Manitoba

Education, Citizenship and Youth

SENIOR 3 BIOLOGY 30S
A Foundation for Implementation
Unit 1 – Wellness and Homeostasis

DRAFT / Unedited Version

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Manitoba
Building for the Future

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Unit 1: Wellness and Homeostasis

Personal Wellness

S3B-1-01 Increase awareness of personal wellness and family health history.

S3B-1-02 Develop a personal wellness plan.

S3B-1-03 Recognize how individual wellness choices affect others. *Examples: community, family, fetus...*

Background Information – Wellness Portfolio

Wellness is a major theme in the Biology 30S course. 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 Biology 30S program. The intent is to have students learn more about their medical histories (e.g. medical chart), and how their body works; to collect data on how their body is performing (e.g. heart rates); to analyze how well they are taking care of themselves (e.g. checklist) and to make decisions about their own lifestyle to promote their wellness (e.g. life goals).

This portfolio has a number of possible assignments in a variety of formats. Each is matched up to an appropriate section of the course. The Wellness Portfolio Overview **(Appendix 1**) provides a summary of possible wellness portfolio assignments, including type of product and suggested value. Additional assignments can be added by the teacher.

A suggested approach is to have all students complete the introduction and big picture assignments. After that, the assignments could be teacher assigned, a combination of teacher assigned and student selected, or all student selected. Students may be required to complete sufficient assignments to add up to 100 points. This would push them to work in more than one section. Consider guiding the students to choose assignments from a variety of formats as well.

The wellness portfolio learning activities are referenced throughout this document, in the appropriate sections. The following icon has been used to indicate a wellness portfolio activity: 

NOTE: If you choose to begin with a different unit the concept of wellness should be introduced early on as it is a major theme of the course. Also, the

wellness portfolio activities should be completed throughout the course, as appropriate, not left until the end of the course.

Suggestions for Instruction

ACTIVATE

Wellness Checkup WP

As an introduction to some of the factors that influence wellness, have students complete the Wellness Checkup (**Appendix 2**)

ACQUIRE / APPLY

Microtheme WP

Background Information: Microthemes are writing assignments designed to help students learn the material by looking at it in a different way (Martin, 1989). They involve 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. Refer to **Appendix 3** for Teacher Guidelines, and blackline masters for First and Final Drafts.

Once Upon a Time – Microtheme

Provide students with the following microtheme assignment:

> Remember back to 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 about that illness or injury. Write down what you would tell them. Be sure to include what happened, how you were diagnosed and treated, if you visited the hospital, etc. Your account can be dramatic but must also be factual. Option: if you suffer from a chronic disease you may choose to write about that.

Suggestion for Assessment: Refer to **Appendix 3b and 3c** for assessment tools.

Family History WP

Have students carry out research on their family members (immediate and distant) to create a family health history. Refer to **Appendix 4** 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.
Teacher Note: While this learning activity provides a tremendous opportunity for students to connect with family members, teachers will need to be sensitive with regard to students who may not be able to contact family members (for example, adopted students). An alternative Wellness Portfolio activity can be used for these students.

Suggestion for Assessment: A sample rubric is provided below. It should be modified, with student input.

Family History Assessment

A	Interview notes - indicate individual interviewed, date of interview and relationship to 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
B	Pedigree - used proper format to indicate relationships - listed birth and death dates - listed conditions - listed cause of death	0 – not done 1 – met one criteria 2 – met two criteria 3 – met three criteria 4 – met four criteria	X 3 = /12
	Total		/20

Personal Wellness

In a science journal or notebook, 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 in this:

- 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 related to my own health, affect others around me (e.g. family, community)?

For more information on Focused Free Writing Activities refer to Chapter 13: Writing to Learn Science in the Senior Years Science Teachers Handbook (pg. 13.3).

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

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

Suggestion for Assessment: This type of Focused Free Writing task should be viewed as 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, etc... 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:

- Follows guidelines
- Relates material to own experiences or expresses opinion of content
- Responds critically and reflectively, showing growth in entries and increased understanding of content

Medical Chart Assignment

Provide students with the following information:

> You are a family doctor. You have to submit part of the medical chart of one of your patients. You must have the notes for 10 visits that you had with your patient. The visits don't need to be consecutive. Only one visit can be an annual check-up.
>
> Each visit must contain the date of the appointment, the reasons for it, the information received by the patient, your conclusion and/or recommendation. You must also contain your "doctor name", the name of the patient, and sex, date of birth of the patient, medical number and a short relevant family medical history.

Refer to **Appendix 5** for a sample Medical Chart Template.

Suggestion for Assessment:

Medical Chart Assignment

	3	**2**	**1-0**
Organization	The information in chart 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	The family history and	The family history and	The family history and

information	the visits are well-developed and contain required details	the visits contain most of the required details.	visits lack required details.
	8-7	**6-5-4-3**	**2-1-0**
Quality of information	The information is scientifically correct	The information contains some scientific errors	The information contains many scientific errors
	4	**3-2**	**1-0**
Presentation	Clear and appealing presentation of information, no spelling or grammatical errors	Clear presentation of information, a few spelling or grammatical errors	Unclear /confusing presentation of information ,numerous spelling or grammatical errors that detract from the message

Introduction to Homeostasis

S3B-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.
Include: thermoregulation (maintenance of body temperature), osmoregulation (water balance), waste management.

S3B-1-05 Explain the principle of negative feedback and identify how the body stabilizes systems against excessive change.
Include: role of receptors, effectors.

Entry-Level Knowledge

Students in grade 8 study body systems, what happens when systems aren't functioning properly, and the inter-relatedness of systems.

Suggestions for Instruction

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. For example: 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.

ACQUIRE / APPLY

Article Analysis

Have students read the article "*A degree of luck: How did a 13-month-old baby come back to life after being "frozen solid"*? **(Appendix 6)** As they are reading, students should record the key changes that happen due to lower body temperature and provide an indication as to whether these changes are potentially "positive" or "negative", or both. This can be done in simple note form, in a table, or using a concept-map structure.
Sample findings:
Positive: lower heart rate, lower oxygen requirements, reduced enzyme activities
Negative: blood clotting, kidneys work overtime, hallucinations

Extension
The University of Manitoba operates a Laboratory for Exercise and Environmental Medicine. Dr. Giesbrecht operates this lab, where he studies 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. Dr. Giesbrecht has undertaken a number of unique projects, such as a Lake Winnipeg Marathon on Ice, so students may be interested in finding out what Dr. Giesbrecht's most current project is. Contact information:

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Suggestions for Assessment
Have students answer the following questions (formative assessment):

1. What role did luck play in the survival of the 13-month old baby and 2 year-old?
2. Why wouldn't an adult with a body temperature lowered to 14-16C be likely to survive?
3. What are the practical applications of the knowledge of the effects of reduced core body temperature?

Word Splash

Have students use a Word Splash (Saphier and Hayley, 1993) to obtain information about homeostasis. Provide each group of students with the Homeostasis Word Splash BLM (**Appendix 7a).** 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 (2 or more) and writing on the line the connections. Or, students may choose to write statements that show the connections between words.

Following this activity, have students read Homeostasis- Background Information (**Appendix 7b)** 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 task is not required.

A summary of the categories used for each frame is provided below. For more details and blackline masters, refer to Senior Years Science Teachers' Handbook (pg. 11.23-11.24, 11.36-11-37).

Concept Frame

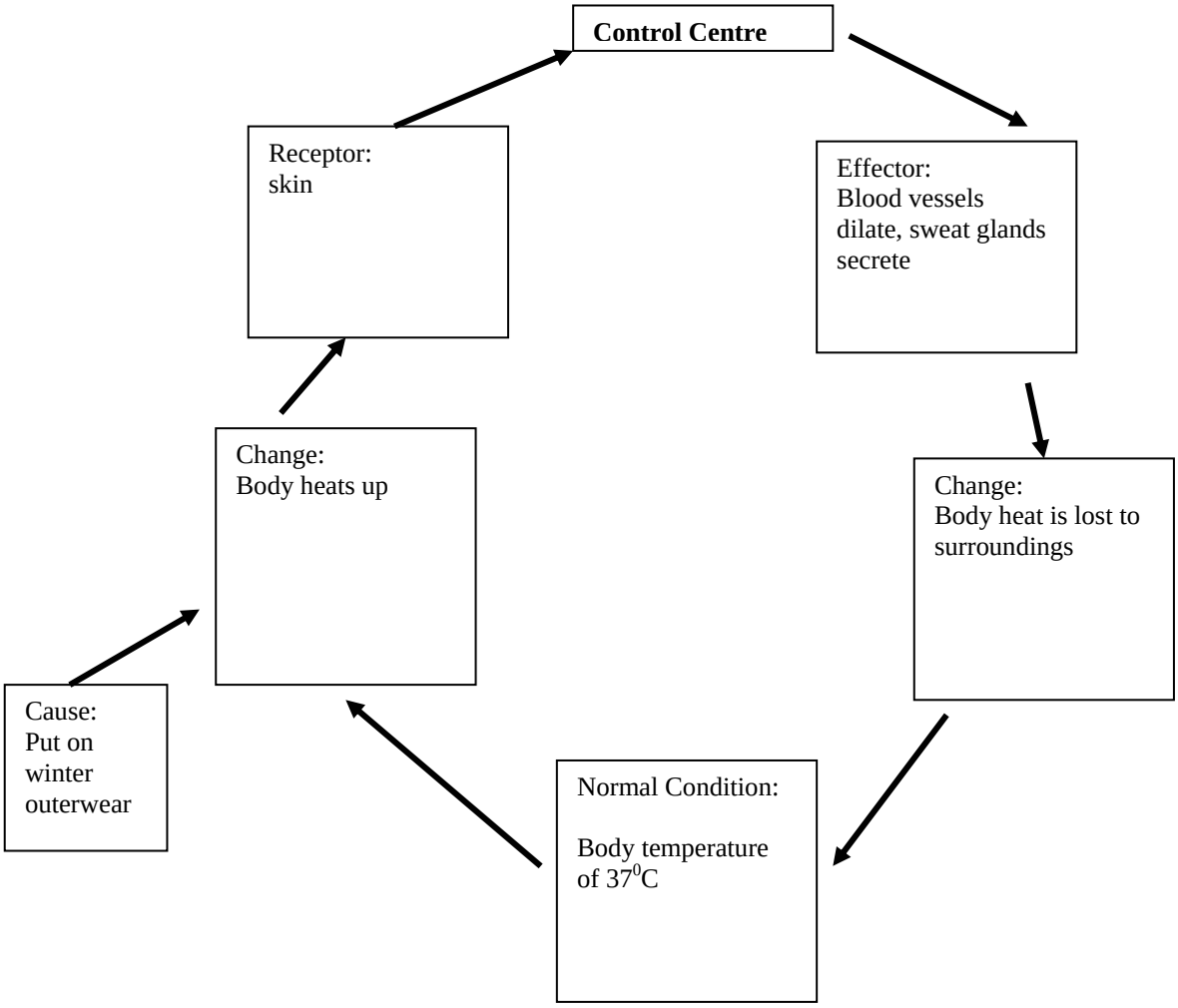
- Concept
- Characteristics
- Examples
- What is it like?
- What is it unlike?
- Definition
- Can you illustrate it?

Concept Overview

- Key word or concept
- Figurative representation
- Explanation or definition in your own words
- Facts
- Create your own questions about the concept
- Create an analogy

Negative Feedback

Have students re-read the "A Cold Walk" section of the Homeostasis- Background Information (**Appendix 7b**) and, in small groups, use the Negative Feedback Mechanisms BLM provided (**Appendix 8**) to describe what is happening to the body. Students will need to use a different BLM for each portion of the story. See the example on the following page:



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 that they encountered and what their final consensus was.

Case Study

Analysis of "The Swimming Race" (**Appendix 9**) Case study allows students to apply what they have been learning about homeostasis.

Suggestion 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 peer assessed 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 demonstrate their understanding of how the body strives to maintain homeostasis by providing their own example. This task could be given to the students one day, and then the response is written individually, on another date. This would allow for time for research and discussion, with the student ultimately being asked to respond to the question individually.

Cells and Homeostasis

S3B-1-06 Identify life processes that individual cells, as well as complex organisms, need to manage.
Include: obtain food, convert energy, eliminate wastes, reproduce, grow and repair, transport substances.

S3B-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.
Include: passive transport, active transport, endo/exocytosis.

S3B-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.
Examples: size of molecule, concentration gradient, temperature, polarity of molecules, surface area ...

S3B-0-S4 Select and use scientific equipment appropriately and safely.
Examples: microscopes, dissection equipment, prepared slides...

S3B-0-S6 Record, organize and display data and observations using an appropriate format.
Include: biological drawings.

Entry-level Knowledge:
Grade 8 exposed students 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 Senior 3 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 conduct investigations on the movement of nutrients and wastes across cell membranes, are introduced to the terms osmosis and diffusion, and explain the importance of transport, 8-1-07. In Senior 3 students are now 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 diffusion and active transport. A general understanding of the important role of proteins in movement of substances across a membrane is sufficient.

Suggestions for Instruction

ACTIVATE

Life Processes

Provide students with the following:

Complex organisms need to carry our 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 our by individual cells? Justify your answer.

This question can be answered by students working individually or in small groups.

What Happened to the Egg?

Place some eggs in vinegar and soak 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 the following day and explain any differences they observe.

Students should see the egg in the distilled water will be 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

Direct Instruction – Transport Mechanisms

Using overheads, labeled diagrams, 3D paper models, video and computer animations, illustrate passive transport, active transport and endo/exocytosis. Use a notetaking strategy such as 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.

Laboratory Activities

Teacher Note: Refer to **Appendix 10** for Teacher Background Information on assessing and evaluating student lab skills.

Have students investigate factors that influence the movement of substances across a membrane by completing one or more of the following activities:

- "Investigating the Movement of Starch, Iodine and Glucose" (**Appendix 10a – Student Handout and 10b-Teacher Background**) This lab addresses the effect of the size of molecule on movement across a membrane.
- "Cell Size and Diffusion" (**Appendix 11a – Student Handout and 11b – Teacher Background**) This lab addresses the effect of surface area on movement across a membrane.
- "Effects of Osmosis on Living Tissue" (**Appendix 12a – Student Handout and 12b – Teacher Background**) This lab addresses the effect of concentration gradient on movement across a membrane.
- "Effects of Concentration on Diffusion" (**Appendix 13a – Student Handout and 13b Teacher Background)** This is a student-designed lab where students choose to investigate either distance a substance travels or time it takes to travel a given distance.

Note: additional labs may be done to address other factors.

Suggestions for Assessment:
1) Refer to **Appendices 15a Lab Skills Checklist – General Skills and 15b Lab Skills Checklist – Thinking Skills.**

2) In order to have students apply their learning about osmosis and diffusion have them 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).

Analogy

Review the concept of an analogy and then have students explain the analogy "A cell is like a prison …" to describe how the cell membrane functions.

Introduction to Microscope Work (for Endocytosis Investigation)

The lab that follows involves use of the microscope and creating a biological drawing. Prior to carrying out this lab students may need to review proper techniques. Microscope diagrams can be found in most Biology Texts. A blackline master can also be found in *Grades 5 to 8 Science: A Foundation for Implementation*, BLM 8-A.

There are a variety of approaches commonly used for the creation of biological drawings. One approach can be found in **Appendix 16** – Biological Drawings.

Endocytosis Investigation

Ameoba proteas are larger protists. Students can observe these organisms digesting coloured starch granules through endocytosis.

Teacher Notes: Cultures of *Ameoba proteus* can be purchased from a biological supply company. Place the Ameoba 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 coloured food colouring to the petri dish. Leave the Ameoba in this solution for a few minutes before students place on a slide. Use a microscope to observe the Ameoba digesting the blue starch granules. At the end of the laboratory the solution can be safely disposed of down the sink.

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

Suggestions for Assessment*:* The focus for assessment of this learning experience can be in two skill areas as well as the understanding demonstrated by the student's ability to relate observations to the function of a cell membrane. The teacher should specify, in advance, what the focus will be. For tools to assess the skills involved, refer to **Appendix 17** - Rating Scale for Biological Drawings, **Appendix 18** - Microscope Skills Checklist.

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

1. Provide unlabelled diagrams of active transport diffusion, osmosis. Have students identify what each represents and explain what is happening.
2. Compare and contrast passive and active transport.
3. Draw a concept map to illustrate how materials move in and out of a cell.
4. 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.)

Energy

S3B-1-09 Explain the role of energy in maintaining equilibrium in the cell.
Include: role of ATP in metabolism.

Entry-level Knowledge: In Grade 7 students compared photosynthesis to cellular respiration. The cellular respiration equations used in this grade was:
sugar + oxygen ⟶ water + carbon dioxide + energy

Suggestions for Instruction

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

Direct Instruction- ATP and Energy

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.

Teacher Notes

The Wiley interactive site provides a series of animations and games students can use to learn difficult biochemical concepts.
http://www.wiley.com/legacy/college/boyer/0470003790/animations/animations.htm

Microtheme/Case Study

Provide students with the following:

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.

Suggestions for Assessment- Use microtheme assessment sheet(s) found in **Appendix 3.**

Creative Presentation

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 student develop a song (which could be performed) or a poem. Refer to **Appendix 19** for a sample song – "Those Magic Membranes".

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.

Appendix

Appendix 1: Wellness Portfolio Overview

Assignment	Type of Product	Biological Skills
a. wellness checkup	a. checklist	a. scientific inquiry
a. family tree b. birth and development record c. microtheme about personal illness/injury d. medical chart	a. flowchart or table and interview b. news release c. essay d. chart and report	a. research, attitudes b. research, attitudes c. research, attitudes d. research, decision making
a. examine a disorder b. microtheme about biological career	a. essay, poster, slide show, video b. job advertisement	a. research, attitudes
a. collect personal diet and exercise information, analyse b. microtheme proposing a diet c. microtheme on body mass index (BMI) d. let's make a meal and nutritional profile	a. chart and scrapbook, journal entries b. essay c. lab work and essay	a. research, scientific inquiry, decision-making b. research, attitudes, decision-making c. Research, attitudes, decision-making
a. record heart rate, pulse and/or blood pressure, analyse b. determine lung capacity, analyse c. microtheme proposing an physical activity plan d. perform a fitness test and design a fitness program	a. lab work with journal entry b. lab work with journal entry c. essay d. lab work with report	a. Scientific inquiry, decision making b. Scientific inquiry, research, decision making, attitudes c. Research, attitudes, decision making d. Scientific inquiry, research, decision making, attitudes
a. track water, salt and caffeine intake; compare to urinary output b.microtheme regarding dialysis and organ donation c. microtheme on conserving water	a. lab work b. essay c. Essay	a. scientific inquiry, decision-making b. decision-making, attitudes c. Research, decision making, attitudes
a. measure reaction rate b. vaccination record c. use of protective devices d. microtheme about safe environments e. microtheme on sleep patterns	a. lab work b. timeline and journal entry c. journal entry, collage d. journal entry, essay	
a. letter to myself outlining wellness life goals	a. letter	a.attitudes, decision-making

Appendix 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 checkmark when the statement applies to you.

General Information
_____ I am aware of diseases that run in my family
_____ I know what type of illnesses I have had
_____ I can explain the types of diagnostic test I have had
_____ I know what type of treatment I have had
_____ I know the story of my birth
_____ I spend time with people much younger or much older than myself
_____ I have supportive family and friends
_____ I like school
_____ I am involved in extra-curricular 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

Nutrition and digestion
_____ 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, etc.)
_____ I include high fiber foods in my diet (e.g. whole wheat breads, fruit with peels)
_____ I eat at least 5 servings of fruit and vegetables a day
_____ I have at least 3 serving of milk products per day (e.g. milk, cheese, yogourt, etc.)
_____ I have at least 5 servings of grain products per day (e.g. toast, cereal, pasta, etc.)
_____ I have at least 2 servings of meat and alternatives (meat, eggs, peanut butter, etc.)
_____ I know what a single serving size is for most food item
_____ I limit my junk food intake
_____ 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 20-30 nonstop minutes of moderately intense exercise 3 or more time a week
_____ If I am unable to do 30 minutes of activity, I am still active in 10 to 15 minutes sessions 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 drug

Excretion and waste management

_____ I know the signs of urinary tract infection
_____ I drink 6 to 8 glasses of non-caffeinated drinks a day (water, juice, milk, etc…)

Protection and control

_____ I stay current on necessary immunizations
_____ I do self-exams (breast and testicular)
_____ I wear seat belt in a car
_____ I only travel with sober driver
_____ I wear a helmet when riding (bicycle, motorcycle, snowmobile, etc…)
_____ I wear safety gear when participating in sports
_____ I practice abstinence
_____ I practice safe sex
_____ I wear sunscreen
_____ I follow directions for any medications that I take
_____ I go for regular physical examinations
_____ I go for eye tests
_____ I don't speed

Appendix 3a: Microthemes - Teacher Background

Microthemes are writing assignments designed to help students learn the material by looking at it in a different way (Martin, 1989). 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, ie. create an analogy, analyze data, write from a particular point of view, examine more than one point of view, etc.

Microthemes can be included in student Wellness Portfolios.

Assessment of microthemes is usually approached differently than traditional classroom activities. Microtheme tasks require higher level thinking. It is preferable to have students complete fewer microthemes but to rework them until they have met the standard set. This usually requires a minimum of 2 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 devalue other categories (such as 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, etc.) but still need to work with the material.

Appendix 3b: Microthemes – First Draft Checklist (BLM)

(For Teacher or Peer Editing)

Name_____ Microtheme_____

Edit (Please comment on each section)

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)

Task Completion

- ❑ Task completed effectively (e.g. explanation given, question answered, argument made, point of view represented, etc.)

- last paragraph should provide a concise summary of problem and solution, statement of recommendation, etc.

PROVIDE ADDITIONAL CRITERIA RELATED TO SPECIFIC MICROTHEME:

- ❑
- ❑
- ❑

Communication

- ❑ Communicate 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

Appendix 3c: Microthemes - Final Draft Assessment (BLM)

Name_____ Microtheme_____

Possible Points

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)

5 - met all criteria
3-4 - met most criteria
1-2 - met few criteria

SCORE: _____

Task Completion

- ❑ Task completed effectively (e.g. explanation given, question answered, argument made, point of view represented, etc.)

- last paragraph should provide a concise summary of problem and solution, statement of recommendation, etc.

PROVIDE ADDITIONAL CRITERIA RELATED TO SPECIFIC MICROTHEME:

- ❑
- ❑
- ❑

5 - met all criteria
3-4 - met most criteria
1-3 - met few criteria

SCORE: _____

Communication

- ❑ Communicate 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

5 - met all criteria
3-4 - met most criteria
1-4 - met few criteria

SCORE: _____

OVERALL SCORE: _____

Appendix 4: Medical Chart

TO BE ADDED

Appendix 5: Family History (BLM)

When you visit a doctor s/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 for?
- ✓ 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 these 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 they 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 notes added in. 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 family tree. There is no prize for having the family with the most disorders!

Appendix 6: A Degree of Luck (BLM)

SECTION: Guardian Features Pages, Pg. 15

LENGTH: 731 words

HEADLINE: Health: **A degree of luck: How did a 13-month-old baby come back to life after being 'frozen solid'?** Tim Radford investigates

BYLINE: Tim Radford

BODY:

Don't try this at home, folks: the Lazarus effect is a capricious one. The 13-month-old Canadian baby who came back to life this week, after apparently freezing to death, was lucky. Erika Nordby, who somehow toddled out of the backdoor of a house in the middle of the night in sub-zero conditions - in only a nappy - was "frozen solid" when her mother Leyla found her a few hours later. But Erika had "died" at the right temperature (the air temperature was minus 24C; her body temperature had gone down to 16C). And she was a baby.

The membranes of the cells of a baby's tissue are just that much more flexible, according to Nancy Rothwell, a physiologist at the University of Manchester, and are more likely to survive the formation of ice fragments within them. "But the big thing is being exactly the right temperature, and that was absolutely luck," she says.

Freezing is very, very dangerous: lower the temperature and the blood starts to clot, which can lead to kidney damage (babies once again are much more likely recover). But some other things go your way. Oxygen requirements fall dramatically off as body temperature falls. So lower the temperature in a controlled way - they do it on the operating table every day - and there can be virtually no circulation, and virtually no heartbeat for a period, yet the brain will survive.

People with severe head injuries who have fallen into snow and frozen a bit have survived when others at room temperature have died. This has been so noticeable that doctors have tried chilling head injury victims to enhance their survival. Once again, when it works, it tends to work for the young; the older ones get kidney and cardiovascular problems. But the ones who survive this are more likely to recover from brain injury. At a lower temperature, the oxygen requirement falls 10-fold.

First the fingers and toes go numb, and then the limbs, because the body reacts to keep the vital organs warm: this is the core temperature at the heart of human survival. Oxygen consumption falls, blood thickens, fluids retreat to the centre, the kidneys work overtime: people who are cold become conscious of a need to urinate.

At 31C (well below normal body temperature) hallucinations begin. Nazi doctors experimenting with cold water baths at Dachau established death at a core temperature of about 25C. But there have been dramatic tales of children

surviving at far lower temperatures. In 1994, a two-year-old girl in Saskatchewan was found with her limbs frozen solid, her core temperature at 14C. She lived.

The same principle keeps hibernating polar bears alive through the long Arctic night. "They lower their body temperature, the heart rate goes down to say, two a minute, and they manage to survive because they have such low requirements," says Prof Rothwell. The mammalian machinery that keeps bears going as a matter of evolutionary course could also occasionally work its magic for humans caught in the snow.

"Most enzyme activities in the body double with every 10C change. So if you drop by 10C you have halved all chemical reaction, and if you drop 10C more you halve again. Probably if they were around 5C or 8C core, they could survive. There is a lot of luck involved, being at the right temperature, after cooling at the right rate, and then rewarming at the right rate - and the risk was in the rewarming. But it can happen, and it has happened. They were clinically dead, of course, by the criteria we used, but not obviously really dead because they could function again."

In her 1998 televised Royal Institution lectures, Prof Rothwell lowered a PhD student into freezing water to make a point about physiology. She also pointed to Canadian frogs that did, literally, freeze.

"They were frozen solid in the ice, and then they gradually thawed and just woke up. A key thing with the ability to cool - animals or people - is the fluidity of their membranes, so that you don't get fracture. It seems likely that animals that survive very low temperatures - ice fish and so on - have very high levels of polyunsaturated fats in their membrane. They also have antifreeze type things in their blood."

And, she points out, the refrigerator and the ice bucket are now routinely called in to keep life going. "Hearts for transplant are transported in ice, and other organs," she says.

Appendix 7a: Word Splash – Homeostasis (BLM)

Internal balance

Death

Fluctuation

Normal range

Body systems

Body temperature

Interaction

Blood pressure

Negative feedback

Body systems

Blood pH

Thermoregulation

Waste management

Osmoregulation

Changes in environment

Glucose concentrations

Appendix 7b: Homeostasis- Background Information (BLM)

Introduction

At any given time our body is working to maintain its 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 outer wear 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 degrees Celsius. 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 a body temperature of about 37 degrees Celsius, 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 100mg/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.

In order 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 an important mechanism 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, and coordinating centre and an effector. The sensor is responsible for detecting variation in the set point and will send messages to the coordinating centre that will then send a message to a specific effector to rectify any variation from a set point.

Temperature set to 20^0 C (NORMAL CONDITION)
Internal house temperature drops to 17^0 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 20^0 C (NORMAL CONDITION)

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

Homeostatic Systems

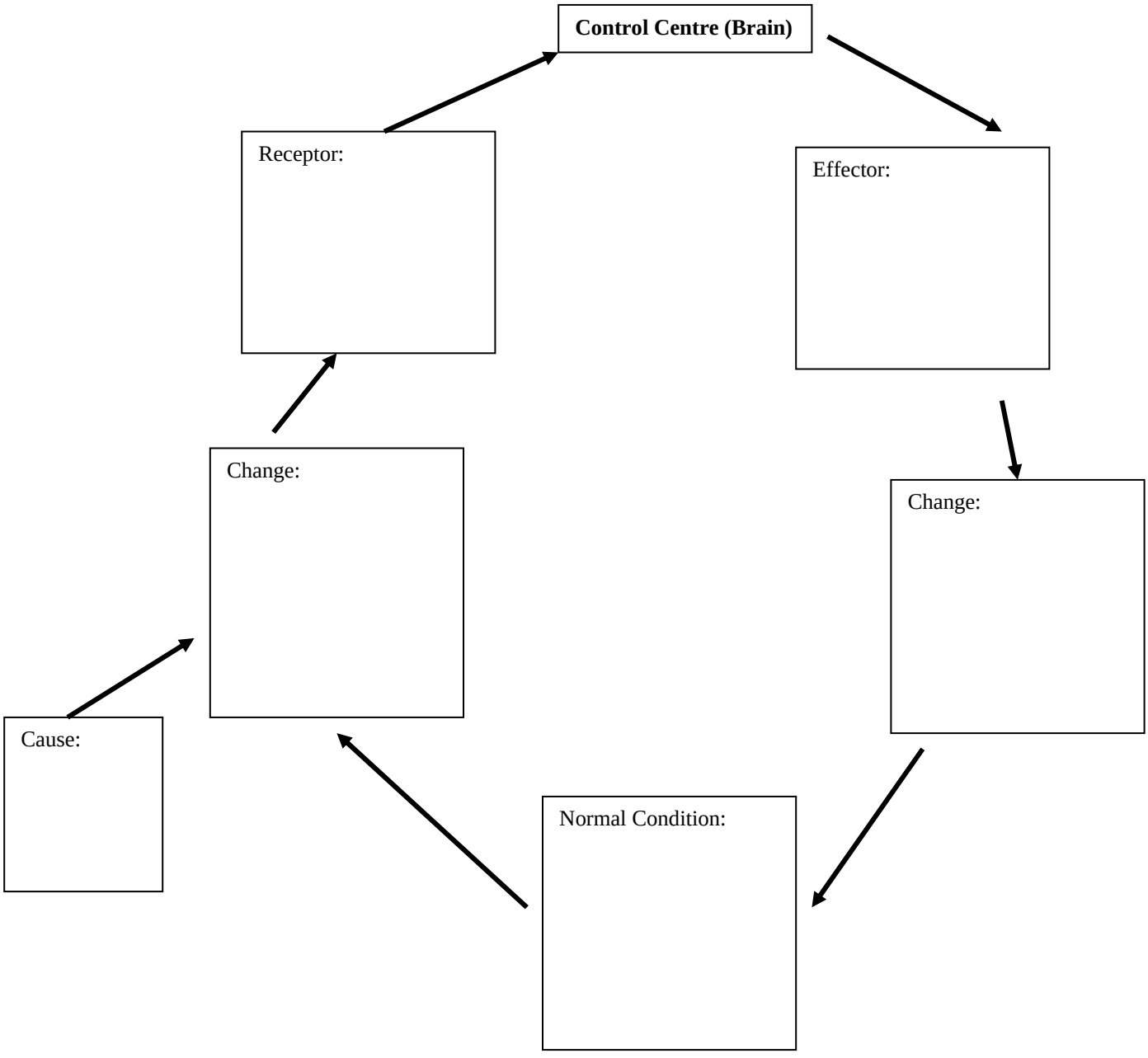
Three important homeostatic systems in the human body that depend upon negative feedback mechanisms to maintain equilibrium are: thermoregulation (the maintenance of body temperature), osmoregulation (water balance) and waste management.

Thermoregulation is the ability to maintain a constant body temperature. The constant body temperature for humans is 37 degrees Celsius, 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 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) then 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 most important organ involved in the elimination of ammonia. Various organs, such as the kidneys, lungs, skin and stomach, as well as the liver, are involved in the elimination of various other waste products.

Appendix 8: Negative Feedback Mechanisms (BLM)



Appendix 9: The Swimming Race (BLM)

65 kg Debra was sitting quietly along the side of the pool. She was anticipating the swimming race that she would be competing in shortly. Four-hundred 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, but 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.

That was an hour ago. Now, she was standing on the lane four starting block ready to go. She could see two swimmers to her left and three to her right. The swimmers all looked bigger than her, 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 of her strength into each stroke.

Thirty seconds later, she had traveled just over 50 meters. Debra was completely focussed shutting out the external extractions and concentrating on keeping the power up. She was giving each stroke about 80% of her maximum power. Her heart rate was 201. Her respiratory rate was also up slightly. He 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 6 strokes, fast and forced. Her body temperature was 38° C.

With 100 meters to go to the finish line, Debra had been swimming for just over 3 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 3 strokes. Her heart rate was 195 beats per minute and her body temperature was 38.5° C.

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 two, 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 kgs. 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

Working in your assigned study groups, each group will describe what is going on in Debra's body and why at each of the 7 moments described: on the starting block, 30 seconds after the start, 60 seconds after the start, 3 minutes into the race, at the finish, and after the cool down. 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 urinary system.

One suggestion would be for each student to take a body system or two 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 7 moments and describe the stresses encountered and the responses made.

Be sure that the answers to these questions are included in your report, but your report should not consist only of the answers to these questions.

STUDY QUESTIONS

At the start

1. What is responsible for raising Debra's heart and respiratory rate and stimulating sweating before the race at the starting block?

30 Seconds In

1. Swimming hard is putting new demands on Debra's body. What are these new demands and how does the body respond to them?

One minute

At the finish

1. Debra has stopped swimming and her muscles are now at rest. Why are her heart and breathing rates still so high?

After the Cool Down

1. What changes have occurred in the last 10 minutes to allow Debra's heart and respiratory rates to come down?

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.

Modified from: The 2000-Meter Row: A Case in Homeostasis by **Nathan Strong**
Chemistry/Biological Sciences Department, New Hampshire Technical Institute
http://www.sciencecases.org/crew/crew.asp

Appendix 10: Student Lab Skills – Teacher Background

Student lab skills consists of two parts: their actions in the lab and the report that they produce. All to 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 that 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.

Prelab

Traditionally, teachers outline purpose, procedure, methods of data collection, and safety considerations during the prelab 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, like 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 that 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.

Postlab

You would conduct your traditional postlab 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 completely change their approach to solving the initial problem and retest. Consider the possibility of having your students do one less new lab during the course and redoing a lab that

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 postlab.

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

INTRODUCTION	▪ Purpose or question ▪ *Hypothesis or prediction *May be supported by a rationale (what does the think will be found and why)
METHODOLODY	▪ Materials ▪ Methods/procedure 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: ▪ Data tables ▪ Graphs and calculations
ANALYSIS	This section should include any of the following items that are appropriate to the lab: ▪ Interpretation/discussion of results ▪ Was hypothesis supported ▪ Implications of results ▪ Link results to prior knowledge ▪ Answers to questions ▪ Error analysis/sources of error ▪ Summary

Appendix 11a: 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

1. Cut a piece of dialysis tubing of approximately 20 cm in length. Tie one end and fill with a mixture of water and molasses. Tie the other end of the tubing and place it in a beaker of water.

2. Cut another piece of dialysis tubing but this time, pour water in the tubing. Tie the other end of the tubing and place it in a beaker containing a mixture of water and molasses.

3. Place a dilute iodine solution in a piece of dialysis tubing. Tie the other end of the tube and place it in a beaker containing a starch and water mixture.

4. Pour a dilute iodine solution into a beaker and a starch and water mixture into a piece of dialysis tubing. Place the tubing in the beaker containing the iodine solution.

5. Pour water into a beaker and a glucose solution into a piece of dialysis tubing. Place a glucose test strip in the beaker at the end of the class 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	Molasses and water in tubing, water in beaker	Water in tubing, molasses and water in beaker	Iodine solution in tubing, starch and water in beaker	Starch and water in tubing, iodine solution in beaker	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 don't. Explain why 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

Appendix 11b: 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 able to cross a cell membrane and which substances can't. 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

**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 form a biological supply company. Sandwich bags can be used instead of the tubing.

Results

1. The amount of liquid in the tubing gradually increases. The mixture in the tubing becomes paler.

2. The amount of liquid in the dialysis tubing gradually decreases. The mixture in the tubing becomes darker.

3. The mixture in the beaker turns black and the solution in the dialysis tubing gradually becomes paler.

4. The mixture in the dialysis tubing turns black and the solution in the beaker gradually becomes paler.

5. The glucose test strips change colour to indicate the presence of glucose. The glucose concentration should slowly increase.

Analysis

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.

2. The water and molasses mixture is hypertonic. Water molecules will migrate from an area of higher concentration (dialysis tubing) to and area of lower concentration (molasses and water mixture in the beaker).

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).

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).

5. The glucose test strips should 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).

Appendix 12a: Cell Size and Diffusion –

Student Handout (BLM)

Introduction

When cells grow to a certain size, their rate of growth slows down until they stop growing entirely. They have reached their size limit when one of these larger cells divides into two smaller cells, the rate of growth again increases.
Materials needed for cell activity and growth must in some way gain entrance into the cell and waste products must leave.
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.

Methods

Materials

27 sugar cubes
Metric ruler
Calculator

1. Create a table that shows the relationship between the surface area the volume and the surface area:volume ratio for sugar cubes of four different dimensions: 3 cm/side, 2 cm/side, 1 cm/side and 0.1 cm/side.

The following two equations may help you.
SURFACE AREA OF A CUBE= L x W x # of sides
VOLUME OF A CUBE= LxWxH

Express all ratios in their simplest form i.e.3:1 and not as 9:3.

2. Obtain 27 sugar cubes and assume that their dimensions are 1.0 cm per side. Arrange the cubes as specified below and for each arrangement calculate the volume and the total surface area. Create a table to record the values.

Arrangement	Description
A	a cube-3 cubes/side
B	a rectangle-3 cubes x 9 cubes
C	a rectangle-2 cubes x 13.5 cubes
D	a rectangle-1 cube x 27 cubes

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

3. Using 8 sugar cubes build a cell that is 2 cubes/side. Calculate for this cell its volume, surface area and the A:V ratio. Create a table to record this information and save space for additional cells of various dimensions.

Divide this cell in half; this will simulate cell division. Calculate the volume, surface area and A:V ratio for this 'BABY CELL'. Record these values into a table.

CELL TYPE	VOLUME cm^3	SURFACE AREA cm^2	A:V RATIO
ORIGINAL	_____	_____	_____
"BABY"	_____	_____	_____

Analysis

1. What happens to the A:V ratio when a cell undergoes division?

2. From the point of view of diffusion, is there a advantage for dividing cells?

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

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

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

Appendix 12b: Cell Size and Diffusion – Teacher

Introduction

When cells grow to a certain size, their rate of growth slows sown until they stop growing entirely. They have reached their size limit when one of these larger cells divides into two smaller cells, the rate of growth again increases.
Materials needed for cell activity and growth must in some way gain entrance into the cell and waste products must leave.
Two questions will be explored in this dry lab situation:

2. 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.

Methods

Materials

27 sugar cubes
Metric ruler
Calculator

1.Complete table #1 relying on these formulae:

SURFACE AREA OF A CUBE= L x W x # of sides
VOLUME OF A CUBE= LxWxH

Express all ratios in their simplest form i.e.3:1 and not as 9:3.

TABLE 1

Cube Dimensions	Total Surface Area (cm^2)	Volume (cm^3)	Ratio SA:V
3 cm/side	54	27	2:1
2 cm/side	24	4	6:1
1 cm /side	6	1	6:1
0.1 cm/side	0.06	0.001	60:1

2. Obtain 27 sugar cubes and assume that their dimensions are 1.0 cm per side. Arrange the cubes as specified below and for each arrangement calculate the volume and the total surface area .Record the values in the table.

Arrangement Description
- A a cube-3 cubes/side
- B a rectangle-3 cubes x 9 cubes
- C a rectangle-2 cubes x 13.5 cubes
- D a rectangle-1 cube x 27 cubes

Arrangement	Volume cm^3	Surface area cm^2	A:V ratio
A	27	54	2:1
B	27	84	3.1:1
C	27	85	3.2:1
D	27	110	4.1:1

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

Surface Area increases

3. Using 8 sugar cubes build a cell that is 2 cubes/side.Calculate for this cell its volume, surface area and the A:V ratio.

Divide this cell in half; this will simulate cell division as it happens in the real world.Calculate the volume,surface area and A:V ratio for this BABY CELL.

CELL TYPE	VOLUME cm^3	SURFACE AREA cm^2	A:V RATIO
ORIGINAL	*8*	*24*	*3:1*
"BABY"	*4*	*16*	*4:1*

Analysis

1. What happens to the A:V ratio when a cell undergoes division?

Increases

2. From the point of view of diffusion, is there a advantage for dividing cells?

Improves movement of molecules in and out of the cell

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

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

More difficult to exchange waste products and required molecules.

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

Smallest cells have more S.A. therefore they will be able to diffuse materials more efficiently.

Appendix 13a : Effects of Osmosis on Living Tissue-

Student Handout (BLM)

Purpose

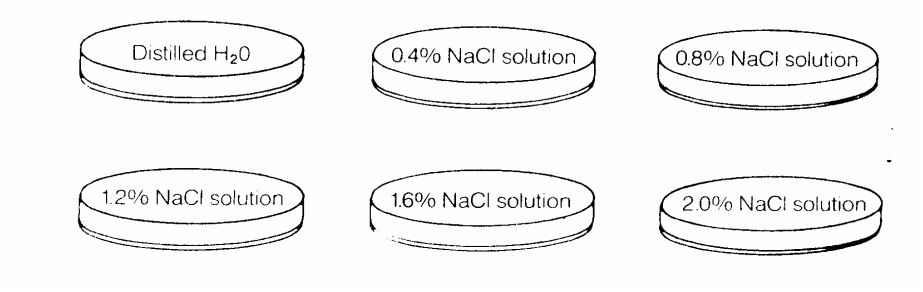
To measure the effect of osmosis on celery tissue and use this data to estimate the concentration of dissolved substances in the cytoplasm of a cell.

Methods

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

Materials

3 Petri dishes	Distilled H_2O	scalpel	razor blade
Marking pencil	Ruler	Fresh celery stalks	
0.4% NaCl solution			
0.8% NaCl solution	1.2% NaCl solution	1.6% NaCl solution	2.0% NaCl solution



1. Obtain 3 Petri dishes. Label the bases and tops 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.

Which solution has the highest percentage of water? The lowest? Explain.

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 6 strips about 3mm thick.

5. Select six strips of 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- 3mm 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 70mm 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 undisturbed for a minimum of 25 min.

10. After 25 min. 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

Create a data table in your notebook. Complete the data table below by entering the test solution (include the distilled water) and the initial length (l_i) of the celery strips under the appropriate heading.

% Concentration of Salt	Initial Length mm l_i	Final Length mm l_f	Change in Length mm Δl	Rigidity of Strip

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.

Graph your own results by plotting the change in length against the concentration of the solution. Also plot the class averages on the same graph. It will be necessary to draw a "**zero**" line half-way up the paper in order to plot points indicating an increase (+) or decrease (-) in length.
Identify the manipulated (independent) variable and the responding (dependent) variable in the title of the graph.

Draw a straight line through the points.
Record the points (concentration) at which each line intersects the zero axis.
What information is provided by the points along the zero axis?

Analysis

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

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

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

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

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

Appendix 13b: 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.

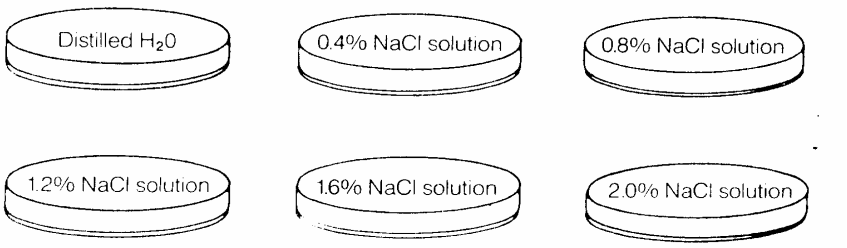
Pre-lab Suggestions

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

Procedure

Note: Have students work as a team. One member should do steps 1 and 2 while the other is doing steps 3 to 6.

3 Petri dishes Distilled H_2O scalpel razor blade
Marking pencil Ruler Fresh celery stalks
0.4% NaCl solution
0.8% NaCl solution 1.2% NaCl solution 1.6% NaCl solution 2.0% NaCl solution



1. Obtain 3 Petri dishes. Label the bases and tops 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.

Which solution has the highest percentage of water? The lowest? Explain.

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 6 strips about 3mm thick.

5. Select six strips of 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- 3mm 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 70mm 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 undisturbed for a minimum of 25 min.

10. After 25 min. 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

Complete the data table below by entering the test solution (include the distilled water) and the initial length (l_i) of the celery strips under the appropriate heading.

% Concentration of Salt	Initial Length mm l_i	Final Length mm l_f	Change in Length mm Δl	Rigidity of Strip

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.

Along with each of the other lab groups, record your Δl data on the group data sheet at the front. Record the group data, then calculate the average Δl value for each concentration.

Graph your own results by plotting the change in length against the concentration of the solution .Also plot the class averages on the same graph. It will be necessary to draw a "**zero**" line half-way up the paper in order to plot points indicating an increase (+) or decrease (-) in length.

Analysis

Which is the manipulated (independent) variable?

Concentration of NaCl

Which is the responding (dependent) variable?

Change in length

Draw a straight line through the points.

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

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

No change in the cell length.

Analysis

1. 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 shrunk.

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

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

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

Isotonic

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

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

5. 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 14a: Concentration and Diffusion –

Student Handout (BLM)

Introduction:

This laboratory 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.

Materials:

▪ 2 firm potatoes ▪ metric ruler (30 cm) ▪ 1%, 5% and 10% solutions of potassium permanganate (in beakers) ▪ paper towels ▪ waste container	▪ stopwatch/clock ▪ 3 small beakers (approx. 150 ml) ▪ forceps ▪ scalpel ▪ experiment Display Sheet ▪ graph paper

a) 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.

b) Tests: What will you do to help answer your questions? 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 would follow. Perform the experiment by following the steps outlined in your procedure.

c) 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.

d) 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?)

e) Reflection: Compare your results and interpretation of results with 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 14b: Concentration and Diffusion –

Teacher Background

This laboratory investigation presents a more student-centered approach. Students will be provided a list of materials but 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 laboratory 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 claim). 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.

As part of recording and interpreting data students should be encouraged to construct graphs (if they are not doing so already). 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. 1999. Inquiry investigation: A new approach to laboratory reports. *The Science Teacher* 66(4): 27-29.

Keys, C.W., B. Hand, V. Prain, and S. Collins. 1999. Using the science heuristic as a tool for learning from laboratory investigations in secondary science. *Journal of Research in Science Teaching* 36(10): 1065-1084.

Appendix 15a: Lab Skills Checklist-General Skills

Course: _____ Name: _____
Evaluation Dates: _____

	General Skills	Expectations	Not meeting expectations yet	Meeting expectations
A	- is prepared to conduct the lab	- read lab outline ahead, made tables, asks questions that clarify the task instead of asking "What do I do next?"		
B	- sets up 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)		
C	- follows safety procedures	- demonstrates general safety procedures as well as specifics outlined in prelab		
D	- 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)		
E	- 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		
F	- manages time efficiently	- divides and orders tasks to meet deadlines		
G	- cleans up adequately	- leaves table and sink clean, puts away all equipment, washes table top, washes hands		

Appendix 15b: Lab Skills Checklist – Thinking Skills

			Understanding of Lab		
	Thinking Skill	**Questions**	**Limited**	**General**	**Specific**
H	Knowledge/ Comprehension	- What is the purpose of doing this lab? - How does this relate to what you a 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?			
I	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?			
J	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 16 – Biological Drawing (BLM)

Making a Biological Drawing

What to Use:
- A sharp pencil
- A clean sheet of unlined paper

What to Draw:
- Draw only what you see
- Draw only what is necessary

How to Draw:
- Center your diagram
- Draw a large enough diagram to clearly show details (approx. ½ page in size)
- Make your proportions accurate

Showing Depth:
- Do not shade
- Show depth with stippling

Label your drawing:
- Your title should include name of slide, total magnification and date observed, the field diameter and size of object
- Label information should be printed, written horizontally, and be placed to the right of the drawing.
- Use a ruler to draw labelling lines and do not cross the lines

Appendix 17: Rating Scale for Biological Drawings (BLM)

	Possible Points	Self-Assessment	Teacher Assessment
Tools/Material: a. sharp pencil b. clean sheet of paper			
Content: a. only what was observed b. only what is necessary			
Approach: a. diagram centered b. diagram large enough to clearly show details c. proportions are accurate			
Showing Depth: a. did not shade b. used stippling to show depth			
Labelling: a. title includes name of slide, total magnification and date observed, the field diameter and size of object b. specifics on diagram labelled c. labelling lines are drawn with a ruler and do not cross			
Totals:			

Comments:

Appendix 18: Microscope Skills Checklist

Course: _____

Name: _____ Evaluation Dates: _____

Teacher Notes: Use one page per student and use throughout the entire course. Either a checkmark 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 paper and pencil 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 assessment should be used whenever possible.

Skills	Not meeting expectations yet	Meeting expectations
A) General Microscope Skills ▪ Handle and care for microscope properly ▪ Select proper magnification to see the object ie. Cell or tissue ▪ Use only fine focus on medium and high power ▪ Watch from the side when bringing object and lens together ▪ Use diaphram and/or mirror to adjust light properly		
B) Use proper technique to focus object under various magnifications (ie. Parfocal) a. start on low power with coarse adjustment b. center object c. adjust fine focus d. move up to medium or high power using only fine focus		
C) Preparing a Wet Mount Slide a. place specimen and drop of water on slide b. lower cover slip at a 45 degree angle c.		
D) Staining a Wet Mount Slide a. prepare the wet mount slide b. place a drop of stain on one side of the cover slip c. draw through with a paper towel		
E) Use Oil Immersion Technique (optional) a. properly focus slide on high power b. swing lens to the side c. put drop of oil on slide position oil immersion lens and focus		
Technical Skills ▪ Determine Total Magnification ▪ Determine Object Size		

Comments:

Appendix 19: 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 cotransport 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

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!