Unit 1: Matter and Energy for Life
Specific Curriculum Outcomes
Suggested Time: 27 Hours

Matter and Energy for Life

Introduction

"Biology" is the study of life. However, the study of the science of life is far from simple, it is complex as living things are complex and diverse. Living things are much more than a mere set of chemical reactions or a physical machine. They are composed of individual units called cells, considered to be the basic unit of structure and function and the smallest independent unit capable of displaying the characteristics of life. During this unit, the historical development of cell theory and the role of the microscope in the advancement of biological knowledge will be discussed. Students will gain an appreciation for the complexity of life at the cellular level of organization and the delicacy of interactions between components at this level as they study cell structures and their functions.

Focus and Context

In its consideration of the cell as the fundamental unit of life, the focus of this unit is placed within the area of scientific inquiry. This involves primarily an emphasis on observation and inquiry. Sections within this unit ask students to consider structures, processes and interactions within cells and to gain familiarity with basic laboratory techniques.

Science Curriculum Links

This preliminary discussion of cells builds upon clusters of information that have preceded it in the student's earlier study of the science curriculum. Characteristics and needs of living things and their dependence on the environment are first introduced in a general format in primary grades. This base is built upon with the discussion of the interaction of plants with the environment. Students in elementary grades begin to become familiar with the use of magnifying tools to observe microorganisms. By the end of the intermediate grades, students have been introduced to plant and animal cells as living systems exhibiting the characteristics of life. In addition, structural and functional relationships between cells, tissues, organs and body systems and their relationship to the functioning of the human organism as a whole have been investigated.

Curriculum Outcomes

STSE

Students will be expected to

Nature of Science and Technology

114-1 explain how a paradigm shift can change scientific world views

114-2 explain the role of evidence, theories, and paradigms in the development of scientific knowledge

114-5 describe the importance of peer review in the development of scientific knowledge

114-9 explain the importance of communicating the results of a scientific or technological endeavour, using appropriate language and conventions

115-5 analyze why and how a particular technology was developed and improved over time

Relationships between Science and Technology

116-2 analyze and describe examples where scientific understanding was enhanced or revised as a result of the invention of a technology

116-6 describe and evaluate the design of technological solutions and the way they function, using scientific principles

Skills

Students will be expected to

Performing and Recording

213-2 carry out procedures controlling the major variables and adapting or extending procedures where required

213-3 use instruments effectively and accurately for collecting data

213-5 compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data

213-8 select and use apparatus and materials safely

Analysing and Interpreting

214-3 compile and display evidence and information, by hand or computer in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots

Communication and Teamwork

215-6 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

Knowledge

Students will be expected to

314-5 explain the cell theory

314-6 describe cell organelles visible with the light and electron microscopes

314-7 compare and contrast different types of procaryotic and eucaryotic cells

314-8 describe how organelles manage various cell processes such as ingestion, digestion, transportation and excretion

314-9 compare and contrast matter and energy transformations associated with the processes of photosynthesis and aerobic respiration

Historical Development of the Cell Theory

Outcomes

Students will be expected to

- explain the cell theory (314-5)
  - define biogenesis and abiogenesis
- describe how the contributions of scientists lead to a better understanding of biogenesis and abiogenesis (114-1, 114-2, 114-5, 114-9) Include:
  - (i) Aristotle
  - (ii) Redi
  - (iii) Needham
  - (iv) Spallanzani
  - (v) Pasteur

- analyze and describe how scientific understanding was revised as a result of the invention of the microscope (116-2)
  - explain how the invention of the microscope permitted scientists to discover the existence of cells
  - explain the contributions of
    - (i) Hooke
    - (ii) Leeuwenhoek
- describe how the contributions of scientists lead to the progressive development of the cell theory (114-1, 114-2, 114-5, 114-9)
  - (i) Brown
  - (ii) Schleiden
  - (iii) Schwann
  - (iv) Braun
  - (v) Virchow
  - (vi) Pasteur

Elaborations—Strategies for Learning and Teaching

It is important that students understand the concepts of biogenesis and abiogenesis before discussing the experiments of scientists who fueled this debate.

The concepts of biogenesis and spontaneous generation could be approached historically through the investigation of the contributions of philosphers, such as Aristotle, and scientists such as Redi, Needham, Spallanzani, and Pasteur. Sketches of their experimental setups are a useful visual representation and are valuable to students' understanding of the progression in cell theory development. Questions such as, "How did the scientists' equipment evolve?" and "What are the strengths and weaknesses of their research?" could be pursued.

This historical approach can be used to illustrate the development and functioning of the scientific method. Spontaneous generation (abiogenesis) resulted from conclusions drawn from faulty or misinterpreted observations and lack of experimental control. This concept was discredited, and biogenesis supported, through the use of controlled experiments.

It is important to recognize that the debate between biogenesis and abiogenesis contributed to the development of the cell theory and resulted in a significant paradigm shift.

Students should understand that the development of the microscope and the development of the cell theory were directly related.

The accomplishments of the early cell biologists paved the way for study. Emphasis should be placed on the way this scientific knowledge developed. As each scientist worked, they built on previous knowledge, modified present techniques and changed the way science viewed the origins of life (i.e., a paradigm shift occured).

To put these developments into a historical perspective, students could be asked as groups to create a time line to chronicle the development of this theory.

Historical Development of the Cell Theory

Suggested Assessment Strategies

Presetation

- Teachers could provide students with a list of individuals who have contributed historically to the development of the cell theory. Students could collect information on the researcher assigned to them or their group and prepare a brief oral presentation to be given to the class. Students could create index cards providing in point form the individuals name, the time frame in which he or she worked, and their main contributions to the development of the cell theory. Presentations could be made in chronological order and the index cards affixed to the time line prepared at the front of the class. (114-1, 114-2, 114-5)

Paper and Pencil

- Teachers could provide students with the statements on cell theory and ask them to identify the research and scientist that contributed to each particular cell theory statement. Students should organize statements and researchers in chronological order. (314-5, 114-5)
- Students could construct a concept map involving the work of scientists who were pro-spontaneous generation and anti-spontaneous generation. (213-5)
- Teachers could invite students to debate biogenesis and abiogenesis. (314-5, 116-2)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

MGH Biology, pp. 6-11

MGH Biology, p. 6

MGH Biology, p. 11

MGH Biology, pp. 8-10

MGH Biology, pp. 7-10

Introduction to the Microscope

Outcomes

Students will be expected to

- select and use apparatus and materials safely (213-8)
  - identify the microscope as an important tool for biological research
- use instruments effectively and accurately for collecting data (213-3)
  - identify microscope parts and their function
  - demonstrate general care, focusing techniques and safety concerns
  - prepare, stain, and observe a wet mount of a specimen
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)
- work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (215-6)

Elaborations—Strategies for Learning and Teaching

The Laboratory outcomes (213-3, 213-5, 213-8, 214-3, 215-6) are addressed by completing *"Caring for and Using a Microscope",* AND Mini Lab *"Observing Stained Cells"* CORE LAB #1. Teachers should note that this lab will take at least 2-3 class periods.

Students should develop the techniques and skills required for a microscope's efficient use. Students will arrive in Biology 2201 with varying levels of competency in the use of the microscope and accommodations will need to be made for this.

Hands on activities are useful for students to become acquainted with the proper use of the instrument, its parts and their functions, and specimen preparation. Students will require practice with focusing techniques and they should be made aware of the proper care and cleaning of the microscope and safety concerns. If both a compound microscope and dissecting (stereo) microscope are available, a look at the contrasts and different uses for these two instruments would be valuable. Teachers should demonstrate the proper preparation and staining of a temporary, or wet mount slide, in order to minimize air bubbles and distractions to viewing.

It is important for students to realize that the image they view under the microscope may not be exactly how the cell always appears, as the procedures and material (stains) used to prepare specimens may alter their appearance, and the microscope yields a two-dimensional view of a three-dimensional object. A good extension of this activity might be for students to look at pond water, as this would demonstrate whether students fully comprehend the proper use of the microscope. The importance of the contrast added by the staining technique could be illustrated by having students alternately observe the same specimen unstained, and then stained.

This microscope work complements and reinforces the concepts previously discussed and teachers may choose to align their instruction into this section. Students are presented here with the opportunity to practice and build on the knowledge from the previous section. They have been introduced to the proper techniques for slide preparation and staining and now have additional opportunities to use these techniques.

Introduction to the Microscope

Suggested Assessment Strategies

This section involves an emphasis on hands on laboratory experiences

Pencil and Paper

- Students could draw a freehand diagram of a specimen provided. They should label it, title it, and estimate size and/or scale. (213-3, 213-5, 214-3)

Performance

- Students could prepare and stain a wet mount slide. A visual scan of their product will allow an assessment of their slide preparation and focusing techniques. (213-3, 214-3)
- Students should be prepared to answer questions on the parts of the microscope, their purposes, focussing techniques (including depth of field), and safety concerns. (213-3, 214-3, 213-8)

Laboratory Activities

- Students could sketch on a piece of paper a tiny upper case "H". It must be small enough that the entire letter can be seen under low power of the microscope. They should prepare a wet mount, position the slide on the stage in its normal orientation, observe, and sketch the image of the letter as viewed through the microscope. They could repeat with the letter "A" and letter "F". Students should make a summary statement describing how the microscope influences the orientation of all images produced. (213-5, 214-3, 213-8)
- Each group could be given a variety of samples of fibres (e.g., linen, wool, cotton, silk, nylon). Students would make wet mounts, examine, and sketch. Each group would develop a crime scene scenario using one or a number of these fibres. These would be exchanged between groups to be solved. Alternatively, a number of hair samples might be considered for use. (213-5, 213-8)

Resources

Core Lab #1: *"Caring for and Using a Microscope"*, pages 15-19 AND Mini Lab *"Observing Stained Cells"* p. 24

Introduction to the Microscope *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• compile and display, using line diagrams and/or digital imagery, evidence and information collected through the use of the microscope (214-3) – draw a biological drawing which includes the concept of field of view and calculation of specimen size – define depth of field	**Note:** Biological drawings should indicate the structure within the field of view that is to be studied e.g., a single onion cell. It is not necessary to draw all structures found within the field of view or to draw a circle to illustrate the field of view. Teachers could reference rules for biological drawings on the Department of Education website. Ideally, each student should be assigned his or her own microscope. The specimens utilized for the activities involving line diagrams should have distinct colour and contrast and be easy for the students to distinguish. A brief introduction to the concept of field of view and estimation of specimen size is useful to help students maintain the proper perspective of what they are viewing through the microscope.
• analyze why microscope technology continued to develop and improve over time (115-5)	Opportunity exists here to link the use of the electron microscope in biology with the physical sciences and the basic technology of the microscope. Students can research the development of the light and/or electron microscopes from a historical perspective, and their association with cell theory development and knowledge of cellular detail. Like any technology, the microscope has advanced over time. Aspects such as magnification, resolution, imaging, preparation of specimens have improved. The driving force behind microscope technology is the desire by scientists to view smaller and smaller specimens.
• describe and evaluate the design of microscope technologies and the way they function (compound, scanning electron microscopes and transmission microscopes) (116-6) – compare different microscopes in terms of illumination, magnification, and specimen preparation – describe the career opportunities that exist within the biological sciences	During the progression of Biology 2201, it is appropriate to make students aware of the career opportunities that exist in various areas of biology. Students may consider cytology, or laboratory technology, specializing in electron microscopy as a career option.

Introduction to the Microscope *(continued)*

Suggested Assessment Strategies

Portfolio

- Students could compile a collection of biological drawings and examples of electron micrographs (or other microscope images) of various organelles and organisms. (214-3)

Research

- Students could research about careers involving microscopy on the Internet. (116-6)

Pencil and Paper

- Students can practice biological drawings using prepared slides. (214-3)

Resources

Core Lab #1: *"Caring for and Using a Microscope"*, pages 15-19. *MGH Biology,* Appendix E p. 742

MGH Biology, pp. 20-21

Throughout the text biological careers are highlighted.

Prentice-Hall. *Biology: The Study of Life*. **Appendix D**: *Career in Biology* p. 891

Interaction of Cell Structures

Outcomes

Students will be expected to

- using different types of cells as examples, compare and contrast prokaryotic and eukaryotic cells (314-7)
  - describe the structural differences between prokaryotic and eukaryotic cells
  - observe features of prokaryotic and eukaryotic cells using microscope technology
- describe the appearance of cell organelles visible with the light and electron microscopes (314-6)
  - examine and compare images of cell structure generated by both the light and electron microscopes
  - describe the role of the following cellular structures:
    (i) cell membrane
    (ii) cytoplasm
    (iii) nucleus
    (iv) cucleolus
    (v) endoplasmic reticulum
    (vi) ribosome
    (vii) mitochondria
    (viii) chloroplast
    (ix) vacuole
    (x) vesicle
    (xi) golgi apparatus
    (xii) microtubules/filaments
    (xiii) cilia
    (xiv) lysosome
    (xv) flagella
    (xvi) cell wall
  - compare plant and animal cells in terms of type of organelles present

Elaborations—Strategies for Learning and Teaching

Specimens can be selected that illustrate prokaryotic features (cyanobacteria, *lactobacillus* in yogurt). Eukaryotic examples can be selected from prepared slides that will illustrate their characteristics. A variety of structures are visible with the light microscopes that will be used by the students. Examples include, but are not limited to: nucleus in yeast; nucleus, vacuole and cell wall in onion epithelium. A variety of specimens should be examined to illustrate to students that not all cells are identical despite the similarity of cellular structures. Use of a video microscope is extremely useful in illustrating the structure of cells in a larger group setting.

Micrographs produced by both transmission electron microscopes and scanning electron microscopes could be available for student examination. These will illustrate details of some cell structures that cannot be distinguished by students in a laboratory setting. Textbooks and websites are a good source for these.

Physical models, charts of cells, and/or Internet websites graphically illustrate structures of cells and distinguish features predominant in plant or animal cells

Comparing the working of a cell's organelles to a functioning city could be an effective strategy for emphasizing the role of each organelle and how they work together.

Comparison of diagrams on pages 25 and 32 of textbook can aid in highlighting these differences. **Note:** the ribosome on figure 1.11, p. 25, is incorrect.

Interaction of Cell Structures

Suggested Assessment Strategies

Presentation

- Students could prepare a model of a plant or animal cell and its structures. They should be creative in their choice of materials (e.g., playdough, jello, clay, etc.) (314-5, 314-7, 215-6)

Paper and Pencil

- Individually or in groups of two, students could prepare a chart to contrast some of the elements studied in this section. Suggestions may include:
  - plant versus animal cells
  - eukaryotic versus prokaryotic cells
  - light microscope versus scanning electron microscope
  - light microscope versus transmission electron microscope
  - scanning electron miscroscope versus transmission electron microscope (314-6, 314-7)

Resources

MGH Biology, p. 23

MGH Biology, pp. 25-33

Images can be found throughout chapters 1 and 2 of *MGH Biology*

MGH Biology, pp. 25-33

MGH Biology, pp. 25-33

Interaction of Cell Structures (continued)

Outcomes

Students will be expected to

- describe how organelles manage various cell processes such as ingestion, digestion, transportation and excretion (314-8)
  - explain how materials are able to move into and out of cells through a selectively permeable membrane. Include passive transport (osmosis, diffusion and facilitated diffusion), and active transport (exocytosis and endocytosis; pinocytosis, phagocytosis)
  - define the terms hypotonic, hypertonic and isotonic
  - describe the effects of osmosis on cells with and without cell walls
  - investigate the relationship between membrane surface area and cell size, summarizing findings and formulating a conclusion

Elaborations—Strategies for Learning and Teaching

The processes of osmosis and diffusion can be easily illustrated within the classroom by setting up a situation where concentration gradients exist. Filling a thistle tube with a sugar solution, covering it with a semipermeable membrane (dialysis tubing) and placing it in a beaker containing coloured water would be an example.

Creation of a model cell by students is an effective method, as well, to show passive, yet selective transport through a membrane. Dialysis tubing or sandwich bag can be utilized to represent the cell membrane. Example: starch, sugar and water inside the cell; iodine and water outside.

Students can discuss the concept of osmosis and the influence of hypotonic, hypertonic and isotonic solutions through a discussion of food preservation (sugar and salt), why plants may be adversely affected by too much fertilizer, why vegetables are sprayed with water at the local grocers, and the use of intravenous fluids in medical situations.

A good demonstration is inflating a balloon verses inflating a balloon inside a closed shoe box.

The Elective Lab could also be done as a teacher demonstration. Alternatively, cells may be constructed from cubes of potato and immersed in potassium permanganate solution. Data collected from the lab should be organized in an appropriate format for discussion and display. Surface area and volume of a sphere can be studied mathematically.

Surface Area to Cell Size

Radius of Sphere	Surface Area $4\pi r^2$	Volume $\left(\frac{4}{3}\right)\pi r^3$	Surface/ Volume Ratio

Students could be asked to turn in a laboratory write-up, answer questions based on the relationships seen through the laboratory work, or to discuss additional potential difficulties that cells may experience as they increase in size.

Interaction of Cell Structures *(continued)*

Suggested Assessment Strategies

Laboratory Activities

- Students could design and carry out a controlled experiment, using dialysis tubing as a model cell and various solutes, to test hypotheses concerning osmosis and diffusion. (213-2, 213-5, 314-8)

Presentation

- Students could observe demonstrations prepared on osmosis and/or diffusion and explain observations made based upon understanding of these concepts. (213-5, 214-3)
- Students could investigate one of these situations related to osmosis and diffusion (hypertonic, hypotonic and isotonic solutions) individually or in groups. They may also select an original scenario, upon approval by teacher. They should record their findings and be prepared to present them to the class, or expand upon in a science fair.
  - food preservation
  - wilting of plants (plasmolysis of onion cells)
  - effects of too much fertilizer on plants
  - why IV's must contain isotonic solutions
  - difficulties that must be dealt with as fish (salmon) move from fresh to salt water or vice versa (314-8, 213-5, 214-3, 215-6)

Journal

- If a cell membrane were completely permeable, how would this effect the cell? (314-8)

Resources

MGH Biology, pp 50-64

MGH Biology TR BLM 2-2 Illustrating Concenteration Gradients

Elective Lab *"The Limits of Cell Size"* pp. 54-55

Interaction of Cell Structures *(continued)*

Outcomes

Students will be expected to

- carry out procedures controlling major variables and adapting or extending procedures where required (213-2)
- work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (215-6)
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (213-5)

Elaborations—Strategies for Learning and Teaching

The Laboratory outcomes (213-2, 213-3, 213-5, 213-8, 214-3, 215-6) and, in part, 314-8 are addressed by completing *Osmosis in a Model Cell,* CORE LAB #2. Note: Exploring Further question #6, p. 57, is an important part of this Lab.

Interaction of Cell Structures *(continued)*

Suggested Assessment Strategies

Performance

- Working as a co-operative group, students could research and investigate some formal experiments and select one that relates to the topics being discussed. Examples might include investigation of the sizes of a variety of cells or the physical comparison of cells from different areas of a plant. They would be required to present their plan for approval. The plan should include how they intend to organize themselves, collect data, and control and measure the variables. Teachers should watch for understanding of the basic principles and the tasks, clarity of thought and reasonable creativity.
- Students could perform the laboratory activities provided for them which investigate the relationship between cell surface area and cell size and complete the evaluation requirement as indicated. (213-2, 213-3, 213-5, 214-3, 215-6)
- Once the experiments have been designed and intentions stated, an opportunity exists for assessing how the students actually perform the intended activity. The following points should be considered:

– Is their plan adequate?

– Is the plan followed?

– Are experimental techniques utilized properly and safely?

– Are unexpected events dealt with effectively? (213-2, 213-5, 314-8)

Presentation

- Students could present their experimental findings to their teacher and/or entire class group. They should be able to explain the rationale behind the experiment and be able to answer questions on the data collected. Two questions they should think about, "Did any questions arise during the course of this experiment that might lead to further investigations? If so, what were they?" and "Are there any ways that the experimental design you followed could have been improved? If so, how?" (314-8, 214-3)

Journal

- Why are the cells of an elephant not larger than those of a cat? (213-2, 314-8)

Resources

Core Lab #2: *"Osmosis in a Model Cell"* pp. 56-57

MGH Biology TR BLM 2-1
Osmosis in a Living Potato Cell

Photosynthesis and Respiration

Outcomes

Students will be expected to

- compare and contrast matter and energy transformations associated with the processes of photosynthesis and aerobic respiration (314-9)
  - explain the importance of the processes of photosynthesis and aerobic respiration for individual organisms
  - demonstrate, using equations, that photosynthesis and aerobic respiration are complementary processes
  - explain the importance of the processes of photosynthesis and aerobic respiration on a global basis
  - define anaerobic respiration

Elaborations—Strategies for Learning and Teaching

The emphasis of this outcome (314-9) is the difference between aerobic processes and photosynthetic processes. It is not intended for students to investigate biochemical processes (such as Kreb Cycle, glycolysis, fermentation, and so on) or light and dark reactions associated with plant growth.

Teachers should explain that photosynthetic organisms, using light as an energy source, remove CO_2, water and other materials from their environment in order to assemble more complex organic compounds and release, as a by-product, oxygen gas. Teachers should explain that respiration is a chemical process utilized by all organisms to extract energy from organic molecules. These organic substances are broken down into the components of CO_2, water and the energy released is utilized by the organism for its own purposes or released to the environment.

An analysis of the role of photosynthesis as the biological basis of the primary industries of agriculture, forestry and the fisheries would be appropriate. This may lead into a subsequent discussion of how the human population has an effect upon these processes through the release of specific chemical compounds into the environment, intentionally or unintentionally, and the current and future impacts this may have. Students may also suggest ways that humans are manipulating these natural processes of photosynthesis and respiration directly through their activities (such as selective breeding to increase productivity) and the potential ramifications of these.

Laboratory experiments can be performed to help students investigate the two basic and critical processes of photosynthesis and respiration. The consumption of CO_2 by a water plant during the process of photosynthesis can be visually illustrated using a methylene blue solution. (Methylene blue changes to yellow in an acidic solution such as when CO_2 is added; conversely reverses to blue when CO_2 is removed.) Students may design and/or perform an experiment that demonstrates the production of starch by leaves during the process of photosynthesis. Students could be asked to design and/or perform a chromatography experiment to demonstrate that plant leaves contain a range of pigments involved in the process of photosynthesis.

Students should be aware that some microorganisms are capable of metabolizing without the presence of oxygen. This is called anaerobic respiration.

Photosynthesis and Respiration

Suggested Assessment Strategies

Laboratory Activities

- Students could discuss plans for their experimental design and how they intend to proceed, measure variables and record data. They must illustrate understanding of the task at hand, development of a hypothesis and a workable plan, clarity of thought and logical creativity. Possibilities for investigations may include the following:
  - production of sugars by plant leaves
  - effects of temperature, light, sugar concentration on gas production by yeast
  - variety of pigments found in the leaves of plants
  - respiration in germinating plant seeds compared to boiled seeds (213-2, 213-5, 214-3 215-6, 314-9)

Presentation

- When the experiments have been completed, students may be asked to present to the class their data and conclusions. They should be prepared to explain their experimental design and why they made certain decisions during the planning and implementation. Based on their lab experience, students could design an additional experiment to answer a question that arose from their previous work. This could be evaluated for completeness, originality and logical thought. (213-2, 214-3, 215-6, 314-9)

Paper and Pencil

- Students could prepare a demonstration to illustrate the consumption of CO_2 or production of O_2 by a water plant found in a local pond/stream or pet store or to monitor production of O_2 bubbles versus light intensity. They should record their observations and explanations. (213-2, 214-3, 314-9)

Performance

- For assessment purposes, teachers should consider whether students follow their design, use correct techniques, work safely and troubleshoot as required during the performance of the experiment. (213-2, 214-3, 215-6, 314-9)

Resources

MGH Biology, pp. 73, 82-84 and 86-88, 90

MGH Biology, p. 82

MGH Biology, p. 86

MGH Biology, pp. 86-88, 90

Unit 2: Biodiversity
Specific Curriculum Outcomes
Suggested Time: 32 Hours

Biodiversity

Introduction

Millions of living things have been recently classified with more constantly being identified. Scientific opinion suggests that there may be anywhere betweem ten to thirty million of the total number of species actually in existence. Dealing with a system as large and widespread as this requires a taxonomic organizational structure to allow scientists and students to investigate the types and characteristics of these living things. This unit introduces Linnaeus' classification system as a basis for this study.

Organisms exhibit a huge range of diversity, yet maintain a number of basic things in common. All living things are therefore unique, in this, their unity and diversity. An appreciation for this paradigm is encouraged as students are given the opportunity to experience the array of organisms within a logical survey of the taxonomic categories of life, and investigate their anatomy, physiology and life cycles.

Focus and Context

This unit on biodiversity contains an emphasis on scientific inquiry and observation. There are ample opportunities for students to sample and gain an appreciation for the diversity and complexity of life on Earth through their investigation of the classification of these living things.

Science Curriculum Links

Students begin looking at different examples of living things as early as primary grades. Within the elementary grades, the concept and importance of classification systems and the diversity of living things are discussed. At this level students compare characteristics of common mammals, birds, reptiles, fishes and arthropods. The intermediate grades provide an explanation as to how biological classification can take into account the diversity of life on Earth. Level I students add another variable to the concept of biodiversity when they are given the opportunity to discuss how biodiversity contributes not only to the variety within, but also the sustainability of, an ecosystem.

Curriculum Outcomes

STSE

Students will be expected to

Nature of Science and Technology

115-7 explain how scientific knowledge evolves as new evidence comes to light and as laws and theories are tested and subsequently restricted, revised, or replaced

Relationships between Science and Technology

116-2 analyze and describe examples where scientific understanding was enhanced or revised as a result of the invention of a technology

118-6 construct arguments to support a decision or judgement, using examples and evidence and recognizing various perspectives

Skills

Students will be expected to

Performming and Recording

213-5 compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data

213-6 use library and electronic research tools to collect information on a given topic

Analyzing and Interpreting

214-1 describe and apply classification systems and nomenclatures used in the sciences

214-2 identify limitations of a given classification system and identify alternative ways of classifying to accommodate anomalies

214-3 compile and display evidence and information, by hand or computer in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots

214-17 identify new questions or problems that arise from what was learned

Communication and Teamwork

215-6 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

Knowledge

Students will be expected to

313-1 analyse and explain the life cycle of a representative organism from each kingdom, including a representative virus

316-5 use organisms found in a local or regional ecosystem to demonstrate an understanding of fundamental principles of taxonomy

316-6 describe the anatomy and physiology of a representative organism from each kingdom, including a representative virus

Classifying Living Things

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• explain how scientific knowledge evolves as new evidence comes to light and as laws and theories are tested and subsequently restricted, revised, or replaced (115-7)	This section provides a structural framework for the subsequent study of living things. Teachers could make a connection with Science 1206 by referring to paradigm shifts.
– develop a list of characteristics that differentiate living and non-living things (cells, biogenesis, growth and development, metabolism, water requirement, organic compound production, reproduction with inheritance and adaptations)	Brainstorming and guided discussion could be used to assist students to develop the list of characteristics (cells, biogenesis, and so on). Once the list is delineated, students should classify the living and nonliving things in these terms. For example, living things have cells, nonliving do not; living things require water, nonliving do not. Students should be aware that there are various definitions for what constitutes a living organism.
– explain how scientific classification systems have developed	Students could conduct library or electronic research on some of the newer techniques involved in the classification of organisms and compare those techniques with the methods utilized by early scientists such as Aristotle or Linnaeus.
• describe and apply classification systems and nomenclatures used in the biological sciences (214-1)	Use of a biological classification key to identify organisms (e.g., microorganisms, weeds, insects, leaves) increases a students understanding of the complexities of taxonomy. Microslide sets are available that allow students to work their way through a biological key. As well, other examples of keys are commercially available. Students may design their own key, which could be used by others in the class to identify specific items or organisms.
– list and describe the seven major categories of Linnaeus' classification system (i) kingdom (ii) phylum (iii) class (iv) order (v) family (vi) genus (vii) species	It must be recognized that in addition to these, subcategories (superclass, suborder) exist, adding further layers of complexity to this system.
– explain the advantages of binomial nomenclature	The binomial nomenclature system is a standardized, accepted way of naming organisms. Furthermore, similar organisms have similar names. For example, *Canis lupus* (wolf) is similar to *Canis latrans* (coyote). The first word is the genus and the second word is the specific epithet (an adjective used to describe the genus).
– demonstrate how to use a taxonomic key to group and identify an organism	

Classifying Living Things

Suggested Assessment Strategies

Laboratory Activities

- Students could visit a locally accessible ecosystem and observe its organisms. They could develop their own grouping system for what they observe and give the rationale of their system of biological organization. (214-1, 214-2, 316-5, 215-6)

Paper and Pencil

- Using the sheets of 'animalcules' (imaginary critters, e.g., various candys, nuts and bolts, etc.) provided, students could prepare an efficient biological classification key that could be used to identify five of these imaginary creatures. (214-1, 214-2, 215-6, 316-5)
- Following this, they could use the sample organisms provided by the teacher and develop a simple classification key suitable for their identification. Upon its completion, they could exchange this key with that of a classmate and use it to identify one of the organisms and discuss with this classmate any strengths or weaknesses noticed in each other's work. They could explain the system. (115-7, 214-2, 316-5)
- Students could develop a dichotomous key using the pupils in class. (214-1, 214-2, 214-3, 215-6, 316-5)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

MGH Biology, pp. 102-104

MGH Biology, pp. 104-109, 104-105, 108
MGH Biology TR BLM 4-2 *What is a Swizzle?*

MGH Biology, pp. 108-109

MGH Biology, pp. 108-109 and 112

Forestry Module
Newfoundland Trees and Shrubs by Glen Ryan

Classifying Living Things *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• use organisms found in a local or regional ecosystem to demonstrate an understanding of the fundamental principles of taxonomy (316-5)	
• compile and organize data to facilitate interpretation of the data (213-5) • compile and display evidence and information in a variety of formats (214-3) • work co-operatively to develop and carry out a plan, and troubleshoot problems as they arise (215-6)	The Laboratory outcomes (213-5, 214-1, 214-3, 214-17, 215-6) and, in part, 316-5 are addressed by completing *Creating A Dichotomus Key* CORE LAB #3. The intent of this lab is to expose students to classification based on observable characteristics, rather than to identify specific anatomical characteristics of beetles.
• explain how scientific knowledge evolves as new evidence comes to light and as laws and theories are tested and subsequently restricted, revised, or replaced (115-7) • analyze and describe examples where scientific understanding was enhanced or revised as a result of the invention of a technology (116-2) • construct arguments to support a decision or judgement, using examples and evidence and recognizing various perspectives (118-6)	The CORE STSE component of this unit incorporates a broad range of Biology 2201 outcomes. More specifically it targets (in whole or in part) 115-7, 116-2, 118-6, 214-17, 316-5. The STSE component, *Modern Classification Techniques*, can be found in Appendix B. Teachers should note that students are only expected to have a basic understanding of the process of DNA amplification. They are not expected to know the step by step process as presented in Figure 2 of the STSE module.
• identify limitations of a biological classification system and identify alternative ways of classifying to accommodate anomalies (214-2) – examine the common names of some species of organisms and show the inadequacies and language problems associated with this method of identification	The use of common or local names for a species can be confusing. For example, bakeapple, *Rubus chamaemrus,* is also called cloudberry.

Classifying Living Things *(continued)*

Suggested Assessment Strategies

Presentation

- Students could present the results of their research on modern classification techniques to the class. They could use any appropriate format (oral, poster, computer presentation). This may best be used as an enrichment activity. (115-7, 116-2, 213-6)
- Students could select one of the organisms they observed and investigate its classification utilizing Linnaeus' system. They could share this classification with other class members in a visual format. Teachers should ensure that a wide variety of organisms are included so students can choose different organisms. (214-1, 316-5)

Pencil and Paper

- Students could write a short research paper on the contribution of Linnaeus to the classification of living things. (116-2)

Laboratory

- Have students collect local flora and fauna such as samples of insects, flowers, trees, etc., and use appropriate field guides and dichotomous keys to classify. This collection should be made at an appropriate time when weather conditions are more favorable. (316-5)

Resources

A variety of field guides may be useful (i.e., *Peterson's Field Guides*)

Core Lab #3: *"Creating a Dichotomous Key"* pp. 110-111

Core STSE #1: *"Modern Classification Techniques",* **Appendix B**

MGH Biology, p. 112

Classifying Living Things *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• identify limitations of a biological classification system and identify alternative ways of classifying to accommodate anomalies (214-2) **Cont'd**	Teachers should be aware that viruses, according to the McGraw-Hill Biology text, are not classified in any kingdom of living things because, by definition, they are not organisms. They have no cellular structure (i.e., no cytoplasm, organelles, or cell membrane) and they are not able to grow, respire, or reproduce independently. They act as parasites, relying totally on their hosts for survival. As a result, they are classified based on the type of disease they cause (e.g., HIV virus, polio virus, and so on). Students should be aware that a virus' ability to induce reproduction of its nuclear material qualifies them as organisms under some definitions.
– explain why a virus does not fit neatly into the existing classification system	
• identify new questions or problems that arise from what was learned (214-17)	
– recognize the difficulties inherent in the categorization of some organisms into distinct groups and identify the limitations of a five-kingdom system that led to the six-kingdom system	Examples of difficulties in classifying organisms and how decisions were made could be introduced (*Limulus*—horseshoe crab, members of the Protista kingdom). These examples can be used to remind students that no classification is etched in stone, and that one of the advantages of Linnaeus' system is its adaptability. Recently, the Linnaeus system has changed as new knowledge about bacteria has been discovered. Linnaeus' adaptability is evident when it changed from a five-kingdom to a six-kingdom system. Students should also be aware that different interpretations can lead to defining additional kingdoms.
• use library and electronic research tools to collect information on modern techniques used in the classification process (213-6)	
– explain how organisms are classified using: (i) radioactive dating (ii) biochemical information (DNA/protein comparisons) (iii) structural information (iv) comparative embryology (v) cellular structure (vi) behaviour	Information collected could be presented to class.
• describe how classification systems improved as a result of the development of modern techniques (116-2)	Through the use of these techniques, organisms once thought to be closely related, were found to be unrelated and vice versa. For example, echinodermata (e.g., sea stars, sea urchins) are more closely related to the chordates than to any invertebrate.

Classifying Living Things *(continued)*

Suggested Assessment Strategies

Presentation

Teachers should ensure that a good variety of organisms are selected within the class.

- Students could create a presentation on one of the major phyla or classes within the animal kingdom using library and/or electronic research. (316-6, 214-17)
- Students could debate whether or not a virus is alive. (316-6, 214-17)

Resources

MGH Biology, p. 122

MGH Biology, pp. 105-107

MGH Biology, pp. 113-116

throughout chapter 4

Diversity Among Living Things

Outcomes

Students will be expected to

- describe the anatomy and physiology of viruses and organisms from each kingdom (316-6)
  - identify the general characteristics (cell type, nutrition, body form, reproduction, locomotion) that distinguish the members of the six recognized kingdoms (Bacteria, Archaea, Protista, Fungi, Plantae, Animalia) from each other.
  - identify examples of members of each of the Kingdoms
  - describe the differences that exist between the major groups of plants (bryophytes, ferns, gymnosperms and angiosperms)

Elaborations—Strategies for Learning and Teaching

Students should demonstrate an understanding that the six recognized kingdoms of living things represent a diversity of organisms exhibiting extensive variety in terms of form and function.

Teacher should note this section is intended to provide students with a brief overview of biodiversity. For consistency and clarity, Appendix A provides teachers with tables that illustrate content and depth of treatment. These are not designed to limit what is covered, but to represent a minimum level of detail.

An effort should be made to use organisms that are easily available and/or indigenous to the local area. Teachers may consider the following as examples of organisms that may help illustrate some of the characteristics of each kingdom: *Lactobacillus* in yogurt, pond water organisms, yeast, mushrooms, mosses, flowers, grasshoppers, earthworms, sea stars, trout, frogs, and pigs. A variety of techniques including wet mounts, prepared slides, classification sets, models, specimens, dissections, computer simulations, etc., may provide hands-on activities to reinforce students' learning. Commercial charts are also available that summarize the anatomy, physiology and life cycles of many organisms.
See Appendix A **Table 1: Kingdoms.** Note: viruses do not fit readily into the McGraw-Hill text classifications of living things, therefore, they are not included in the **Kingdoms** table.

The student tables presented in the appendices could be treated as resource based learning activities whereby students access resources outside the textbook to develop their knowledge. Information presented in the appendices represent core content.

As it is impossible to include a complete summary of the plant phyla, the focus within the plants should be on the comparison of nonvascular and vascular plants.
See Appendix A **Table 2: Plants.**

Diversity Among Living Things

Suggested Assessment Strategies

Presentation

- Students could select, with the teacher's guidance, a virus, or a member of one of the groups of organisms that were discussed. They could investigate a virus, using library or electronic research, the anatomy, physiology and life cycle of this organism. They could present the information on this organism to the rest of the class in the form of a model and/or poster and a brief oral report. They should be sure to include any new or surprising pieces of information they may collect, and to indicate where this organism might be found. (313-1, 316-6)

Journal

- Students could discuss the likihood of discovering a bryophyte in a desert. (316-6)
- Certain organisms have not changed greatly over time (e.g., sharks, crocodiles, turtles). Students could determine what features have allowed them to remain relatively unchanged. (316-6)
- Students could discuss why bryophytes are small. (316-6)

Laboratory Activities

- Students could observe vascular transport by placing celery stalks in food coloring. This may also be done using a fern. Wet mounts could also be made to observe the vascular tissue. (213-5, 316-6)
- Students could observe how food coloring travels through the vascular tissue of carnations by observing the edges of the petals, prior to and after supplying flowers in colored water. (316-6, 213-5)

Resources

throughout chapters 4-6

MGH Biology, pp. 164-167

throughout chapters 4-6

Table #1: *"Kingdoms",* **Appendix A**

Table #2: *"Plants",* **Appendix A**

MGH Biology, pp. 169-179

Diversity Among Living Things *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• describe the anatomy and physiology of viruses and organisms from each kingdom (316-6) **Cont'd**	
– explain why angiosperms are the most diverse plant group	To explain the diversity of angiosperms, discussion should include mention of these key factors: 1) the assistance of animals, wind, and water in pollination; 2) the presence of structures in plants specific to attracting certain animal pollinators whom the plants supply with food; 3) the way seeds are protected; 4) the function of fruits and specialized structures in seed dispersal, and 5) the presence of specialized tissues in plants to help them survive heat, cold, and drought.
– describe the differences that exist between the invertebrate phyla (symmetry, body cavity, reproduction, digestion)	See Appendix A **Table 3: Invertebrates**. In order to complete this table students should be presented with information on types of symmetry (asymmetry, radial, bilateral) and the differences between coelomates and acoelomates. This table, as well as the vertebrate table below, are intended to illustrate developmental trends for these organisms.
– explain why arthropods are the most successful phylum of animals	In discussing the diversity of arthropods reference can be made to insects which, biologically, are the most successful class of arthropods. Note the variety of characteristics contributing to the success of insects including adaptations for feeding, reproduction, and movement. Small body size, a short life cycle, social behaviour, and adaptations in appearance are also variously mentioned.
– describe the differences that exist between the vertebrate taxa (symmetry, body cavity, circulation, respiration, reproduction, endoskeleton)	See Appendix A **Table 4: Vertebrates.**
• analyze and explain the life cycle of a sample organism from each kingdom, including a representative virus (313-1)	The examples given are not necessarily representative of every member of each kingdom. In fact, students should now realize how difficult it is to select one representative organism for each kingdom.
– Life cycle of: (i) Virus - "T4" (ii) Bacteria/Archaea - *"E. coli"* (iii) Protista - "Plasmodium" (iv) Fungi - "Rhizopus" (v) Plantae - "Fern" (vi) Animal - "Frog"	Since Bacteria and Archaea have very similar life cycles it is unnecessary to study both. *E. coli* is an example of Bacteria and is a good representative of both. The retrovirus (HIV) has a more complex life cycle; however, students may find studying it more applicable. Teachers may choose to enrich by studying it.

Diversity Among Living Things *(continued)*

Suggested Assessment Strategies

Laboratory Activities

- Students could observe the organisms provided as samples of members of each kingdom. They should be sure to follow the directions specified for the use of the classification set, living or preserved specimens, dissections, computer simulation, or microscopy involving wet mounts or prepared slides. (316-6, 313-1)

  Assessment could be accomplished in a laboratory format through the completion of proper lab diagrams or assignment questions.

Resources

MGH Biology, pp. 174-179 and 181

Table #3: *"Invertebrates",* **Appendix A**

MGH Biology, pp. 182-186

MGH Biology, pp. 186-189

Table #4: *"Vertebrates",* **Appendix A**

MGH Biology, pp. 191-195

MGH Biology, p. 123
MGH Biology, p. 134
MGH Biology, p. 146
MGH Biology, p. 154
MGH Biology, p. 173
MGH Biology, p. 193

Unit 3: Maintaining Dynamic Equilibrium I
Specific Curriculum Outcomes
Suggested Time: 42 Hours

Maintaining Dynamic Equilibrium I

Introduction

Cells, tissues, organs, organ systems and ultimately organisms must maintain a biological balance despite changing external conditions. Homeostasis is the state of internal balance so critical to existence. It represents a dynamic equilibrium displaying constant interactions and checks and balances both within organisms and between organisms and their environment. There are a variety of systems within living things responsible for the maintenance of this delicate balance. This unit will identify and introduce the role of those plant and animal systems, including the circulatory, respiratory, digestive, excretory and immune systems. The vital links that exist between them will be investigated.

Focus and Context

This unit has its primary focus within the area of decision-making (STSE) as social and environmental issues are considered. This STSE component contributes to the development of scientific literacy and a sense of global citizenship. In addition, there are numerous opportunities for problem-solving and scientific inquiry incorporated into the discussion of the circulatory, respiratory, digestive, excretory and immune systems.

Science Curriculum Links

Biology students have studied the components of body systems at a number of different levels. Students in primary grades are introduced to the importance of maintaining a healthy lifestyle. When they reach the elementary level they begin to discuss the role of specific body systems in growth and reproduction. The major components of the structure and functions of the digestive, excretory, respiratory, circulatory and nervous systems are introduced. The contributions of the skeletal, muscular and nervous system to movement are also integrated into their study. In addition, body defences against infection and nutritional requirements to promote health are discussed. When students reach the intermediate level, they begin to consider the basic factors that effect the functioning and efficiency of the human respiratory, circulatory, digestive, excretory and nervous systems and are encouraged to discover and describe examples of the interdependence of various systems of the human body. These provide a good introduction to the role of systems in the maintenance of homeostasis discussed in more detail here. A cross-curricular link exists between the life sciences and physical sciences in the discussion of dynamic equilibrium incorporated into chemistry and physics.

Curriculum Outcomes

STSE

Students will be expected to

Nature of Science and Technology

115-5 analyse why and how a particular technology was developed and improved over time

Relationships between Science and Technology

116-4 analyse and describe examples where technologies were developed based on scientific understanding

116-7 analyse natural and technological systems to interpret and explain their structure and dynamics

Social and Environmental Contexts of Science and Technology

117-4 debate the merits of funding specific scientific or technological endeavours and not others

Skills

Students will be expected to

Initiating and Planning

212-6 design an experiment and identify specific variables

Performing and Recording

213-5 compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data

Analysing and Interpreting

214-3 compile and display evidence and information, by hand or computer in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots

214-15 propose alternative solutions to a given practical problem, identify the potential strengths and weaknesses of each, and select one as the basis for a plan

Communication and Teamwork

215-4 identify multiple perspectives that influence a science-related decision or issue

215-6 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

Knowledge

Students will be expected to

314-1 identify chemical elements and compounds that are commonly found in living systems

314-2 identify the role of some compounds, such as water and glucose, commonly found in living systems

314-3 identify and describe the structure and function of important biochemical compounds, including carbohydrates, proteins and lipids

317-1 explain how different plant and animal systems, help maintain homeostasis.

317-3 explain the importance of nutrition and fitness to the maintenance of homeostasis

317-4 identify, in general terms the impact of viral, bacterial, genetic and environmental diseases on the homeostasis of an organism

317-6 predict the impact of environmental factors such as allergens on homeostasis within an organism

Homeostasis

Outcomes

Students will be expected to

- explain the concept of homeostasis and its critical nature to living things (317-1)
  - define homeostasis including the concept of dynamic equilibrium
- explain the importance of temperature regulation in maintaining homeostasis (317-3)
  - define homeotherm and poikilotherm
  - describe how homeotherms maintain a dynamic equilibrium
  - discuss mechanisms of temperature control, behaviourial and physiological

Elaborations—Strategies for Learning and Teaching

During this section, students should be given the opportunity to study a variety of factors that affect the homeostasis of an organism. Through this, they will begin to appreciate the complexity of mechanisms involved in the maintenance of homeostasis. For an illustration of how human systems interact to maintain homeostasis refer to *MGH Biology* p. 301, MHR

Teachers might establish a scenario that could be used to show the interdependence between body systems and their importance in the maintenance of homeostasis. Students could brainstorm responses to the following questions: "What happens to your body as you run? Why?" Answers generated by students may include increased heart rate; breathing faster and deeper; thirst; sweaty and hot; tired; or sore muscles. Students should suggest why the body would respond in each of these ways and what body systems would be involved. An example could be increased heart rate (circulatory system)—increases the distribution of O_2/CO_2 (respiratory system) and sugar (digestive system) to and from the tissues.

Temperature regulation is only one of a number of the body's homeostatic mechanisms. Investigating the importance of temperature regulation is a good introductory example of the body's feedback mechanisms.

Some organisms incorporate behaviours to help control temperature. Examples include, lions moving to shady areas during mid-day sun, desert animals being primarily nocturnal.

Physiologically temperature control can be accomplished through the responses of the circulatory system. Vasoconstriction and vasodilation can assist in this.

Homeostasis

Suggested Assessment Strategies

Paper and Pencil

- Students could consider the following scenario and prepare a concept map to illustrate the interaction between the reactions produced and the body systems involved in the maintenance of homeostasis. Possible example: What happens to your body when you are frightened? What happens to your body when you have a cold? Or the flu? (317-3, 317-1, 215-6)

Journal

- When a person is sick they often feel tired. How is this related to the maintenance of homeostasis? (317-1, 317-4)

Presentation

- Using an analogy (e.g., a furnace) explain how your body maintains temperature. Present and explain your analogy to the class. (317-3, 217-1)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

MGH Biology, pp. 300-301

MGH Biology, p. 300

MGH Biology, pp. 300-303

Circulatory System

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• explain how the human circulatory system helps maintain homeostasis (317-1)	All organisms have some mechanism to circulate materials and dispose of wastes. Larger organisms require specialized transport systems in order to ensure all cells have access to materials required for survival and removal of wastes.
– explain the need for a transport system – explain how the circulatory system contributes to the maintenance of dynamic equilibrium through its role in the transport of heat energy and matter	
– describe the structure of an artery, vein and capillary, and, relate these structures to their function in blood circulation	Students could observe, within a laboratory situation, differences in the physical structure of an artery, vein and capillary by studying prepared microscope slides. Effects of external factors (temperature, caffeine) on peripheral blood flow can be investigated using liquid crystal thermometers.
– identify the main components of the human heart and explain the role of each. Include: (i) atria (ii) ventricles (iii) valves (bicuspid, tricuspid, semilunar) (iv) aorta (v) pulmonary vein (vi) pulmonary artery (vii) septum	Students should use models, dissections or computer simulations. They should also identify these structures through the use of drawings or photographs. Students should be aware that the left AV valve is the bicuspid value [2 sections], the right AV valve is the tricuspid value [3 sections]. The reason for the structural difference is due to the blood pressure differentials.
– trace the flow of blood through the heart and describe the pulmonary and systemic pathways	During this process students should have the opportunity to observe and appreciate how the structures control the direction of blood flow through a heart. Observation of a heart using preserved specimens, models or computer simulations will help students clarify how the structure of the heart allows it to function as a mechanical pump. Students could discuss the mechanics and sounds of the heartbeat in relation to this role.
– identify the main components of blood and explain the role of each. Include: (i) erythrocytes (ii) leukocytes (iii) platelets (iv) plasma	Within the laboratory, students could use the microscope to examine prepared slides of human blood and to observe the contrasting morphologies and relative abundance of the cellular components (red and white blood cells). Teachers should note that the clotting process should be covered while discussing the role of platelets.

Circulatory System

Suggested Assessment Strategies

Paper and Pencil

- Students could sketch the cellular components of blood, label any visible structures, and identify and label the different types of leucocytes. (213-5)
- Students could sketch diagrams of cross-sections of arteries, veins, and capillaries, and compare these cross-sections with those of diseased blood vessels. (213-5)
- Have students observe prepared slides of arteries, veins and capillaries. Students could sketch these. (213-5)

Resources

MGH Biology, pp. 304-305

MGH Biology, pp. 305-307

MGH Biology, pp. 314-315

MGH Biology, p. 315

MGH Biology, p. 320

MGH Biology, pp. 311-312

Circulatory System *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• carry out an experiment to relate blood pressure and physical activity and identify the specific variables involved (212-6)	The Laboratory outcomes (212-6, 213-5, 214-3, 214-4, 215-6) are addressed by completing *The Effects of Stress on Blood Pressure* CORE LAB #4.
• compile and organize data, using appropriate formats and data treatments, to facilitate interpretation of blood pressure data (213-5, 214-3)	Students could measure their own blood pressure (systolic and diastolic pressures) and investigate the role of posture, exercise or other activities on blood pressure. All group or class data can be organized and displayed in graph or table form.
• identify multiple perspectives that influence a science-related decision or issue (215-4)	
• work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (215-6)	
• identify the impact of circulatory diseases on the homeostasis of an organism (317-4) – describe disorders linked to the circulatory system and their effect on the homeostasis of the system and the organism as a whole. Include: (i) hypertension (ii) atherosclerosis (iii) arteriosclerosis	The specific diseases of the circulatory system should be discussed or researched along with the capability of technology to diagnose, treat or cure the problem (angioplasty, clot-busting drugs). Students may research, assess and debate the effect that lifestyle choices play in the development of these disorders and the importance of promoting continued physical fitness.
• analyze why and how technology related to the treatment of circulatory disorders was developed and improved over time (115-5) – describe the progress from bypass surgery to modern techniques. Include: (i) shunts (ii) angioplasty (iii) clot-busting drugs	Students may be interested in investigating additional disorders related to the circulatory system—varicose veins, heart murmur, aneurysm, blood clots, leukemia, pulmonary edema (congestive heart failure).

Circulatory System *(continued)*

Suggested Assessment Strategies

Laboratory Activities

- Students could perform lab activities that are designed to illustrate some aspects of a transport/circulatory system. These may include measurement of blood pressure and heart rates, dissection of available specimens to observe the heart and circulatory systems, and effects of external factors on peripheral blood flow. (212-6, 213-5, 214-3)

  Assessment would depend on the nature and depth of the activities selected. Many of these activities involve collection of data that can be tabulated and graphed. Enrichment may be provided by allowing students the opportunity to design their own investigations from questions that these activities may generate. For example, students may compare the heart rate/blood pressure of a smoker versus a non-smoker; athlete versus non-athlete.

  Teachers should ensure that students are aware that interpretation of statistical data from small sample sizes may not reflect the true nature of the general population.

Presentation

- Students could research and present, in a variety of formats, disorders linked to the circulatory system, and modern methods of diagnosis and treatment.(317-1, 317-3, 214-3)
- Teachers could expose students to individuals knowledgeable in circulatory pathologies by using community resources such as physicians, organizations (Heart and Stroke Foundation), sufferers of these disorders or transplant recipients. They could research and prepare questions related to the topic being presented by the guest speaker. Working in groups, these questions should be reviewed and revised, and questions selected to be asked during the presentation. Following this presentation, students may be asked to prepare a brief summary of it, or of the answers to questions. Assessment may be based on a student summary of the guest's talk or answers provided to one or more of their questions. (213-5, 115-5, 214-3)

Journal

- Why do some doctors recommend heart patients take one tablet of ASA (Aspirin ™) a day? (115-5)

Resources

Core Lab #4: *"Blood Pressure"*

– The Effect of Stress on Blood Pressure pp. 324-325

Respiratory System

Outcomes

Students will be expected to

- explain how the human respiratory system helps maintain homeostasis (317-1)
  - explain the need for a respiratory surface in humans
  - identify and state the function of:
    (i) nasal cavity
    (ii) trachea
    (iii) bronchi
    (iv) bronchioles
    (v) alveoli
    (vi) diaphragm
  - investigate the mechanics of inhalation/exhalation and the regulation of the breathing cycle
- carry out an experiment to collect data on respiratory function and identify the specific variables involved (212-6)
- compile and organize data, using appropriate formats and data treatments, to facilitate interpretation of a completed respiratory activity (213-5)

Elaborations—Strategies for Learning and Teaching

Students should be reminded that humans require a respiratory surface for gas exchange and ultimately to provide O_2 for respiration at the cellular level.

The respiratory surface must be moist and large enough for efficient gas exchange. Students should realize that moisture is required to allow gases to dissolve and to allow cross-membrane transport. A large surface area aids in efficiency and accounts for the advantage of the mammalian lung.

Students may construct a model to illustrate the functioning of the diaphragm in respiration. A popular design involves the use of a bell jar, balloons to represent lungs and a membrane for the diaphragm.

The Laboratory outcomes (212-6, 213-5, 214-3, 214-4, 215-6) are addressed by completing *Measuring Respiratory Volumes* CORE LAB #5.

There are many short activities that students could undertake during their investigation of the respiratory system. Students could design and/or perform experiments to investigate the mechanics of breathing. These might include measurement of lung volume and vital capacity using a spirometer, measurement of breathing rates at different times of rest or activity, and measurement of the carbon dioxide content of exhaled air.

Both individual and class data can be compiled and organized in tabular and graphic form by hand or using available technology. Comparisons can be made of lung functions between different groups of individuals in the class based on the class demographics such as smokers and non-smokers; athletes and non-athletes; asthmatics and non-asthmatics; asthmatics before and after using an inhaler; correlation with gender and mass. Students should be aware that correlation does not imply causation.

Respiratory System

Suggested Assessment Strategies

Laboratory Activities

- Students could perform the available activities designed to illustrate some aspects of the respiratory system. These might include the following:
  - measurement of lung volume and vital capacity using a spirometer
  - measurement of breathing rates under different conditions
  - measurement of carbon dioxide concentration in inhaled or exhaled air
  - dissection of available specimens to observe the systems of respiration
  - investigation of air quality indices
  - development of a model illustrating effect of the diaphragm (212-6, 213-5, 317-1)

  Assessment would depend on the nature and depth of the activities selected. Many of these activities involve collection of data that can be tabulated and graphed. Enrichment may be provided by allowing students the opportunity to design their own investigations from questions that these activities may generate. For example, students may compare the vital capacity of a smoker versus a non-smoker; athlete versus non-athlete; asthmatic versus non-asthmatic; male versus female.

  Teachers should ensure that students are aware that interpretation of statistical data from small sample sizes may not reflect the true nature of the general population.

Resources

MGH Biology, pp 334-339

Core Lab #5: *"Respiratory Volumes"*

- Measuring Respiratory Volumes, pp. 340-341

Respiratory System *(continued)*

Outcomes

Students will be expected to

- identify how respiratory diseases affect the homeostasis of an organism (317-4)
  - investigate the disorders:
    (i) lung cancer
    (ii) asthma
    (iii) pneumonia

- predict the impact of environmental factors, such as allergens, on homeostasis within an organism (317-6)
  - identify the impact of environmental factors on the respiratory system of an asthmatic
    (i) cigarette smoke
    (ii) allergens (dust, mould, food)
    (iii) petrochemical fumes, perfumes

Elaborations—Strategies for Learning and Teaching

The specific pathologies of the respiratory system created by respiratory disorders should be discussed or researched along with the capability of technology to diagnose, treat or cure the problem.

Students may choose to investigate additional respiratory disorders such as bronchitis or emphysema. Students may choose to research treatments of these disorders.

Students may discuss other environmental concerns related to respiratory difficulties and clean air, including the 'scent free' policy that exists within many public buildings, 'sick' building syndrome and smog.

Students could investigate the existence of air quality indices, what they measure and the units used. Records of these can be obtained for local areas over periods of time and the data graphed or presented in tabular form. Students can hypothesize reasons for varying air quality indices (correlation with weather, environmental events) and the effects on individuals with respiratory difficulties when these indices register high readings.

Students could be asked to assess and debate or discuss the effects of legal and over the counter drugs on the functioning of the respiratory system, including but not exclusive to nicotine, codeine and prescription medicines. Students might be asked to investigate provincial and community standards on smoking in public places and tobacco advertising. Debates/discussions may involve a discussion of the rights of the smoker versus the non-smoker; the issue of exposure to second hand smoke; why smoking remains a growing habit among youth, particularly among young women; whether high schools should provide a smoking area for their students. Alternate approaches to stopping smoking can be investigated (e.g., nicotine gum, patches, acupuncture, hypnotism) and their relative effectiveness compared.

Respiratory System *(continued)*

Suggested Assessment Strategies

Presentation

- Within a debate, students could be required to display the results of research and "argue" against other stakeholders concerning issues such as: "Should smoking be allowed in public places? Should tobacco companies be permitted to sponsor sporting events? Should tobacco advertising be permitted?" In some provinces, young people cannot purchase cigarettes until the age of 19, yet it is not illegal to smoke at a younger age. Is this hypocritical? Should schools provide their students with a smoking area? Sectors of society that will be considered may include: lung cancer victim, executive from tobacco company, student, smoker, or clean air activist. Teachers could assess the participation of selected students, on the bases of preparation of the argument and thoroughness of the research. (117-4, 116-4, 213-5, 215-4, 215-6)
- Teachers could expose students to individuals knowledgeable in respiratory pathologies by using community resources such as physicians, organizations (Lung Association, Canadian Cancer Society) or sufferers of these disorders. (214-3)
- Students could research and prepare questions related to the topic being presented by the guest speaker. Working in groups, these questions should be reviewed and revised, and questions selected to be asked during the presentation. Following this presentation, students may be asked to prepare a brief summary of it, or of the answers to questions. Assessment may be based on a student summary of the guest's talk or answers provided to one or more of their questions. (116-4, 117-4, 215-4, 215-6, 214-3, 317-6, 317-1)

Journal

- The incidence of respiratory ailments, such as bronchitis is much greater in urban than rural environments. What factors might be responsible for this difference? (317-6)

Resources

MGH Biology, p 344
MGH Biology, p 346
MGH Biology, p 345

MGH Biology, pp 346-348

Digestive System

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• explain how the human digestive system helps maintain homeostasis (317-1)	Students should be aware that the purpose of digestion is to convert large molecules into smaller ones capable of being utilized by the cell.
– describe the purpose and functioning of the digestive system	
– define mechanical and chemical digestion and explain the relationship between them	
– identify the major organs and glands of digestion and investigate their role in the digestive process Include: (i) salivary glands (ii) stomach (iii) liver (iv) pancreas (v) gall bladder (vi) small intestine (vii) large intestine	The chart provided in Appendix A represents the minimum level of student understanding. Teachers could supplement this material as time and resources permit.
– trace the pathway of food through the human digestive tract and explain the efficiency of its structure (i) teeth (ii) taste buds (iii) tongue (iv) mucous lining (v) sphincters (vi) villi (vii) peristalsis	Students should be provided with the opportunity to observe the principal features of the digestive system, utilizing models, computer simulations or dissection, and to identify those structures through the use of drawings or photographs. Teachers could relate the function of intestinal villi to active transport. In active transport, materials are carried across the cell membrane. Intestinal villi increase surface area for absorption of amino acids, sugars, and peptides from the intestines into the blood vessels. Fats are transported to the liver.

Digestive System

Suggested Assessment Strategies

Laboratory Activities

- Students could perform lab activities that illustrate some aspects of the digestive system. These may include utilizing qualitative and/or quantitative tests to detect the presence within food of organic substances such as carbohydrates, lipids and proteins or the dissection of available specimens to observe the systems of digestion. Assessment would depend on the nature and depth of the activities selected. (212-6, 213-5, 317-1)

Journal

- Individuals who have had much or even all of their digestive system damaged or diseased can still survive. How is his possible? (317-1)
- After having surgery to remove the gall bladder, how would a patient have to modify his/her diet? (317-1)

Resources

MGH Biology, p. 354

MGH Biology, p. 359

Table #5: ***"Digestion",*** **Appendix A**

MGH Biology, p. 359
MGH Biology, p. 360
MGH Biology, p. 365
MGH Biology, p. 368
MGH Biology, p. 368
MGH Biology, p. 361
MGH Biology, p. 362

MGH Biology, pp. 359-362

Digestive System *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• identify chemical elements and compounds that are commonly found in living systems (314-1) – identify the six basic nutrients: carbohydrates, lipids, proteins, vitamins, minerals and water and determine the sources of each of these nutrients	Outcomes 314-1 and 314-2 describe both the identification of the chemicals (nutrients and enzymes) involved in digestion, and their role in digestive processes. An alternative approach is to identify all the chemicals first, then to describe their role in the digestive process, or investigate each individually.
• identify the role of some compounds involved in digestion (314-2) – discuss the role of the six basic nutrients – discuss the general role of enzymes and secretions, and the role of these substances pertaining to the digestive system	
• identify and describe the structure and function of the important biochemical compounds, carbohydrates, proteins and lipids (314-3) – explain the role of hydrolysis and dehydration reactions within the digestive process – discuss the basic structural units of carbohydrates, lipids and proteins – discuss the basic structure of carbohydrates, lipids and proteins – describe the end products of digestion for carbohydrates, lipids and proteins	To understand this component of the biology course, it is sufficient for students to simply recognize that the large molecules of carbohydrates, proteins and lipids consist of basic smaller components that are the product of digestion. Hydrolysis is the breaking apart of larger biochemical molecules by the addition of the parts of a water molecule, H^+ and OH^-. Dehydration synthesis or condensation reactions refers to the removal of a water molecule during the joining of two molecules, such as amino acids or sugars.

Digestive System (continued)

Suggested Assessment Strategies

Performance

- To reinforce the steps in the digestive process, teachers could have students imagine that they are eating a meal containing starches, proteins, and fats. Then ask them to think about what happens to each of these food molecules as they pass through the digestive tract. Teachers could choose one student to begin the process by naming the first digestive compartment (the mouth) and describing what happens to one of the food molecules in that location (e.g., chunks of protein are chewed by the teeth). They might then ask the next student to describe what happens to another type of food molecule in that same location (e.g., starch is hydrolzed by amylase). Continue around the room naming compartments and processes until the end of the digestive tract is reached. (314-2)

Presentation

- Design a webpage that illustrates the utilization of the six Basic nutrients. (314-2, 214-3)

Resources

MGH Biology, pp. 354-358

MGH Biology, pp. 355, 363-364, 42-46

Digestive System *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• carry out an experiment to investigate the effect of specified variables on the effectiveness of an enzyme (212-6)	The Laboratory outcomes (212-6, 213-5, 214-3, 214-4, 215-6) are addressed by completing *What's Here? Testing Macromolecules* CORE LAB #6.
• compile and organize data, using appropriate formats and data treatments, to facilitate interpretation of the data from a completed digestive activity (213-5)	Experiments can be performed to detect the presence in food of organic molecules, such as carbohydrates, lipids and proteins, using qualitative and/or quantitative tests. Calorimetry experiments can be designed and/or performed to determine in a quantitative fashion the potential energy found in carbohydrate or lipid food materials. Data can be recorded, displayed and food categories compared. Students could perform laboratory activities to demonstrate the action of digestive enzymes on an animal or plant tissue (egg white) or prepared solution (starch). Students could design and/or perform experiments to investigate the influence of enzyme concentration, temperature and pH on the activity of these enzymes. Students may design an experiment to investigate the relative effectiveness of commercially advertised antacid products. Teachers should be aware that student's saliva should not be collected for investigations.
• describe disorders and the treatment of disorders linked to organs of the digestive system and their effect on the homeostasis of the system and the organism as a whole. (317-4) Include: (i) ulcers (ii) gall stones (iii) ileitis/colitis	The specific pathologies of the digestive system created by digestive disorders should be discussed or researched along with the capability of technology to diagnose, treat or cure the problem. Students may discuss other conditions related to digestive function, such as cancer, Crohn's disease, or celiac disease. Students can be asked to assess and debate or discuss the effects of legal and over the counter drugs on the functioning of the digestive system including but not exclusive to alcohol, codeine and prescription medicines. Students could be asked to debate or discuss the question of whether society can, or should, play a more proactive role in promoting the improvement of diets and the prevention of diseases versus a more reactive role in the treatment of these diseases.

Digestive System *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Working in groups, students could gather nutritional information about a minimum of three fast food/restaurant menus. Some possible sources of this information would be from the restaurants themselves, dieticians, or the Internet. Students could design what they think is the healthiest "take out" meal plan possible for three days. How does the plan compare to the recommendations in Canada's Food Guide? (213-5)

Laboratory Activities

- Students could perform lab activities that illustrate some aspects of the digestive system. These may include calorimetry activities to determine the energy value in foods or tests for the action of digestive enzymes on animal or plant tissue. Assessment would depend on the nature and depth of the activities selected. Enrichment may be provided by allowing students the opportunity to design their own investigations from questions that these activities may generate. For example, students may investigate what would be the optimal temperature or pH for activity of a given enzyme. (212-6, 213-5, 317-1)

Resources

Core Lab #6: *"What's Here? Testing Macromolecules"*, pp. 356-357
Chemistry 3202 Core STSE, #3 *"What Fuels, You"*

MGH Biology, pp. 368-373

Digestive System *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• explain the importance of fitness and nutrition in maintaining homeostasis (317-3)	Students could investigate the terms "healthy nutrition" and "fitness." Students could suggest what aspects of their bodies or what body systems are involved in the achievement of health and fitness. Example: Students may suggest that a balanced diet is important and propose a connection with the digestive system to break down the food, circulatory system to distribute nutrients, etc. This provides another opportunity to have students establish the interrelationships between systems within the body as they work to maintain homeostasis.
• propose alternative solutions to a given practical problem, identify the potential strengths and weaknesses of each, and select one as the basis for a plan (214-15) – investigate the value of vitamins, minerals and herbal supplements in support of a healthy lifestyle	Many individuals routinely consume various vitamins, minerals and herbal supplements in their search for a healthy lifestyle. Students could research and investigate the origins of and the claims made by manufacturers of these herbal medicines (e.g., *Echinacea*, St. John's Wort, *Gingko biloba*, garlic, etc.) and any scientific basis or data that exists for these assumptions.
• identify multiple perspectives that influence a science-related decision or issue (215-4) – evaluate how nutritional deficiency and starvation diets such as bulimia and anorexia nervosa can adversely affect the dynamic equilibrium – discuss whether the images portrayed through the media and advertising promote positive self image and a healthy lifestyle for men and women	The media inundates the public with information on fad diets. Students could be asked to investigate the physiological basis of these diets (e.g., high protein, high carbohydrate, low fat), their safety and effectiveness. They may include more drastic weight loss measures that involve anatomical operations such as stomach stapling or removal of a portion of the small intestine. For enrichment, students could also choose to: • research and debate the safety and necessity of food additives, food irradiation and other technologies used to improve the shelf life or the attractiveness of food products • examine the relative value of the use of processed versus non-processed foods • examine the use of pesticides on food crops • examine the necessity of techniques used only to make food more visually appealing to the consumer • discuss the question of where our food comes from • examine the potential of the inadvertent introduction of foreign organisms to an ecosystem through the importation of food

Digestive System *(continued)*

Suggested Assessment Strategies

Presentation

- Teachers could bring in presenters such as physicians, organizations (Ileitis and Colitis Association, Canadian Liver Association) or sufferers of these disorders (anorexia nervosa). They could research and prepare questions related to the topic being presented by the guest speaker. Working in groups, these questions should be reviewed and revised, and questions selected to be asked during the presentation. Following this presentation, students might be asked to prepare a brief summary. Assessment may be based on a student summary of the presentation. (116-4, 117-4, 215-6, 317-4, 317-6)

Paper and Pencil

- Students could research and collect information on alternate diets that are currently proposed or advertised within the media, surgical approaches to deal with the problem of obesity, and the potential health effects of these. Information could be presented to the class as a whole. Students might select a herbal health supplement and investigate the health claims that the manufacturers of these products make. Alternately, students might investigate the health benefits and sources of vitamins and minerals within the diet. Information will be presented to the class as a whole and students will subsequently place the information on a poster board designed to collate the essential elements of the class information for classroom or school display. Students could select a situation requiring dietary restrictions such as lactose or gluten intolerance, investigate its prevalence, causes, and methods employed to control the symptoms. (215-4, 317-1, 317-3)
- An opportunity to integrate the digestive and respiratory system is provided here. Students could research and present the effects of legal drugs, illegal drugs, over the counter, and prescription drugs on the functioning of the digestive and respiratory systems. Groups would be assigned different categories of drugs and the resulting presentations will thereby provide an overview of this topic. Assessment would be based upon thoroughness of research and accuracy of information presented. (215-4, 317-1)

Resources

MGH Biology, pp. 370-371

MGH Biology, pp. 372-373

Excretory System

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• explain how the excretory system, helps maintain homeostasis (317-1)	Excretory systems maintain homeostasis with respect to water, salt and metabolite concentrations within the blood.
– explain how the following act as organs of excretion (i) lungs (ii) skin (iii) liver (iv) kidney	Students may oversimplify the excretory system by thinking it is all about the kidney (which removes metabolic wastes). Several other organs involved in the excretory system are often overlooked. The lungs (which remove CO_2), the skin (which removes heat), and the liver (which removes metabolic wastes) are vital organs that play a major role in the excretory system. Students should investigate their role in maintaining homeostasis.
– explain the role of the kidney as an excretory organ in removing metabolic wastes from the body – identify and describe the main structures of the human urinary system including kidney, ureter, bladder, and urethra	Students should be provided with the opportunity to observe the principal features of the human excretory system, utilizing models, dissection or computer simulations, and to identify those structures through the use of drawings or photographs. Diagrams or charts could be used to illustrate the structure of the nephron and to emphasize its role as the working unit of the kidney. Microscopic analysis of a kidney cortex section could provide some visual confirmation of the structural components of the kidney.
– identify and describe the internal structure and function of the kidney, including the cortex, medulla and pelvis – identify and describe the function of the glomerulus – identify and explain the function of the parts of a nephron. Include: (i) Bowman's capsule (ii) loop of Henle (iii) tubules-proximal and distal (iv) collecting duct	Students will recognize the kidney's structure as including the cortex, medulla and pelvis, and the filtration and reabsorption functions of the nephron. Students could perform experiments to investigate simulated urine composition, perform data analysis and summarize the role of the kidney in homeostatic regulation of pH, water and ionic substances.
• describe disorders linked to the excretory system and their effect on the homeostasis of the system and the organism as a whole (317-4) Include: (i) kidney stones (ii) kidney infections (iii) bladder infections	The specific diseases of the excretory system created by excretory disorders could be discussed or researched along with the capability of technology to diagnose, treat or cure the problem. Students may discuss other disorders related to kidney function, including diabetes and nephritis. Teachers could discuss the effects of lifestyle on the homeostasis of the excretory system and have students hypothesize why consumption of alcohol induces more trips to the washroom than does the consumption of water alone.

Excretory System

Suggested Assessment Strategies

Laboratory Activities

- Students could perform lab activities that might include microscopic examination of a kidney cortex, investigations using simulated urine, dissection of available specimens to observe the systems of excretion, and observation of the contractile vacuole in paramecium. (212-6, 213-5, 317-1)

  Assessment would depend on the nature and depth of the activities selected. Enrichment may be provided by allowing students to design their own investigations from questions that these activities may generate.

Presentation

- Teachers could bring in presenters such as physicians, organizations (Kidney Foundation) or sufferers of these disorders (dialysis patients, transplant recipients). Students could research and prepare questions related to the topic being presented by the guest speaker. Working in groups, these questions should be reviewed and revised, and questions selected to be asked during the presentation. Following this presentation, students might be asked to prepare a brief summary. Assessment may be based on a student summary of the presentation. (115-5, 213-5, 214-3)

Paper and Pencil

- Students could sketch a longitudinal section of the kidney and label the cortex, medulla, pelvis, renal artery and renal vein. (213-5)

Journal

- What effect on your lifestyle would a non-functioning bladder have? (317-1)

Resources

MGH Biology, p. 374 and throughout section 11.3

MGH Biology, p. 374

MGH Biology, pp. 374-378

Excretory System *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• analyze and describe examples where technologies were developed, based on scientific understanding, to treat renal failure (116-4, 115-5) – briefly explain how the technology of dialysis works	The CORE STSE component of this unit incorporates a broad range of Biology 2201 outcomes. More specifically, it targets (in whole or in part) 115-5, 116-4, 116-7, 117-4, 215-4, and 317-4. The STSE component, *Kidney and Urological Diseases*, can be found in Appendix B. Kidney shutdown or renal failure may result from a variety of conditions and can lead to many deleterious effects including abnormal concentrations of salt and water, altered pH and general deterioration of homeostasis. Ideally, dialysis is a temporary measure used to replace normal kidney functioning until the kidneys begin to function again on their own, or in more serious cases, until a transplant becomes available.
• analyze natural and technological systems to interpret and explain their structure and dynamics (116-7) – compare the human kidney system with that of kidney dialysis technology – briefly explain why dialysis is a temporary measure for treating kidney disease	The discussion of dialysis should be limited to the fundamental aspects of how kidney dialysis functions. Kidney dialysis is the process whereby blood is removed from the body, harmful metabolic waste products are removed from the blood by the processes of osmosis and diffusion and the processed blood is returned to the body. This process has limitations.
• discuss the merits of funding kidney transplant therapy versus improvements in dialysis technology (117-4) • identify multiple perspectives that influence a science-related decision or issue (215-4)	Students could consider the implications of the utilization of other species as potential donors. Students could, in groups, propose guidelines for selecting the most appropriate expenditures. They could then debate and defend their choices.

Excretory System *(continued)*

Suggested Assessment Strategies

Presentation

- Students could be assigned to a group and given directions to research a topic in preparation for a debate. The format of this debate would require them to display the results of their research and "argue" against other stakeholders concerning issues such as selection procedure for organ transplant recipients, ethics of the sale of human organs (developing countries), ethics of organ transplants across species. Assessment may be based on the participation of selected students, preparation of the argument, thoroughness of the research and/or written summary. (115-5, 117-4, 214-3, 213-5)
- Students would present, in various formats, a summary of their kidney dialysis research. (115-5, 117-4, 213-5, 214-3)

Paper and Pencil

- Students could research information about kidney dialysis. Why is it used? What type of person is a dialysis candidate? What different methods are available? What complications are possible? (116-7)

Resources

Core STSE #2: *"Kidney and Urologic Diseases",* **Appendix B**

MGH Biology, pp. 377-379

MGH Biology, pp. 377-381

Immune System

Outcomes

Students will be expected to

- predict the impact of environmental factors on homeostasis within an organism (317-6)
  - explain the meaning of antigen (allergen) and antibody, and their role in an allergic reaction

Elaborations—Strategies for Learning and Teaching

Students should be aware that a properly functioning immune system is essential for health and well being, and recognize the consequences that result when the immune system does not function properly. Students should be aware of the sequence of the general physiological events that result in an allergic reaction and identify the resulting symptoms. The typical symptoms of runny nose, swollen eyes, sneezing, coughing, and rash are caused by a release of highly active substances, including histamine, from body cells at the site of the immune reaction (production of special antibodies against the allergen). Histamine induces an inflammatory reaction, as it does whenever there is an injury or infection. Students should be able to describe how allergic responses affect the maintenance of homeostasis within an organism. This may be accomplished through a comparison of the following questions: "How would the body have responded to the presence of an allergen (pollen) in a non-allergic or non-sensitive individual? How does the body respond in an allergic individual?"

Students could investigate and compare respiratory allergies such as hay fever with food allergies. It is important to understand how and why some allergies are severe enough to be life threatening (anaphylaxis) and the significance of the accurate labeling of commercial food products. Students could investigate the prevalence of use and the effectiveness of over the counter antihistamines and decongestants and allergy shots to control allergies. The methods by which these medications relieve the symptoms can be investigated.

Immune System

Suggested Assessment Strategies

Journal

- What concerns would you expect a potential kidney donor to have? (117-4)

Presentation

- Students could select an herbal supplement or vitamin and investigate its effect on the functioning of the immune system. They could prepare a poster for display. They should be sure to include both natural and synthetic sources of these products. (115-5, 116-4, 213-5, 317-1, 317-4)
- Students could investigate the natural response of the body to a bacterial infection or a viral disease such as a cold or the flu. They could investigate the mechanism of selected auto-immune disease (rheumatoid arthritis, myasthenia gravis, multiple sclerosis, rheumatic fever, systemic lupus erythematosus (lupus), thyroiditis). Students would be expected to present to the class the symptoms of the disorder. Assessment would be based on thoroughness and accuracy of information. Alternately, this activity could become a research activity where work is passed in for written assessment. (115-5, 116-4, 215-4, 317-1, 317-3, 317-4, 317-6)

Paper and Pencil

- To supplement the study of the allergic process, students could prepare and conduct a survey on the prevalence and variety of allergies within the school population and the remedies used to alleviate symptoms. Data would be tabulated, graphed by hand or utilizing available technology and presented via a bulletin board display to the school population in general. Assessment would be based on the efficiency of the survey and its presentation. (213-5, 214-15, 317-1, 317-6)

Resources

MGH Biology, pp. 382, 386

Immune System *(continued)*

Outcomes

Students will be expected to

- explain how the immune system helps to maintain homeostasis (317-1)
  - explain the complete immune response
    (i) 1st line of defence (physical and chemical barriers)
    (ii) 2nd line of defence (inflamatory response)
    (iii) 3rd line of defence (immune response)
  - compare the role of white blood cells in the defence process including phagocytes and lymphocytes
  - compare the mechanism of acquired immunity including passive (breast milk) and active (actual exposure, vaccines)
- identify how autoimmune disorders cause diseases such as rheumatoid arthritis (317-4)
- analyze why and how a particular technology was developed and improved over time (115-5)
- analyze and describe examples where technologies were developed based on scientific understanding (116-4)
- debate the merits of funding specific scientific or technological endeavors and not others (117-4)
- identify in general terms the impact of viral, bacterial, genetic, and environmental diseases on the homeostasis of an organism (317-4)

Elaborations—Strategies for Learning and Teaching

A study of the non-specific first line defences would include both physical and chemical barriers such as skin, sweat and stomach acids. The inflammatory response and phagocytes as second line defenders and the immune response involving T cells, B cells and antibody production should be summarized. A visual display (chart or sketch) of the role of each of these factors in the body's defence system may help students grasp the basics of these concepts. This discussion may be expanded to include the role of the lymphatic system within the immune response. Students can expand their study by investigating how vaccines make use of the workings of the immune system in order to be effective and by studying the requirements, interest and financial resources society has to support the prevention of the spread of disease-causing organisms such as HIV, *Staphylococcus*, and smallpox. Some herbal supplements (*Echinacea*) claim that they boost the immune system. Students may investigate these claims and investigate the antioxidant (chemical altering of free radicals) nature of Vitamins E, C and beta-carotene, and the relevance of these to the health of the human population (e.g., link with cancer and cardiovascular disease).

The CORE STSE component of this unit incorporates a broad range of Biology 2201 outcomes. More specifically, it targets (in whole or in part) 115-5, 116-4, 117-4, 317-1, and 317-4. The STSE component, *Hodgkin's Disease*, can be found in Appendix B.

Immune System *(continued)*

Suggested Assessment Strategies

Laboratory Activities

- Students could suggest a hypothesis and design an experiment to investigate the antimicrobial nature of substances such as mouthwash, and extracts from a variety of plants (garlic, ginger, aloe). They could compare the effectiveness of soaps or other cleaning products labeled antibacterial with those of the same brand that are not labeled as such. (212-6, 317-1, 317-6)

Performance

- Once the experiments have been designed and the design approved, there is opportunity for assessing how students actually perform the activities. Do they follow the design, use correct and safe techniques, troubleshoot as required? (213-5, 317-1, 317-6)

Resources

MGH Biology, pp. 382-385

MGH Biology, p. 386

Core STSE #3: *"Hodgkin's Disease",* **Appendix B**

Unit 4: Interactions Among Living Things
Specific Curriculum Outcomes
Suggested Time: 10 Hours

Interactions Among Living Things

Introduction

During a discussion of human ecology (the relationship between the human population and the environment), students will build on their understanding of the basics of ecology and ecosystems and certain principles of population dynamics. It is important that they understand the many interrelationships affecting human population growth and dynamics, and the issues facing global population growth, particularly the subsequent and continuous pressure being placed on the natural resources of the globe.

Focus and Context

Within this section of study, a variety of curriculum outcomes are met through the integration and discussion of a number of societal and sustainability issues. Therefore, the primary focus is within the decision-making and STSE mode. There does remain, however, opportunity for observation and inquiry.

Science Curriculum Links

This unit on population dynamics connects with other clusters in the science curriculum primarily at elementary and intermediate and building to Level I. Previous to this, primary students learned how humans and other living things depend on their environment. They expand on this by describing features of environments that support the health and growth of animals. The major focus in elementary grades is on habitats and community, including the identification of regional and local habitats and how the removal of plant or animal populations would effect the remainder of the community. The life science portion of the curriculum in intermediate grades concentrates on interactions within ecosystems, an introduction to biotic and abiotic factors, the flow of energy within an ecosystem through producers, consumers and decomposers, and ecological succession. Science 1206 continues to build on this background with its more in-depth look at the sustainability of ecosystems, discussion of characteristics and responses of ecosystems, cycling of matter through biotic and abiotic components, and an introduction to ways in which natural populations are kept in equilibrium in relation to the availability of resources. By the time students arrive in Biology 2201, they have a broad background through which to pursue their study of interactions among living things.

Curriculum Outcomes

STSE	Skills	Knowledge
Students will be expected to	*Students will be expected to*	*Students will be expected to*
Contexts of Science and Technology	Performing and Recording	
118-10 propose courses of action on social issues related to science and technology, taking into account an array of perspectives, including that of sustainability	**213-5** compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data	**318-8** describe population growth and explain factors that influence population growth
	213-6 use library and electronic research tools to collect information on a given topic	**318-10** evaluate Earth's carrying capacity, considering human population growth and its demands on natural resources
	Analysing and Interpreting	
	214-3 compile and display evidence and information, by hand or computer in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots	
	214-7 compare theoretical and empirical values and account for discrepancies	
	Communication and Teamwork	
	215-6 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise	

Population Change

Outcomes

Students will be expected to

- describe population growth and explain factors that influence it (318-8)
  - describe how population growth is dependent upon the difference between natality and mortality rates and a balance between emigration and immigration
  - distinguish between density independent and dependent factors
  - explain how biotic potential, environmental resistance and carrying capacity interact in population dynamics
- compile and organize data, using appropriate formats and data treatments, to facilitate interpretation of the data (213-5)
- compile and display evidence and information in a variety of formats (214-3)
- work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (215-6)

Elaborations—Strategies for Learning and Teaching

Students can take an example of a local or regional endangered species and review the determinants of population: natality, mortality, emigration, and immigration. Students can then brainstorm factors that affect human natality and mortality. This exploration may lead to the following question for discussion "Why should we be concerned about the Earth's carrying capacity for the human population?"

Students should analyze and describe the limiting factors that regulate population size within ecosystems. Some of these are competition, environmental quality, disease, parasitism, predation, and stress.

The concept of environmental quality can include the availability of food, shelter and water, and the climate. Students can design and/or perform an experiment to demonstrate the effect of environmental factors on human growth.

The Laboratory outcomes (213-5, 213-6, 214-3, 214-7, 215-6) are addressed by completing *Sampling Hare Populations* CORE LAB #7.

Population Change

Suggested Assessment Strategies

Paper and Pencil

- Students could investigate a threatened or endangered species and prepare a visual display on this organism. They should try to find a local species. The report should include a diagram, estimated current population and reasons for endangerment, as well as interventions necessary to alleviate the problem and any difficulties there may be with their implementation. The intent would be to prepare a bulletin board display for observation by the entire school to ensure that the work is of display quality. Assessment will be based on accuracy of information collected and its presentation. (213-5, 213-6, 214-3, 318-8)
- Given demographic data from various regions of the world, students could produce graphs that show different population growth patterns. (118-10, 214-3, 215-6, 318-8, 318-10)

Resources

www.gov.nl.ca/edu/science_ref/main.htm

MGH Biology, pp. 225-226

MGH Biology, pp. 233-237 and throughout section 7.3

MGH Biology, pp. 243-244, 226

Core Lab #7: *"Sampling Hare Populations"* pp. 238-239

Population Change *(continued)*

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	
• compare theoretical and empirical population values and account for discrepancies (214-7) – examine and label the sections of an S-shaped (logistic) and J-shaped (exponential) growth curve (i) lag (ii) exponential (iii) equilibrium – compare how J & S curves describe the general population growth patterns observed in animal populations – explain the predator-prey cycle with respect to population growth curves	Students should recognize that the shape of the "S" in the S-shaped curve varies depending on the growth strategy of the species (many offspring with little parental investment, few offspring with much parental investment). Students should recognize that there is no equilibrium section in a J-shaped curve. The J-shaped curve generally exists in a manipulated situation.
• gather and examine information on the limiting factors that work to influence human population growth (213-6) – describe the limiting factors within the human population (i) space (ii) war (iii) disease (iv) poverty	Limiting factors such as space, war, disease and poverty reflect competition within the human population dynamic. These limiting factors are studied more deeply in the remaining outcomes of this unit. During class discussions, students should easily generate a list of limiting factors that affect the human population. These limiting factors should be explained by further research within the textbook (or other resources).
• evaluate Earth's carrying capacity,	

Population Change *(continued)*

Suggested Assessment Strategies

Paper and Pencil

- Students could research why the province of Newfoundland and Labrador has a declining population. (213-5, 213-6, 318-8)

Paper and Pencil

- Students could research population growth patterns of introduced species in our province (e.g., moose, coyotes, shrews, squirrels, rats, air wigs, etc.). Their research should explain why these populations have exploded since the introduction. (213-5, 213-6, 318-8)

Resources

MGH Biology, pp. 225-232

MGH Biology, p. 256 and throughout sections 8.1, 8.2 and 8.3

Teachers may refer to the World Geography 3202 resources for additional information on Earth's population.

Global Resources

Outcomes

Students will be expected to

considering human population growth and its demands on natural resources (318-10)

- determine the current growth rate of the human population and the projected growth rate
- investigate the demands that will be placed upon Earth's natural resources by future population growth
- explain how technological developments have raised, and continue to raise, the carrying capacity of Earth
- describe the four phases of demographic transition

- propose courses of action on the social issue of global population control, taking into account an array of perspectives, including that of sustainability (118-10)

Elaborations—Strategies for Learning and Teaching

The previous section leads into a preliminary discussion of human population growth and issues related to this growth. Graphs may be found in resource materials (library, electronic, population or government agencies) or constructed from data tables that illustrate the historical growth of human population based on estimated data. Students can be asked to project that graph line into the future as an exercise of prediction and extrapolation. This would lead to a discussion of linear or exponential growth and doubling time. Students can investigate the population growth rates of developing and developed countries and relate that to elements such as standard of living, education level of the population and level of health care. They may discuss why population is stabilizing in developed countries but still increasing at a rapid rate in the developing world. Students may, in turn, discuss and identify what social and environmental factors need to be considered and controlled locally, regionally and globally to create a sustainable human growth pattern for Earth. This may lead to the following questions: "What population size do you believe would allow the world's people to maintain a good quality of life? What needs to be done to attain this?" Students may debate and justify their responses.

The size of early human population was low due to limiting environmental factors like disease and food shortages. With the advancement of civilization (development of agriculture, advances in medicine, etc.) the carrying capacity increased and rapid growth of the human population occurred.

Students may choose to research and debate the ethics of human population control methods as practised within various areas of our globe (e.g., China's one child per family rule). Students may then discuss how improved infrastructure, education of the woman, use of advanced technologies and changed lifestyles may help a population meet its energy/material needs.

Global Resources

Suggested Assessment Strategies

Paper and Pencil

- Students could select a country for which to gather demographic data, including total population, population density, natality, mortality, life expectancy, annual income, immigration, emigration, standard of living, availability of education and health care. They could be asked to report their findings to the remainder of the class, and add this information, in abbreviated form to a global map prepared by members of the class. This would serve to illustrate in a dramatic fashion some of the population issues that exist within the world today. Students should be prepared to participate in a discussion. Organizations such as CIDA have produced both maps and brochures that outline this information. Students should be sure to have included in this survey a range of both developing and developed countries that represent all areas of the globe. Assessment can be based on presentation of information collected and observation of participation by students within the subsequent discussion. (118-10, 213-5, 318-8, 318-10)

Journal

- It can be argued that some third world regions have reached their carrying capacity. What factors do you think have contributed to this? How would other countries help increase their carrying capacity? (213-5, 214-3, 318-8, 318-10)

Performance

- Teachers could separate the class into two opposing sides and have a debate on the pros and cons of mandatory birth control. (118-10, 213-5, 215-6)

Presentation

- Select a country and research its population dynamics. Determine the stage of the Demographic Transit Model that this country is in. Present your findings to the class. (213-6, 213-5, 215-6)

Resources

MGH Biology, pp. 268-270, 256-257 and throughout sections 8.2 and 8.3
MGH Biology, pp. 275-284, 263-267

MGH Biology, pp. 270-273

MGH Biology, pp. 257-263

MGH Biology, pp. 286-287, 282-283

APPENDIX A

Supplementary Tables