is in recess.

Shortly before Jerrod's seventh birthday, he had a small seizure. He was out playing with his dad and Jump in the yard, when suddenly he stopped, his right arm twitched a little and he seemed disoriented for a few seconds. Afterward he said he was fine, but his mother Karen thought he was quieter than usual. Both his parents watched him more closely in the following days. Soon he had another couple of episodes of muscle twitching and weakness. During these seizures, Jerrod also stared blankly, moving his head slightly back and forth, and for a minute or two could not respond to his parents. When the seizures ended, Jerrod had no memory of them.

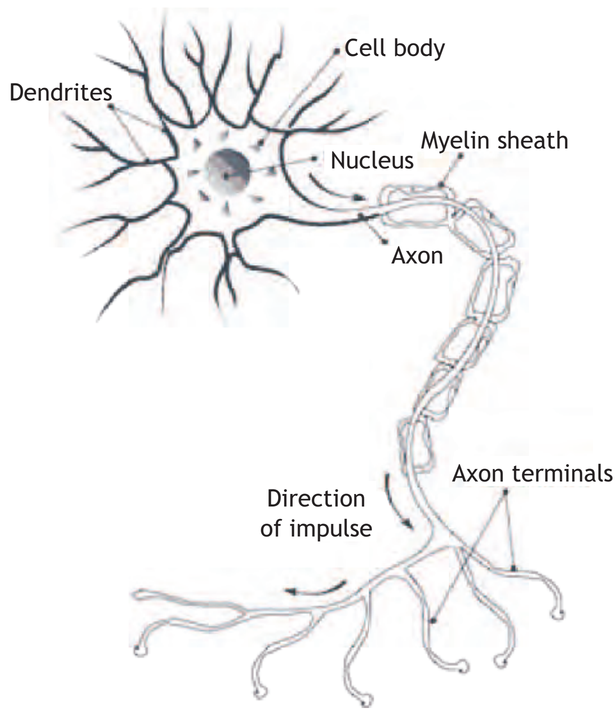
Jerrod's parents took him to their pediatrician, Dr. Madeline Sierra, who listened as Jerrod's parents described his symptoms.

"Before I try to conclude anything, I'd like to order several tests for Jerrod, including an EEG and an MRI scan. I know that sounds a little scary, but the tests are painless and non-invasive. We should get the results back very quickly. Once I see those, I'll know more about what's going on."

"A friend of mine said it sounds like Jerrod might have epilepsy," said Karen. "Is that what you think? How serious would that be?"

"Epilepsy is one possibility," replied the doctor. "It is a relatively common problem and there are some very good treatments for it."

Dr. Sierra went on to explain: "The brain uses electrical energy. The cells of the brain, called neurons, emit a small electrical charge when they send messages to other cells. This is how the brain communicates and runs your mind and body." Dr. Sierra interrupted her explanation for a moment to show them a diagram of a neuron.



"In epilepsy, the neurons somehow get out of control," Dr. Sierra continued. "The electrical activity increases to a level that the brain cannot manage. That produces what we call seizures, where people lose control of their voluntary behaviours for a brief time. Sometimes seizures are nothing more than short lapses of consciousness. Other times they involve convulsions or involuntary movements."

Jeff and Karen looked at each other. "That sounds sort of like what's happening to Jerrod," Jeff said.

"Yes, it does. But let's not jump to any conclusions. I'd rather wait for the tests." Dr. Sierra paused. "I would also recommend something else," she said. "This is something that many families find helpful. Starting today, I suggest that you keep a journal or record of Jerrod's illness. Include his symptoms, tests, information from doctors, any treatments or therapies. Document everything. I will help you, but ultimately, you and Jerrod are the ones who will have to make the decisions, and there will be lots to think about along the way. I think you will be grateful later to have a record of what you learn and observe."

That evening Karen and Jeff called a family meeting to share the results of the doctor's visit.

You will help Jerrod's family by keeping the record Dr. Sierra suggested. Begin creating Jerrod's records by including the following information in a way that Jerrod's family can use and understand. You are encouraged to do further research, but you must synthesize the information you get from the research into a new form that suits Jerrod's situation. Do not just cut and paste from the Internet.

Jerrod's Records

- Why is there electrical activity in the brain? Describe how it is used by neurons.
- What happens in the brain during a seizure?
- What is epilepsy? How is it diagnosed?
- What are the procedures for doing an EEG test and MRI scan? What type of information does each of these tests provide? [See <www.epilepsy.com/epilepsy diagnosis>.]
- What are some possible causes of seizures other than epilepsy?
- Based on the information in the case, what types of seizures does Jerrod appear to be having?
- What should you do during a seizure to help Jerrod?
- What are some treatments for epilepsy?

Part II—A Difficult Decision

Jerrod's tests were done right away, and his parents met again with Dr. Sierra. Jerrod's symptoms were escalating. He had daily seizures, and they included disorientation as well as uncontrollable repetitive movements on the right side of his body. He often felt tired and weak after the seizures.

"Why is this happening to Jerrod?" his mother asked. "Did he get hit in the head or something?"

Dr. Sierra shook her head. "Jerrod's test results show no evidence of an injury like that. The other good news is that there is nothing to indicate a brain tumour. I am more confident that we are dealing with a form of epilepsy, which is probably very treatable. It's also unlikely to be caused by anything he did or you did. However, given the rapid change in Jerrod's symptoms, I would like to refer you to a specialist in neurological disorders. Our office will help set up an appointment."

"Now, I want you to know I'm not abandoning you on this. I'll be following Jerrod carefully, too. But I don't think we should take any chances with this little guy." She smiled and ruffled Jerrod's hair.

Dr. Sierra's referral sent Jerrod and his parents to a neurologist who specialized in seizure disorders. Dr. Benjamin Singh questioned Jerrod and his parents carefully about the seizures. He then opened up the folder with Jerrod's test results and discussed them with Karen and Jeff.

"Here is the output from Jerrod's EEG exam." Dr. Singh showed them a printout. "This test shows us the level of electrical activity in Jerrod's brain. There is a particular pattern of spikes here that shows his seizure activity. Based on these tests and some other indications, I believe Jerrod's seizures are what we call 'partial' seizures. This means that they only involve part of the brain. And right now, his MRI scan is okay."

Jerrod's parents looked at each other with some relief.

"However," the doctor added, "if we do not find a way to reduce or control the current level of seizure activity I am afraid that Jerrod's brain will begin to show some damage, regardless of how much of it is now involved. Fortunately, there are several treatment options available to us. Let's start with a seizure medication."

Dr. Singh prescribed medication to help treat Jerrod's disorder. The first medication didn't succeed, so Dr. Singh and Dr. Sierra conferred and then tried another. After some time and other combinations of medications, it became clear that this type of treatment would be problematic for Jerrod. His seizures were becoming more severe and more frequent. The doctors ordered more tests and then Dr. Singh met with Jeff and Karen.

Dr. Singh pulled out Jerrod's records. "Here is a picture from Jerrod's new MRI scan. Look at this area in the left side of the brain. We are beginning to see some slight abnormalities here that indicate Jerrod's brain is starting to be damaged by the seizures."

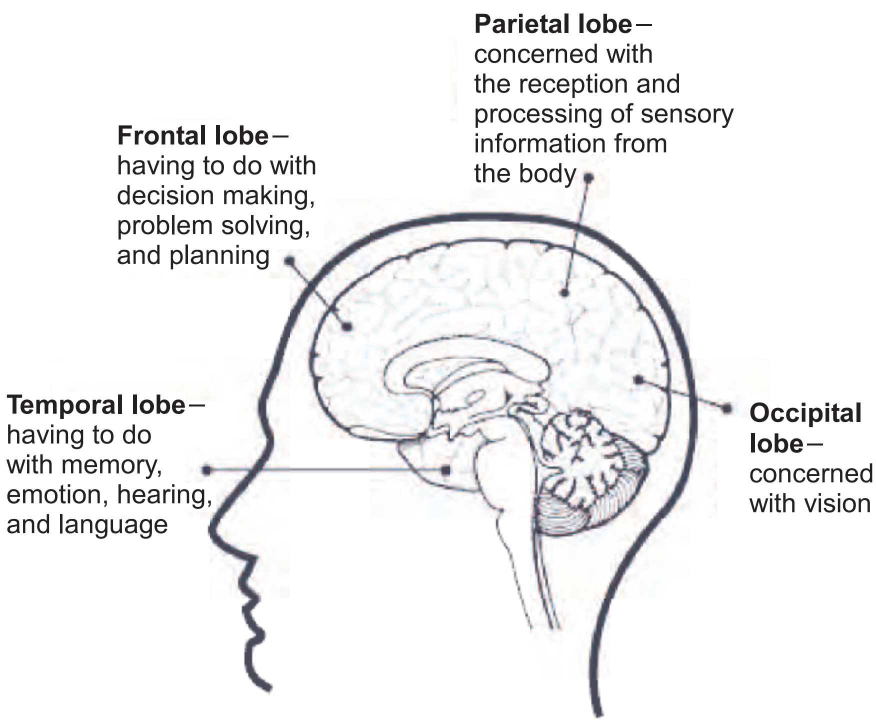
Jeff asked, "What is going on? Why don't the medicines work? You've said there's no injury or tumour. So, is this a condition he inherited from us somehow? Or is it an allergic reaction to something?"

"No," Dr. Singh reassured them. "Most likely none of those things are causing Jerrod's problem. This is also not your fault or Jerrod's fault. I believe that Jerrod has a disorder called Rasmussen Syndrome. Unfortunately, we don't know what causes it. Some people suspect it may be some type of viral infection, but we don't know for sure. So, likely there is nothing you could have done to prevent it. It involves the type and frequency of seizures we are seeing in Jerrod and usually occurs in children of about Jerrod's age. I must warn you that it is a progressive and potentially serious illness that often does not respond to medication."

Dr. Singh went on to describe another type of more drastic treatment that might work in Jerrod's case.

"The upper part of the brain, the cerebrum, is divided into two halves, or two hemispheres," Dr. Singh explained. "In some cases of severe seizure disorders, seizure activity seems to be concentrated in one half or hemisphere of the brain. This is the case in Jerrod's illness."

Dr. Singh showed them a diagram of the brain.



"In Jerrod's case, his seizure activity is located primarily in the left hemisphere of his brain. Sometimes, we can control or even eliminate seizure activity by removing the portion of the brain which is suffering. We call this a functional hemispherectomy."

"What do you mean, 'removing'? You take out his brain?" Karen was horrified.

"Not his entire brain, just the parts that show abnormal activity. In Jerrod's brain, that would mean a large part of his left hemisphere. We would remove Jerrod's left temporal lobe, part of his left frontal lobe, and perhaps some areas in his parietal and occipital lobes. We would also sever the corpus callosum, the band of tissue that connects the two hemispheres and allows them to communicate. We would leave intact Jerrod's thalamus, amygdala, hippocampus, and other deep structures of the brain."

Image credit: Diagram showing lobes of the cerebral cortex courtesy of National Institute on Drug Abuse (NIDA).

Dr. Singh looked at their worried faces. "It sounds terrible, but there have been quite a number of these surgeries performed. We have an excellent team of specialists with a great deal of experience performing this type of surgery and with the rehabilitation that would follow. In cases like Jerrod's, where medications are not working, it can lead to a significantly better quality of life for the patient. Believe it or not, and I know it is difficult to believe, this may be our best option."

Dr. Singh took out a sheet of paper from a folder. "I have the name of a support group that can put you in contact with people who have had to make this same decision for their children. You may want to talk with some of them before you decide."

Jerrod's Record—continued

Add to the family records information about the following:

- What is Rasmussen Syndrome (what are its history, symptoms, prognosis, etc.)?
- What structures or abilities of the brain are concentrated in the areas of the left hemisphere that would be removed in the hemispherectomy?
- Other than reducing his seizures, how else might Jerrod's thinking or behaviour be affected by losing these parts of his brain?
- What types of abilities would he still retain, because the brain structures would remain intact?
- What might the family do to help Jerrod recover after such a surgery?
- If Jerrod had the surgery, would his level of functioning get better, worse, or stay the same over time?
- What other kinds of questions would you have about the surgery? Can you find the answers?
- What decision do you recommend to the family? Why or why not go ahead with surgery?

Appendix 5.4:
Impulse Transmission Demonstration (BLM)

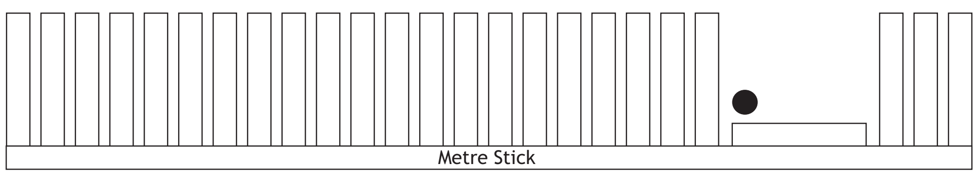
Purpose

The following apparatus is designed to demonstrate the transmission of a nerve impulse along the axon of a neuron and at the point of a synapse.

Materials

1 pkg. of dominoes	1 pencil
1 metre stick	1 marble
tape	

Set up apparatus as indicated in the diagram below.



The dominoes are spaced along the length of the metre stick and secured in place with tape along one side. A gap is left in the space of the dominoes to serve as a synapse. A pencil can be cut in half and secured in place on either side of the metre stick to serve as rails for the marble.

At the start of the demonstration, the neuron is polarized or resting and not actively carrying an impulse. However, a light tap that serves as neural stimulation is applied once the first domino starts the impulse. If the threshold is met, then the impulse will be transmitted. Similarly, if the threshold is not met, then no impulse is transmitted according to the all-or-none response. The last domino before the synapse pushes the marble, which acts as a neurotransmitter in the synapse to carry the impulse to the next neuron. After the impulse is transmitted, the neuron is unable to be stimulated again—this is the refractory period. By tilting the apparatus, the dominoes are once again standing and ready to carry the next impulse.

Appendix 5.5: Comparing Two Systems (BLM)

Compare ways in which the nervous system and the endocrine system protect the human body.

	Nervous System	**Endocrine System**
Communication		
Response Speed		
Duration		
Target Pathway		
Action		

Appendix 5.6: Article Analysis Frame (BLM)

Issue

Summary (Main Ideas)

Your Opinion (Evidence)

Author's Opinion (Evidence)

Questions

Relevance Today

Appendix 5.7: A Profile of Sledding Injuries* (BLM)

Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)
Issue 9, November 1996
by Janet Brown, Analyst
Child Injury Division

Sledding is a popular winter activity among children. It has been reported that each winter 75% of Canadian children participate in at least one snow-sliding sport.

This report is based on information collected from the CHIRPP database for sledding injuries occurring in the six months between November 1, 1994, and April 30, 1995. All types of snow-sliding equipment were looked at, including GT-type sleds (three-ski sleds), toboggans, crazy carpets, inner tubes, and snow disks. Snowboarding injuries were not included. Records of injuries that occurred indoors or that involved a sled being towed by a vehicle were eliminated. A total of 806 records were identified.

Distribution of Patients by Age and Sex

Most sledding injuries were to children between the ages of 5 and 14. Of all sledding injuries, 14.7% were to children younger than 5 years of age, 35.1% were to 5–9 year olds, 41.8% were to 10–14 year olds, and 8.3% were to people 15 years of age or older. The proportion of records in the CHIRPP database during this time period due to sledding injuries was 1.5%. Overall, 57.7% of injuries were to males.

Circumstance of Injury

More than half (59.3%) of the injuries occurred in an outdoor recreation area. Other places included the home yard (17.8%), daycare or school (6.9%), and transportation areas such as a road, footpath, or parking area (1.7%).

Overall, patients were injured most frequently when they fell to the ground while sliding (40.1%), collided with an obstacle such as a rock, tree, or snowbank (32.6%), or collided with another person (15.3%). Other circumstances included being injured on a sled, for example, by getting a body part caught in the sled (7.3%), sliding into a dangerous area such as a street or river (2.4%), or being injured while carrying or pulling a sled (1.0%).

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* Source: Brown, Janet. "A Profile of Sledding Injuries." *CHIRPP News* 9 (Nov. 1996).

The table below shows how the circumstances of injury varied by age. For the younger patients, colliding with an obstacle was the most common circumstance, while for the older ones collisions were less likely to occur.

Distribution (%) of circumstance of injury by age				
	<5 years (n = 118)	**5–9 years (n = 282)**	**10–14 years (n = 336)**	**>14 years (n = 67)**
Fell off sled	24.9	35.8	47.6	47.8
Collided with object	44.9	36.5	25.9	28.4
Collided with person	15.3	19.1	12.5	13.4
Other/unknown	14.9	8.6	14.0	10.4

In only 37.2% of the cases was the type of sled used specified. Of the sled types that were specified, 41.0% were GT-type sleds, 36.5% toboggans, 15.0% crazy carpets, 3.9% snow disks, 2% luges, and 1.6% inner tubes. For patients younger than 9 years of age, the most common type of sled specified was a toboggan. Among patients aged 10 and older, the GT-type sled was most often reported.

Distribution (%) of circumstance of injury by age				
	<5 years (n = 36)	**5–9 years (n = 91)**	**10–14 years (n = 39)**	**>14 years (n = 31)**
GT-type sled	8.3	33.0	52.3	48.4
Toboggan	63.9	42.9	26.2	35.5
Crazy carpet	16.7	17.6	14.1	9.7
Other/unknown	11.1	6.5	7.4	6.4

Nature of Injury and Body Part Injured

Overall, the most common body part injured was the leg (20.5%) and the most frequent type of injury was abrasion, bruising, or inflammation. Head or neck injuries were more common among younger children than older children. For children younger than 10, these injuries comprised approximately one-third of the injuries. For children 10–14 years of age, approximately 10% of injuries were to the head or neck.

Treatment

Half (51.6%) of patients with sledding-related injuries received advice only or minor treatment, 36.7% had significant treatment, and 11.1% were admitted to hospital. This indicates a high rate of serious injury: it is twice the percentage of all injuries in the CHIRPP database that resulted in hospital admission (5.7%). While severity of injury fluctuated slightly among age groups, hospitalization rates remained the same.

Less than 1% of the patients, six in all, reported wearing a safety device. In five of these cases, the type of safety device specified was a helmet. Due to the high risk of head injury, particularly among children younger than 10, helmet use should be encouraged.

Questions

Answer the following questions based on the information in “A Profile of Sledding Injuries.”

1. What percentage of Canadian children participate in at least one snow-sliding sport each winter?
2. What age levels received the most injuries?
3. Did males or females experience the most injuries?
4. In what type of location did most of the injuries occur?
5. Under what circumstances did most injuries take place (e.g., crashing, falling off)?
6. Did the type of circumstances of injury differ by age?
7. What was the most common body part injured?
8. What is the most frequent type of injury?
9. How many, of those injured, received significant treatment?

Write a letter to younger siblings, or to a Grade 2 class, talking to them about the potential hazards of sledding, using information from the report to support your message, and making suggestions as to how they could make sledding safer for themselves.

Appendix 5.8: A Need for Needles: Acupuncture—Does It Really Work?* (BLM)

by Sarah G. Stonefoot and Clyde Freeman Herreid
University at Buffalo, State University of New York

Janet sat in her car in the driveway of her mother's house and eyed the front yard, which was completely taken over by a vegetable garden. It was possible that somewhere in there her mother was hidden, picking over her prized vegetables. Her mother was a bit eccentric. Actually, the word "crazy" sometimes came to Janet's mind when considering her mother. But she never said it out loud. This was her mother, after all.

Janet took a deep breath and then grabbed the door handle. It was time for another lunch with her mother, a meal that would inevitably turn into an argument, as [these lunches] always did.

Audrey greeted her daughter at the door even before Janet had a chance to knock.

"Why, hello, darling."

Janet was carefully unhooking a tomato vine from her foot before her mother noticed. She looked up and greeted her with a sense of apprehension.

"Hello, Mother."

"Oh, Janet, it's so nice to see you. Isn't it just a gorgeous day today?" Her mother was bubbling over with her usual happiness and high spirits.

"It's hot," Janet grumbled, "too hot."

"Well, come on in. I've just put together a delicious salad for lunch."

Salad again, Janet thought to herself. She was glad she had stopped at McDonald's on the way over. She forced a smile and followed her mother into the house.

Lunch went well, until Audrey decided she couldn't hold her idea back any longer. "I was reading that magazine you got me the other day."

"Oh, really," replied Janet, pleased. She had gotten her mother a subscription to *Time* magazine for Christmas. It was her attempt to get her mother on the same track as the rest of the world, or at least aware of what was happening. She knew her mother used [the magazines] as coasters on the coffee table more than anything else.

"Yes, and I came across this really interesting article. It was on acupuncture."

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* Source: Stonefoot, Sarah G., and Clyde Freeman Herreid. "A Need for Needles: Acupuncture—Does It Really Work?" <www.sciencecases.org/acupuncture/acupuncture.asp>. Reproduced by permission of the National Center for Case Study Teaching in Science, University at Buffalo, State University of New York.

Janet sighed. Her hopes evaporated. Of course, the only thing to interest her mother was an article on some sort of nonsense.

"As I was reading it, it began to make a lot of sense. It mentioned that arthritis was one of the things that it helped. And seeing how you're always telling me that arthritis is why my wrists bother me, I thought it might be helpful. My wrists have been acting up a little. I couldn't garden the other day. My poor tomato plants are going to wither away in the sun if I don't get to them soon."

"Mom, you don't want acupuncture. The whole thing is ridiculous. It's a big scam. There is no way that putting needles in your body is going to stop your pain. What you need is to see a doctor." Janet's frustration level was quickly rising.

"I had a feeling you would say that," Audrey sighed. "So I think you should read the article." She handed her daughter the magazine.

"No, Mom," Janet said, pushing it away.

Janet knew she had the final say in this situation. After all, she worked for her mother's insurance agency and had pulled some strings to get her mother covered. She felt strongly that she had a say in what treatment her mother had. Audrey had reluctantly accepted the insurance, knowing that Janet would have some control over her life. She solved the problem simply. She avoided going to doctors.

"Mom, I really think you should go to a doctor about your arthritis. If you don't, it will just get worse. This could become serious. I'm sure there are tons of different medicines you could choose from to help the pain," Janet preached. It was a speech she had given many times before, yet as before it got nowhere with her mother.

"Janet—don't start that again. You know that I'm not putting any drugs into my body, especially when there's no good reason."

"No good reason? Mom, you're in pain," Janet responded with a touch of sympathy entering her voice.

Audrey sighed. She looked down and realized she had been massaging her wrist the whole time. She knew she was being difficult. Her daughter was right, at least about the pain.

"OK—what if we compromise," Audrey began. "What if we talk to a doctor about acupuncture. Will you be convinced to let me try the treatment if you hear from a doctor that it is beneficial?"

"Fine," Janet replied. She knew no sensible doctor would agree to sticking needles in her mother to get rid of her pain. The whole thing was ludicrous.

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It was two weeks later and Janet and her mother were on their way to see a doctor. Audrey had already jumped out of the car and had headed into the doctor's office. Janet dragged herself out and followed.

They sat in the waiting room for what seemed like hours. Janet, in her business suit, was hiding behind the *New York Times* trying not to imagine what people were thinking of her mother. At least her mother had taken off her apron, but she was still in gardening clothes, straw hat resting in her lap. The nurse had seemed amused when she collected the initial data. She now reappeared.

"Audrey Baker, you can come in now."

Janet was glad to escape the eyes of everyone in the waiting room and followed her mother into the doctor's office. Moments later, Dr. Ramirez walked in as they were getting settled.

"Hello, how are you two doing today?" Dr. Ramirez asked.

"Great, thank…" Janet began.

"Just wonderful," Audrey interrupted. "The reason why we're here today is that my daughter can't seem to grasp the concept of acupuncture. I have some pain in my wrists, and I understand it can help that. So, I was wondering if you could just take a couple minutes to explain it to her."

Janet scowled, but before she could say anything, the doctor answered.

"What kind of pain do you have?"

"Oh, nothing serious," Audrey said. "I'm just getting old and my bones aren't what they used to be. When I'm pulling weeds they tend to get a little sore."

"Oh, you're a gardener," Dr. Ramirez said, pleased. "You know, I have a garden of my own."

"Really!" said Audrey. "Flowers or vegetables?"

"Both, actually."

"OK," Janet interrupted. "I'm sorry to be rude, but I am on a tight schedule. Can you just tell my mother that acupuncture will not work on her pain, so that we can set up a suitable treatment?"

"I see," Dr. Ramirez said.

He could see how this was going. He looked at Audrey's chart and paused as he thought how to most effectively approach this case.

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Your task is to assist Dr. Ramirez in reaching his goal. There is a recent trend in medicine termed "evidence-based medicine," in which physicians search the literature to determine effective approaches to treatment, rather than just doing what one of their teachers taught them to do in medical school. Your task is to approach the case in this manner, to scientifically investigate the pros and cons of acupuncture treatment, consult with Dr. Ramirez on what you find, and offer suggestions on how to best proceed with Audrey and Janet.

You will be divided into groups of four; two will search for the "pro" literature (that which supports acupuncture) and two for the "con" literature. Be sure you understand the theory behind acupuncture, the different treatments that acupuncturists might use, and the evidence or lack of it that suggests that acupuncture may work, including the argument that any positive results are due to the placebo effect.

When you return to class armed with evidence, your job will be to work out a consensus consultative opinion to Dr. Ramirez in your group of four students, and to share that opinion with the rest of the class. Part of that sharing will involve the soundness of the evidence. Then, you will need to work out among yourselves what you think Dr. Ramirez should do.

A good place to start your research would be the Acupuncture Information and Resources, National Center for Complementary and Alternative Medicines, National Institutes of Health website at <http://nccam.nih.gov/health/acupuncture/>.

Appendix 5.9:
Assessment—Collaborative Process (BLM)

Assessment of Collaborative Group Work

Assess your collaborative processes, using the following rating scale.

Rating Scale

4 — We were consistently strong in this area.

3 — We were usually effective in this area.

2 — We were sometimes effective in this area.

1 — We were not effective in this area. We experienced problems that we did not attempt to resolve.

Group Process	Rating
• We were respectful of individual group members' approaches and strengths.	
• We encouraged and supported each person in contributing to group discussion and decision making.	
• We questioned and challenged each other's ideas, but did not make personal attacks.	
• We tried to explore a wide range of ideas and perspectives prior to making decisions.	
• We shared work and responsibility equitably.	
• We dealt successfully with the problem of absent or disengaged members.	
• We made our decision through consensus.	
• We used our time productively.	

Unit 6:
Wellness and Homeostatic Changes

Unit 6: Wellness and Homeostatic Changes

Specific Learning Outcomes

B11-6-01: Analyze examples of how different body systems work together to maintain homeostasis under various conditions. (GLOs: D1, E2, E3)

Examples: cold weather, organ transplant...

B11-6-02: Recognize that aging is a progressive failure of the body's homeostatic responses and describe some changes that take place in different body systems as we age. (GLOs: D1, E2, E3)

Examples: less blood and oxygen delivered to muscles and other tissues due to decreased efficiency of heart and lungs; lower calorie requirement due to decreased metabolic rate; increased susceptibility to autoimmune diseases due to fall in number of T cells and decreased activity of B cells...

B11-6-03: Recognize the difficulties faced in defining "death" and identify some of the different definitions in use today. (GLOs: C8, D1)

Examples: medical definition, legal definition, religious viewpoint…

B11-6-04: Identify and analyze social issues related to the process of dying. (GLOs: B3, C4, C5, C8)

Examples: euthanasia, advanced directive, choice of treatments, organ donation, availability of palliative care…

B11-6-05: Describe how technology has allowed us to control our wellness, and describe the ethical dilemmas that the use of technology can create. (GLOs: B1, B2, B3, C5, C8)

Examples: reproductive technologies, stem-cell research, surgery, anaesthetic, pharmaceuticals...

BODY SYSTEM INTERRELATIONSHIPS

SPECIFIC LEARNING OUTCOMES

B11-6-01: Analyze examples of how different body systems work together to maintain homeostasis under various conditions. (GLOs: D1, E2, E3)

Examples: cold weather, organ transplant...

SLO: B11-6-01

SUGGESTIONS FOR INSTRUCTION

BACKGROUND INFORMATION

Throughout this course students have been studying homeostasis through an examination of individual human body systems. The intent of this section is to serve as a culminating look at homeostasis from a holistic perspective, without being restricted to a particular body system. Students will have the opportunity to apply what they have learned throughout the course.

ACTIVATE

Interrelationships

Have students discuss examples (from previous units) of how two or more systems must work together to help the body maintain homeostasis.

ACQUIRE/APPLY

The Homeostatic Challenges of Diabetes: Being Your Own Homeostatic Monitor (U1, U2, P3, I1, I4)

Have students describe, using print and/or electronic resources, all the human body systems that help maintain a constant blood sugar level. Then have them explain how individuals with diabetes must become their own homeostatic monitors for blood sugar by paying attention to indicators and monitoring their blood sugar levels. Examine the implications of not maintaining a constant blood sugar level.

Resource Link

For extensive information on diabetes, including complications associated with diabetes and information about living with diabetes as a First Nations person, see the following website:

- Canadian Diabetes Association. Home Page. <www.diabetes.ca/>.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Suggestion for Assessment

Together with students, develop criteria indicating what a quality response could look like. The primary focus is on demonstrating a deep understanding of body systems, how they are involved in maintaining a constant sugar level, and implications of fluctuating blood sugar levels for diabetics. The secondary focus could be on the means of presentation (e.g., essay, poster, oral presentation).

Cumulative Assessment

Provide an opportunity for students to apply what they have learned about homeostasis and the human body systems as a cumulative assessment. Provide a particular context for students to analyze. For example, have students revisit The Swimming Race case study they analyzed in Appendix 1.7 of Unit 1. Have students revisit their responses and add more details. Students should have access to all their notes for this learning activity. Together with students, develop guidelines for this assessment activity, as well as a rubric for assessment.

Other suggested contexts for this type of assessment would be a case study related to hypothermia or a case study dealing with an organ transplant.

AGING

SPECIFIC LEARNING OUTCOMES

B11-6-02: Recognize that aging is a progressive failure of the body's homeostatic responses and describe some changes that take place in different body systems as we age. (GLOs: D1, E2, E3)

Examples: less blood and oxygen delivered to muscles and other tissues due to decreased efficiency of heart and lungs; lower calorie requirement due to decreased metabolic rate; increased susceptibility to autoimmune diseases due to fall in number of T cells and decreased activity of B cells...

SLO: B11-6-02

SUGGESTIONS FOR INSTRUCTION

BACKGROUND INFORMATION

With aging comes a breakdown of the body's homeostatic mechanisms. A study of aging will allow students to apply the knowledge they have gained throughout the course to another aspect of human life—the aging process.

ACTIVATE

Senior Citizens

Have students generate a list of things they have noticed about older relatives or seniors they are in contact with, related to general health, day-to-day complaints, and so on.

For example, older people are often cold, have difficulty sleeping, and are not able to eat the same kinds of food they used to.

ACQUIRE/APPLY

Models of Aging (U1, U2)

Using print or electronic resources, students create a chart that describes the reasons for reduced efficiency in the three homeostatic processes as one ages: thermoregulation, osmoregulation, and waste management.

Sample:

Thermoregulation	Osmoregulation	Waste Management
• decreased metabolic rate • decreased efficiency in heart and lungs • less respiratory surface due to breakdown of aveoli • fewer oil and sweat glands	• decreased kidney function • urinary incontinence may occur	• decreased oxygen circulated to muscles • less efficient elimination of waste • decreased ability to uptake nutrients • fewer digestive enzymes produced in the intestines

SKILLS AND ATTITUDES OUTCOMES

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

Suggestion for Assessment

As an Exit Slip, have students provide one example of a change that happens in each of the three main homeostatic processes as people age.

Living to 150 Years Old—Article Analysis (U2, P3, D1, D2, I4, G2)

Part 1

The article "Staying Alive" presents a debate about the limits of the human lifespan (see Appendix 6.1). Introduce the article by having students respond to the following question and including an explanation for their response:

Could someone alive today survive to the age of 150?

Part 2

Use a Jigsaw approach to have students address the content of the article "Staying Alive." Separate students into groups and refer to them as the "home" groups. Each group member selects (or is assigned) Section 1, 2, 3, or 4 of the article. All students begin by reading the Introduction. Students then move into the "expert" groups, based on the section they will be reading (i.e., all the 1s get together to look at Section 1, and so on). The expert groups analyze their assigned section and then students take the information back to their respective home groups. The analysis will summarize evidence for or against the argument that someone born today could live to 150 years old. Each group also has to create a heading for their section of the article. A Staying Alive Template

AGING

SPECIFIC LEARNING OUTCOMES

B11-6-02: Recognize that aging is a progressive failure of the body's homeostatic responses and describe some changes that take place in different body systems as we age. (GLOs: D1, E2, E3)

Examples: less blood and oxygen delivered to muscles and other tissues due to decreased efficiency of heart and lungs; lower calorie requirement due to decreased metabolic rate; increased susceptibility to autoimmune diseases due to fall in number of T cells and decreased activity of B cells...

is provided in Appendix 6.2. When the sharing is taking place back in the home groups, team members should be encouraged to take notes on the analysis provided by each team member.

Suggestion for Assessment

Following the sharing of all expert and home group discussions, have students revisit the question, "Could someone alive today survive to the age of 150?" Students can write an individual response that gives their opinion, justifying their opinion using facts from the article. This could be written as a persuasive piece intended to convince someone of his or her position. Regardless of what format the responses take, the responses could be assessed using criteria such as the following:

- The opinion is clearly stated.
- The opinion is supported by extensive detail from the article.
- The argument is logical and convincing.

Aging Relative—Microtheme (U2, D4, I4)

Have students respond to the following case study.

> **Microtheme**
> Six months ago, Grandma moved from her house into a retirement home. Your parents are concerned and comment that she seems to have "aged" a great deal in that time. You notice that Grandma is not involved in the same activities at the retirement home as she was in the community. Indicate how this change in lifestyle has contributed to her aging process. Based on your research into aging, what would you recommend that Grandma do?
>
> Option: Write your response as a dialogue or an essay.

Skills and Attitudes Outcomes

B11-0-U1: Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-P3: Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

Suggestion for Assessment

Refer to Appendix 1.3B: Microthemes—First Draft Checklist (BLM) and Appendix 1.3C: Microthemes—Final Draft Assessment (BLM) in Unit 1 for assessment tools.

Cumulative Assessment

Have students write a response to the following question:

> Would you want to live to 150 years old? Justify your answer using your own knowledge and what you have learned in biology.

The responses could be included in students' Wellness Portfolios.

DEATH

SPECIFIC LEARNING OUTCOMES

B11-6-03: Recognize the difficulties faced in defining "death" and identify some of the different definitions in use today. (GLOs: C8, D1)

Examples: medical definition, legal definition, religious viewpoint…

B11-6-04: Identify and analyze social issues related to the process of dying. (GLOs: B3, C4, C5, C8)

Examples: euthanasia, advanced directive, choice of treatments, organ donation, availability of palliative care…

SLO: B11-6-03
SLO: B11-6-04

SUGGESTIONS FOR INSTRUCTION

TEACHER NOTE

This set of activities provides students with the opportunity to discuss the topic of death, and to realize how something as simple as the definition of death is really not simple at all. Through the learning activities in this section, students will come to appreciate this complexity. They will begin to see death as a process, rather than as a distinct point in time. This discussion will be controversial and raise many ethical issues. It may also be very emotional for some students; teachers should be sensitive to this and provide alternative assignments for students who may not feel able to participate in specific discussions or learning activities.

Resources

The following resource provides a description of medical definitions of death, the processes involved in organ harvesting, and the ethical issues involved in donation and transplantation:

- *Life Is a Gift: A Manitoba Grade 11 Biology Resource for Organ Donation and Transplantation* (Manitoba Education and Transplant Manitoba)

The following website looks at death from various perspectives:

- ThinkQuest. *Death and How People Go about It*. 2001. Oracle Education Foundation. <http://library.thinkquest.org/C0122781/index.htm>.
  — Science—biological process (including definitions)
  — Psychology—how the mind reacts to death, coping
  — Anthropology—cultural and religious differences in how death is treated around the world
  — Sociology—social implications of death

ACTIVATE

Criteria for Death

Have students respond to the following statement:

Describe what you think the criteria are to determine when a person is dead.

SKILLS AND ATTITUDES OUTCOMES

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. GLO: B4)

ACQUIRE/APPLY

"Substituted Sammy"—Case Study (U2, D1, D2, D3, D4, D5, G1, G2)

Introduce a case study related to an issue associated with the process of dying (see *SYSTH*, pp. 4.14–4.17). Appendix 6.3: "Substituted Sammy": An Exercise in Defining Life provides a sample case study. Students should be given the opportunity to work with others to discuss and answer the questions provided in the case study. However, each student may record his or her individual responses, which could be different from someone else's. Students must decide at what point "Sammy" died.

Resource

See Organ Donation in Relation to Society Lesson Plan in *Life Is a Gift* (Manitoba Education and Transplant Manitoba) for learning activities related to Unit 6: Wellness and Homeostatic Changes.

Suggestion for Assessment

Observe students as they read and debate this issue, which can be emotionally charged. Observe students' willingness to listen to others and their openness to other opinions.

DEATH

SPECIFIC LEARNING OUTCOMES

B11-6-03: Recognize the difficulties faced in defining "death" and identify some of the different definitions in use today. (GLOs: C8, D1)

Examples: medical definition, legal definition, religious viewpoint…

B11-6-04: Identify and analyze social issues related to the process of dying. (GLOs: B3, C4, C5, C8)

Examples: euthanasia, advanced directive, choice of treatments, organ donation, availability of palliative care…

Ask the Doctor (I1, W1)

Invite a medical professional to speak to students about the physiology of dying, palliative care, the medical definition of death, advanced directives, and life supports.

Suggestion for Assessment

As a formative assessment, have students write a summary of key points mentioned during this presentation. It can be presented in the form of text, or a graphic representation such as a Concept Map. This assessment will help ensure that students understand some of the key issues/questions on the topic of death, prior to moving on to further learning activities.

Skills and Attitudes Outcomes

B11-0-U2: Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2: Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C6, C7)

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3: Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5: Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-G1: Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2: Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. GLO: B4)

Notes

TECHNOLOGY AND WELLNESS

SPECIFIC LEARNING OUTCOMES

B11-6-05: Describe how technology has allowed us to control our wellness, and describe the ethical dilemmas that the use of technology can create. (GLOs: B1, B2, B3, C5, C8)

Examples: reproductive technologies, stem-cell research, surgery, anaesthetic, pharmaceuticals…

SLO: B11-6-05

SUGGESTIONS FOR INSTRUCTION

ACTIVATE

Using Technology

Have students respond to the following question:

In what ways have you used technology to maintain your life so far?

Create a class list of all the ways the people in the classroom have prolonged their lives. Ensure that a broad definition of technology is employed. The list could include examples such as hospital medical equipment to assist in births, routine vaccinations, thermometers, and so on.

ACQUIRE/APPLY

Technology News (D1, D4, I1, I2, I4, W1, W2)

Create a classroom newspaper that contains student research about a biotechnology in which they are interested. The research should contain information such as

- the inventor(s) of the biotechnology
- the history of discovery
- a description of how it works in the human body
- an argument for its use or cessation of its use

Have students individually write an editorial or a letter that could be placed in the newspaper.

Suggestion for Assessment

Assessment criteria for this performance-based task could include the following:

- The main idea is clearly stated.
- Supporting details and information related to the main idea are accurate.
- References to source information are given for added emphasis and effect.
- The tone of the editorial/letter is rational and logical.
- The editorial/letter style is maintained throughout.
- The editorial/letter is well organized.

Skills and Attitudes Outcomes

B11-0-D1: Identify and explore a current health issue. (GLOs: C4, C8)

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D4: Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-I1: Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)

Include: print and electronic sources, resource people, and personal observations

B11-0-I2: Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)

Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact vs. opinion…

B11-0-I4: Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

B11-0-W1: Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. (GLO: B4)

B11-0-W2: Appreciate the contributions of scientists, including Canadians, to the field of human biology. (GLOs: A4, B4)

WP

Science Saves the Day!—Reflection (W1, D4)

Present students with the following statement:

> Because of the advances in science and technology I don't need to work so hard at maintaining my personal wellness—science can fix whatever goes wrong!

Students can be asked to agree or disagree with the statement and share their opinions in a number of ways:

- classroom or small-group discussion
- written response
- debate

Whatever method is used, students should also be asked to complete a reflective piece on this topic for their Wellness Portfolios.

Suggestion for Assessment

Assessment will vary depending on the type of learning activity used and the focus of the assessment (e.g., group discussion skills, debating skills, justification of position).

Notes

Unit 6:
Wellness and Homeostatic Changes

Appendices

Appendix 6.1: Staying Alive* (BLM)

A century ago, most Americans lived to be about 50. Today people over 100 make up the fastest-growing segment of the population. As some researchers bet that children born today will live to be 150, others say there is no upward limit on longevity.

by Karen Wright

Introduction**

A few years back, biodemographer Jay Olshansky called his friend Steve Austad, a gerontologist, after reading an outrageous quote attributed to Austad about aging. Olshansky, at the University of Illinois, and Austad, at the University of Idaho, have long shared an interest in the human life span. But they differ on some points. Austad had been quoted as saying that someone alive today could survive to the unprecedented age of 150.

"You don't really mean that," Olshansky told his friend.

"Oh yes, I do," Austad replied. In fact, he would bet on it. Before long he and Olshansky had agreed to put $150 each into an investment fund, to be distributed to the relatives of the winner in 2150. They agreed that, in order for Austad's progeny to collect, the 150-year-old has to be in reasonably good health and that proof of the person's age has to be impeccable. By adding $10 each every year, they figure that by 2150, the $300 fund will grow to be worth $500 million.

Austad isn't worried about his kin collecting: "We've made phenomenal progress in understanding aging in other animals in the last 10 years. I can't believe we won't make improvements in [human] antiaging treatments in the next hundred."

Most students of human longevity agree that exercise, antioxidants, low-fat diets, and prostate exams will join forces with a battery of new techniques to extend the lives of seniors and improve their quality of life. But that amiable projection raises a tough question: If medical science were to eliminate geriatric infirmity and disease entirely, how long would the human body last? Is there some built-in expiration date for each member of our species beyond which no one will ever survive? If so, what is it, and why does it exist?

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* Source: Wright, Karen. "Staying Alive." *Discover Magazine* 24.11 (November 2003): 64, 66, 68, 70. Reproduced by permission of Discover Media LLC.

** Note: The section headings are not part of the original article.

Section 1

Demographics of the last two centuries seem to be on the side of soaring life spans. Worldwide, average life expectancy has increased from about 27 years to more than 65. In the United States, a person born in 1900 lived, on average, less than 50 years; now the average life span is 78. Japanese women, the longest-lived people ever known, now have a life expectancy of 85 at birth.

These unprecedented gains are reflected in the number of people surviving to extreme ages. The longest-lived human whose age has been unequivocally documented is Jeanne Louise Calment, a Frenchwoman who died six years ago at age 122. Although people of such advanced age are still rare, they're becoming more commonplace by the minute. The United States now boasts a population of more than 40,000 people aged 100 and older. In 1950 there were only 2,300 centenarians in this country. James Vaupel of the Max Planck Institute for Demographic Research in Rostock, Germany, says the number of centenarians in many industrialized nations is doubling every decade.

Vaupel has shown that the maximum life expectancy among such countries has risen steadily by more than two years each decade since 1840. The increase is "so extraordinarily linear that it may be the most remarkable regularity of mass endeavor ever observed," Vaupel wrote in a 2002 paper coauthored by Jim Oeppen of Cambridge University. If that pace continues, Vaupel maintains, the average life span in industrialized countries in 2150 will be 122.5, making 150-year-olds common.

Demographer Ronald Lee of the University of California at Berkeley says Vaupel's analysis came as "a big surprise. We just did not expect to see a linear increase in life expectancy. It's hard to resist extrapolating that line. That's a 25-year gain every century."

Still, Olshansky has reason to be skeptical. The astounding improvements in public health between 1900 and 1950, aided by such factors as refrigeration, sewage treatment, and safer working environments, produced many of the increases in life expectancy in the last century. The advances helped young people most of all by greatly reducing infectious and parasitic diseases that decimated infants and children. Each young life saved added decades to the raw numbers from which life-expectancy averages are drawn, since a person who survived childhood at the turn of the last century was likely to live decades more.

"Once you've accomplished that, you've accomplished your easy gain in life expectancy," Olshansky says.

Around 1950, he says, the pattern reversed, and most medical gains helped prolong the lives of older people. Medical interventions headed off many ills of the aged, especially the number one killer: heart disease. But saving those who are living out the last years of their lives adds only a few months or years to the actuarial tables. Olshansky therefore believes that even major advances in geriatric care won't push life expectancy much past 85—at least not in the lifetime of anyone alive right now.

"There are no lifestyle changes, surgical procedures, vitamins, antioxidants, hormones, or techniques of genetic engineering available today with the capacity to repeat the gains in life expectancy that were achieved during the 20th century," he and his collaborator Bruce Carnes, of the University of Chicago, have declared.

"Will the maximum human life span increase in the future? Probably," Olshansky says. "It's possible someone might make it to 130. But to go another 20 years? I don't see it happening."

Vaupel says Olshansky belongs to "a sorry saga of distinguished people" who postulate that some maximum age will never be exceeded, only to see it exceeded within five to seven years. "If life expectancy were close to reaching a maximum, then the increase in the record expectation of life should be slowing," he and Oeppen wrote. "It is not."

When Vaupel's daughter was born in 1984, he claimed often and in writing that she would live to see 100. Olshansky's daughter was also born in 1984. While wishing her no ill, he says she most likely won't live to be 100. "Purely mathematical extrapolation of a biological phenomenon is inherently dangerous," he warns. And so it has gone, with Vaupel and Olshansky trading fire in the scientific literature for decades.

Section 2

Statistics might well be misleading when it comes to predicting trends in aging, so another kind of analysis seems in order. What's needed is a model that describes how and why age kills us—a model that explains what it means to die of "natural causes." So far, that model doesn't exist. Biomedical research has produced vast stores of knowledge about the diseases of old age, but scientists still don't understand why our bodies begin to deteriorate when we reach our thirties. It's not even clear that aging, as a process, can be separated from its pathologies.

"Opinions go from nothing ever dies from old age to everything dies from old age," says Austad. "We don't really know very well why people age to death."

Most researchers agree that the biggest boost in human life expectancy will not come from curing diseases. Instead, the rate of aging itself has to be slowed down. Richard Miller, a biogerontologist at the University of Michigan, says Olshansky's research shows that the average 50-year-old woman would live to be 95 if cancer, heart disease, stroke, and diabetes were curable. But studies with rodents, Miller says, indicate that if her aging could be retarded, she'd live to be 115. Most important, those extra years would be lived in good health.

There is tantalizing evidence from laboratory studies that aging can be slowed. Experiments with mice, fruit flies, yeast cells, and tiny worms called nematodes, or roundworms, have pointed to environmental modifications that can extend life span dramatically. Mice fed an austere low-calorie diet, for example, will live up to 40 percent longer. Fruit flies kept in refrigerators can live six times as long as unrefrigerated flies. Cats, dogs, and even humans live years longer than average when they are castrated. And the bonus years seem to be truly golden: Methuselan mice are strong, healthy, and alert.

Those interventions entail sacrifices that most people probably aren't willing to make. But further research may yield more palatable strategies. In August researchers announced that a compound called resveratrol, found in red wine, mimics calorie deprivation and prolongs the life span of yeast cells by 70 percent. Some scientists doing that work said they had taken to drinking a glass of red wine each day.

In the last decade, animal studies also turned up dozens of genes that can extend life span. For example, a single mutation in a roundworm can extend its life 600 percent. The genes involved code for proteins that control basic physiological processes such as energy consumption, growth rate, and cell division. Some of the genes protect critical proteins from damage due to stress. Scientists speculate that mild, chronic stress—like a low-calorie diet or a cold room—may spark these genes into action.

Nonetheless, not a single life-extending gene has been found in the human genome yet. "We know a lot about genes that make humans live shorter lives," says Austad. "But we don't know any genes that make humans live to extreme old age."

Given Olshansky's confidence that humans won't live to be 150, it may be surprising to learn that he thinks there's no predetermined biological limit to the human life span. He agrees with Austad and other researchers that there aren't any physiological determinants of mortality: no molecular switch that gets thrown, no ticking chromosomal clock that says your time is up, no somatic schedule for checkout. There are no death genes that terminate life the way that countless other genes orchestrate growth, metabolism, and reproduction.

And nature supplies ample evidence that the rate of aging is flexible rather than predetermined. The evidence comes from comparisons between species. A fruit fly lives three weeks, a mouse three years, a quahog clam 200 years, and a bristlecone pine 4,000 years. In each of these species, the same cellular processes are at work.

"To me," says Austad, "the interesting thing has always been, why does [life span] differ so much in different species?" A number of theories have addressed that question. One notion, the influential rate-of-living theory first advanced about 100 years ago, is that the speed of an animal's metabolism limits its life span. Hence, cold-blooded animals like turtles live longer than warm-blooded ones like hares, and fast-living creatures die young. Body size also seems to have something to do with it. Larger animals have slower metabolisms and tend to have longer lives than small animals.

The rate-of-living model gives rise to some seductively simple ideas. It suggests, for example, that all species of mammal have the same number of heartbeats in a lifetime. And it was buttressed by evidence that the normal metabolic consumption of energy generates reactive molecules called free radicals that damage DNA, enzymes, and cell membranes. The damage accumulates over time and results in an organism's increased susceptibility to cancer, or its inability to repair clogged arteries, or a slide into senility. The free-radical model is now a leading theory of aging, and it fits neatly with the rate-of-living theory of life span: The faster the metabolism, the faster free radicals do their damage.

But the rate-of-living theory succumbed to the weight of exceptions. Birds, for example, have metabolisms twice as fast as those of mammals, yet they can live much longer. Parrots can outlive elephants; hummingbirds have been known to survive to 14—the equivalent, in terms of energy consumption per pound, of a human living to 500. A species of North American bat half as big as a mouse can live 30 years in the wild. Opossums, on the other hand, rarely last more than two years, even in captivity. Yet they are the size of house cats and cannot by any measure be accused of living fast.

There is one more glaring exception: Humans live four times longer than they should based on their size and metabolic rate.

Section 3

A new perspective on mortality came in the 1950s from distinguished British immunologist Sir Peter Medawar. Inspired by evolutionary theory, Medawar pointed out that death and disease are staved off by natural selection, which impels all living things to survive long enough to reproduce. Natural selection favors any trait, genetic or otherwise, that helps an organism live to reproductive age: mechanisms for DNA repair, robust immune systems, good eyesight, strong bones, quick thinking. The downside, of course, is that natural selection doesn't promote an individual's survival past reproductive age. In people there's no evolutionary advantage to fending off cancer, heart disease, stroke, arthritis, cataracts, Alzheimer's, and other banes of the aged, because these conditions usually show up long after genes have been passed on to the next generation.

Investigators have shown that life span and reproduction are intimately linked in many species of mammal and bird. In general, the earlier an organism reaches sexual maturity, the sooner it dies. Life span also correlates with the number of offspring an animal has. Longer-lived animals tend to have fewer young per year, in part because their continued presence helps ensure their brood's survival. Evolution tends to pick either quantity—short-lived beasts with superbroods—or quality, as exemplified by long-lived creatures with low fecundity but highly conscientious parenting. Because the young of humans, whales, and many other mammals require substantial parental care, natural selection continues to protect the health of adults for some time after they've produced offspring. If the adults are around, the offspring are much more likely to make it.

Experiments with fruit flies published in the 1980s proved there was a causal connection between the timing of reproduction and the evolution of life span. By culling and fertilizing eggs from only older females for many generations, Michael Rose of the University of California at Irvine managed to double his flies' life span. If an environment allows or requires fecundity late in life, then life gets longer. Austad speculates that a similar experiment performed on humans would produce a measurable increase in life expectancy in 10 generations, or about 250 years.

Although people would never tolerate Rose's draconian methods, women in some developed countries are voluntarily delaying the age at which they start having children. "[Rose's] experiment might be going on right now," says gerontologist George M. Martin of the University of Washington in Seattle, "though we won't see the results for hundreds of years." The evolutionary theory of longevity "clearly predicts plasticity," he says. "Given the right conditions, nature can evolve longer and longer life spans."

Austad got a hint of what the right conditions might be 20 years ago. During a stay at a field station in Venezuela, he had his first exposure to the accelerated aging of the opossum. He trapped healthy 18-month-old opossums, then trapped them again just a few months later, and found them lame, half blind, balding, and full of parasites. Austad decided that opossums age and breed relatively quickly because they are easy targets for predators.

"Because they are slow moving and not terribly well armed with claws, teeth, brains, or agility, opossums will be killed by nearly every type of predator—owls, coyotes, wolves, feral dogs, cougars, bobcats. . . . " Austad wrote in his 1997 book *Why We Age*. "If a predator is likely to kill you in the next few weeks or months, it makes little sense to waste resources on a long-lasting, effective immune system or an array of free-radical defenses. It is better evolutionarily to reproduce copiously, and the sooner the better."

To test his theory, Austad located a group of opossums that had been isolated for thousands of years on an island off the coast of Georgia. The island had almost no natural opossum predators. He found that the animals' reproductive systems aged more slowly than their mainland relations' did: More than half enjoyed a second breeding season, a luxury for opossums. Brood sizes were smaller, too, in accordance with the quality versus quantity hypothesis. And sure enough, the average life expectancy was about 25 percent greater, while maximum life span—the longest any individual lived—was 50 percent longer.

Austad's findings have been generalized to encompass any external cause of death. Whether the hazards are from accidents, weather, food shortages, or predators, species and organisms that live in dangerous environments will breed sooner, have more young more quickly, and die earlier than species and organisms in safe environments. Mice are lucky if they make it through a few months before an owl snags them. Pacific salmon die immediately after spawning because reproducing, for them, entails a literally upstream battle they are never to repeat. Birds and winged mammals, on the other hand, can escape many hazards because they can fly. The stability of temperature on the ocean floor shelters the bottom-dwelling quahog clam; the Galápagos tortoise has impenetrable armor.

And people? Austad ascribes our anomalous longevity to the low-risk environment we have created for ourselves. Human beings live twice as long as captive chimpanzees, he notes, despite the fact that the two species share 99 percent of their genes: "I think the key has been our social system—our mutual means of support and our ability to manipulate the environment." Because one of the abiding aims of civilization is to make life safer for people, Austad says, the trend toward a longer life span will continue, and the luxury of long life, afforded by a civilized lifestyle, will eventually become encrypted in our DNA. Nurture becomes nature; culture dictates biological destiny.

"Evolution has definitely modified life span—it's happening even as we speak," says Judith Campisi, a molecular biologist at the Buck Institute for Age Research in Novato, California. "We're already living 50 years beyond the natural life span determined by the environment in which we evolved."

Therefore, Austad, unlike Olshansky, is unwilling to put a cap on the possible increase in life span that humans can achieve. "We can expect that within the next 20 to 30 generations, evolution will slow human aging considerably, by about 25 percent," Austad says. That's quick enough to demonstrate the flexibility of life span, but too slow to guarantee his heirs will beat out Olshansky's. "I'm not counting on evolution to help out with the bet," he admits.

So what is he counting on? Austad reasons that medical science can figure out ways to slow aging without waiting on generations of natural selection. The free-radical theory of aging offers helpful hints. Most of the nasty molecules produced by routine energy consumption in the body are oxidants. In 1998 Austad, his colleague Donna Holmes, an evolutionary gerontologist at the University of Idaho, and Martin demonstrated that bird cells suffer less oxidative damage than the cells of mice when exposed to free-radical stressors. Either birds have enzymes that combat oxidation better than mammalian enzymes do, or they produce fewer oxygen radicals. Until our physiology catches up, humans may be able to soften free-radical damage with antioxidants—compounds such as vitamin E that are found in foods and supplements.

Section 4

Geriatrician Tom Perls of the Boston University School of Medicine runs the world's largest ongoing study of people who are at least 100 years old, with more than 750 participants. His research has convinced him that, with proper care, the contemporary human's genetic endowment will support a healthy life into the mid to late eighties. Centenarians, in contrast, seem to have congenital advantages. Perls calls them "genetic booster rockets." He suspects that centenarians lack genes that predispose them to geriatric diseases and possess genes—as yet unidentified—that protect them from the ravages of time.

"We have a small number of people, particularly guys, who do everything short of throwing an atomic bomb at their bodies and still live to 100," Perls says. Many members of his group ignore dietary guidelines and refuse to exercise; some have been smoking three packs a day for 50 years. "They have genes that allow them to get away with things that aren't very good for them. We'd like to understand what's going on."

Perls says chance also plays a role in determining life span. Chance chooses the genes in which random mutations show up; chance takes the fatal step in front of the crosstown bus. And the longer you live, the more opportunity for misfortune. "It's not just nature-nurture," Martin agrees. "It's nature, nurture, and luck. There is a lot of luck in being a centenarian."

Thus Olshansky and other scientists like him say that while there may be no biological limits to the human life span, there are practical ones. In addition to luck, these include the amount of money society is willing to invest in antiaging research and the amount of time and effort that individuals are willing to spend on treatments that result from the research. Olshansky says that plenty of cheap, simple life-extending measures are already being ignored by a significant percentage of the general public. People still smoke, and most don't exercise. In fact, Olshansky says, the threats posed by obesity and emerging infectious diseases such as AIDS are largely responsible for his pessimism about 150-year life spans.

"Technically, anything is possible," he says. "But in the real world, we're just getting fatter."

Appendix 6.2: Staying Alive Template (BLM)

Someone alive today could survive to the age of 150.

Article Section Title ______________________________

Evidence/Arguments For	Evidence/Arguments Against

Summary	
Key Terms	**Questions**
I was surprised to learn...	

Appendix 6.3: "Substituted Sammy": An Exercise in Defining Life* (BLM)

by Donald F. Shebesta

"Substituted Sammy" was a normal, healthy boy. There was nothing in his life to indicate that he was any different from anyone else. When he completed high school, he obtained a job in a factory, operating a press. On this job he had an accident and lost his hand. It was replaced with an artificial hand that looked and operated almost like a real one.

Soon afterward, Sammy developed a severe intestinal difficulty, and a large portion of his lower small intestine had to be removed. It was replaced with an elastic silicone tube.

Everything looked good for Sammy until he was involved in a serious car accident. Both his legs and his good arm were crushed and had to be amputated. He also lost an ear. Artificial legs enabled Sammy to walk again, and an artificial arm replaced the real arm. Plastic surgery and the use of silicone plastic enabled doctors to rebuild the ear.

Over the next several years Sammy was plagued with internal disorders. First, he had to have an operation to remove his aorta and replace it with a synthetic vessel. Next, he developed a kidney malfunction, and the only way he could survive was to use a kidney dialysis machine. (No donor was found to give him a kidney transplant.) Later, his digestive system became cancerous and was removed. He received his nourishment intravenously. Finally, his heart failed. Luckily for Sammy, a donor heart was available, and he had a heart transplant.

It was now obvious that Sammy had become a medical phenomenon. He had artificial limbs. Nourishment was supplied to him through his veins; therefore, he had no solid wastes. All waste material was removed by the kidney dialysis machine. The heart that pumped his blood to carry oxygen and food to his cells was not his original heart.

But Sammy's transplanted heart began to fail. He was immediately placed on a heart-lung machine. This supplied oxygen and removed carbon dioxide from his blood, and it circulated blood through his body.

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* Source: Shebesta, Donald F. "'Substituted Sammy': An Exercise in Defining Life." *The American Biology Teacher* (May 1972): 286–287. Reproduced by permission of the National Association of Biology Teachers.

The doctors consulted bioengineers about Sammy. Because almost all of his life-sustaining functions were being carried on by machines, it might be possible to compress all of these machines into one mobile unit, which could be controlled by electrical impulses from the brain. This unit would be equipped with mechanical arms to enable him to perform manipulative tasks. A mechanism to create a flow of air over his vocal cords might enable him to speak. To do all this, they would have to amputate at [Sammy's] neck and attach his head to the machine, which would then supply all nutrients to his brain. Sammy consented, and the operation was successfully performed.

Sammy functioned well for a few years. However, slow deterioration of his brain cells was observed and was diagnosed as terminal. So the medical team that had developed around Sammy began to program his brain. A miniature computer was developed; it could be housed in a machine that was humanlike in appearance, movement, and mannerisms. As the computer was installed, Sammy's brain cells completely deteriorated. Sammy was once again able to leave the hospital with complete assurance that he would not return with biological illnesses.

Question

Obviously Sammy ceased living sometime during the story. When do you consider Sammy to have ceased living? Cite specific examples in the story and use the characteristics of life discussed in class to help explain your answer.

General Appendices

Appendix 7: Scientific Communication

One of the primary skill thrusts of Grade 11 Biology is that of providing many opportunities for *scientific communication*. Some of these instances will mimic the behaviours, traditions, and organizational aspects of a *scientific community*. Others are intended to be more authentic and directly promote student-centred development of skills related to the unique demands of communicating scientific ideas and results effectively.

The following strategies can be used in the science classroom to communicate scientific information. For additional information about the strategies, see the following teacher resources:

- *Senior Years Science Teachers' Handbook* (Manitoba Education and Training), abbreviated as *SYSTH*
- *Senior 3 English Language Arts: A Foundation for Implementation* (Manitoba Education and Training), abbreviated as *Senior 3 ELA*

Audience (Adaptation for)

Students adapt information, such as a paragraph in a textbook, for a different audience.

Booklet, Brochure, Pamphlet

Students may present information they have obtained through research or investigation in the form of a booklet, brochure, or pamphlet. This medium is most effective if the information to be represented involves a series of individual steps or points, and includes diagrams or pictures. Students involved in graphic arts may consider this an effective means of communication.

Cartoons

An individual scientific concept, rule (such as a safety rule), or law may be effectively communicated by a cartoon, an illustration, or a series of pictures.

Charts

Information or results that show related tendencies or patterns may be presented best in an organized chart. A flow chart may allow the steps of a process to become more apparent.

Concept Overview Frame (See *SYSTH* 11.25, 11.37)

After studying a concept, students may fill out a Concept Overview Frame. This will allow them to summarize what they have learned.

Data Table

Data measured during the course of an investigation are often best organized in a data table. The data table should have a title, labelled rows and columns, and the correct units. It may include several trials and the average values, as well as the equations used (in variable form). The data table should be prepared before the experiment begins.

Debates (See *SYSTH* 4.19)

Debates are effective in presenting divergent opinions and attitudes related to STSE issues. The debate usually draws on students' own positions on science-related social issues. Pro and con formats can be used to illustrate the main points and to create a dialectic within the debate. While the scenario is often make-believe, the debate provides a forum for personal commentary. Because students often hold debated opinions with greater personal conviction, the debate must be structured in a manner in which sensitivity to various points of view is accepted, if not agreed upon.

Suggested Organization of Debates

1. Select two small balanced groups of students who support divergent and opposing views on a science-related social issue.
2. Provide or have students research background information.
3. Students on each side of the issue prepare and coordinate their evidence to avoid redundant arguments.
4. Select a moderator to monitor time and response to questions.
5. Remind students to listen to and respect divergent points of view. Discourage the notion that only one viewpoint is correct.

Demonstrations

Demonstration of a technique or a procedure is an effective way to communicate an understanding of the process.

Diagrams

Visual communication is often more effective than a written description. Labelled diagrams may be useful for showing equipment set-ups, cycles, and so on.

Dramatic Presentations

Many creative students enjoy dramatizing the information to be presented (such as the history of science) in the form of a skit, a role-play, a play, or a movie. Students must be prepared to research appropriate materials before constructing the dramatic presentation, as this process may be time-consuming. Care must be taken to ensure that students concentrate on the scientific concepts and knowledge, not solely on the dramatization.

Graphing

Representing data in graphical form helps make the relationship between variables more obvious.

- When planning the graph, students need to consider scale. They determine the maximum values for both axes and make the scale accordingly.
- Students label both the vertical and horizontal axes with the factors being graphed and indicate the units being used.
- If the points indicate a straight line, students may use a straight edge. If a line of best fit is required and calculated on the calculator, students need to represent their calculations accurately.
- In a sentence or two below the graph or within the analysis, students explain the implications or main point revealed by the representation.

Historical Perspectives

Students communicate information from the perspective of an individual (scientist, layperson) in another time period. They may choose to write an article critiquing an idea that was controversial in its time (such as smallpox vaccination or the Earth's orbit). Students research information and reflect on their response. Variations include responding from a different age or cultural perspective.

Inquiry or Research Paper Handbook (See *Senior 3 ELA* 4–270)

Working in groups, students produce a handbook outlining the various stages, processes, and strategies of the inquiry or research process. This handbook is then available as a reference during the course of study, and may be adapted or supplemented as required.

Journals

A scientific journal is an effective way for students to record thoughts and ideas during the progression of learning. Teachers may ask students to reflect on and respond to particular questions, such as noting their thoughts on a current issue in the newspaper. Alternatively, students may record their thoughts and feelings as they read a certain piece of scientific literature.

Learning Logs

Students keep an inquiry or research log throughout their inquiry or research project. In this log, students may collect various artifacts representing stages in the research process, as well as record anecdotes of the experience.

Microthemes

When provided with a case study, students interpret the events and express their ideas in a short written assignment. A microtheme may require specific thinking skills (e.g., creating an analogy, analyzing data, examining more than one point of view), and writing must be concise, detailed, and accurate. See Appendix 1.3A: Microthemes for more information.

Models

Students may create two- or thee-dimensional models of a particular concept, theory, or idea. This may involve the use of materials such as papier mâché or modelling clay.

Multimedia Presentations

Students may choose to communicate their understanding through the use of *PowerPoint* software, a video, or other types of electronic media.

Newspaper Articles

By writing as reporters from a particular period of a society's history, students may see different perspectives of a scientific issue or idea.

Oral Presentations

Gaining ease, composure, and a public presence while speaking to an audience are skills developed over many years of schooling and extracurricular activity. At certain points in a student's experience, some growth is encouraged in the arena of public oracy. When oral presentations are compulsory for students, teachers are encouraged to exercise caution and discretion. Focusing on these situations as celebrations of learning that students have mastered promotes confidence and success in addressing peers publicly.

Posters

The poster session at scientific meetings has long been a standard in scientific communication, and provides an alternative venue for the presentation of new results to the large-scale public lecture that is not able to engage at a personal level. In a poster presentation, there is ample opportunity to "get close" to the creators of the work, ask questions, point out interesting facets of their work, and offer suggestions for continued efforts.

Presentation Software

Students may use presentation software, such as *PowerPoint*, to present their information. Students must determine which sounds and images are suitable and enhance communication, as well as learn how to use the program's elements to unify their presentation.

RAFTS (Role-Audience-Format-Topic and Strong Verb) (See *SYSTH* 13.23 for Format)

The RAFTS writing assignment is a portfolio strategy designed to produce creative and imaginative writing pieces in science. Through these assignments, students can

- see alternative perspectives on a science topic or issue
- uncover divergent applications of science concepts
- make connections between their world of experience and their science learning (e.g., metaphorical stories)

Recommendation Report (See *Senior 3 ELA* 4–270)

Students write a short reflection on the implications of their inquiry findings. In their reflections, students may wish to

- identify subsequent inquiry topics that might grow out of the one they have researched
- suggest how the information gathered in the inquiry could be applied
- recommend action that should be taken to solve a problem
- explore how public awareness could be raised about an issue
- describe how they will think or act differently because of the inquiry

Role-Playing (See *SYSTH* 4.18)

Role-playing scenarios teach selected social processes that govern relations, such as negotiation, bargaining, compromise, and sensitivity. Ultimately, students would use these skills as they move from vision to action in dealing with STSE issues. Role-playing often provides an avenue for presenting biased opinions, which may or may not agree with the opinions of students. Most importantly, it introduces divergent points of view and allows students to analyze and respond, thereby giving them an opportunity to gain an appreciation for why individuals hold divergent points of view. Ideally, the role-playing scenario fosters critical-thinking skills while promoting tolerance of other world views. All simulations have rules that govern human interaction. Regardless of the roles assumed, certain behaviours should be promoted, while others should not be allowed.

Roundtable

A roundtable discussion should engage all students in open scientific discussion. The discussion may be initiated by concepts outlined in a scientific article. The opening question should engage all participants and should be based on the text of the article. Although it is not necessary, the teacher may ask *each* student to respond briefly to the first question to "break the ice." (Examples of opening questions are: "What is the most important idea in this text? Why?" and "Do you think this text is scientifically valid? Why?") The core question may be changed during the roundtable discussion to clarify a response or to refocus the group. This question should be focused more directly on the text. (For example: "Why did the scientists use [this animal, technique, equipment]?" or "Explain what the author meant by the word ______ in Paragraph 4.") This question should encourage students to examine how their thinking has changed during the course of the roundtable discussion. The teacher may want to ask questions (such as "How have your answers to the opening question changed?" or "How does the topic relate to your lives?" or "What could be done next?" or "What would you change?"). These questions should not solicit answers to which everyone would agree.

- **Role of Teacher:** The teacher's role is to facilitate, not validate. Try not to make any response, whether with a facial expression, nod, or frown, that would indicate a right or wrong answer. Ask questions that provoke and take thought to a new level. Remind students to back up thoughts with facts from the document. An idea might be to diagram the seating arrangement, "web" the responses, and add a word or phrase beside the name of the speaker. This strategy can help

- identify who speaks and how often
- provide cues to additional questions
- keep the teacher from physically affirming responses

If one student appears to monopolize the roundtable, each student may be issued five chips. Each time the student speaks, he or she gives up a chip. Therefore, the student has five opportunities to speak.

- **Role of Student:** Student participation (both speaking and listening) is mandatory. Students need to be courteous and respectful of classmates. They speak without raising their hands, talk to each other, and address the person they are speaking to by name. A roundtable is a way for students to communicate what they think about the document, not what they feel. They should always refer to the text.

Scientific Paper (See *SYSTH* 14.13 for Format)

At the Senior Years, exposure to the writing of a technical, scientific "paper" is of utmost importance, but it should be treated in an introductory manner. Many students face the reading (or writing) of the scientific paper rather suddenly at the post-secondary level of study, and are ill-prepared for it. In reality, particular scientific journals have their own writing style, format, and so on. No single format or referencing style should be advocated exclusively, but exposure to a few examples is helpful (for instance, using an American Psychological Association [APA] style of referencing versus numerical endnotes).

In the *Senior Years Science Teachers' Handbook*, teachers are offered some standard, normative samples of the Laboratory Report Format and the Scientific Paper Format (see *SYSTH*, Chapter 14: Technical Writing in Science, 14.11 to 14.15). Keep in mind that one of the chief purposes of the classical scientific paper is to announce the results of research related to *new contributions* in a field. Consequently, its role and purposes are distinct from those of a research or position paper.

Storyboard

Students could create storyboards to show the development of a scientific concept or theory. Discussion may then centre on the suggestion: "What might have happened if the order of occurrence had been changed?" (changing chronology).

Web Page Creation (See *Senior 3 ELA* 4–168)

Stages of creating a website may include

- surveying other websites on the same subject
- compiling a list of criteria for an effective website on the chosen subject
- writing a proposal for the website, describing its intended audience and purpose
- using a flow chart for constructing a personal website or contributing to the school's website

Word Cycle, Word Glossary (See *SYSTH* 10.21)

A Word Cycle is considered a strategy in building a scientific vocabulary (for instance, see *SYSTH*, Chapter 10: Building a Scientific Vocabulary). The value in using a Word Cycle comes from taking a broad concept such as an ecosystem, providing a list of terms that could be related to that concept, and then asking students to link these words coherently. Students then learn how terminologies are related, broaden meaning of terms, and promote collaboration. Teachers are encouraged to use Word Cycle learning activities with their students in a cooperative manner (e.g., pairings).

A Word Glossary, steadily accumulated over time, is a useful way for students to organize the large number of terms that science topics bring forth. Pay close attention to the repetitive use of prefixes (e.g., neuro-) and suffixes (e.g., -logical) in scientific parlance.

Written Laboratory Report (See *SYSTH* 11.38, 11.39, 14.12)

There are a variety of formats for lab reports within a common framework. A lab report may contain the following information:

- **Abstract/Introduction:** A condensed version of the entire paper, placed at the beginning of the report. The material in the abstract is written in the same order as it appears within the paper, and should include a sentence or two summarizing the highlights from each section. The abstract is written once the paper is complete.
- **Purpose/Objective/Problem:** A brief statement of the purpose or objective of the experiment.
- **Background Information:** Information drawn from research.
- **Pre-Lab Theory:** The posing of a theoretical solution to the problem before the experimental procedure. It may involve a conceptual explanation and mathematical calculations.
- **Hypothesis:** Contrary to the persistent myth, a hypothesis is not an "educated guess" about what will happen. A statement such as "cigarette smoking causes cancer" is a hypothesis because it is a statement of suggested behaviour in the material world that is *testable* by scientific means. A hypothesis intends to make a *contingent claim* based on prior accepted models about how the world works. The claim, then, is subject to testing over and over again. It is the task of the investigation procedure either to support or to nullify the hypothesis statement.
- **Variables:** For the purposes of this curriculum, anything that comes in different types or different amounts and could possibly enter into an investigation. The simplest sort of relationship to examine is that between two variables (e.g., a person's height and arm span). It is not always a simple task, however, to *control* all the variables that may confound a scientific investigation.
- **Materials:** A list of the materials to be used in the experiment and a labelled diagram of equipment set-up, if applicable.

- **Procedure:** Written step-by-step directions for performing the experiment and regulating the controls, and a summary of the steps taken, so that someone who has not performed this lab would be able to repeat it. If a mixture is heated, the temperature should be given. Any modifications to the procedure should be noted. When following a procedure from a secondary source, reference should be given for the source.
- **Results:** Include drawings, measurements, averages (if applicable), observations, data tables, calculations, and graphs.
- **Observations:** Qualitative interpretations of what is occurring during the course of an experiment. Examples include colour changes, odour, formation of a precipitate, release of gas, temperature differences, pressure changes, or changes in solubility.
- **Quantitative Data:** Measurements taken directly from laboratory instruments. Data must be collected with care during the experiment, properly identified, and the correct numerical values and units used. Suspected faulty data must be presented and explained in the conclusions if not used in the analysis.
- **Sample Problems:** Show the conversion of data into results. Calculations should be properly labelled, with the accuracy and precision of the instruments taken into consideration, and the correct number of significant figures used.
- **Analysis:** An important part of the report that demonstrates an understanding of the experiment. It contains an interpretation or explanation of results, indicating their significance, how accurate the original hypothesis was, sources of error and their effect on results. The analysis also indicates ways to improve the experiment, including modifying the procedure, the equipment, the variables, and so on. The analysis can relate results to the real world and may describe a follow-up or auxiliary experiment.
- **Conclusions:** A summary of results and whether the purpose of the experiment has been achieved. Readers often read the conclusion first.

Zines (See *Senior 3 ELA* 4-166)

Zines (or fanzines, or mini-magazines) usually treat a particular theme. Components may include

- cartoon
- collage
- editorial
- interview
- memoir
- poem
- review
- survey results

Appendix 8: Research

Learning through student-directed or student-initiated projects is known to be a highly effective pathway to promote individualized instruction or to make the best use of the diversity within the classroom. The inquiry approach advocated in Grade 11 Biology presupposes that students will have ample opportunity to develop and refine their research skills through gathering, filtering, processing, and evaluating scientific information.

The following learning strategies can be used in the science classroom to help students develop research skills and strategies. For additional information about the strategies, see the following teacher resources:

- *Senior Years Science Teachers' Handbook* (Manitoba Education and Training), abbreviated as *SYSTH*
- *Senior 3 English Language Arts: A Foundation for Implementation* (Manitoba Education and Training), abbreviated as *Senior 3 ELA*

Action Plan (See *Senior 3 ELA* 4–216 for Whole-Class Inquiry)

Students may submit action plans for group inquiries that include the following components.

Group Inquiry Action Plan					
Objectives	**Strategies**	**Responsibilities**	**Timelines**	**Results**	**Resources**

Concept Maps (See *SYSTH* 9.6, 11.7, 11.8, 11.11)

A Concept Map is intended to help students identify key vocabulary for a topic or identify the relationships between terms in a topic. The teacher may model this procedure by arranging pieces of paper with key terms to show the relationships or logical connections between them. Concept Maps may follow a category, a chain, or a hierarchy as an organizational strategy.

Email

The teacher can arrange links with schools, universities, or other research facilities in other parts of Canada or the world to have students carry out parallel research and to share and discuss data through email.

Interviews (See *Senior 3 ELA* 4–240, 4–226)

Students may analyze models of interviews and practise with peers before conducting interviews in the community. It may be useful to have a preliminary interview in which students introduce themselves, describe the topic and purpose, ask the interviewee what information or experience he or she is able to relate on the topic, explain how the interview will be conducted and how the information will be used, and discuss the time, length, and place of the interview.

Literature-Based Research Projects (See *SYSTH* 4.7)

A literature-based research approach can be applied to many STSE topics. A series of questions can direct students during their topic research. Students with competent literature research skills will be able to

- locate and analyze the validity of scientific information
- reduce unnecessary duplication of laboratory investigations
- recognize multiple perspectives from various interest groups
- determine how decisions are made at the local, provincial, and federal levels of government
- examine scientific, environmental, technological, societal, and economic sides of an issue

Teachers should model the five stages of effective research: planning, information retrieval or gathering, information processing, information sharing, and evaluation.

Plagiarism (Avoidance of)* (See *Senior 3 ELA* 4–260)

Teachers use direct instruction to teach students the conventions for summarizing, paraphrasing, and quoting from research materials. To avoid plagiarism, students need opportunities for supervised practice in using secondary sources appropriately in their research.

Three Ways to Use Secondary Sources (Student Handout)
• **Summaries:** Summarize general information as you proceed with your research. General information consists of facts and concepts that are generally known and that appear in several sources. If you cannot judge whether information is generally known or is the property of one writer, you need to read several more sources. When you write your own text, synthesize the facts and concepts from these summaries in your own words. This information does not need to be referenced. • **Paraphrases:** Paraphrase ideas and statements that belong to one writer, but that you do not wish to quote. To paraphrase, restate the ideas in a passage in your own words. You may need to use common words that appeared in the original, but do not repeat striking words or unique phrases that can be recognized as the style of the original writer. Reference the source of this material. It is considered good style to name the original writer in your paraphrase (e.g., Eldon Craig argues that the hog-nosed snake is a newcomer to Manitoba prairies.). • **Quotations:** Quote striking or powerful lines that would lose their impact if they were paraphrased. Take care to quote lines accurately, and ensure that you do not lose or change their meaning by taking them out of their original context. Make arguments in your own words, and support them with a quotation rather than using quotations to make key arguments. Name the speaker or writer you are quoting, enclose the quoted material in quotation marks, and reference the source of the quotation.

* Source: Manitoba Education and Training. *Senior 3 English Language Arts: A Foundation for Implementation.* Winnipeg, MB: Manitoba Education and Training, 1999. Section 4, p. 260.

A form such as the following can help students distinguish between material cited directly and their own paraphrases, summaries, and comments.

Form for Recording Information	
Author's name (last) ________________ (first) ________________ Title of source ________________ Place of publication ________________ Publisher ________________ Year of publication ________________	
Summaries Briefly note the main ideas of the whole text.	**Paraphrases** Write important and supporting information in your own words. Record the page number(s).
Comments Record your own responses to questions about what you read.	**Direct Quotations** Record only passages that you are very likely to quote in your final article. Record the page number(s).

Proposals (See *Senior 3 ELA* 4–221)

Students may submit proposals for major group projects. Depending on the project, the proposal may include the following categories:

- Purpose
- Audience
- Outline
- Resources
- Team Members and Their Responsibilities
- Steps in Research
- Risk Factors and Plans for Addressing Them
- Form for Reporting
- Timelines
- Progress Reports
- Criteria for Success

Reading Scientific Information (See *SYSTH*, Chapter 12)

Chapter 12 of *SYSTH* presents strategies to help students acquire the skills they need to comprehend science texts and scientific information accessed from multimedia sources. Students use interactive and collaborative strategies to understand and learn the content.

Good readers begin by skimming and analyzing a text and providing themselves with a structural and conceptual framework into which new information might fit. They then read for detail, with three levels of comprehension: literal understanding, interpretation, and application.

Students will be able to become better readers if teachers divide reading exercises into three sections:

- **Pre-reading:** Pre-reading strategies are intended to establish a purpose or focus, to activate prior knowledge, to emphasize new terms and vocabulary, or to provide familiarity with text features.
- **During-reading:** During-reading strategies are meant to promote collaboration, to help students recognize text structure, or to promote questioning and paraphrasing.
- **Post-reading:** Post-reading strategies are designed to teach students how to apply content by increasing comprehension and recall, connecting details to the big picture, making new connections, applying ideas, and transferring knowledge.

Various strategies are developed in *SYSTH*.

Surveys and Questionnaires (See *Senior 3 ELA* 4–226, Appendix C)

Students may submit a proposal for a survey or questionnaire in which they describe

- type of information they wish to gather
- type of survey they intend to implement
- target group and plan for random sampling
- how and when they will pilot the survey
- how and when they will administer the survey
- how they will analyze, interpret, and report data

Surveys are a useful tool for collecting information, particularly on timely, community-based inquiry topics. The following should be considered when designing and conducting a survey:

- purpose
- appropriateness
- practicality
- clarity
- reliability
- target group
- sample
- random selection

Types of surveys include fixed-response questions (multiple choice, agree-disagree, checklists), rating scales (numerical, categorical), open-ended, and phenomenological (extended interview). Students may choose to pilot their survey before administering it.

WebQuest

A WebQuest is an inquiry-oriented activity in which most or all of the information used by learners is drawn from the Web. WebQuests are designed to make efficient use of time, to focus on using information rather than looking for it, and to support learners' thinking at the levels of analysis, synthesis, and evaluation.

A basic WebQuest design includes an introduction, a task, a set of information sources needed to complete the task (not all sources need to be web-based), a description of the process in clear steps, guidance (such as guiding questions, timelines, Concept Maps), and a conclusion. WebQuest design information, templates, and samples may be obtained at WebQuest.org <http://webquest.org>.

NOTES

Appendix 9: Assessment

For the purpose of this curriculum, assessment is the systematic process of gathering information about what a student knows, is able to do, and is currently *learning to do*. Science education today, therefore, demands a broad range and variety of assessment tools to gauge student learning. An inclusive classroom will encourage, whenever possible, assessment opportunities that provide *all students* with the chance to demonstrate what they know *most of the time*.

This appendix provides an overview of various assessment perspectives intended to promote fair assessment and evaluation and increase students' role and responsibility in their own ongoing assessment. Some actual assessment instruments that are proving to be effective in today's classrooms are also included.

Teachers are encouraged to review the *Senior Years Science Teachers' Handbook* (see *SYSTH*, Chapter 15: Assessing and Evaluating Science Learning). Further information is also provided in *Senior 3 English Language Arts: A Foundation for Implementation* (Manitoba Education and Training), abbreviated as *Senior 3 ELA* on the following pages.

Concept Relationship Frame (See *SYSTH* 11.20, 11.25, 11.35)

This differentiated instruction technique is designed to help students examine particular, detailed associations between two concepts (i.e., cause/effect, problem/solution, either/or, compare/contrast). The aim is to avoid superficial analysis by probing for deeper associations. Chapter 11: Developing Science Concepts Using Graphic Displays in *SYSTH* demonstrates how the Concept Relationship Frame can be used effectively.

Developing Assessment Rubrics in Science (See Appendix 10)

Appendix 10 outlines various ways in which students can be engaged with their teachers in the development of assessment rubrics. It addresses questions such as the following:

- What are assessment rubrics?
- Why do teachers use assessment rubrics?
- How can assessment rubrics enhance instruction?
- What are some sources of rubrics? Sources include classroom-developed, teacher-developed, and externally developed rubrics.

Journal Writing and Assessment (See *SYSTH* 13.21)

Journal writing is a *writing to learn* strategy that engenders mixed feelings among students. Part of the "uncertainty" comes from the inability to be passive about one's learning if one is asked to comment upon it, write carefully about it, or be reflective about it. Journals should have an *informal*, familiar tone but should not be quaint or dismissive. Journal entries can be simple and short, vary in frequency, and be structured to a particular format or free-form. It is valuable to consider how best to use journal writing in the science classroom, but experience shows that overuse defeats the purposes of the journal. For instance, if journal writing has little or no assessment/evaluation potential toward a student's grade, or does not provide a means of obtaining teacher feedback, it is difficult to sustain a successful experience.

Establishing a dialogue with students is an important element of formative assessment. Teachers may respond to students' journal entries, extending student thinking through comments and questions. In assessing journal entries, teachers may look for different interpretations and consideration of different perspectives, analyses, and growth.

Laboratory Report Assessment (See Appendix 11)

The Lab Report Assessment rubric is designed for both self-assessment and teacher assessment, and includes criteria categories such as the following:

- Formulates Testable Questions
- Formulates a Prediction and/or Hypothesis
- Creates a Plan
- Conducts a Fair Test and Records Observations
- Interprets and Evaluates Results
- Draws a Conclusion
- Makes Connections

Observation Checklist: Scientific Inquiry—Conducting a Fair Test (See Appendix 11)

This rubric is designed with five performance criteria, and can be used for an entire class list. The emphasis is on gathering information over time through observation. The criteria categories include the following:

- Demonstrating Safe Work Habits
- Ensuring Accuracy and Reliability
- Observing and Recording
- Following a Plan
- Showing Evidence of Perseverance and/or Confidence

Peer Assessment (See *Senior 3 ELA* 4–307)

Peer conferences could be organized to allow peers to act as problem solvers who offer concrete suggestions. The teacher may choose to provide students with questions and prompts. For instance, if students are editing a research paper, the peer assessment may include the following questions:

- Does the text contain enough information?
  - Pose questions that are not answered.
  - Mark passages that require more information.
- Is the text well-organized?
  - Use arrows to show suggested reordering of paragraphs.
  - Mark places where a transition is required.
- Is the text clear?
  - Mark passages that are clear.
  - Mark words or phrases that need to be explained or defined.
  - Mark passages that need charts, graphs, diagrams, or examples.
- Is the information communicated in an interesting way?
  - Mark the least and most interesting sections.
- Are the sources referenced?
  - Mark un-referenced information.
  - Suggest other sources that may be used.

Performance Assessment

Performance assessment may take the form of

- demonstrating a lab technique (e.g., lighting a Bunsen burner, using a balance, focusing a microscope)
- demonstrating a safety procedure
- interpreting Workplace Hazardous Materials Information System (WHMIS) labels
- identifying an unknown

Portfolios (See *Senior 3 ELA* 4–180)

Portfolio items that allow students to demonstrate attainment of specific learning outcomes include

- inquiry logs
- project proposals
- webs and maps
- samples of notes
- reports on primary research
- reflective pieces

Reading Scientific Information (Concept Map Evaluation) (See *SYSTH* 12.15 to 12.19)

Chapter 12: Reading Scientific Information in *SYSTH* suggests techniques for comprehending science texts. It includes examples of how students could take notes from text in the manner of a detailed Concept Map organizer (see 12.16) and how this strategy can connect to *reading for meaning*. Once teachers have effectively modelled the techniques and students have had ample time to practise with scientific reading skills and note-taking, some criteria can be established that can be used in evaluation (see 12.19).

References

Students hand in a preliminary list of references as part of their proposal for a research paper.

Rubric for Assessment of Class Presentation (See Appendix 11)

This rubric is designed with four performance levels, and includes assessment criteria categories such as the following:

- Content
- Interest and Enthusiasm
- Clarity and Organization of Materials
- Use of Visual Aids

Rubric for Assessment of Research Project (See Appendix 11)

This rubric is designed with four performance levels, and includes criteria categproes such as the following:

- Source of Information
- Information Collected
- Organization of Material
- Presentation of Material

Rubric for Assessment of Scientific Inquiry (See Appendix 11)

This rubric is designed for guidance of student assessment in relation to the performance of *scientific inquiry tasks.* The rubric is not intended to be comprehensive, but seeks to provide some project-management parameters for teachers who are observing their students' initial attempts at sophisticated investigation work.

The rubric is designed around four levels of competency, as continua, and includes criteria in the following areas:

- Development of a Position Statement (Proto-Abstract)
- Objective/Purpose/Testable Question
- Procedure (design of the investigation)
- Data Collection
- Analysis and Interpretation of Results
- Application/Discussion of Scientific Results and Concepts
- Independence Factors (measuring degree of reliance upon outside assistance)

Self-Assessment

Self-assessment by students is integral to the overall assessment of learning. To assess their own work, however, students require some detailed advance knowledge (e.g., criteria) of what the expectations are. More advanced learners in this self-reflection process can then participate in setting criteria with their teacher(s). Teachers are encouraged to model self-assessment before expecting students to assess themselves.

Word Cycle (See *SYSTH* 10.6 to 10.8, 10.21)

A Word Cycle is considered a Level 1 strategy in building a scientific vocabulary (see *SYSTH*, Chapter 10: Building a Scientific Vocabulary). The value in using a Word Cycle comes from taking a broad concept such as an ecosystem, providing a list of terms that could be related to that concept, and then asking students to link these words coherently. Students then learn how terminologies are related, broaden the meaning of terms, and promote collaboration. Teachers are encouraged to use Word Cycle learning activities with their students in a cooperative manner (e.g., pairings).

NOTES

Appendix 10: Developing Assessment Rubrics in Science*

The Nature, Purposes, and Sources of Assessment Rubrics for Science

What Assessment Rubrics Are

Rubrics are assessment tools that identify criteria by which student processes, performances, or products will be assessed. They also describe the qualities of work at various levels of proficiency for each criterion.

The following types of assessment rubrics may be used in classroom assessment:

- **General rubrics** provide descriptions of proficiency levels that can be applied to a range of student processes, performances, or products. Using the same rubric for similar tasks helps teachers manage marking assignments based on student choice. It also helps students internalize the common qualities of effective processes, performances, and products.
- **Task-specific rubrics** describe the criteria used in assessing specific forms, such as using a balance, writing a laboratory report, or calibrating CBL probes. Complex student projects may require a different rubric for each phase (for example, a group inquiry project may require a rubric for collaborative work, information-gathering processes, oral presentations, and written reports).
- **Holistic rubrics** are used to assign a single mark to a process, performance, or product on the basis of its adequacy in meeting identified criteria.
- **Analytic rubrics** are used to assign individual scores to different aspects of a process, performance, or product, based on their specific strengths and weaknesses according to identified criteria. See the Rubric for Assessment of Decision-Making Process Activity in Appendix 11.
- **Checklists** are lists of criteria that do not distinguish levels of performance. They are used to assess the presence or absence of certain behaviours, and are most suitable for assessing processes (for example, "Did the student perform all the necessary steps?"). Because they require "Yes/No" judgments from the assessors, checklists are easy for students to use in peer assessment.
- **Rating scales** ask assessors to rate various elements of a process, performance, or product on a numerical scale. They do not provide complete descriptions of performance at various levels.

Why Teachers Use Assessment Rubrics

The best assessment tasks ask students to perform the sorts of scientific literacy tasks they will be called upon to perform in real-world situations. They allow students to demonstrate not only the declarative knowledge they have gained, but also the interplay of attitudes, skills, and strategies that constitute their learning.

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* Source: Manitoba Education and Training. *Senior 3 English Language Arts: A Foundation for Implementation.* Winnipeg, MB: Manitoba Education and Training, 1999. Adapted from Appendices, pp. 3 to 10.

Authentic assessment tasks invite a range of responses and allow students to express their individuality. For all these reasons, assessing scientific literacy is a complex matter.

Assessment rubrics

- help teachers clarify the qualities they are looking for in student work
- ensure that all students are assessed by the same criteria
- help teachers communicate the goals of each assignment in specific terms
- allow teachers within schools, school divisions, and the province to collaborate in assessment
- play an important part in instruction

How Assessment Rubrics Enhance Instruction

The best assessment tools do not simply sort and score student work; instead, they describe it in specific terms. This assessment information

- helps teachers adjust instruction to meet student learning requirements
- tells students what teachers expect and will look for in their work, and helps them to focus their efforts
- allows students to assess their own work using the criteria teachers will use to set goals and to monitor their progress
- aids in the development of metacognition by giving students a vocabulary for talking about particular aspects of their work

Sources of Assessment Rubrics

Teachers develop assessment rubrics in collaboration with students, on their own, and/or with other teachers, or obtain them through published sources.

- **Classroom development:** Developing assessment rubrics in collaboration with students can be a time-consuming process, but one that has many benefits in instruction and learning. (Both the benefits and the process are explored on the following pages.) Although it may not be possible to involve students in the process in every instance, their experience in developing rubrics will help students to use ready-made rubrics with more understanding.
- **Teacher-developed:** Teachers develop general performance and product rubrics individually in collaboration within a school or school division. Rubrics must be adapted regularly to reflect student performance levels accurately. It is important that teacher-developed rubrics use language that students understand, and that teachers provide an example of work at each level of proficiency. These examples (called anchors or exemplars) illustrate for students the descriptive phrases used in the rubrics.
- **Published sources:** High-quality assessment rubrics are available in various educational resources. The disadvantage of ready-made rubrics is that they may not be congruent with the learning outcomes targeted in a particular assignment, and may not accurately describe Grade 11 performance levels and criteria.

Developing Rubrics in Collaboration with Students

Student Benefits

Developing rubrics in collaboration with students requires them to look at work samples and to identify the attributes that make some samples successful and others unsuccessful. Teachers assist students by providing them with the vocabulary to articulate the various elements they see, and by ensuring that the criteria are comprehensive and consistent with learning outcomes. This collaborative process in developing rubrics

- requires students to make judgments about the work they see, and to identify the qualities of effective writing, speaking, and representing of science concepts
- results in an assessment tool that students understand and feel they own—they see that assessment criteria are not arbitrary or imposed, but rather express their own observations about what constitutes quality work

The Development Process

For their first experience in designing a rubric, ask students to articulate the criteria they use in making judgments about something in everyday life—the quality of a restaurant, for example. The model rubric that they develop for assessing restaurants may help students grasp how the parts of a rubric work.

Students may also find it helpful to develop rubrics after they have done some preliminary work on the assessment task, and so are familiar with the demands of the particular assignment.

The process of developing assessment rubrics in collaboration with students involves numerous steps.

1. ***Look at student work samples.***

   Develop assessment rubrics by analyzing genuine samples of student work that illustrate the learning outcomes that the assessment task in question addresses. Samples are usually drawn from student work from previous years, used with permission and with names removed. Beginning teachers who do not have files of samples may need to borrow from colleagues.

   Select samples that are clear and characteristic of student work at various levels. Streamline the process by distributing examples at only three levels of proficiency: excellent, adequate, and inadequate. Provide two or three examples of each level. Allow students time to read the examples and to talk about them in groups.

2. ***Describe the work samples.***

   Suggest that students focus on the examples of excellent work first. Pose the question: "What makes this piece successful?" Then ask students to brainstorm attributes of, or criteria for, success. Some of the attributes students list will describe behaviours that are useful in meeting the goals of the work (for example, the topic is stated at the beginning, there are few spelling errors, a graph is used to represent statistical findings).

What rubrics must attempt to articulate, beyond identifying these behaviours, is the essence of a good product or performance. As Wiggins points out, eye contact may be important in the delivery of an oral report, but it is possible to give a dreary talk while maintaining eye contact (V1-5: 6). Together with students, identify the salient qualities of works related to science that are engaging and effective. These may be qualities that are harder to define and illustrate (for example, the speaker has moved beyond a superficial understanding of the subject, the producer of a video is aware of the audience, the writer's voice is discernible in a science journalism piece).

3. ***Develop criteria categories.***

   From the brainstormed list of attributes, select the criteria categories that will make up the assessment rubric. Most rubrics are limited to three to five criteria categories. A greater number makes the rubrics difficult for assessors to use, especially in assessing live performances. Listing too many criteria can also overwhelm or confuse students who use the rubrics for self-assessment and setting goals.

   Develop criteria categories by combining related attributes and selecting three to five that are considered most important. Label the criteria categories in general terms (organization, style, content) and expand them by listing the specific elements to be examined in assessing quality in these criteria (for example, in the "organization" category, the elements may be statement of purpose, topic sentences, transition words and phrases, paragraph breaks, order of ideas).

   Ensure that no essential attribute that defines good performance is left out. This means including elements considered hard to assess (such as style or creativity). Ignoring elements such as these signals that they are not important. Addressing them helps students grasp the things they can do to improve their own work in these areas. If graphical analysis is identified as one criteria category, for example, the rubric may list elements that convey the details of such an analysis (for example, placement of dependent and independent variables, placement of data points, line of "best fit"). It may also provide definitions.

   As students collaborate to develop criteria categories, monitor whether the criteria chosen are related to the intended learning outcomes.

4. ***Decide how many performance levels the rubric will contain.***

   The first rubric students develop will have three performance levels, based on identifying student work samples as excellent, adequate, or inadequate. In later rubrics, students may move to finer distinctions between levels. The number of levels needed to make meaningful judgments regarding the full range of proficiency is best decided by the teacher. If the scale is large (seven levels, for example), finer distinctions can be made, but it may be difficult to differentiate clearly one level from the next. In science, assessment rubrics designed to be used by students as well as teachers generally use three, four, or five performance levels.*

Using the same number of performance levels for various tasks throughout the curriculum has the advantage of giving students and the teacher a common vocabulary in talking about ways to improve performance (for example, “This piece does not have the concrete detail of level 4 writing.”). Once the number of criteria categories and performance levels has been determined, a rubric template such as the following can be used in developing rubrics.

		Criteria Categories			
Performance Levels	1				
	2				
	3				
	4				
	5				

5. *Describe the performance levels.*

In developing the assessment criteria (step 3), students analyze successful pieces of work. They now fill in descriptions of excellent, adequate, and inadequate performance in all criteria categories.

There are two ways of describing performance levels:

- **Evaluative rubrics** use comparative adjectives (for example, “weak organization”).
- **Descriptive rubrics** specify the qualities of work at each performance level with respect to the criteria (for example, “unconnected ideas appear in the same paragraph”). The attributes listed may be negative (for example, “subscripts and coefficients are incorrectly applied”), for sometimes the most telling characteristic of certain levels is their failure to do what they should be doing.

Descriptive rubrics have many advantages over evaluative rubrics. They are more helpful to students because they spell out the behaviours and qualities students encounter in assessing their own and others’ work. They also help students identify the things they can address in their own work in order to improve.

* Many designers of rubrics advocate a five-level scale. Levels 1, 3, and 5 are developed from an initial sorting of student work into excellent, adequate, and inadequate samples. Levels 2 and 4 describe work that is between these anchor points. Other educators argue that an even-point scale (four or six levels) forces more care in judging than an odd number does; it prevents assessors from overusing a middle category for work that is difficult to assess.

When beginning to write descriptive rubrics, students may suggest generally descriptive adjectives (such as "interesting," "boring"), which may not convey information about what an interesting piece looks like, and how they can improve their work in this area. The description needs to state the attributes that make a work interesting, and should be written in an acceptable style for scientific communication. Classes may need to begin by using comparative language or general descriptions. As the students and teacher collect examples, they can fine-tune the rubric with specific descriptions.

By the end of this step, students will have a description of performance at three levels. If the class has decided to create a rubric with four, five, or six performance levels, it may be most efficient for the teacher to draft gradations of quality for the middle levels, and present them to the class for revision. These middle levels are the most difficult to write, and call on more experience and expertise in developing a smooth continuum of proficiency.

6. ***Use the assessment rubric for student self-assessment, for teacher assessment, and for instruction.***

   Before using the rubric on an actual assignment, students and the teacher may want to test it against unsorted samples of work from previous years. Applying the rubric to student work helps the class determine whether the rubric accurately describes the qualities of the work they see, and helps students make meaningful distinctions between work at different levels of proficiency. As students become more adept at using the rubric, and when they have internalized the performance levels, the teacher can present them with more diverse samples and assessment challenges.

   Rubrics make it possible for students to assess their own work on the basis of the criteria that the teacher will use. Any differences in scores between a student's and a teacher's assessment can be the subject of profitable and focused discussion in student conferences.

   If numerical scores are required, point values assigned to each level can be totalled. If the teacher and students decide that certain criteria categories should be more heavily weighted than others, the points assigned to these categories can be multiplied by a factor.

   A rubric developed collaboratively can also become a valuable instructional tool, encouraging students to look closely at the specific things they can do to improve a piece of work. If students decide that a writing sample in science is at level 3, for example, they can be asked to work together in groups to improve the work so that it fits the description for level 4.

7. ***Continue to revise the assessment rubric.***

   Any assessment rubric can be considered a work in progress, especially if it is stored on the computer. Both the teacher and students should carefully review the rubric each time they use it, asking, "Do these criteria capture the most important qualities of excellence in this work?" "What other words and phrases can we use to describe work at this level?" In keeping with this, the rubrics appearing in Appendix 11 of this document are intended as templates, open to situational revisions.

Appendix 11: Assessment Rubrics

Rubric for Assessment of Research Project

Student Name(s) ____________________ Topic/Title ____________________

Criteria	Performance Levels			
	Level 1	**Level 2**	**Level 3**	**Level 4**
Source of Information	❐ Only one source of information was used.	❐ Two sources of information were used.	❐ A variety of sources was used.	❐ A wide variety of sources was used in a unique manner.
Information Collected	❐ The information collected was not relevant.	❐ The information collected was relevant to the topic but was not blended into a cohesive piece of research.	❐ The information collected was relevant to the topic and was somewhat organized into a cohesive piece of research.	❐ The information collected was relevant to the topic and was carefully organized into a cohesive piece of research.
Organization of Material	❐ The information collected was not organized.	❐ The information was somewhat organized.	❐ The information was organized and contained recognizable sections.	❐ The information was organized and contained recognizable sections that included an introduction, a main body with supporting evidence, and a conclusion that summarized the report.
Presentation of Material	❐ The report was handwritten, contrary to established guidelines.	❐ The report was neatly handwritten. ❐ The report contained a bibliography that was not correctly formatted.	❐ The report was typed. ❐ The report contained graphics. ❐ The report contained a bibliography that was not correctly formatted.	❐ The report was typed and appropriately formatted. ❐ The report contained a title page. ❐ The report contained relevant graphics. ❐ The report contained a complete, correctly formatted bibliography.

Note: *This rubric would vary, depending on the assignment and the presentation format.*

Rubric for Assessment of Decision-Making Process Activity

Student Name(s) ____________________ Topic/Title ____________________

Criteria	Performance Levels			
	Level 1	**Level 2**	**Level 3**	**Level 4**
Identifies STSE Issue	❒ Cannot identify an STSE issue without assistance.	❒ Shows a basic understanding that an issue could have STSE implications, but does not necessarily differentiate among the areas.	❒ Shows a good understanding of a connection between an issue and its STSE applications. ❒ Shows some awareness of the need for an individual response.	❒ Demonstrates excellent depth and sensitivity in connecting an issue with its STSE implications. ❒ Demonstrates a level of social responsibility.
Evaluates Current Research on Issue	❒ Is able to access a small amount of current research but does not evaluate it.	❒ Demonstrates some ability to recognize the positions taken in the research data but makes no clear evaluative statements.	❒ Secures an array of research, narrow in its scope, but clearly identifies the positions taken. ❒ Can offer personal opinions on issue but not necessarily an evaluation.	❒ Acquires research that is current, relevant, and from a variety of perspectives. ❒ Demonstrates insight into the stated positions and can frame an evaluation.
Formulates Possible Options	❒ Is unable to identify the possible options clearly. ❒ Can formulate options that are not clearly connected to the problem to be solved.	❒ Offers at least one feasible option that is connected to the problem. ❒ Offers other options that may be somewhat related to the problem.	❒ Develops at least two feasible options that are internally consistent and directly address the problem. ❒ Recognizes that some options will fail.	❒ Displays a sophisticated understanding of feasible options that is beyond expectations. ❒ Presents choice of options that demonstrate a reasonable chance of succeeding.
Identifies Projected Impacts	❒ Is unable to foresee the possible consequences of the options selected. ❒ Appears to have a naive awareness of consequences.	❒ Identifies potential impacts of decisions taken in a vague or insubstantial way. ❒ Views most of the feasible options as having projected impacts.	❒ Identifies potential impacts of decisions taken in an organized way. ❒ Views all the feasible options as having projected impacts: some beneficial, some not.	❒ Offers a cost/benefits/risks analysis of each feasible solution. ❒ Constructs an organized report that clearly outlines the impacts of each option.

(continued)

Rubric for Assessment of Decision-Making Process Activity *(continued)*

Student Name(s) ______________________ Topic/Title ______________________

Criteria	Performance Levels			
	Level 1	**Level 2**	**Level 3**	**Level 4**
Selects an Option and Makes a Decision	❐ Is unable to come to a decision that clearly connects with the problem to be solved. ❐ Requires direction from the outside to make a choice.	❐ Identifies a feasible option, but cannot clearly decide on a plan. ❐ Requires outside influences to stand by a decision to proceed.	❐ Clearly selects an option and decides on a course of action, but others can identify that a better course of action remains untried. ❐ Recognizes potential safety concerns.	❐ Thoroughly analyzes all options collaboratively. ❐ Makes firm decision, justified by the research base, and recognizes most of the safety concerns.
Implements the Decision	❐ Is unable to implement the decision fully, but has an opportunity to modify it. ❐ Lacks the clarity to proceed.	❐ Implements the decision with a recognition that not all details are laid out in advance. ❐ Lacks clarity in having a plan for implementation.	❐ Implements the decision with some clarity of purpose. ❐ Demonstrates confidence that the implementation plan can follow a scientific inquiry approach.	❐ Implements the decision with clarity of purpose, backed by the research base. ❐ Clearly demonstrates that the implementation plan can be carried to completion as inquiry.
Identifies and Evaluates Actual Impacts of Decision	❐ Cannot clearly recognize more than one possible actual impact of the decision. ❐ Cannot effectively evaluate the effects of the decision taken.	❐ Can clearly recognize more than one possible actual impact of the decision taken. ❐ Cannot effectively evaluate the effects of the decision taken in most instances.	❐ Is able to recognize and comment upon the actual observed impacts of the decision. ❐ Demonstrates some ability to evaluate the impacts of the decision.	❐ Is able to recognize and comment deeply upon the actual observed impacts of the decision, noting unforeseen or unique outcomes. ❐ Is able to evaluate the impacts of the decision with ease.
Reflects on the Decision Making and Implementation of a Plan	❐ Begins to demonstrate an awareness of the need to review the implementation plan. ❐ Is reluctant to consider a re-evaluation of the plan.	❐ Reflects upon and intends to communicate the results of the implementation plan. ❐ Has some difficulty in knowing how to proceed with a re-evaluation of the problem-solving plan.	❐ Reflects upon and communicates the results of the implementation plan. ❐ Recognizes how to proceed with a re-evaluation of the problem-solving plan.	❐ Reaches higher order of synthesis in the reflection process. ❐ Has a sophisticated environmental awareness that informs this post-implementation period.

Note: *The above criteria are suggestions only, and will need to be adapted in collaboration with students according to the purpose of the assignment.*

Observation Checklist: Scientific Inquiry—Conducting a Fair Test

Names	Demonstrating Safe Work Habits (workspace, handling equipment, goggles, disposal)	Ensuring Accuracy and Reliability (repeating measurements/ experiments)	Observing and Recording (carried out during experiment)	Following a Plan	Showing Evidence of Perseverance and/or Confidence	Comments

Note: *A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.*

Lab Report Assessment

Project Title ____ Date ________________________

Team Members ____

Area of Interest	Possible Points	Self	Teacher
Formulates Testable Questions Question is testable and focused, and the cause-and-effect relationship is identified.			
Formulates a Prediction/Hypothesis Independent and dependent variables are identified and the prediction/hypothesis clearly identifies a cause-and-effect relationship between these two variables.			
Creates a Plan All steps are included and clearly described in a logical sequence. All required materials/equipment are identified. Safety considerations are addressed. Major intervening variables are controlled.			
Conducts a Fair Test and Records Observations Evidence of repeated trials is presented and all data are included. Detailed data are recorded, and appropriate units are used. Data are recorded in a clear/well-structured/appropriate format for later reference.			
Interprets and Evaluates Results Patterns/trends/discrepancies are identified. Strengths and weaknesses of approach and potential sources of error are identified. Changes to the original plan are identified and justified.			
Draws a Conclusion Conclusion explains cause-and-effect relationship between dependent and independent variables. Alternative explanations are identified. Hypothesis is supported or rejected.			
Makes Connections Potential applications are identified and/or links to area of study are made.			
Total Points			

Rubric for Assessment of Student Presentation

Student Name(s) ______________________ Topic/Title ______________________

Criteria	Performance Levels			
	Level 1	**Level 2**	**Level 3**	**Level 4**
Organization	❒ Presentation shows poor organization and lack of preparation.	❒ Presentation shows signs of organization, but some parts do not seem to fit the topic.	❒ Presentation is organized, logical, and interesting.	❒ Presentation is well organized, logical, interesting, and lively.
Preparation	❒ Some student preparation is shown.	❒ A fair amount of student preparation is shown.	❒ An adequate amount of student preparation is shown.	❒ A great deal of student preparation is shown.
Content	❒ Small amount of material presented is related to the topic.	❒ Some material presented is not related to the topic.	❒ Almost all material presented is related to the topic.	❒ All material presented is related to the topic.
Language	❒ Language used is hard to follow and understand.	❒ Some language used is hard to follow and understand.	❒ Most language used is easy to follow and understand.	❒ Language used is well chosen and is easy to follow and understand.
Format	❒ Poor use of aids and support materials (diagrams, overheads, maps, pictures); few support the topic.	❒ Adequate use of aids and support materials; most support the topic.	❒ Good use of aids and support materials; almost all support the topic.	❒ Excellent use of aids and support materials; all aids support the topic.
Delivery	❒ Many words are unclear or spoken too quickly or too slowly; voice is monotonous; no pausing for emphasis; voice is too low to be heard easily.	❒ Some words are unclear or spoken too quickly at times; voice is somewhat varied; some pausing for emphasis; voice is sometimes too low to be heard easily.	❒ Most words are clear and generally spoken at the correct speed; voice is often varied and interesting; frequent pausing for emphasis; voice is loud enough to be heard easily.	❒ Words are clear and generally spoken at the correct speed; voice is frequently varied and interesting; effective pausing for emphasis; voice is loud enough to be heard easily.
Audience	❒ Audience is not involved or interested.	❒ Audience is somewhat involved, and sometimes interested.	❒ Audience is involved and interested.	❒ Audience is very involved and interested.

Note: *The above criteria are suggestions only, and will need to be adapted in collaboration with students according to the purpose of the assignment.*

Rubric for Assessment of Class Presentation

Student Name(s) ______________________ Topic/Title ______________________

Criteria	Performance Levels			
	Level 1	**Level 2**	**Level 3**	**Level 4**
Content	❒ No understanding of the topic was evident.	❒ Basic understanding of the topic was evident. ❒ No attempt was made to relate material presented to students' own experiences.	❒ Good understanding of the topic was evident. ❒ Knowledge was thorough and detailed. ❒ Attempt was made to relate material presented to students' own experiences.	❒ Excellent depth of understanding was evident. ❒ Material presented went beyond what was required. Excellent research. ❒ Material presented related to students' own experiences.
Interest and Enthusiasm	❒ Presenter(s) displayed little interest in and enthusiasm for the topic of the presentation. ❒ The class conveyed limited attentiveness during the presentation.	❒ Presenter(s) showed some interest in and enthusiasm for the topic. ❒ The class showed some attentiveness during the presentation.	❒ Presenter(s) clearly showed interest in and enthusiasm for the topic. ❒ The class was noticeably attentive during the presentation.	❒ Presenter(s) showed exceptional interest in and enthusiasm for the topic. ❒ The class was keenly attentive during the presentation.
Clarity and Organization of Material	❒ The information presented was confusing.	❒ The information presented was somewhat vague. ❒ The presentation reflected some organization.	❒ The information was clearly presented. ❒ The presentation was well-organized.	❒ All information was relevant and clearly presented. ❒ The presentation was exceptionally well-organized. ❒ Main points were emphasized and reinforced with appropriate examples.
Use of Visual Aids	❒ Visual aids were not used.	❒ A few visual aids were used. ❒ Visual aids were not well done. ❒ Visual aids used were somewhat relevant to the presentation.	❒ Visual aids were used. ❒ Visual aids were quite well done. ❒ Visual aids were relevant to the presentation.	❒ Strong visual aids were used with care. ❒ Visual aids were clear and exceptionally well done, showing effective use of colour. ❒ Visual aids were designed to emphasize and strengthen the presentation and were successful.

Note: *This rubric would vary according to the assignment and the presentation format.*

Rubric for Assessment of Research Skills

Student Name(s) ______________________ Topic/Title ______________________

Research Skills	Performance Levels			
	Level 1	Level 2	Level 3	Level 4
Ability to formulate questions to identify problems for research purposes	❒ Shows limited ability	❒ Shows some ability	❒ Shows general ability	❒ Shows consistent and thorough ability
Ability to locate relevant primary and secondary sources of information	❒ Unable to locate	❒ Somewhat able to locate	❒ Generally able to locate	❒ Always or almost always able to locate
Ability to locate and record relevant information from a variety of sources	❒ Unable to locate and record	❒ Somewhat able to locate and record	❒ Generally able to locate and record	❒ Always or almost always able to locate and record
Ability to organize information related to identified problem(s)	❒ Shows limited ability	❒ Shows some ability	❒ Shows general ability	❒ Shows consistent and thorough ability
Ability to analyze and synthesize information related to identified problems	❒ Shows limited ability	❒ Shows some ability	❒ Shows general ability	❒ Shows consistent and thorough ability
Ability to communicate results of inquiries using a variety of appropriate presentation forms (oral, media, written, graphic, pictorial, other)	❒ Unable to communicate	❒ Somewhat able to communicate	❒ Generally able to communicate	❒ Always or almost always able to communicate

Note: *This rubric would vary according to the assignment and the presentation format.*

Rubric for Assessment of Scientific Inquiry

Student Name(s) ____________________ Topic/Title ____________________

Criteria	Performance Levels			
	Beginning 1	**Developing 2**	**Accomplished 3**	**Exemplary 4**
Position Statement/ Proto-Abstract (Not intended to be an abstract in the style and purpose of scientific journals)	The student ❒ does not discuss the relevance of the inquiry	The student ❒ offers some discussion but no clear explanation of the importance or goals of the inquiry	The student ❒ discusses the importance of the inquiry but not its relationship to the curriculum or to the real world	The student ❒ clearly summarizes the inquiry, highlights relevant information, and makes critical connections
Objective/Purpose/ Testable Question (Formulation of scientific questions and hypotheses)	❒ omits an objective/ purpose, or states an objective not relevant to the problem under investigation	❒ states an objective that is not a hypothesis or a testable question, but identifies variables to be investigated	❒ states a testable question related to the problem, and identifies variables to be investigated	❒ clearly states a testable hypothesis that addresses the problem, and clearly delineates the variables to be tested
Procedure (Design of the investigation)	❒ does not outline reproducible steps in the procedure ❒ shows some use of methodology, but no account of experimental or systematic error	❒ outlines clear, ordered steps in the procedure ❒ identifies need for treatment of variables, but does not state how this will be achieved	❒ outlines clear, ordered steps in the procedure ❒ identifies need for treatment of *specific* variables, and states how this will be achieved	❒ outlines clear, ordered steps in the procedure ❒ identifies need for treatment of *specific* variables, and states how this will be achieved ❒ provides a concise summary of the procedure
Data Collection	❒ collects some data that can be traced to the investigation itself, but data are inaccurate and incomplete	❒ provides reasonably complete data, organized in tabular form (+/– titles) ❒ gives no indication of use of basic accuracy and precision techniques (e.g., significant figures)	❒ provides complete data, organized in tabular form (+/– titles) ❒ demonstrates some use of basic accuracy and precision techniques (e.g., significant figures)	❒ provides complete data with error analysis, organized in tabular form (+/– titles) ❒ demonstrates use of basic accuracy and precision techniques (e.g., significant figures)

(continued)

Rubric for Assessment of Scientific Inquiry *(continued)*

Student Name(s) ______________________ Topic/Title ______________________

Criteria	Performance Levels			
	Beginning 1	**Developing 2**	**Accomplished 3**	**Exemplary 4**
Analysis and Interpretation of Results	❒ provides improper, incomplete graphical representation of data ❒ attempts no “fit” for plotted data ❒ requires abundance of supervision	❒ provides proper graphical representation of data ❒ attempts to fit a *linear* regression line to data ❒ ensures axes are labelled correctly and positioned consistently with identified variables	❒ provides proper graphical representation of data ❒ shows some evidence of mastery in fitting a *linear* regression line to data, and states *slope* and *y*-intercept ❒ ensures axes are labelled correctly and positioned consistently with identified variables	❒ provides proper graphical representation of data in a variety of forms ❒ shows evidence of mastery in fitting a *non-linear* regression line to data, and states *slope* and *y*-intercept ❒ ensures axes are labelled correctly and positioned consistently with identified variables ❒ demonstrates understanding of how variables relate to a model equation
Application/ Discussion of Scientific Results and Concepts	❒ attempts to explain inquiry results in terms of random error alone (“where I went wrong”) ❒ makes inaccurate, improper, or no conclusions based on data	❒ attempts to connect inquiry results with model systems encountered in class experience ❒ identifies where systematic error may have caused problems	❒ draws accurate and detailed comparison between the system under investigation and what could occur in an ideal system ❒ makes use of introductory statistical analyses ❒ identifies “outliers” in data set(s)	❒ draws accurate and detailed comparison between the system under investigation and what could occur in an ideal system ❒ uses a range of statistical analyses ❒ identifies “outliers” in data set(s)
Independence Factors (Reliance on assistance)	❒ requires extensive assistance from text sources and classmates to do inquiry tasks ❒ requires constant teacher supervision	❒ requires little assistance to complete inquiry tasks ❒ is able to internalize teacher intervention, and work independently afterward	❒ requires no assistance to complete inquiry tasks ❒ demonstrates cooperation with partners ❒ resists efforts of others to assist	❒ requires no assistance to complete inquiry tasks ❒ demonstrates cooperation with partners ❒ seeks opportunities to discuss procedures and results with others

Appendix 12: General and Specific Learning Outcomes

General Learning Outcomes

General learning outcomes (GLOs) provide connections to the Five Foundations for Science Literacy that guide all Manitoba science curricula in all science discipline areas.

Nature of Science and Technology

As a result of their Senior Years science education, students will:

A1 Recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena.

A2 Recognize that scientific knowledge is based on evidence, models, and explanations, and evolves as new evidence appears and new conceptualizations develop.

A3 Distinguish critically between science and technology in terms of their respective contexts, goals, methods, products, and values.

A4 Identify and appreciate contributions made by women and men from many societies and cultural backgrounds that have increased our understanding of the world and brought about technological innovations.

A5 Recognize that science and technology interact with and advance one another.

Science, Technology, Society, and the Environment (STSE)

As a result of their Senior Years science education, students will:

B1 Describe scientific and technological developments—past and present—and appreciate their impact on individuals, societies, and the environment, both locally and globally.

B2 Recognize that scientific and technological endeavours have been, and continue to be, influenced by human needs and the societal context of the time.

B3 Identify the factors that affect health, and explain the relationships among personal habits, lifestyle choices, and human health, both individual and social.

B4 Demonstrate knowledge of, and personal consideration for, a range of possible science- and technology-related interests, hobbies, and careers.

B5 Identify and demonstrate actions that promote a sustainable environment, society, and economy, both locally and globally.

Scientific and Technological Skills and Attitudes

As a result of their Senior Years science education, students will:

C1 Recognize safety symbols and practices related to scientific and technological activities and to their daily lives, and apply this knowledge in appropriate situations.

C2 Demonstrate appropriate scientific inquiry skills when seeking answers to questions.

C3 Demonstrate appropriate problem-solving skills when seeking solutions to technological challenges.

C4 Demonstrate appropriate critical thinking and decision-making skills when choosing a course of action based on scientific and technological information.

C5 Demonstrate curiosity, skepticism, creativity, open-mindedness, accuracy, precision, honesty, and persistence, and appreciate their importance as scientific and technological habits of mind.

C6 Employ effective communication skills and use information technology to gather and share scientific and technological ideas and data.

C7 Work cooperatively and value the ideas and contributions of others while carrying out scientific and technological activities.

C8 Evaluate, from a scientific perspective, information and ideas encountered during investigations and in daily life.

Essential Science Knowledge

As a result of their Senior Years science education, students will:

D1 Understand essential life structures and processes pertaining to a wide variety of organisms, including humans.

D2 Understand various biotic and abiotic components of ecosystems, as well as their interaction and interdependence within ecosystems and within the biosphere as a whole.

D3 Understand the properties and structures of matter, as well as various common manifestations and applications of the actions and interactions of matter.

D4 Understand how stability, motion, forces, and energy transfers and transformations play a role in a wide range of natural and constructed contexts.

D5 Understand the composition of the Earth's atmosphere, hydrosphere, and lithosphere, as well as the processes involved within and among them.

D6 Understand the composition of the universe, the interactions within it, and the implications of humankind's continued attempts to understand and explore it.

Unifying Concepts

As a result of their Senior Years science education, students will:

E1 Describe and appreciate the similarity and diversity of forms, functions, and patterns within the natural and constructed world.

E2 Describe and appreciate how the natural and constructed world is made up of systems and how interactions take place within and among these systems.

E3 Recognize that characteristics of materials and systems can remain constant or change over time, and describe the conditions and processes involved.

E4 Recognize that energy, whether transmitted or transformed, is the driving force of both movement and change, and is inherent within materials and in the interactions among them.

Cluster 0: Skills and Attitudes

Cluster 0 in Grade 11 Biology comprises various categories of specific learning outcomes that describe the skills and attitudes involved in scientific inquiry and the decision-making process for Science, Technology, Society, and the Environment (STSE) issues. From Grades 5 to 10, students develop scientific inquiry through the development of a hypothesis/prediction, the identification and treatment of variables, and the formation of conclusions. Students begin to make decisions based on scientific facts and refine their decision-making skills as they progress through the grades, gradually becoming more independent. Students also develop key attitudes, an initial awareness of the nature of science, and other skills related to research, communication, the use of information technology, and cooperative learning.

In Grade 11 Biology, students continue to use scientific inquiry as an important process in their science learning, but also recognize that STSE issues require a more sophisticated treatment through the decision-making process.

Teachers should select appropriate contexts to introduce and reinforce scientific inquiry, the decision-making process, and positive attitudes within the Grade 11 Biology units throughout the school year. To assist in planning and to facilitate curricular integration, many specific learning outcomes within the Skills and Attitudes cluster can link to specific learning outcomes in other subject areas.

Demonstrating Understanding

B11-0-U1 Use appropriate strategies and skills to develop an understanding of biological concepts. (GLO: D1)

Examples: using concept maps, sort-and-predict frames, concept frames…

B11-0-U2 Demonstrate an in-depth understanding of biological concepts. (GLO: D1)

Examples: use accurate scientific vocabulary, explain concepts to someone else, make generalizations, apply knowledge to new situations/contexts, draw inferences, create analogies, develop models…

Personal Perspectives/Reflection

B11-0-P1 Demonstrate confidence in their ability to carry out investigations. (GLOs: C2, C5)

B11-0-P2 Demonstrate a willingness to reflect on personal wellness. (GLO: B3)

B11-0-P3 Appreciate the impact of personal lifestyle choices on general health and make decisions that support a healthy lifestyle. (GLOs: B3, C4)

B11-0-P4 Demonstrate an understanding of, and respect for, a diversity of cultural perspectives and approaches to maintaining health and treating illness. (GLOs: A4, B3)

Examples: Asian approaches to health and wellness based on concepts of balance; Indigenous people's traditional medicines, concepts of healing; homeopathy…

Scientific Inquiry

B11-0-S1 State a testable hypothesis or prediction based on background knowledge or on observed events. (GLO: C2)

B11-0-S2 Plan an experiment to answer a specific scientific question. (GLOs: C1, C2)

Include: materials; independent, dependent, and controlled variables; methods; and safety considerations

B11-0-S3 Demonstrate work habits that ensure personal safety, the safety of others, and concern for the environment. (GLOs: B3, B5, C1, C2)

Examples: application of Workplace Hazardous Materials Information Systems (WHMIS), proper disposal of chemical or biological specimens…

B11-0-S4 Select and use scientific equipment appropriately and safely. (GLOs: C1, C2)

Examples: microscopes, dissection equipment, prepared slides…

B11-0-S5 Demonstrate sensitivity toward, and respect for, living and non-living tissues, specimens, and organisms utilized for biological research. (GLOs B5, C1)

B11-0-S6 Make detailed observations and/or collect data; organize and display this information using an appropriate format. (GLOs: C2, C5)

Include: biological drawings

B11-0-S7 Evaluate the relevance, reliability, and adequacy of data and data collection methods. (GLOs: C2, C4, C5, C8)

Include: discrepancies in data or observations and sources of error

B11-0-S8 Analyze data and/or observations in order to identify patterns or draw conclusions. (GLOs: C2, C5, C8)

Decision Making

B11-0-D1 Identify and explore a current health issue. (GLOs: C2, C4, C6)
Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information...

B11-0-D2 Evaluate implications of possible alternatives or positions related to an issue. (GLOs: B1, C4, C5, C8)
Examples: positive and negative consequences of a decision, strengths and weaknesses of a position...

B11-0-D3 Recognize that decisions reflect values and consider personal values and those of others when making a decision. (GLOs: C4, C5)

B11-0-D4 Recommend an alternative or identify a position, and provide justification. (GLO: C4)

B11-0-D5 Propose a course of action related to an issue. (GLOs: C4, C5, C8)

B11-0-D6 Evaluate the process used by self or others to arrive at a decision. (GLOs: C4, C5)

Information Management and Communication

B11-0-I1 Synthesize information obtained from a variety of sources. (GLOs: C2, C4, C6)
Include: print and electronic sources, resource people, and personal observations

B11-0-I2 Evaluate the quality of sources of information, as well as the information itself. (GLOs: C2, C4, C5, C8)
Examples: scientific accuracy, reliability, currency, balance of perspectives, bias, fact versus opinion...

B11-0-I3 Quote from or refer to sources as required, and reference sources according to accepted practice. (GLOs: C2, C6)

B11-0-I4 Communicate information in a variety of forms appropriate to the audience, purpose, and context. (GLOs: C5, C6)

Group Work

B11-0-G1 Collaborate with others to achieve group goals and responsibilities. (GLOs: C2, C4, C7)

B11-0-G2 Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions. (GLOs: C2, C4, C7)

B11-0-G3 Evaluate individual and group process used. (GLOs: C2, C4, C7)

Working in Science

B11-0-W1 Demonstrate a continuing, increasingly informed interest in biology and biology-related careers and issues. (GLO: B4)

B11-0-W2 Appreciate the contributions of scientists, including Canadians, to the field of human biology. (GLOs: A4, B4)

Specific Learning Outcomes

The specific learning outcomes (SLOs) identified here constitute the intended learning to be achieved by the student by the end of Grade 11 Biology. These statements clearly define what students are expected to achieve and/or be able to perform at the end of course. These SLOs, combined with the Skills and Attitudes SLOs, constitute the source upon which assessment and instructional design are based.

Unit 1: Wellness and Homeostasis

B11-1-01 Increase awareness of personal wellness, as well as personal and family health history. (GLO: B3)

B11-1-02 Develop a personal wellness plan. (GLOs: B3, B5)

B11-1-03 Recognize how individual wellness choices affect others. (GLOs: B3, B5)
Examples: community, family...

B11-1-04 Describe how the body attempts to maintain an internal balance called homeostasis, recognizing that the conditions in which life processes can occur are limited. (GLOs: D1, E2, E3)
Include: thermoregulation (maintenance of body temperature), osmoregulation (water balance), and waste management

B11-1-05 Explain the principle of negative feedback and identify how the body stabilizes systems against excessive change. (GLOs: D1, E2, E3)
Include: role of receptors and effectors

B11-1-06 Identify life processes that individual cells, as well as complex organisms, need to manage. (GLOs: D1, E1)
Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, and transport substances

B11-1-07 Explain how cell membranes regulate movement of materials into and out of cells, and recognize the importance of this regulation in managing life processes and maintaining homeostasis. (GLOs: D1, E2, E3)
Include: passive transport, active transport, and endo/exocytosis

B11-1-08 Identify factors that influence movement of substances across a membrane, recognizing that movement of these substances is important for the internal balance of the cell. (GLOs: D1, E2, E3)
Examples: size of molecule, concentration gradient, temperature, polarity of molecule, surface area…

B11-1-09 Explain the role of energy in maintaining an internal balance in the cell. (GLOs: D1, D4, E4)

Include: role of adenosine triphosphate (ATP) in metabolism

Unit 2: Digestion and Nutrition

B11-2-01 Identify major structures and functions of the human digestive system from a diagram, model, or specimen. (GLO: D1)

Include: tongue, teeth, salivary glands, epiglottis, esophagus, pharynx, sphincters, stomach, small intestine, large intestine, rectum, anus, appendix, liver, gallbladder, pancreas, and uvula

B11-2-02 Describe the processes of mechanical digestion that take place at various sites along the alimentary canal. (GLO: D1)

Include: chewing in the mouth, peristalsis along the tract, muscle contractions in the stomach, and emulsification by bile in the small intestine

B11-2-03 Identify functions of secretions along the digestive tract. (GLO: D1)

Include: to lubricate and to protect

B11-2-04 Identify sites of chemical digestion along the alimentary canal, as well as the type of nutrient being digested. (GLO: D1)

Include: starch in the mouth; proteins in the stomach; and carbohydrates, lipids, and proteins in the small intestine

B11-2-05 Explain the role of enzymes in the chemical digestion of nutrients and identify factors that influence their action. (GLOs: D1, E2)

Examples: pH, temperature, coenzymes, inhibitors, surface area…

B11-2-06 Describe the processes of absorption that take place at various sites along the alimentary canal. (GLO: D1)

Include: uptake of nutrients by villi in the small intestine and uptake of water in the large intestine

B11-2-07 Describe the homeostatic role of the liver with respect to the regulation of nutrient levels in the blood and nutrient storage. (GLOs: D1, E2, E3)

Include: carbohydrate metabolism

B11-2-08 Describe the functions of each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

Include: ATP production, construction/repair, and regulating

B11-2-09 Identify dietary sources for each of the six basic types of nutrients—carbohydrates, lipids, proteins, vitamins, minerals, and water. (GLOs: B3, D1)

B11-2-10 Evaluate personal food intake and related food decisions. (GLOs: B3, C4, C8)

Examples: percentage of daily values of nutrients, portion size, nutrient labels, balance between lifestyle and consumption...

B11-2-11 Investigate and describe conditions/disorders that affect the digestive process. (GLOs: B3, C6, D1)

B11-2-12 Use the decision-making process to investigate an issue related to digestion and nutrition. (GLOs: B3, C4, C5, C8)

Unit 3: Transportation and Respiration

B11-3-01 Design and execute an experiment to investigate an aspect of the transportation or respiratory system. (GLOs: C2, D1, E2)

Examples: the effect of exercise on heart and/or respiratory rate; the effect of adrenalin on blood pressure; carbon dioxide production as an indicator of metabolism…

B11-3-02 Compare the characteristics of blood components in terms of appearance, origin, numbers, relative size, and function in the body. (GLO: D1)

Include: plasma, erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (platelets)

B11-3-03 Compare and contrast the characteristics of different blood groups. (GLO: D1)

Include: ABO and Rh factor

B11-3-04 Predict the physiological consequences of blood transfusions involving different blood groups. (GLOs: D1, E2)

B11-3-05 Describe the blood donation process and investigate related issues. (GLOs: B3, C4, C5, C6, C8)

Examples: compatible blood groups, screening procedure, frequency of donation, use of donated blood products, blood-borne diseases…

B11-3-06 Compare the structure and function of blood vessels. (GLOs: D1, E1)

Examples: diameter, elasticity, muscle layers, valves, what they transport...

B11-3-07 Identify the materials transported between cells and capillaries. (GLO: D1)

Include: carbon dioxide, oxygen, hormones, nutrients, and nitrogenous wastes

B11-3-08 Describe the cardiac cycle. (GLO: D1)

Include: systole and diastole

B11-3-09 Describe, in general terms, the nervous and chemical control of heartbeat. (GLOs: D1, E2)

B11-3-10 Explain the meaning of blood pressure readings and identify the normal range. (GLOs: B3, D1)

Include: given as a ratio of systolic over diastolic

B11-3-11 Identify factors that affect blood pressure or cardiac function and describe their effects. (GLOs: B3, D1)

Examples of factors: exercise, caffeine, nicotine, shock, beta blockers, diuretics, hormones, stress...
Examples of effects: low blood pressure, high blood pressure, increased heart rate…

B11-3-12 Explain how transport systems help to maintain homeostasis in the body. (GLOs: D1, E2)

Include: transport nutrients, oxygen, carbon dioxide, wastes, and hormones; help maintain fluid balance; regulate body temperature; and assist in the defence of the body against invading organisms

B11-3-13 Distinguish between cellular respiration, internal respiration, and external respiration. (GLO: D1)

B11-3-14 Identify major structures and functions of the human respiratory system from a diagram, model, or specimen. (GLO: D1)

Include: lungs, pleura, nasal cavity, epiglottis, bronchi and bronchioles, alveoli, pulmonary capillaries, diaphragm, pharynx, larynx, trachea, uvula, ribs, and intercostal muscles

B11-3-15 Describe how breathing is controlled to help maintain homeostasis in the human body. (GLOs: D1, E2)

Include: chemoreceptor and medulla oblongata

B11-3-16 Investigate and describe conditions/disorders associated with transportation and/or respiration in the human body. (GLOs: B3, C6, D1)

Examples: cardiovascular diseases…

B11-3-17 Identify personal lifestyle choices that contribute to cardiovascular and respiratory wellness. (GLOs: B3, C4, D1)

Examples: active lifestyle, not smoking…

Unit 4: Excretion and Waste Management

B11-4-01 Identify the primary metabolic wastes produced in the human body and the source of each. (GLO: D1)

Include: ammonia, urea, mineral salts, carbon dioxide, and water

B11-4-02 Describe the roles of the major excretory structures in eliminating wastes and helping the body maintain homeostasis. (GLOs: D1, E2)

Include: kidneys, lungs, skin, and intestines

B11-4-03 Describe the important role of the liver in the process of excretion and the maintenance of homeostasis. (GLOs: D1, E2)

B11-4-04 Identify structures of the human urinary system from a diagram, model, or specimen, and describe the function of each. (GLO: D1)

Include: kidneys, renal cortex, renal medulla, renal pelvis, renal arteries and veins, ureters, urinary bladder, urethra, and urinary sphincters

B11-4-05 Explain the processes of filtration, reabsorption, and secretion in the nephron. (GLO: D1)

B11-4-06 Describe the feedback mechanisms associated with water and salt balance and their role in the maintenance of homeostasis in the human body. (GLOs: D1, E2)

Include: antidiuretic hormone (ADH) and aldosterone

B11-4-07 Describe what types of information can be gained through urinalysis. (GLOs: B3, D1)

Examples: performance-enhancing drugs, diabetes, recreational drugs, pregnancy, infections, kidney failure or damage…

B11-4-08 Investigate and describe issues related to kidney failure and treatment options available. (GLOs: B3, C6, C8, D1)

Examples: organ transplant, personal lifestyle, dialysis…

Unit 5: Protection and Control

B11-5-01 Describe the body's defence mechanisms for protection from foreign agents. (GLO: D1)

Include: non-specific and specific defences

B11-5-02 Describe the body's response to allergens, vaccines, and viruses/bacteria. (GLO: D1)

Include: inflammatory response and immune response

B11-5-03 Explain the role of the lymphatic system in protecting the human body. (GLO: D1)

Include: lymph vessels, lymph nodes, and lymph

B11-5-04 Investigate issues related to the immune system and the protection of public health. (GLOs: B3, C4, C5, C6, C8, D1)

Examples: immunization policies, travel bans and advisories, epidemics…

B11-5-05 Describe the major organization of the nervous system. (GLO: D1)

Include: central nervous system and peripheral nervous system (autonomic and somatic)

B11-5-06 Identify the functional regions of the brain. (GLO: D1)

Examples: general anatomy such as cerebellum, specific regions responsible for speech and other functions, left-brain/right-brain concept…

B11-5-07 Explain how a nerve impulse travels a particular pathway using chemical and electrical signals. (GLO: D1)

Include: synapse

B11-5-08 Compare the general roles of nervous and hormonal controls, recognizing that the nervous and endocrine systems interact to maintain homeostasis in the human body. (GLOs: D1, E2, E3)

Include: communication, speed, duration, target pathway, and action

B11-5-09 Explain the effects of a concussion on brain function and the implications of multiple concussions. (GLOs: B3, C8, D1)

Include: second impact syndrome

B11-5-10 Describe how personal lifestyle choices can influence the functioning of protection and/or control systems. (GLOs: B3, D1)

Examples: impact of recreational drugs, use of anabolic steroids, lack of sleep, poor diet, non-use of protective equipment…

B11-5-11 Investigate and describe conditions/disorders that affect protection and/or control in the human body. (GLOs: B3, C6, D1)

Unit 6: Wellness and Homeostatic Changes

B11-6-01 Analyze examples of how different body systems work together to maintain homeostasis under various conditions. (GLOs: D1, E2, E3)

Examples: cold weather, organ transplant...

B11-6-02 Recognize that aging is a progressive failure of the body's homeostatic responses and describe some changes that take place in different body systems as we age. (GLOs: D1, E2, E3)

Examples: less blood and oxygen delivered to muscles and other tissues due to decreased efficiency of heart and lungs; lower calorie requirement due to decreased metabolic rate; increased susceptibility to autoimmune diseases due to fall in number of T cells and decreased activity of B cells...

B11-6-03 Recognize the difficulties faced in defining "death" and identify some of the different definitions in use today. (GLOs: C8, D1)

Examples: medical definition, legal definition, religious viewpoint…

B11-6-04 Identify and analyze social issues related to the process of dying. (GLOs: B3, C4, C5, C8)

Examples: euthanasia, advanced directive, choice of treatments, organ donation, availability of palliative care…

B11-6-05 Describe how technology has allowed us to control our wellness, and describe the ethical dilemmas that the use of technology can create. (GLOs: B1, B2, B3, C5, C8)

Examples: reproductive technologies, stem-cell research, surgery, anaesthetic, pharmaceuticals…

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