

Manitoba

Education, Citizenship and Youth

SENIOR 3 BIOLOGY 30S

A Foundation for Implementation

Unit 6 – Wellness and Homeostatic
Changes

DRAFT / Unedited Version

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Unit 6 – Wellness and Homeostatic Changes

Body System Interrelationships

S3B-6-01 Analyze examples of how different body systems work together to maintain homeostasis under various conditions.

Examples: cold weather, organ transplant

Background Information

Throughout this course students have been studying homeostasis via 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.

Suggestions for Instruction

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

Part 1 - Blood Sugar Fluctuations

Sugar balance is an important factor in human survival. Diabetes is a disease in which blood sugar levels must be artificially controlled and maintaining constant blood sugar levels plays a large part in preventing complications. Have students test their knowledge of diabetes by completing the Diabetes Quiz (**Appendix 1**)

Part 2 - Being Your Own Homeostatic Monitor

Using print and/or electronic material have students describe all the human body systems that help maintain a constant blood sugar level and then explain how a person with diabetes must become their own homeostatic monitor for blood sugar by paying attention to indicators and monitoring their blood sugar levels. Examine the implications if a constant blood sugar level is not maintained.

Teacher Resources

The Canadian Diabetes Association website contains extensive information on diabetes, including complications associated with diabetes and information about living with diabetes as a First Nations person.

http://www.diabetes.ca/Section_Main/welcome.asp

Cumulative Suggestion for Assessment

Provide an opportunity for students to apply what they have learned about homeostasis and the human body systems as a cumulative assessment. This should be done by providing a particular context for students to analyze. One way would be to have students revisit a case study they analyzed in an introductory fashion as part of Unit 1. It can be found in Appendix 9 of that Unit – “The Swimming Race”. Have students revisit their responses and add more details. Students should have access to all of their notes for this activity. Develop guidelines for this activity as well as a rubric for assessment with the students.

Other suggested contexts for this type of assessment would be a case study related to hypothermia or to organ transplant.

Aging

S3B-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.

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...

Teacher Note

With aging comes a breakdown of the body's homeostatic mechanisms. A study of aging will allow students to apply the knowledge gained throughout the course to another aspect of human life – the aging process.

Suggestions for Instruction

ACTIVATE

Senior Citizens

Have students generate a list of things they have noticed about older relatives or seniors that they are in contact with related to general health, day-to-day complaints, etc.

Possible items include older people are often cold, have difficulty sleeping, are not able to eat the same kinds of food they used to.

ACQUIRE/APPLY

Models of Aging

Using print or electronic resources, have 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 aveioli Fewer oil and sweat glands | Decreased kidney function Urinary incontinence may occur | Decreased oxygen circulated to muscles, elimination of waste less efficient Decreased ability to uptake nutrients Fewer digestive enzymes produced in the intestines |

Suggestions for Assessment: As an Exit Slip, have students provide one sample of a change that happens in each of the three main homeostatic processes as you age.

Article Analysis – Living to 150 years old

Part 1

The article “Staying Alive” presents a debate around the question of the limits of the human lifespan (See **Appendix 2**). Introduce the article by presenting the following question and having students respond, including providing an explanation for their response:

Question: 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". Students are separated into groups referred to as the "home" group. Each group member selects (or is assigned) section 1, 2, 3 or 4 of the article. Students then move into the "expert" groups, based on the section they will be reading. I.e. all of the "1"s get together to look at section 1, etc. The expert groups will be required to analyze their assigned section and then take the information back to their home group. The analysis will summarize evidence for or against the argument that someone born today could live to 150. Each group also has to create a heading for their section of the article. A template is provided in the **Appendix 3**. When the sharing is taking place back in the home groups, group members should be encouraged to take notes on the analysis provided by each team member.

Suggestion for Assessment: Following the sharing of all experts and group discussion, have students revisit the question of "Could someone alive today survive to the age of 150?". Students can write an individual response that gives their opinion and justify their opinion using facts from the article. This could be written as a persuasive piece intended to convince someone of their position. Regardless of what format the response takes, the responses could be assessed using criteria such as:

- Opinion is clearly stated
- Opinion is supported by extensive detail from the article
- Argument is logical and convincing

Aging Relative-Microtheme

Have students respond to the following case study:

Grandma moved from her house into a retirement home six months ago. 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 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 as a dialogue instead of an essay

Suggestion for Assessment: Refer to **Appendix 3b and 3c** in **Unit 1** for Microtheme assessment tools.

Cumulative Assessment:

Have students write a response piece to the following:

Would you want to live to 150 years old? Justify your answer using your own knowledge and what you have learned in biology.

Death

S3B-6-03 Recognize the difficulties faced in defining “death” and identify some of the different definitions in use today.

Examples: medical definition, legal definition, religious viewpoint...

S3B-6-04 Identify and analyze social issues related to the process of dying.

Examples: euthanasia, advanced directive, choice of treatments, organ donation, availability of palliative care...

Teacher Background

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 activities in this section students will come to appreciate this complexity. They will begin to see death as a process, rather than a distinct point in time. This discussion will be controversial and raise many ethical issues. It may also be very emotional for some students so 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.

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.

Manitoba Transplant Program. 2002. Organ and Tissue Donation – A Fact of Life. Supplemental Curriculum Document, Senior 3 Biology. Winnipeg: Manitoba Transplant Program.

Suggestions for Instruction

ACTIVATE

Criteria for Death

Have the students respond to the following statement:

Describe what you think the criteria are to determine when a person is dead.

Substituted Sammy – Case Study

Introduce a case study related to an issue associated with the process of dying (Case study SYSTH, pg. 4.14). A sample case study “Substituted Sammy: An Exercise in Defining Life” is provided in the Appendix (**see Appendix 4**).

Questions have been provided at several different points in the case study. Students must decide at what point "Sammy" died.

ACQUIRE/APPLY

Ask the Doctor

Invite a medical professional to speak on physiology of dying, palliative care, medical definition of death, advanced directives, life supports.

The Meaning of Death - Case Study

This case study (see **Appendix 5**) illustrates the complexity of defining the point at which death occurs and some of the implications identifying the time of death can have. It also introduces the concept of organ transplant and some of the associated issues.

Have students read the Case Study. Possible questions for discussion have been included on a separate page in the appendix and teachers need to determine which questions they feel are appropriate for their students.

As a formal assignment, have students will put themselves in the position of the judge in this case and make a decision as to John's exact time of death, supporting their decision with facts from the case study or supplementary information related to the legal definition of time of death. This can be done in a number of ways, either individually or in groups, and the decision can be shared in a written or oral form.

Suggestion for Assessment: Criteria for assessment of the Judge's decision should be developed with students. Regardless of whether this decision is shared in written or oral form, particular criteria related to the validity of the decision should be met. For example:

- Decision is clearly stated
- Decision is supported with details from the case study
- Decision is supported by definitions of death studied earlier, and/or from research carried out

Technology and Wellness

S3B-6-05 Describe how technology has allowed us to control our wellness and the ethical dilemmas that the use of technology can create.

Examples: reproductive technologies, surgery, anesthetic, pharmaceuticals...

Suggestions for Instruction

ACTIVATE

Using Technology

Have students respond to the following:

In what way have you used technology to prolong your life so far? Create a class list of all the ways the people in the classroom have prolonged their lives.

ACQUIRE/APPLY

Technology News

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)
- 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 that could be placed in the newspaper.

Suggestions for Assessment: Some possible criteria to use for this performance-based task could be:

- The main idea is clearly stated.
- Supporting details and information appropriate 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.

Appendix

**Appendix 1a: Type 2 Diabetes Quick Test – Know Your ABCs
–Student BLM**

Question 1 What are the causes of type 2 diabetes?

- A. Family History
- B. The body has trouble using the insulin it produces.
- C. I come from an ethnic background that makes me at higher at risk for diabetes
- D. All of the Above

Question 2 A1C is a blood test that measures

- A. How much glucose (sugar) is in my bloodstream at the time of the test.
- B. An average of how much glucose has been in my bloodstream over the past three months.
- C. My cholesterol levels

Question 3 If I manage my type 2 diabetes with pills, physical activity and a healthy diet, I only need to test my blood glucose levels:

- A. When I don't feel well
- B. At least once a week
- C. At least once a day

Question 4 My optimal blood pressure target should be

- A. 140/80
- B. 130/80
- C. 140/90

Question 5 I can take care of my cholesterol by watching what I eat. True or False?

- A. True
- B. False

Question 6 If I have type 2 diabetes, my doctor may recommend I begin taking insulin injections:

- A. If my eating habits, physical activity and current diabetes medications don't keep my blood glucose levels in check.
- B. If I start having too many sugar "lows"
- C. Because I have Type 2 diabetes, I do not need insulin shots.

Question 7 My blood glucose levels are too high. Why does my doctor tell me I need to take more pills to manage my diabetes?

- A. Diabetes is a progressive disease and , as time goes on, I may need one or more medications or even insulin.
- B. My doctor says I need to improve my eating habits and become more physically active.
- C. Diabetes won't wait. The doctor wants to get the blood glucose levels down as soon as possible to avoid diabetes complications.
- D. All of the above.

Question 8 How do I know whether I have my diabetes in good control?

- A. My 'finger prick' blood glucose tests results are usually in the range of 4 to 6 mmol/L
- B. I feel fine.
- C. I have no 'lows' where my blood sugars drop dramatically.
- D. My blood glucose tests in the morning are below 9 mmol/L.

Retrieved from: <http://www.diabetes.ca/managingdiabetes/form.asp>

Appendix 1b: Type 2 Diabetes Quick Test – Know Your ABCs - Teacher Copy

Question 1 What are the causes of type 2 diabetes?

The correct answer is **D - All of the above.**

Other risk factors for type 2 diabetes include being age 40 and over, carrying extra weight (especially around the middle), giving birth to a large, having diabetes during a pregnancy (gestational diabetes), having high cholesterol or high blood pressure or having higher than normal blood glucose levels.

Question 2 A1C is a blood test that measures

The correct answer is **B - an average of how much glucose has been in my bloodstream over the past three months.**

A1C is medical shorthand for glycosylated hemoglobin – or how much glucose is in the bloodstream. The A1C test is a test of the average blood glucose levels over the previous three months. Most people with diabetes should strive for an A1C below 7 per cent. Keeping blood glucose levels below 7 helps prevent the onset and/or delay the progression of diabetes complications such as heart disease, stroke, kidney disease, eye disease and limb amputation due to nerve damage.

An A1C of less than 6 should be attempted for those who can do so without undue risk of low blood glucose events. Ask your doctor how to achieve the A1C level that is right for you.

Question 3 If I manage my type 2 diabetes with pills, physical activity and a healthy diet, I only need to test my blood glucose levels:

The correct answer is **C - at least once a day.**

The *2003 Canadian Diabetes Association Clinical Practice Guidelines* state people with type 2 diabetes taking oral medications who test their blood glucose levels *at least once a day* have a moderately lower A1C than those who test less frequently. In those managing their diabetes with diet and physical activity alone, any frequency of testing is associated with an overall lower A1C*.

Keeping A1C levels below 7 helps prevent the onset and/or delay the progression of diabetes complications such as heart disease, stroke, kidney disease, eye disease and limb amputation due to nerve damage.

*A1C is a test of the average blood glucose levels over the previous three months.

Question 4 My optimal blood pressure target should be

The correct answer is **B - 130/80**.

The optimal blood pressure target for people with diabetes is 130/80 or below. The first number represents the systolic pressure (the pressure in your arteries when the heart pumps out blood). The second number is the diastolic pressure (the heart's rate as it rests between beats). People with diabetes are at greater risk for high blood pressure (hypertension) which, left untreated, can lead to heart disease and stroke.

Question 5 I can take care of my cholesterol by watching what I eat. True or False?

The correct answer is **False**.

Dietary cholesterol accounts for an estimated 20% of total cholesterol. Most cholesterol is manufactured naturally in the body. If you have diabetes, watching the amount of cholesterol you eat is only part of the job. It is just as important to know your body's cholesterol target levels as identified by your doctor – and to work to meet them:

- LDL – Low Density Lipoprotein Cholesterol (the 'bad' cholesterol) – Aim for levels less than 2.5 mmol/L . (Less than 3.5 mmol/L for people with diabetes who are younger, have no diabetes complications and no other risk factors for heart disease)
- The ratio of Total cholesterol (TC) to High Density Lipoprotein Cholesterol (HDL or the 'good' cholesterol) – Most people with diabetes should aim for levels below 4 (a ratio of less than 5 for people with diabetes who are younger, have no complications and no other risk factors for heart disease).

Question 6 If I have type 2 diabetes, my doctor may recommend I begin taking insulin injections:

The correct answer is **A - If my eating habits, physical activity and**

current diabetes medications don't keep my blood glucose levels in check.

People with type 2 diabetes will usually begin by managing the condition with healthy eating and physical activity alone, and add oral medications if these lifestyle changes prove ineffective or insufficient. Some people may eventually move to taking insulin to manage their condition.

The Canadian Diabetes Association recommends most individuals with type 2 diabetes aim for blood glucose levels that are as close to normal as possible – as early as is possible. If it is determined that healthy eating, physical activity, and lifestyle changes are not sufficient, your doctor may prescribe one or more diabetes drugs – and these may include insulin. A combination of oral drugs and insulin is often effective at controlling blood glucose levels in adults with type 2 diabetes. Because elevated blood glucose levels can cause serious complications of diabetes, the Canadian Diabetes Association's *Clinical Practice Guidelines* now recommend that some individuals be prescribed insulin *first*, without waiting to see whether the diabetes pills work, especially when the individual has uncontrolled high blood glucose levels (ie. an A1C of 9% or greater). Insulin may also be prescribed temporarily during illness, pregnancy, medical procedures, surgery or times of stress.

Question 7 My blood glucose levels are too high. Why does my doctor tell me I need to take more pills to manage my diabetes?

The correct answer is **D - All of the Above.**

People with type 2 diabetes should be prescribed diabetes medications *as needed* to get their blood glucose levels as close to normal as possible and as quickly as possible. The goal is to get blood glucose levels to an acceptable level within 6 to 12 months. A combination of insulin injections alongside oral drugs may even be recommended for adults with type 2 diabetes.

Question 8 How do I know whether I have my diabetes in good control?

The correct answer is **A - My 'finger prick' blood glucose tests results are usually in the range of 4 to 6 mmol/L .**

While targets and strategies to reach blood glucose targets must be tailored to the individual's circumstances and age, the Canadian Diabetes Association's Clinical Practice Guidelines recommend that people with diabetes aim for blood

glucose targets of 4-6 mmol/L, (millimoles of glucose per litre of blood).

By testing blood glucose levels more frequently (4 or more times per day), people with diabetes can keep close tabs on their glucose levels and take action to keep them in the desired target range (and help prevent incidents of low blood glucose levels or hypoglycemia). This will help prevent or delay the serious complications of the condition.

Appendix 2: Staying Alive (Article)

Staying Alive
By Karen Wright
Discover Magazine
November 2003

This article can be obtained from: www.discover.com/issues

Appendix 3: Staying Alive Template

Someone alive today could survive to the age of 150.

Article Section Title: _____

| | |
|-----------------------------|---------------------------|
| Evidence/arguments for: | Evidence/support against: |
| Summary: | |
| Key Terms: | Questions: |
| I was surprised to learn... | |

Appendix 4: Substituted Sammy- An Exercise in Defining Life

"Substituted Sammy" was a normal healthy boy. There was nothing in his life that indicated 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 like a real one.

Soon afterward, Sammy developed severe intestinal difficulty and a large portion of his lower small intestine had to be removed. It was replaced with an elastic silicon tube.

Everything looked good for Sammy until he was involved in a serious car accident. His legs and good arm were crushed and had to be amputated. He also lost an ear in the accident. Artificial legs enabled Sammy to walk again and an artificial arm replaced the real arm. Plastic surgery and the use of silicon 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, his kidneys malfunctioned and the only way he could survive was to use a kidney dialysis machine. A kidney donor was sought but never found. Later, his digestive system became cancerous and was removed, which resulted in Sammy having to receive his nourishment intravenously. Finally, his heart failed. Luckily for Sammy a donor heart was available and transplanted into his body.

It was now obvious that Sammy had become a medical phenomenon. All of his limbs were artificial. Nourishment was supplied through his veins; therefore, he had no solid wastes. All chemical wastes were 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.

Unfortunately, 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 as it circulated through his body.

The doctors consulted bioengineers about Sammy. Since almost all of his life-sustaining functions were being carried on by machines, they thought it might be possible to compress all of these machines into one mobile unit which could be controlled by electrical impulses from his brain. This unit would be equipped with mechanical arms to enable him to do multiple tasks. A mechanism to create a flow of air over his vocal cords might enable him to speak. In order 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 occurred and the bioengineers diagnosed him as terminal. So the medical/bioengineer team that developed around Sammy began to program his brain. A miniature computer was developed; it could be housed in a machine that was like a human head 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 any biological illness.

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 we discussed in class to help explain your answer.

From Donald F. Shebesta, "Substituted Sammy: An Exercise in Defining Life," reprinted from the American Biology Teacher, Vol. 34 (5) May 1972.

Appendix 5: Case Study - The Meaning of Death

From Van Rooy, W. 2000. Controversial Issues within Biology: Enriching Biology Teaching. *Australian Science Teachers Journal* 46 (1): 20-27.

In the summer of 1988 John Smith, a 45-year-old computer programmer from London, and his second wife, Lucy, were touring in Cornwall in a car which they had hired for their honeymoon. Both were involved in a motorway accident with three other cars and a truck. Lucy, who was driving, suffered the full impact of the collision and sustained head and chest injuries of such magnitude that it was obvious that she had been killed instantly. John was flung clear of the wreck but sustained massive head injuries and was taken within minutes to the hospital. He required several transfusions and a ventilator to maintain oxygenation, although his heart and kidneys appeared to be undamaged.

After 36 hours John was still unconscious and unable to maintain spontaneous respiration. A brain scan revealed no brain activity and further tests revealed absence of spontaneous motion and no reaction to painful stimuli. It was discovered that John was in possession of a donor card. The transplant team was notified and put on alert while a search was undertaken to locate John's next of kin. This proved futile. After consulting two other physicians and conducting tests which revealed complete absence of brainstem functions, the attending doctors declared John dead despite the fact that his heart and lungs were functioning with mechanical assistance. The decision was then made to move John to the operating room where his heart, lungs, and kidney were transplanted into two other patients.

Three days later Joseph Smith, John's son from a previous marriage, arrived at the hospital, followed by Lucy's sister, Mary. Both were overcome with grief which later turned to anger. In due course they initiated legal proceedings. Unbeknown to the medics John was a member of a religious organisation which does not agree with organ donation or blood transfusion. The hospital maintained that John's donor card expressed a clear indication of his wishes and that his death had been determined objectively and confirmed by two doctors independent of the transplant surgeons.

The arguments made by the solicitor representing Lucy's sister were directed at John and Lucy's last will and testament. In the event of Lucy predeceasing John, the whole of her estate would go to John. According to the terms of John's will, the whole of his estate would go to his son Joseph. In the event of a simultaneous death the joint estates would be divided between both Joseph and Mary. Mary's solicitor argued that John and Lucy met their death simultaneously and that John's body was artificially maintained until his organs were transplanted. In reply, Joseph's solicitor argued John had survived Lucy until the

moment artificial ventilation was terminated and his heart and lungs removed. The ensuing legal battle turned on matters of clinical/medical facts and ethics which were themselves based on the criteria for death: in other words, on what it means to be dead.

Case Study – The Meaning of Death: Questions for discussion

1. When John's organs were removed was he alive or dead? What evidence have you used to form the basis of your answer? Would the situation have been different if John was of another religious or ethical tradition or from another country?
2. Who died first, John or Lucy? Upon what evidence should this evidence be based?
3. Does anyone own a dead body?
4. Who then decides to go ahead with organ donation and subsequent organ transplantation?
5. Does a person who needs an organ in order to live have a claim to the organs of another being either alive or dead?
6. Would appeals to the sanctity of the human body outweigh the interests of those who have an urgent need for bodily parts?
7. For some people it is spontaneous breathing and heartbeat, consciousness, cognition or characteristics associated with speech, reason and similar traits which marks a person as living. For others it also includes a spirit or soul. What is it that is lost in death that causes us to regard the person we have known as 'gone'?