

Biology 11 and Biology 12

Guide

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Biology 11 and Biology 12

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Atlantic Canada Science Curriculum Biology 11 and Biology 12

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Foreword

The pan-Canadian Common Framework of Science Learning Outcomes K to 12, released in October 1997, will assist in standardizing science education across the country. New science curriculum for the Atlantic Provinces is described in Foundation for the Atlantic Canada Science Curriculum (1998). The Atlantic Provinces Education Foundation (APEF) has developed new science curriculum for grades 1–10. One of the implications for implementation of the new curriculum is that the Science 10 course is significantly different from the previous Integrated Science 10 course. This change also necessitates revision of biology, chemistry, and physics courses to bring them into alignment with Science 10.

Biology 11 and Biology 12 include the following units: matter and energy for life; biodiversity; maintaining dynamic equilibrium I; interactions among living things; maintaining dynamic equilibrium II; reproduction and development; genetic continuity; evolution, change, and diversity.

This guide is intended to provide teachers with the overview of the outcomes framework for these courses. It also includes some suggestions to assist teachers in designing learning experiences and assessment tasks.

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Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*.

Aim

The aim of science education in the Atlantic provinces is to develop scientific literacy.

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching
- assessing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment that reflects a constructive, active view of the learning process. Learning occurs through actively constructing one's own meaning and assimilating new information to develop a new understanding.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Students' disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum.

Learning experiences in science education should vary and should include opportunities for group and individual work, discussion among students as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations and the evaluation of the evidence accumulated provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

Writing in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to learning. Students, at all grade levels, should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note making is an intrinsic part of learning in science, helping students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawing, and diagrams to represent data and results helps students learn and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of

recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in, and demonstration of, the strategies they need to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analyzing data, and interpreting data are fundamental to engaging in science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important in their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equitable opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of, and make adaptations to accommodate, the diverse range of learners in their classes. To adapt instructional strategies, assessment practices, and learning resources to the needs of all learners, teachers must create opportunities that will permit students to address their various learning styles.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must also actively address cultural and gender stereotyping (e.g., about who is interested in and who can succeed in science and mathematics). Research supports the position that when science

curriculum is made personally meaningful and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science and, indeed, for all students.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates.

Teachers should provide materials and strategies that accommodate student diversity, and should validate students when they achieve the outcomes to the best of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equitable opportunities to experience success as they work toward achieving designated outcomes. Teachers should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Assessment and Evaluation

The terms *assessment* and *evaluation* are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms for the processes described below.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analyzing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible and of the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

The Atlantic Canada science curriculum reflects the three major processes of science learning: inquiry, problem solving, and decision making. When a teacher assesses student progress, it is helpful to know some activities/skills/actions that are associated with each process of science learning. Student learning may be described in terms of ability to perform these tasks.

Curriculum Outcomes Framework

Overview

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the pan-Canadian Common Framework of Science Learning Outcomes K to 12. The diagram below provides the blueprint of the outcomes framework.

Outcomes Framework

[Fig 1 EGLs diagram]

Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. Provinces may add additional essential graduation learnings as appropriate. The essential graduation learnings are

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Science, Technology, Society, and the Environment

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from *the Common Framework for Science Learning Outcomes K to 12*.

Specific Curriculum Outcomes

This curriculum guide outlines specific curriculum outcomes for Biology 11 and Biology 12 and provides suggestions for learning, teaching, assessment, and resources to support students' achievement of these outcomes. Teachers should consult *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Specific curriculum outcome statements describe what students are expected to know and be able to do at each grade level. They are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately the essential graduation learnings.

Specific curriculum outcomes are organized in four units for each grade level. Each unit is organized by topic. Biology 11 units and topics follow.

Biology 11

MATTER AND ENERGY FOR LIFE (30%) (ADVANCED, 25%)

- The Cell (4 hours)
- Interaction of Cell Structures (8 hours)
- Photosynthesis and Respiration (6 hours)

BIODIVERSITY (25%) (ADVANCED, 20%)

- Classifying Living Things (3 hours)
- Diversity among Living Things (17 hours)

MAINTAINING DYNAMIC EQUILIBRIUM I (35%) (ADVANCED, 30%)

- Homeostasis (3 hours)
- Body Systems: Circulatory (10 hours)
- Body Systems: Respiratory (8 hours)
- Body Systems: Digestive (10 hours)
- Body Systems: Excretory (6 hours)
- Body Systems: Immune (6 hours)

INTERACTIONS AMONG LIVING THINGS (10%) (ADVANCED, 5%)

- Biomes (6 hours)
- Population Dynamics (8 hours)

The following pages outline Biology 11 specific curriculum outcomes grouped by units and topics.

MATTER AND ENERGY FOR LIFE (30%) (ADVANCED, 25%)

Students will be expected to

The Cell

- explain how cell theory has developed over time, referencing evidence, theories, and paradigms (114-2, 314-5, 114-1)
- perform experiments using specimens and microscopes and record the data collected (213-3, 214-3)

Interaction of Cell Structures

- using appropriate equipment, observe and describe cell organelles (314-6, 213-8)
- compare and contrast different types of procaryotic and eucaryotic cells (314-7)
- describe how organelles manage various cell processes (314-8)
- do investigations of cell size and display collected data, including variables and conclusions (212-7, 13-2, 213-5)

Photosynthesis and Respiration

- design, perform, and report on experiments that investigate the basic and critical processes of photosynthesis and respiration (214-11, 114-5)
- compare and contrast matter and energy transformations associated with the processes of photosynthesis and aerobic respiration (314-9)

BIODIVERSITY (25%) (ADVANCED, 20%)

Students will be expected to

Classifying Living Things

- describe and apply classification systems and nomenclatures used in the biological science (214-1)
- use organisms found in local or regional ecosystems to demonstrate an understanding of the fundamental principles of taxonomy (316-5)
- analyze and describe examples where scientific knowledge evolved, was enhanced, or revised as a result of new laws, theories, and/or technologies (115-7, 116-2)

Diversity among Living Things

- construct arguments to support a decision or judgment, using examples and evidence, recognizing various perspectives (118-6)
- describe the anatomy and physiology of a representative organism from each kingdom, including a representative virus (316-6)
- analyze and explain the life cycle of a representative organism from each kingdom, including a representative virus (313-1)

MAINTAINING DYNAMIC EQUILIBRIUM I (35%) (ADVANCED, 30%)

Students will be expected to

Homeostatis

- explain the importance of nutrition and fitness to the maintenance of homeostatis, debating the merits of funding specific scientific or technological endeavours and not others (117-4, 317-3)
- explain, with specific examples, how behaviours such as tropisms, instinct, and learned, help to maintain homeostasis and identify multiple perspectives that influence a decision/issue (215-4, 317-8)

Body Systems

Note: Biology 11 requires that a minimum of two (2) of the following five body systems be investigated in detail—circulatory, respiratory, digestive, excretory, and immune systems.

- design and perform experiments, identifying specific variables, to investigate how body systems work based on scientific understandings (212-6, 116-4)
- explain how different plant and animal system maintain homeostasis (317-1)

- analyze and report how natural and technological systems have developed and improved over time, including organ transplants (115-5, 116-7)
- identify and describe the role of chemicals, including elements, compounds, biochemicals, and water on the structure and function of various body systems (314-1, 314-2, 314-3)
- identify and predict the impact of viruses, diseases, and environmental factors on the homeostasis of an organism and propose alternate solutions (317-4, 317-6, 214-15)

INTERACTIONS AMONG LIVING THINGS (10%) (ADVANCED, 5%)

Students will be expected to

Biomes

- compare and interpret patterns of North America's biomes with another continent in terms of climate, vegetation, physical geography, and location (214-5, 318-7)

Population Dynamics

- synthesize information from multiple sources to describe and explain factors that influence population growth and interactions within and between populations (215-3, 318-8, 319-9)
- propose courses of action on social, economic, and cultural issues related to Earth's carrying capacity and demands on natural resources, referencing the energy pyramid (116-7, 118-10, 318-10, 318-11)

Biology 12

The following are specific curriculum outcomes organized by topic for Biology 12.

MAINTAINING DYNAMIC EQUILIBRIUM II (20%) (ADVANCED, 16%)

- Nervous System: Neurons and Structure (8 hours)
- Influences on the Nervous System (4 hours)
- Endocrine System: Maintaining Homeostasis (4 hours)
- Endocrine System: Feedback Mechanisms (3 hours)

REPRODUCTION AND DEVELOPMENT (16%) (ADVANCED, 15%)

- Cell Division (9 hours)
- Reproduction Systems: Regulation and Technologies (5 hours)
- Embryonic Differentiation and Development (3 hours)

GENETIC CONTINUITY (40%) (ADVANCED, 35%)

- Genetics: Molecular Level (5 hours)
- Mendelian Genetics (10 hours)
- Implications (10 hours)

EVOLUTION, CHANGE, AND DIVERSITY (24%) (ADVANCED, 14%)

- Evidence and Mechanisms (7 hours)
- Implications (3 hours)

The following pages outline Biology 12 specific curriculum outcomes grouped by units and topics.

MAINTAINING DYNAMIC EQUILIBRIUM II (20%) (ADVANCED, 16%)

Students will be expected to

Nervous System: Neurons and Structure

- explain how different plant and animal systems maintain homeostasis (317-1)
- identify the role of some compounds, such as water, glucose, and ATP, commonly found in living systems (314-2)
- design an experiment to investigate and collect data on aspects of the nervous system and identify specific variables involved (212-6)
- analyze the nervous system and compile and organize data to interpret its structure and dynamics (116-7, 213-5)

Influences on the Nervous System

- evaluate the impact of viral, bacterial, genetic, and environmental diseases on an organism's homeostasis (317-4)
- analyze how and why technologies and drugs developed and improved over time can affect homeostasis (115-5, 317-7)
- evaluate and describe examples of treatments and technologies for visual and auditory functions (116-4, 317-5)

Endocrine System: Maintaining Homeostasis

- explain how different plant and animal systems maintain homeostasis (317-1)
- identify and describe the structure and function of important biochemical compounds, including protein and steroid hormones (314-3)
- explain the critical role of enzymes in cellular metabolism (314-4)
- design and do an experiment, identify variables, and compile and organize data on selected aspects of the endocrine system (212-6, 213-5)

Endocrine System: Feedback Mechanisms

- analyze homeostatic phenomena to identify the feedback mechanisms involved (317-2)
- analyze contributions, including Canadian, to science and technology and how these have improved over time (117-11, 115-5)

REPRODUCTION AND DEVELOPMENT (16%) (ADVANCED, 15%)

Students will be expected to

Cell Division

- design, perform, compile data, and evaluate experiments on plant materials, using instruments effectively, controlling major variables, and selecting appropriate processes (212-3, 213-3, 212-8, 213-5)
- describe in detail mitosis and meiosis (313-2)
- investigate, analyze, and communicate genetic techniques, giving examples from organized data, that use technologies that have been developed based on cells (116-2, 116-3, 116-7, 213-5, 215-2)
- evaluate the physiological and ethical consequences of medical treatments such as radiation therapy and chemotherapy (317-5)

Reproductive Systems: Regulation and Technologies

- analyze and describe the structure and function of female and male mammalian reproductive systems (313-3)

- identify and apply criteria, including potential applications, chemicals, and diseases, to explain the human reproductive cycles (214-9, 214-18, 313-4)
- select and integrate information from various sources and explain current reproductive technologies for plants and animals (231-7, 313-5)
- distinguish between scientific questions and technological problems to evaluate the use of reproductive technologies for humans (115-1, 313-6)

Embryonic Differentiation and Development

- explain the human reproductive cycles, including analyzing examples of the effects of technology and science on reproduction (313-4, 116-2)

GENETIC CONTINUITY (40%) (ADVANCED, 35%)

Students will be expected to

Molecular Level

- summarize the discoveries, including the role of evidence, that led to the modern concept of the gene (315-1, 114-2)
- identify and describe the roles of chromosomes in the transmission of hereditary information from one cell to another (315-2)
- explain how the current model of DNA replication, the structure of DNA and RNA, and protein synthesis revolutionized thinking in scientific communities (315-4, 315-5, 115-3)
- describe and predict the effects of genetic mutations on a cell's information, including protein synthesis, phenotypes, and heredity (315-6, 315-7)

Mendelian Genetics

- using Mendelian genetics, state a prediction, perform, and interpret patterns and trends in genetic data of monohybrid and dihybrid crosses and explain how the data supports or refutes the situation (212-4, 214-5, 315-3, 214-12)

Implications

- explain the circumstances that lead to genetic diseases (315-8)
- analyze the risks and benefits to society and the environment and construct arguments concerning the use of genetic engineering, using examples and evidence from various perspectives (118-2, 315-9, 118-6)
- analyze, describe, and evaluate genetics-based technology development, design, and solutions (116-4, 116-6)
- explain and analyze, from a variety of perspectives, the risks and benefits of the influence of the Human Genome Project (315-10, 117-2)
- investigate, perform, and defend a position or course of action on genetic modification, integrating various sources and science- and technology-based careers (215-5, 117-7, 213-7)

EVOLUTION, CHANGE, AND DIVERSITY (24%) (ADVANCED, 14%)

Students will be expected to

Evidence and Mechanisms

- describe and evaluate scientific peer review and evidence that have changed evolutionary concepts and feeds the debates on gradualism and punctuated equilibrium (114-5, 316-1, 316-2)
- explain and analyze the roles of evidence, theories, and paradigms as these are tested, and subsequently restricted, revised, or replaced (114-2, 115-7, 116-2)

Implications

- identify questions to investigate, collect information, and construct arguments to support the development and diversity of living organisms, using examples and evidence (212-1, 213-6, 118-6)
- outline evidence and arguments pertaining to the origin, development, and diversity of living organisms on Earth and identify new questions that arise from what was learned (316-4, 214-17)

Attitude Outcomes

It is expected that the Atlantic Canada science program will foster certain attitudes in students throughout their school years. The STSE, skills, and knowledge outcomes contribute to the development of attitudes, and opportunities for fostering these attitudes are highlighted in the Elaborations—Strategies for Learning and Teaching sections of each unit.

Attitudes refer to generalized aspects of behaviour that teachers model for students by example and by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what students learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcome statements for attitudes are written as key-stage curriculum outcomes for the end of grades 3, 6, 9, and 12. These outcome statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the pan-Canadian *Common Framework of Science Learning Outcomes K to 12* for the end of grade 12.

Key-Stage Curriculum Outcomes: Attitudes

By the end of grade 12, students will be expected to

APPRECIATION OF SCIENCE

436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not

437 appreciate that the applications of science and technology can raise ethical dilemmas

438 value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds

Evident when students, for example,

- consider the social and cultural contexts in which a theory developed
- use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on STSE issues
- recognize the usefulness of being skilled in mathematics and problem solving
- recognize how scientific problem solving and the development of new technologies are related
- recognize the contribution of science and technology to the progress of civilizations
- carefully research and openly discuss ethical dilemmas associated with the applications of science and technology
- show support for the development of information technologies and science as they relate to human needs
- recognize that western approaches to science are not the only ways of viewing the universe
- consider the research of both men and women

INTEREST IN SCIENCE

439 show a continuing and more informed curiosity and interest in science and science-related issues
440 acquire, with interest and confidence, additional science knowledge and skills using a variety of resources and methods, including formal research

441 consider further studies and careers in science- and technology-related fields

Evident when students, for example,

- conduct research to answer their own questions
- recognize that part-time jobs require science- and technology-related knowledge and skills
- maintain interest in or pursue further studies in science
- recognize the importance of making connections among various science disciplines
- explore and use a variety of methods and resources to increase their own knowledge and skills
- are interested in science and technology topics not directly related to their formal studies
- explore where further science- and technology-related studies can be pursued
- are critical and constructive when considering new theories and techniques
- use scientific vocabulary and principles in everyday discussions
- readily investigate STSE issues

SCIENTIFIC INQUIRY

442 confidently evaluate evidence and consider alternative perspectives, ideas, and explanations

443 use factual information and rational explanations when analyzing and evaluating

444 value the processes for drawing conclusions

Evident when students, for example,

- insist on evidence before accepting a new idea or explanation
- ask questions and conduct research to confirm and extend their understanding
- criticize arguments based on the faulty, incomplete, or misleading use of numbers
- recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen
- expend the effort and time needed to make valid inferences
- critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation
- critically assess their opinions of the value of science and its applications
- criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist
- insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged
- seek new models, explanations, and theories when confronted with discrepant events or evidence

COLLABORATION

445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas

Evident when students, for example,

- willingly work with any classmate or group of individuals regardless of their age, gender, or physical and cultural characteristics
- assume a variety of roles within a group, as required
- accept responsibility for any task that helps the group complete an activity
- give the same attention and energy to the group's product as they would to a personal assignment
- are attentive when others speak
- are capable of suspending personal views when evaluating suggestions made by a group
- seek the points of view of others and consider diverse perspectives
- accept constructive criticism when sharing their ideas or points of view
- criticize the ideas of their peers without criticizing the persons
- evaluate the ideas of others objectively

- encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making
- contribute to peaceful conflict resolution
- encourage the use of a variety of communication strategies during group work
- share the responsibility for errors made or difficulties encountered by the group

STEWARDSHIP

446 have a sense of personal and shared responsibility for maintaining a sustainable environment

447 project the personal, social, and environmental consequences of proposed action

448 want to take action for maintaining a sustainable environment

Evident when students, for example,

- willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation
- assume part of the collective responsibility for the impact of humans on the environment
- participate in civic activities related to the preservation and judicious use of the environment and its resources
- encourage their peers or members of their community to participate in a project related to sustainability
- consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors
- participate in social and political systems that influence environmental policy in their community
- examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans
- willingly promote actions that are not injurious to the environment
- make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations
- are critical-minded regarding the short- and long-term consequences of sustainability

SAFETY IN SCIENCE

449 show concern for safety and accept the need for rules and regulations

450 be aware of the direct and indirect consequences of their actions

Evident when students, for example,

- read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood
- criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment
- consider safety a positive limiting factor in scientific and technological endeavours
- carefully manipulate materials, cognizant of the risks and potential consequences of their actions
- write into a laboratory procedure safety and waste-disposal concerns
- evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms
- use safety and waste disposal as criteria for evaluating an experiment
- assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place
- seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions
- keep the work station uncluttered, with only appropriate lab materials present

Curriculum Guide Organization

Specific curriculum outcomes are organized in units for each grade level. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units of a grade appear in the guide is meant to suggest a sequence. In some cases, the rationale for the recommended sequence is related to the conceptual flow across the year. That is, one unit may introduce a concept that is then extended in a subsequent unit. Likewise, one unit may focus on a skill or context that will be built upon later in the year.

Some units or certain aspects of units may also be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world. In some cases, a unit may require an extended time frame to collect data on weather patterns, plant growth, etc. These cases may warrant starting the activity early and overlapping it with the existing unit. In all cases, the intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful and socially and culturally relevant contexts.

Unit Organization

Each unit begins with a two-page synopsis. On the first page, introductory paragraphs provide a unit overview. These are followed by a section that specifies the focus (inquiry, problem solving, and/or decision making) and possible contexts for the unit. Finally, a curriculum links paragraph specifies how this unit relates to science concepts and skills addressed in other grades so teachers will understand how the unit fits with the students' progress through the complete science program.

The second page of the two-page overview provides a table of the outcomes from the *Common Framework of Science Learning Outcomes K to 12* that the unit will address. The numbering system used is the one in the pan-Canadian document as follows:

- 100s—Science-Technology-Society-Environment (STSE) outcomes
- 200s—Skills outcomes
- 300s—Knowledge outcomes
- 400s—Attitude outcomes (see pages 19–21)[TK]

These code numbers appear in brackets after each specific curriculum outcome (SCO).

Outcomes

The curriculum has been organized into four sections to relate learning experiences to the outcomes by

- providing a detailed explanation of the outcome, an understanding of what students should know at the end of the study, and ideas around inquiry that relate to the outcome
- providing a range of strategies for teaching, learning, and assessment associated with a specific outcome
- providing teachers with suggestions in terms of supplementary resources

This section provides specific curriculum outcomes students are expected to know, be able to do, and value by the end of the year.

Tasks for Instruction and/or Assessment

This section provides suggestions for ways that students' achievement of the outcomes could be assessed. These suggestions reflect a variety of assessment techniques and materials that include, but are not limited to, informal/formal observation, performance, journal, interview, paper and pencil, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in parentheses after the item.

Elaborations—Strategies for Learning and Teaching

This section provides teachers with a detailed explanation of the outcomes through the elaboration. It identifies what teachers are expected to focus on in this outcome and gives direction to that focus. The enduring understanding tells teachers what students will be expected to know or be able to do at the end of the study.

These suggestions offer a range of strategies for learning and assessment from which teachers and students may choose. Suggested learning experiences can be used in various combinations to help students achieve an outcome. It is not necessary to use all of these suggestions, nor is it necessary for all students to engage in the same learning or assessment activity.

Resources/Notes

The Resources/Notes section provides links to other curriculum areas and suggested supplementary resources (including groups and agencies).

Biology 11 Outcomes

Matter and Energy for Life (30%) (Advanced, 25%)

Introduction

“Biology” is the study of life. However, the study of the science is far from simple, and as 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 the 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 Science 1. This base is built upon with the discussion of the interaction of plants with the environment in Science 3. Students in Science 6 begin to become familiar with the use of magnifying tools to observe microorganisms. By the end of Science 8, 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

114-2, 314-5, 114-1 explain how cell theory has developed over time, referencing evidence, theories, and paradigms

Skills

Students will be expected to

213-3, 214-3 perform experiments using specimens and microscopes and record the data collected

212-7, 213-2, 213-5 do investigations of cell size and display collected data, including variables and conclusions

214-11, 114-5 design, perform, and report on experiments that investigate the basic and critical processes of photosynthesis and respiration

Knowledge

Students will be expected to

314-6, 213-8 using appropriate equipment, observe and describe cell organelles

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

314-8 describe how organelles manage various cell processes

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

The Cell

(4 hours)

OUTCOMES

Students will be expected to

- explain how cell theory has developed over time, referencing evidence, theories, and paradigms (114-2, 314-5, 114-1)
- perform experiments using specimens and microscopes and record the data collected (213-3, 214-3)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Paper and Pencil

- Using the statements on cell theory, identify the research and scientist that contributed to each particular cell theory statement. Organize statements and researchers in chronological order. (114-2, 314-5, 114-1)
- Construct a concept map involving the work of scientists who were pro-spontaneous generation and anti-spontaneous generation. (114-2, 314-5, 114-1)
- Debate biogenesis and abiogenesis. (114-2, 314-5, 114-1)

Presentation

- Use a list of individuals who have contributed historically to the development of the cell theory. Collect information on the researcher assigned to you or your group and prepare a brief oral presentation to be given to the class. On the index cards provided, outline 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 will be made in chronological order and the index cards affixed to the time line prepared at the front of the class. (114-2, 314-5, 114-1)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should explain how cell theory developed over time. The accomplishments of the early cell biologists paved the way for study. The concepts of biogenesis and spontaneous generation should be approached historically through the investigation of the contributions of scientists such as Van Helmet, 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?" "Why do you think controls are important in any experiment?" could be pursued.

Students could discuss the contributions of scientists including Robert Hooke, Anton van Leeuwenhoek, Schleiden, Schwann, Virchow, and others to the development of the cell theory. 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.

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 incomplete observations and lack of experimental control. This concept was discredited, and biogenesis supported, through the use of controlled experiments.

Students should explain how the invention of the microscope permitted scientists to discover the existence of cells. The development of the microscope could be used as an example of a situation where a technology enabled more scientific discoveries.

During the progression of Biology 11, it is appropriate to make students aware of the career opportunities that exist in various areas of this science (e.g., cytology or the study of cells as a component of laboratory technology).

Microscope work complements and reinforces techniques. Students are presented here with the opportunity to gain some practise and build on the skills. They have previously been introduced to the proper techniques for slide preparation and staining and now have additional opportunities to use these techniques. If more microscope help is needed, it should be embedded in these activities. Specimens can be selected that illustrate procaryotic features (cyanobacteria, lactobacillus in yogurt). Eucaryotic examples can be selected for slide preparation that will illustrate their characteristics. A variety of structures are visible with the light microscopes used by the students. Examples include chloroplasts in spinach, leucoplasts in unripe banana, nucleus in yeast, nucleus, vacuole, and cell wall in onion epithelium. A variety of specimens should be used 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.

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

Students should examine and compare images of cell structure generated by both the light and electron microscopes.

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 easily. Textbooks and websites are a good source of these.

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.

RESOURCES/NOTES

Experiments

- What Items Show Evidence of Cell Organization? *Biology Living Systems*, p. 9
- Making a Model of Primitive Cells

Activities

- Comparing Plant Cells, p. 7
- Making a Model of Primitive Cells, p. 9

STSE Issues

- Don't Let the Sun Catch You Fryin', *Biology Living Systems*, p. 139
- Spider Silk, *Biology Living Systems*, p. 128
- Debate Cell Research, p. 25
- Research in Canada: Killing of Cancer Tumours

Interaction of Cell Structures

(8 hours)

OUTCOMES

Students will be expected to

- using appropriate equipment, observe and describe cell organelles (314-6, 213-8)
- compare and contrast different types of procaryotic and eucaryotic cells (314-7)
- describe how organelles manage various cell processes (314-8)
- do investigations of cell size and display collected data, including variables and conclusions (212-7, 213-2, 213-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Once the experiments have been designed and intentions stated, an opportunity exists for assessing the intended activity. The following points should be considered.
 - Is the plan adequate?
 - Is the plan followed?
 - Are experimental techniques utilized properly and safely?
 - Are unexpected events dealt with effectively? (314-8)
- Working as a co-operative group, research and investigate some formal experiments and select one that ties in with 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. Present your plan for approval. (314-8)
- Do the laboratory activities that investigate the relationship between cell surface area and cell size and complete the evaluation requirement as indicated. (212-7, 213-2, 213-5)
- Propose a hypothesis, design and carry out a controlled experiment to determine if certain molecules that surround a model cell, made using dialysis tubing, will result in net movement of water by osmosis, or will diffuse themselves. (212-7, 213-2, 213-5)

Journal

- If a cell membrane were completely permeable, how would this effect the cell? (314-8)
- Explain why are the cells of an elephant not larger than those of a cat? (212-7, 213-2, 213-5)

Paper and Pencil

- Individually or in groups of two, prepare a chart to contrast some of the elements studied in this section. Suggestions may include
 - plant versus animal cells
 - eucaryotic versus procaryotic cells
 - light microscope versus scanning electron microscope
 - light microscope versus transmission electron microscope
 - scanning electron microscope versus transmission electron microscope (314-7, 314-8)

Presentation

- When the experiments have been completed, present your findings to your teacher and/or entire class group. Explain the rationale behind your experiment and be able to answer questions on the data collected. 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)

- Observe osmosis and/or diffusion experiments and explain in scientific terms the observations you make based upon your understanding of these concepts.
Investigate one of these situations related to osmosis and diffusion (hypertonic, hypotonic and isotonic solutions) individually or in groups. Select an original scenario, upon approval by teacher. Record your findings, and be prepared to present them to the class.
 - 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
 - why a person is more likely to recover from a near drowning in sea water than in fresh water (314-8)
- Prepare a model of a plant or animal cell and its structures. Be creative in your choice of materials (e.g., play dough, Jello, clay, etc.) (314-7, 314-8)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should describe the role of the following cellular structures: membrane, cytoplasm, nucleus, nucleolus, endoplasmic reticulum, ribosome, mitochondria, chloroplast, vacuole, vesicle, golgi, microtubules/filaments, cilia, flagella, and cell wall.

Students should explain how materials are able to move into and out of cells through selectively permeable membranes by the processes of passive and active transport, endocytosis, and exocytosis.

Examples of passive transport include osmosis and diffusion/facilitated diffusion. 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.

Students should describe the effects of various solutions (hypertonic, hypotonic) on cells and be able to explain some of the structural adaptations (such as contractile vacuoles and cell walls) cells use to maintain homeostasis.

Creation of a model cell by students is an effective method as well to show passive, yet selective transport through a membrane. Dialysis tubing 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.

Students could perform studies and experiments to illustrate how cells are limited in their size (e.g., the relationship between surface area and volume). One potential example involves the construction of model cells (agar/phenolphthalein cubes) of varying sizes and allowing them to soak in nutrient (sodium hydroxide) solution. Results illustrate visually to students some of the difficulties encountered as cells enlarge.

Alternately, cells may be constructed from potato and immersed in potassium permanganate solution. Data collected should be organized in an appropriate format for discussion and display. Surface area and volume of a sphere can be studied mathematically.

Students should carry out procedures to investigate the relationship between membrane surface area and cell size and summarize your findings.

Surface Area versus Volume of Cells

Radius of Sphere	Surface Area $4\pi r^2$	Volume	Surface/Volume Ratio

A variety of potential experimental methods exist. Students may turn in a 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.

Students could suggest and/or design an experiment that would help to answer a question that arose from their work.

RESOURCES/NOTES

Experiments

- Osmosis in a Model Cell, *Biology Living Systems*, p. 104
- Are Plastic Bags Permeable to Certain Molecules? *Biology Living Systems*, p. 100
- Can Pore Size Be Used to Determine Molecule Size? *Biology Living Systems*, p. 102
- Sizes of Cells, *Biology Living Systems*, p. 120

Activities

- Effect of Salt Water on Potato Strips, p. 51
- Observing Diffusion and Osmosis, pp. 53–54
- Factors Affecting Cell Membrane Permeability (Beets and Pigment), p. 72
- Factors Affecting the Rate of Osmosis, p. 55
- What Organelle Directs Cell Activity? *Biology Living Systems*, p. 130
- Plant and Animal Cells, *Nelson Biology*, p. 140

Videos

- Rental from video outlets: *Osmosis Jones* (Feature film animation with Chris Rock as voice of Osmosis Jones.)
- *Cellular Respiration: Energy for Life*, V2200, 23 min. (dubbing), LRT

Websites

WWW keywords:

- electron microscope
- electron
- mitochondria
- golgi apparatus
- chloroplast

Image search:

- photomicrograph + any organelle name

STSE Issues

- Social Issue: Limits to Cell Technology, *Nelson Biology*, p. 149

Photosynthesis and Respiration

(6 hours)

OUTCOMES

Students will be expected to

- compare and contrast matter and energy transformations associated with the processes of photosynthesis and aerobic respiration (314-9)
- design, perform, and report on experiments that investigate the basic and critical processes of photosynthesis and respiration (214-11, 114-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Look at a variety of scenarios to choose from for investigation. Discuss within your group plans for your experimental design and how you intend to proceed, measure variables, and record data. Illustrate understanding of the task at hand and development of a workable plan. Do the experiment and report the results. Possibilities for investigations may include the following:
 - production of starch by the leaves of plants
 - starch production within variegated leaves (Coleus)
 - effects of temperature, light, sugar concentration on fermentation by yeast
 - variety of pigments found in the leaves of plants
 - colour (wavelength) of light that is most useful for photosynthesis in geranium leaves
 - respiration in germinating plant seeds compared to boiled seeds
 - production of heat as a by-product of respiration in living organisms (214-11, 114-5)

Paper and Pencil

- Illustrate the consumption of CO₂ or production of O₂ by a water plant found in a local pond/stream or pet store or to monitor production of O₂ bubbles versus light intensity. Record your observations and an explanation for them in scientific terms. (314-9)

Presentation

- Research, through print or electronic resources, some of the effects that human manipulation has had upon the natural balance of the processes of photosynthesis and respiration within the environment. Suggested concepts for presentation and subsequent discussion could include the following:
 - selective breeding of crop plants to increase productivity
 - addition of nutrients such as iron and phosphates to the oceans
 - deforestation—both in temperate zones and the tropical rain forest zones
 - dependence of global population on consumption of fossil fuelsPresent your findings. (314-9)
- When the experiments have been completed, present to the class your data and conclusions. Be prepared to explain your experimental design and the reasons why you made certain decisions during the planning and implementation. Design an additional experiment to answer a question that arose from their previous work. (214-11, 114-5)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should discuss of the critical nature of the processes of photosynthesis and respiration for individual organisms as well as on a global basis. Explain that photosynthetic organisms, using light as an energy source, remove CO₂, water and other materials from their environment in order to assemble

more complex organic compounds and release, as a by-product, oxygen gas. Students should discuss the importance of rainforests and phytoplankton as global O₂ providers.

Students should demonstrate how photosynthetic organisms take in substances from the environment in order to synthesize larger organic molecules. Students should explain the importance of the process of photosynthesis. Students should explain the importance of the process of aerobic respiration.

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.

Students must be made aware of the complementary nature of the processes of photosynthesis and respiration. 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 CO₂ and water and the energy released utilized by the organism for its own purposes or released to the environment.

As an extension, students might use fermentation tubes or alternate devices to illustrate the effect of factors such as temperature, light, concentration of sugar on the fermentation process in yeast. (The production of CO₂ by yeast cells during this process can be visually displayed utilizing methylene blue.)

Students may design and/or perform an experiment investigating various factors, and collect, graph, analyze and present the resulting data. Based on this, students could then describe the optimal conditions for the fermentation process utilized in the making of bread. The process of respiration can also be investigated using plant seeds (germinating versus boiled).

Students may design and/or perform an experiment that demonstrates the production of heat as a by-product of respiration by organisms.

Experiments can be performed to help students investigate the two basic and critical processes of photosynthesis and respiration. The consumption of CO₂ 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 CO₂ is added; conversely reverses to blue when CO₂ is removed.) Students may design and/or perform an experiment that demonstrates the production of starch by leaves during the process of photosynthesis. Students may design and/or perform a chromatography experiment to demonstrate that plant leaves contain a range of pigments involved in the process of photosynthesis.

RESOURCES/NOTES

Activities

- Yeast Fermentation, p. 66
- Case Study: Global Warming and Interdependence of Cellular Respiration and Photosynthesis, p. 68

Videos from LRT

- *Photosynthesis: Light into Life*, V2201, 24 min.
- *Photosynthesis*, 20960, 28 min.

STSE Issues

- Social Issue: Interdependence of Cellular Respiration and Photosynthesis, *Nelson Biology*, p. 204
- Plants: Earth's Major Energy Trappers, *Biology Living Systems*, p. 443
- How Shall Our Forests Be Harvested? *Biology Living Systems*, p. 444

Experiments

- Photosynthesis, *Nelson Biology*, p. 196
- Does Light Colour Influence the Rate of Photosynthesis, *Biology Living Systems*, p. 156

Biodiversity (25%) (Advanced, 20%)

Introduction

Millions of living things are known today, with more constantly being identified. The opinions of scientists range anywhere from the possibility of ten to thirty million as being 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 Science 1. Life cycles of familiar animals are compared in Science 2 with the life cycles of plants introduced in Science 3. Within Science 6 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. Science 7 provides an explanation as to how biological classification can take into account the diversity of life on earth. In Science 9, students approach biodiversity through reproduction and cloning. In Science 10, 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

115-7, 116-2 analyze and describe examples where scientific knowledge evolved, was enhanced, or revised as a result of new laws, theories, and/or technologies

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

Skills

Students will be expected to

describe and apply classification systems and nomenclatures used in the biological science (214-1)

Knowledge

Students will be expected to

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

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

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

Classifying Living Things

(3 hours)

OUTCOMES

Students will be expected to

- describe and apply classification systems and nomenclatures used in the biological science (214-1)
- use organisms found in local or regional ecosystems to demonstrate an understanding of the fundamental principles of taxonomy (316-5)
- analyze and describe examples where scientific knowledge evolved, was enhanced, or revised as a result of new laws, theories, and/or technologies (115-7, 116-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Visit a locally accessible ecosystem and observe its organisms. Develop your own grouping system for what you observe. Give the rationale of your system of biological organization. (214-1)

Paper and Pencil

- Using the sheets of imaginary critters or other resources provided by the teacher, prepare an efficient biological classification key that could be used to identify five of these imaginary creatures. Following this, use the sample organisms provided by the teacher and develop a simple classification key suitable for their identification. Upon its completion, 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. Explain your system. (316-5)
- Write a short research paper on the contribution of Linnaeus to the classification of living things. (115-7, 116-2)

Presentation

- Select one of the organisms you observed and investigate its classification utilizing Linnaeus' system. 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)
- Present the results of your research on modern classification techniques to the class. Use any appropriate format (oral, poster, computer presentation). Do a peer evaluation. (115-7, 116-2)
- Review an article on a technological advancement in DNA analysis. (115-7, 116-2)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

This section provides a structural framework for the subsequent study of living things.

Students should explain why scientific classification systems have evolved from the two kingdom to the present kingdom system.

Students should utilize a local or regional ecosystem for their introductory study of taxonomy. They may develop their own broad idea of order among the many different plants and animals observed there. A variety of mechanisms for accomplishing this grouping process may be evident. Students may then divide their large groups into smaller categories based on similarities or differences. Through individual groups of students presenting their own ordering processes, recognition of the potential difficulties in categorization will occur and questions arise regarding biological taxonomy. This will lead into additional discussions and investigations.

Students should examine the common names of some species of organisms and show the inadequacies and language problems associated with this method of identification.

Students should identify the seven major categories of Linnaeus' classification system (kingdom, phylum, class, order, family, genus, species). Recognition must be made that in addition to these, subcategories (superclass, suborder) exist, adding additional layers of complexity to this system. Students can then select a local organism, and research its classification. This classification can be shared with other class members in a visual form (e.g., poster, overhead, computer presentation).

Students should explain the advantages of binomial nomenclature. Students should list, in order, levels of classification (taxa) based on increasingly narrower categories, using the species as the base identification level. Students should demonstrate how to use a taxonomic key to group and identify an organism. Use of a biological classification key to identify organisms (e.g., microorganisms, weeds, insects, leaves) increases a student's understanding of the complexities of taxonomy. Microslide sets are available that allow the student 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.

Students should conduct library or electronic research on some topic 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.

Sample techniques may include radioactive dating, biochemical information (DNA/protein comparisons), structural information, embryology, cellular structure, or behaviour. Information collected may be presented to class.

RESOURCES/NOTES

- See sample "Forest Community Survey-Flora/Fauna" and question sheet submitted by PEI for consideration.
- See Plant Diversity Activity, p. 395 and Examining Peat Moss Activity, p. 384

Experiments

- Making a Key, *Biology Living Systems*, p. 378
- Can You Classify Non-Living Things? *Biology Living Systems*, p. 367
- Activity 9.1.1, *Nelson Biology 11*, p. 332
- Collecting and Examining Lichens, *Nelson Biology 11*, p. 371
- A Leaf Classification
- Inventing a Creature and Justify its Classification
- What Traits Are Used to Classify an Unknown Organism? *Biology Living Systems*, p. 377
- What Traits Are Used to Classify Organisms into Kingdoms? *Biology Living Systems*, p. 380
- What Are the Characteristics of Animals? *Biology Living Systems*, p. 455

Activities

- Activity 3: The Protists
- Activity 4: The Fungi
- Activity 5: The Worm
- Activity 6: The Frog

Videos from LRT

- *Classification: Bringing Order to Diversity*, 23034, 28 min.
- *How Organisms Are Grouped* 20669, 15 min. (loan)

STSE Issues

- Biotechnology: Modern Tools for Classification, *Biology Living Systems*, p. 383

Diversity among Living Things

(17 hours)

OUTCOMES

Students will be expected to

- construct arguments to support a decision or judgment, using examples and evidence, recognizing various perspectives (118-6)
- describe the anatomy and physiology of a representative organism from each kingdom, including a representative virus (316-6)
- analyze and explain the life cycle of a representative organism from each kingdom, including a representative virus (313-1)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Paper and Pencil

- Brainstorm characteristics of living things and justify the classification system. (118-6, 316-6)

Presentation

- Select, with your teacher's guidance, a member of one of the groups of organisms that were discussed. Investigate, using library or electronic research the anatomy, physiology and life cycle of this organism and 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. Be sure to include any new or surprising pieces of information you may collect, and indicate where this organism might be found. Teachers should ensure that there are a good variety of organisms selected within the class. (316-6)
- Create a presentation on one of the major phyla or classes within the animal kingdom using library and/or electronic research. (316-6)

Activities

- Observe the organisms provided as samples of members of each kingdom. 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. (313-1)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

NOTE: *This section is intended to provide students with a brief overview of biodiversity.*

Students should identify that although living things are distinct and unique in many ways, there are a number of characteristics that different organisms have in common that help ensure their survival.

Students should develop a list of characteristics that differentiate living and non-living things. Students should identify the difficulties inherent in the categorization of some organisms into distinct groups and identify the limitations of the 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.

Students should identify the general characteristics that distinguish the members of the recognized kingdoms from each other. 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. Students should describe the general characteristics that distinguish members of the plant and animal phyla.

Students should be exposed to examples of members of each of the Kingdoms. An effort should be made to use examples of organisms that are easily available and/or indigenous to the local area: Lactobacillus in yogurt, pond water organisms, yeast, mushrooms, mosses, flowers, grasshoppers, earthworm, starfish, perch, 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.

Discussion of the major features of the kingdoms should include the following as appropriate for the group described: locomotion, food getting, digestion, circulation, respiration, and excretion. Remember that this discussion is intended as an overview, with a more detailed treatment of systems to be included later in the program.

As it is impossible to include a complete summary of the plant and animal phyla the focus within the plants should be on the comparison of nonvascular and vascular plants. A discussion of the reasons that angiosperms are the most diverse plant group may develop.

Students should analyze and explain the major features of a virus and the basics of a viral life cycle. Selected phyla of invertebrates may be examined to illustrate their general characteristics. Mention should be made of the arthropod group as it includes the insects, biologically the most successful class of living things. Selected classes from the Phylum Chordata of the animal kingdom should be chosen to show the general characteristics of the vertebrates and the developmental trends and increasing complexity they illustrate. Students should research and discuss the placement of viruses within the categorization of living things. Students should compare the common lifecycle features in each kingdom.

RESOURCES/NOTES

- See sample “Animal Kingdom” assignment submitted by PEI for consideration.

Experiments

- Protists, *Biology 11 and Biology 12: A Teaching Resource*
- Fungi, *Biology 11 and Biology 12: A Teaching Resource*
- Earthworm, *Biology 11 and Biology 12: A Teaching Resource*
- Frog, *Biology 11 and Biology 12: A Teaching Resource*
- What Adaptations Were Necessary for Plants to Move onto Land? *Biology Living Systems*, p. 427

Videos from LRT

- *Kingdom of Animals: From Simple to Complicated*, 23297, 21 min. (dubbing) includes
 - on-screen quiz
 - teacher’s guides
 - blackline masters
- Eyewitness Series, 34 min.
 - *Insect*, 22469
 - *Shark*, 22455
 - *Fish*, 22468
 - *Amphibian*, 22467
 - *Reptile*, 22454
 - *Birds*, 22447
- *The Earthworm: Darwin’s Plow*, 22094, 13 min.

STSE Issues

- In Competition: Fish or Dam? *Biology Living Systems*, p. 384
- Considering the Environment: Fighting Pollution with Bacteria, *Biology Living Systems*, p. 416

[Heading??]

- Viral Specificity and Viral Replication, *Nelson Biology 11*, pp. 336–337
- Bacteria, *Nelson Biology 11*, pp. 340–348
- Protista, pp. 349–360
- Fungi, pp. 364–372
- Plants, Lily Dissection, pp. 374–402

Maintaining Dynamic Equilibrium I (35%) (Advanced, 30%)

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 and 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 Science 2 are introduced to the importance of maintaining a healthy lifestyle. When they reach the level of Science 5 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 level of Science 8, they begin to consider the basic factors that affect 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.

Teachers will select a minimum of two of the following systems to investigate in detail: circulatory; respiratory; digestive; excretory; or immune.

Curriculum Outcomes

STSE

Students will be expected to

117-4, 317-3 explain the importance of nutrition and fitness to the maintenance of homeostasis, debating the merits of funding specific scientific or technological endeavours and not others

115-5, 116-7 analyze and report how natural and technological systems have developed and improved over time, including organ transplants

Skills

Students will be expected to

215-4, 317-8 explain, with specific examples, how behaviours such as tropisms, instinct, and learned, help to maintain homeostasis and identify multiple perspectives that influence a decision/issue

212-6, 116-4 design and perform experiments, identifying specific variables, to investigate how body systems work based on scientific understandings

Knowledge

Students will be expected to

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

314-1, 314-2, 314-3 identify and describe the role of chemicals, including elements, compounds, biochemicals, and water on the structure and function of various body systems

317-4, 317-6, 214-15 identify and predict the impact of viruses, diseases, and environmental factors on the homeostasis of an organism and propose alternate solutions

Homeostatis

(3 hours)

OUTCOMES

Students will be expected to

- explain the importance of nutrition and fitness to the maintenance of homeostatis, debating the merits of funding specific scientific or technological endeavours and not others (117-4, 317-3)
- explain, with specific examples, how behaviours such as tropisms, instinct, and learned, help to maintain homeostasis and identify multiple perspectives that influence a decision/issue (215-4, 317-8)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Presentation

- Select a plant that survives in what may be considered an inhospitable environment or simply an environment very different from the local one, and investigate the homeostatic mechanisms it utilizes to ensure its survival and reproduction. Present your conclusions to the class, and/or prepare a poster or model of the organism labelled in such a manner to illustrate the homeostatic mechanisms involved. (215-4, 317-8)
- Research and select a type of tropism of interest to you. Include details of the tropism, its advantages, and evolution. Be prepared to make a brief presentation to the class on your selection. (215-4, 317-8)

Performance

- Propagate a plant. Investigate and assist the homeostatic mechanisms that help it survive under chosen conditions. (117-4, 317-3)
- Within your group, develop a research question and design an appropriate experiment to investigate it. Suggested topics may include Geotropism, Phototropism, Hydrotropism, or Chemotropism. Following the completion of your experiment, present your data and conclusions to the class. Compile and organize your data using appropriate formats (numeric tables, graphs, hand or computer generated). Be prepared to explain why your group made certain decisions in planning and conducting your experiment. (215-4, 317-8)

Paper and Pencil

- 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? (117-4, 317-3)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

During this section, students should 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.

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? Explain 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.

Students could brainstorm the following question: “How do plants respond to their environment?” Student responses may include the following:

- light—leaves track the sun
- water—roots spread out and down to meet demand; guard cells respond to water content of leaves; wilting
- flowers—close at night, open during the day

Students should suggest what part each of these might play in the maintenance of homeostasis by the plant.

Students should 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. For 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, and so on. This provides another opportunity to have students establish the interrelationships between systems within the body as they work to maintain homeostasis.

This section provides an opportunity to investigate aspects of plant tropisms that influence homeostasis.

Students could discuss how plants in their yards, gardens and communities survive some of the extreme weather and climate conditions they experience. They may research how some plants can survive in certain harsh areas and others cannot. This may lead to the questions, “How do plants use homeostatic mechanisms to survive?” “How do gardeners, horticulturists, agriculturists, and tree technologists promote plant adaptation and survival for human use?”

Students could research, design, and/or conduct experiments in a group setting to investigate topics including tropisms (hydro-, geo-, chemo-, phototropism), the transpiration tension theory of vascular plants, or the effect of growth hormones on plants.

Both quantitative (e.g., measurement of angle of phototropism) and qualitative types of data can be collected, displayed in graphic or table form and presented to the class for discussion. Students could choose a plant, propagate it and assist its homeostatic mechanisms to help the plant survive in their home conditions. A written report of both quantitative and qualitative observations and student interventions would be included.

RESOURCES/NOTES

STSE Issues

- Social Issue: Artificial Organs, *Nelson Biology*, p. 226

[Heading??]

- Passive Transport, *Biology 11*, pp. 50–53
- Homeostasis and Control Systems, p. 226
- Maintaining an Internal Balance, *Biology 12*, pp. 332–337
- Performance Task, p. 498
- Determining the Effects of Caffeine on Homeostasis
- Facilitated Diffusion and Osmotic Balance, *Biology 11*, pp. 52–54
- External Factors Affecting Plant Growth, 13.8, *Biology 11*, pp. 534–539
- Investigation, Effect of Light on Plant Growth, p. 535
- Internal Factors, Debate: Plant Hormones, 13.9, pp. 540–542

Experiments

- Plant Tropisms, *Biology 11 and Biology 12: A Teaching Resource*

Body Systems: Circulatory

(10 hours)

OUTCOMES

Students will be expected to

- explain how different plant and animal system maintain homeostasis (317-1) Note: Circulatory
- design and perform experiments, identifying specific variables, to investigate how body systems work based on scientific understandings (212-6, 116-4)
- analyze and report how natural and technological systems have developed and improved over time, including organ transplants (115-5, 116-7)
- identify and describe the role of chemicals, including elements, compounds, biochemicals, and water on the structure and function of various body systems (314-1, 314-2, 314-3)
- identify and predict the impact of viruses, diseases, and environmental factors on the homeostasis of an organism and propose alternate solutions (317-4, 317-6, 214-15)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform the available activities that are designed to illustrate some aspects of a transport/circulatory system. These may include observation of plant transport systems—slides, cross-section of a plant, microscopic examination of components of the blood, or microscopic examination of the structure of blood vessels. (212-6, 116-4)
- Perform the available 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.
Allow 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 non-smoker; athlete versus non-athlete. (317-4, 317-6, 214-15)

Journal

- Explain why some doctors recommend heart patients take one tablet of ASA a day? (314-1, 314-2, 314-3)

Paper and Pencil

- Sketch the cellular components of blood. Label any visible structures. Identify and label the different types of leukocytes. (317-1)
- Sketch diagrams of cross-sections of arteries, veins, and capillaries. Compare these cross-sections with those of diseased blood vessels. (317-1)

Presentation

- Research and present, in a variety of formats, disorders linked to the circulatory system, and modern methods of diagnosis and treatment. (314-1, 314-2, 314-3)
- 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, prepare a brief summary of it, or of the answer to your question. (317-4, 317-6, 214-15)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Note: *Biology 11 requires that a minimum of two of the following five body systems be investigated in detail—circulatory, respiratory, digestive, excretory, and immune systems.*

All organisms have some mechanism to circulate materials and dispose of wastes. Multicellular organisms require specialized transport systems in order to ensure all cells have access to materials required for survival and removal of wastes. Students should discuss the relationship between increased body size and the necessity of transport systems.

Students should discuss how the circulatory system contributes to the maintenance of equilibrium through its role in the transport of heat energy and matter. Students should do a comparative study of circulatory mechanisms of a range of organisms that would illustrate the diversity and varying levels of complexity found within the plant and animal kingdoms. This should include the advantages of both open systems (insects) and closed systems. Organisms to consider may include trees, sponges, flatworms, earthworms, frogs, etc. Students should conduct a closer study of the circulatory systems of representative vertebrates such as the fish, frog, and human.

Students could observe differences in the physical structure of an artery, vein, and capillary by studying prepared microscope slides. Students should relate this structure to the function of each in blood circulation. Effects of external factors (temperature, caffeine, smoking) on peripheral blood flow can be investigated using liquid crystal thermometers. Students should trace the flow of blood through the mammalian heart and describe the pulmonary and systemic pathways.

Students should observe the principal features of the circulatory system, utilizing models, dissections or computer simulations, and to identify those structures through the use of drawings or photographs. In addition, during this process students should have the opportunity to observe and appreciate how the structures control the direction of blood flow through a mammalian heart. Observation of a mammalian 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.

Students should identify the main components of the blood and explain the role of each. Included should be the cellular components such as erythrocytes (red blood cells), leucocytes (white blood cells), and platelets as well as the non-cellular components of the plasma.

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).

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.

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

Specific pathologies of the circulatory system created by circulatory disorders such as hypertension and arteriosclerosis, should be discussed or researched in relation to their effect on homeostasis. As well, the capability of technology to diagnose, treat or cure the problem (angioplasty, clot-busting drugs) should be investigated. 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.

Students may be interested in investigating additional disorders related to the circulatory system—varicose veins, heart murmur, aneurysm, blood clots, and leukemia.

Introduce individuals knowledgeable in circulatory pathologies by using community resources such as physicians, organizations (Heart and Stroke Foundation), sufferers of these disorders or transplant recipients.

RESOURCES/NOTES

Experiments

- Microscopic Examination of Blood, *Nelson Biology*, p. 275
- What Affects Pulse Rate? *Biology Living Systems*, p. 592
- What Are the Effects of Iron Deficiency? *Biology Living Systems*, p. 602
- Effects of Temperature on Peripheral Blood Flow, *Nelson Biology*, p. 251
- Effects of Posture on Blood Pressure, *Nelson Biology*, p. 263
- The Effect of Stress on Blood Pressure, *Biology Living Systems*, p. 596
- How Do You Interpret An EKG? *Biology Living Systems*, p. 598
- Fetal Pig Dissection, Part 1 and 2, *Nelson Biology*, pp. 217–222 (covers five systems)

[Heading??]

- Components of Blood, *Biology 11*, p. 244
- Importance Circulatory System, p. 242
- Invertebrate Circulatory System, p. 243
- Mammalian Circulatory System, p. 256
- Thermoregulation, *Biology 12*, pp. 338–341
- Mapping Veins, *Biology 11*, pp. 254–255
- Blood Pressure, p. 265
- Listening to Heart Sounds, p. 262
- EKG—Diagnosing Heart Conditions, p. 260

Case Studies

- Diagnosis Using Hematocrits, *Nelson Biology*, p. 276

Software

- Riverdeep, Logal, Circulatory System

STSE Issues

- Social Issue: Heart Care, *Nelson Biology*, p. 267
- Looking Inside Your Body, *Biology Living Systems*, p. 606
- Health Connection: Protect Your Heart, *Biology Living Systems*, p. 607

Body Systems: Respiratory

(8 hours)

OUTCOMES

Students will be expected to

- explain how different plant and animal system maintain homeostasis (317-1) Note: Respiratory
- design and perform experiments, identifying specific variables, to investigate how body systems work based on scientific understandings (212-6, 116-4)
- analyze and report how natural and technological systems have developed and improved over time, including organ transplants (115-5, 116-7)
- identify and describe the role of chemicals, including elements, compounds, biochemicals, and water on the structure and function of various body systems (314-1, 314-2, 314-3)
- identify and predict the impact of viruses, diseases, and environmental factors on the homeostasis of an organism and propose alternate solutions (317-4, 317-6, 214-15)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform the available activities designed to illustrate some aspects of the respiratory system. These may include the following:
 - respiration rates in yeast
 - use of aquarium plants to collect bubbles of oxygen
 - 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

Many of these activities involve collection of data that can be tabulated and graphed. Allow 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 non-smoker; athlete versus non-athlete; asthmatic versus non-asthmatic; male versus female. (212-6, 116-4, 115-5, 116-7)

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. (317-4, 317-6, 214-15)

Presentation

- Within a debate format, 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. (314-1, 314-2, 314-3)
- Introduce 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.
- 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. (317-4, 317-6, 214-15)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should be reminded that all organisms require a respiratory surface for gas exchange and ultimately to provide O₂ for respiration at the cellular level.

A comparative study of respiratory mechanisms of a range of organisms would illustrate the diversity and varying levels of complexity found within the animal kingdom. Sample organisms may include earthworms, amphibians, and mammals.

Students should be provided with the opportunity to observe the principal features of the respiratory system, utilizing models, dissection or computer simulations, and to identify those structures through the use of drawings or photographs. Particular attention should be given to adaptive features that provide for efficient gas exchange in humans including cilia, mucous membranes, large surface area of alveoli, cartilaginous rings in the airway, and epiglottis.

Students should investigate the mechanics of ventilation and regulation of the breathing cycle.

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.

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 may 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. Data should be displayed in an appropriate form to enable interpretation.

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.

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 investigate additional respiratory disorders such as bronchitis or emphysema.

Students should investigate disorders linked to the respiratory system and their effect on the homeostasis of the system and the organism as a whole, including lung cancer, asthma, and pneumonia.

Discuss the impact of environmental factors on the respiratory system of an asthmatic. Factors to consider may include cigarette smoke, allergens (dust, mould, food), petrochemical fumes, and perfumes. 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 can 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 individual with respiratory difficulties when these indices register high readings.

Students can 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 may 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 quitting smoking can be investigated (e.g., nicotine gum, patches, acupuncture, or hypnotism) and their relative effectiveness compared.

RESOURCES/NOTES

Experiments

- Human Respiratory Responses, *Biology 11 and Biology 12: A Teaching Resource*
- Monitoring Lung Volume, *Nelson Biology*, p. 305
- Will Water Temperature Influence the Breathing Rate of a Goldfish? *Biology Living Systems*, p. 615
- Carbon Dioxide Levels, *Biology Living Systems*, p. 616
- How Much Air Do You Inhale in One Minute? *Biology Living Systems*, p. 622
- What May Cause Fish Kills in Summer? *Biology Living Systems*, p. 624

[Heading??]

- Importance of Respiratory Systems, *Biology 11*, p. 282
- Determining Lung Volume, p. 296
- The Effects of Exercise on Lung Volumes, p. 299
- Neural Circuits/Reflex Arc, *Biology 12*, p. 416
- How does the nervous system regulate the respiratory systems? p. 435
- Disorders of Respiratory System, *Biology 11*, pp. 294–295
- Case Study: Smoking and Lung Cancer, pp. 299–301
- Debate on Smoking, p. 302
- The Effect of Psychoactive Drugs on Homeostatic Adjustment, pp. 304–306

STSE Issues

- Asbestos Hazard, *Biology Living Systems*, p. 635
- Biotechnology: The Treatment of Respiratory Distress Syndrome, *Biology Living Systems*, p. 634
- Health Connection: Let’s Clear the Air, *Biology Living Systems*, p. 633
- Smoking, *Nelson Biology*, p. 311
- Scuba Diving: Exploring below the Surface, *Biology Living Systems*, p. 619
- How High Can We Live? *Biology Living Systems*, p. 621

Case Studies

- Smoking and Lung Cancer, *Nelson Biology*, p. 310

Body Systems: Digestive

(10 hours)

OUTCOMES

Students will be expected to

- explain how different plant and animal system maintain homeostasis (317-1) Note: Digestive
- identify and describe the role of chemicals, including elements, compounds, biochemicals, and water on the structure and function of various body systems (314-1, 314-2, 314-3)
- design and perform experiments, identifying specific variables, to investigate how body systems work based on scientific understandings (212-6, 116-4)
- analyze and report how natural and technological systems have developed and improved over time, including organ transplants (115-5, 116-7)
- identify and predict the impact of viruses, diseases, and environmental factors on the homeostasis of an organism and propose alternate solutions (317-4, 317-6, 214-15)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Do the activities on 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. (317-1)
- Do activities. 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. Design investigations from questions that these activities may generate. For example, question what would be the optimal temperature or pH for activity of a given enzyme and choose to investigate this further. (317-1)
- To reinforce the steps in the digestive process, imagine that you are eating a meal containing starches, proteins, and fats. What happens to each of these food molecules as they pass through the digestive tract? 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). Ask the next student to describe what happens to another type of food molecule in that same location (e.g., starch is hydrolyzed by amylase). Continue around the room naming compartments and processes until the end of the digestive tract is reached. (212-6, 116-4)

Journal

- Individuals who have had much or even all of their digestive system damaged or diseased can still survive. How is this possible? (115-5, 116-7)
- After having surgery to remove the gall bladder, how would a patient have to modify their diet? (115-5, 116-7)

Paper and Pencil

- Working in groups, gather nutritional information about a minimum of three fast food/restaurant menus. Some possible sources of this information would be from the restaurants themselves, hospitals dieticians, or the Internet). Design what you think is the healthiest “take out” eating meal plan possible for three days. How does your plan compare to the recommendations in Canada’s Food Guide? (212-6, 116-4)
- 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 will be presented to the class as a whole. Select an herbal health supplement and investigate the health claims that the manufacturers of these products make. Alternately, investigate the health benefits and sources of vitamins and minerals within the diet. Information will be presented to the class as a whole and you will subsequently place the information on a poster board designed to collate the essential elements of the class information for classroom or school display. Select a situation requiring dietary restrictions such as lactose or gluten intolerance, investigate its prevalence, causes, and methods employed to control the symptoms. (317-4, 317-6, 214-15)

- Research and present the effects of an example of legal drugs, illegal drugs, over-the-counter and prescription drugs on the functioning of the digestive and respiratory systems. Groups will be assigned different categories of drugs and the resulting presentations will thereby provide an overview of this topic. This is an opportunity to integrate the digestive and respiratory systems. (317-4, 317-6, 214-15)

Presentation

- Research a topic in preparation for a debate. The format of this debate will require you to display the results of your research and “argue” against other stakeholders concerning issues such as the use of fertile land in developing countries for the growth of cash crops rather than food crops that would increase their level of sustainability; the practice of irradiation of food to increase its shelf life; should society and public health care be held responsible for the cost of treatment of health problems caused primarily by correctable lifestyles? (314-1, 314-2, 314-3)
- Expose students to individuals knowledgeable in digestive pathologies by using community resources such as physicians, organizations (Ileitis and Colitis Association, Canadian Liver Association) or sufferers of these disorders (anorexia nervosa). 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. (317-4, 317-6, 214-15)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should be aware that the purpose of digestive systems is to convert large molecules into smaller ones capable of being utilized by the cell.

Students should be able to define and explain the relationship between mechanical digestion that physically creates more surface area and chemical digestion that hydrolyzes large food molecules into smaller molecules with the aid of enzymes.

A comparative study of digestive mechanisms of a range of organisms would illustrate the diversity and varying levels of complexity found within the animal kingdom. Sample organisms may include Hydra, tapeworm, earthworm, etc.

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. Students should be able to explain the role of hydrolysis as the main digestive reaction responsible for breaking down large molecules into molecules small enough to be absorbed by the villi, and its relation to dehydration reactions that reassemble protein and build complex carbohydrates and lipids in the cells.

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, interpreted, displayed and food categories compared.

Students can perform activities to demonstrate the action of digestive enzymes on an animal or plant tissue (egg white) or prepared solution (starch). An investigation of the action of saliva on starch could be performed, while ensuring that all major variables were controlled. Subsequently they 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, and record, display, and interpret the related data.

Students should identify the main secretions of the following glands and/or glandular tissue:

- salivary glands—secrete amylase for preliminary starch digestion
- stomach—glands in stomach lining secrete mucus and gastric juice (contains pepsin and hydrochloric acid) for initial protein digestion
- liver—secretes bile to emulsify fats
- pancreas—secretes sodium bicarbonate to neutralize stomach acids and enzymes to act on proteins (proteases), carbohydrates (amylase) and fats (lipases)
- small intestine—walls secrete juices that complete the digestion of carbohydrates, fats and proteins

Students should 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.

Students should trace the pathway of food through the human digestive tract and explain the efficiency of its structure, including mucous lining, villi, sphincters, and peristalsis activity.

The specific pathologies of the digestive system created by digestive disorders should be discussed or researched in relation to their effect on homeostasis along with the capability of technology to diagnose, treat or cure the problem. Disorders such as ulcers, gall stones, and ileitis/colitis should be mentioned. Students may discuss other conditions related to digestive function, such as cancer, Crohn's disease or celiac disease. Students can 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 can 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.

Many individuals routinely consume various vitamins, minerals and herbal supplements in their search for a healthy lifestyle. Students can 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. Students can research and evaluate how nutritional deficiency and starvation diets (bulimia, anorexia nervosa) can adversely affect the equilibrium of other body systems. 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. Students should discuss whether the images portrayed through the media and advertising promote a positive self-image and a healthy lifestyle for men and women.

Students can research and debate the safety and necessity of food additives, food irradiation and other technologies used to improve the shelf life or attractiveness of food products. There are many issues that lend themselves to a risk/benefit analysis including the relative value of the use of processed versus non-processed foods; the use of pesticides on food crops; the necessity of techniques used only to make food more visually appealing to the consumer; the question of where our food comes from; the potential of the inadvertent introduction of foreign organisms to an ecosystem through the importation of foods.

RESOURCES/NOTES

Experiments

- Biochemical Compounds, *Biology 11 and Biology 12: A Teaching Resource*
- Identification of Carbohydrates, *Nelson Biology*, p. 163
- Identification of Lipids and Proteins, *Nelson Biology*, p. 171
- Enzymes and H₂O₂, *Nelson Biology*, p. 186 (Biology 12, p. 82)
- Effect of pH on Protein Digestion, *Nelson Biology*, p. 237
- Modeling Digestion, *Biology Living Systems*, p. 552
- Are Enzymes Specific for Their Substrates? *Biology Living Systems*, p. 554
- Which Fruits Keep Gelatin from Gelling? *Biology Living Systems*, p. 564
- Why Are Michael's Data Different? *Biology Living Systems*, p. 564

[Heading??]

- Importance of Digestion, *Biology 11*, p. 208
- Digestive Enzymes
- Simple to Complex Organisms
- Investigation: The Effect of pH and Temperature on Starch Digestion, p. 219
- Biological Molecules, *Biology 12*, pp. 27–57
- Role of Enzymes, pp. 69–72
- Investigation: The Effect of the Enzyme Amylase on Starch Digestion, p. 213
- Homeostatic Control of Digestion, p. 227
- Essential Nutrients, *Biology 11*, pp. 234–236
- Roles of Enzymes, *Biology 12*, pp. 69–72
- Investigations: Buffers in Living Systems, 1.1.1, pp. 78–79
- Biological Molecules in 3-D, 1.2.1, pp. 80–81
- Factors Affecting the Rate of Enzyme Activity, 1.4.1, pp. 82–83
- Dieting, *Biology 11*, p. 232
- Take a Stand: Dangerous Diets, p. 233
- Diabetes Mellitus, *Biology 12*, p. 357
- Hormones that Affect Blood Sugar, pp. 378–380

STSE Issues

- Social Issue: Fad Diets, *Nelson Biology*, p. 241
- Health Connection: Does Cholesterol Count? *Biology Living Systems*, p. 571
- Are Liquid Diets a Losing Proposition? *Biology Living Systems*, p. 572

Body Systems: Excretory

(6 hours)

OUTCOMES

Students will be expected to

- explain how different plant and animal system maintain homeostasis (317-1) Note: Excretory
- identify and describe the role of chemicals, including elements, compounds, biochemicals, and water on the structure and function of various body systems (314-1, 314-2, 314-3)
- identify and predict the impact of viruses, diseases, and environmental factors on the homeostasis of an organism and propose alternate solutions (317-4, 317-6, 214-15)
- design and perform experiments, identifying specific variables, to investigate how body systems work based on scientific understandings (212-6, 116-4)
- analyze and report how natural and technological systems have developed and improved over time, including organ transplants (115-5, 116-7)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Do the activities provided to illustrate some aspects of the excretory system. These may 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. Allow students the opportunity to design their own investigations from questions that these activities may generate. (317-1)

Journal

- What effect on your lifestyle would a non-functioning bladder have? (317-1, 314-2, 314-3)
- What concerns would you expect a potential kidney donor to have? (212-6, 116-4)

Paper and Pencil

- Sketch a longitudinal cross-section of the kidney and label the cortex, medulla, pelvis, renal artery, and renal vein. (317-1)
- Research information about kidney dialysis. Explain why it is used. What type of person is a dialysis candidate? What different methods are available? What complications are possible? (212-6, 116-4)

Presentation

- Introduce individuals knowledgeable in excretory pathologies such as community resources such as physicians, organizations (Kidney Foundation), sufferers of these disorders, dialysis patients, transplant recipients. 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. (317-4, 317-6, 214-15)
- You will be assigned to a group and given directions to research a topic in preparation for a debate. The format of this debate will require you to display the results of your 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. (115-5, 116-7)
- Present, in various formats, a summary of your kidney dialysis research. (115-5, 116-7)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Excretory systems maintain homeostasis with respect to water, salt and metabolite concentrations within the blood. A comparative study of excretory mechanisms of a range of organisms would illustrate the

diversity and varying levels of complexity found within the animal kingdom. Sample organisms may include: flatworm (flame cells), earthworm (nephridia), crayfish (green glands), insects (Malpighian tubules).

Students should explain the role of the kidney as an excretory organ in removing metabolic wastes from the body and excreting them into the environment. Students could observe and describe the principal features of the human excretory system including kidney, ureter, bladder, and urethra, by utilizing models, dissection or computer simulations, and to identify those structures through the use of drawings or photographs. Diagrams or charts should be displayed 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 provides some visual confirmation of the structural components of the kidney.

Students should identify 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.

The specific pathologies of the excretory system created by excretory disorders should be discussed or researched in relation to their effect on homeostasis along with the capability of technology to diagnose, treat or cure the problem. Disorders such as kidney stones, kidney infections, and bladder infections should be mentioned. Students may discuss other disorders related to kidney function including diabetes and nephritis.

Discuss the effects of lifestyle on the homeostasis of the excretory system. Have students hypothesize why consumption of alcohol induces more trips to the washroom than does the consumption of water alone.

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. Students should correlate kidney dialysis technology to the functioning of a human kidney.

Students could research and debate the merits of funding organ transplant research. They should consider the implications of the utilization of other species as potential donors. Students can, in groups, propose guidelines for selecting the most appropriate organ transplant recipient from a number of possible candidates. They can then debate and defend their choices. A hypothetical list of potential candidates may be provided by the instructor to help illustrate the inherent and ethical difficulties of this selection process.

RESOURCES/NOTES

Experiments

- Diagnosis of Kidney Disorders, *Nelson Biology*, p. 326

[Heading??]

- Excretion from Simple to More Complex Animals, *Biology 12*, pp. 342–345
- Making a Model of a Filtering Excretory System, p. 343
- Water Balance, p. 353
- Kidney Disease, p. 357
- Diabetes Mellitus/Insipides, Bright's Disease, p. 358

- Dialysis Technology, *Biology 12*, p. 358
- Debate: Xenotransplants, p. 360
- Kidney Transplants, p. 361

Case Studies

- Comparing Solutes in the Plasma Nephron and Urine, *Nelson Biology*, p. 320

Videos from LRT

- *Critical Choice*, V0189, 12 min.
- *The Ultimate Gift*, V1240, 25 min.

STSE Issues

- Social Issue: Fillings and Kidney Disease, *Nelson Biology*, p. 328

Body Systems: Immune

(6 hours)

OUTCOMES

Students will be expected to

- explain how different plant and animal system maintain homeostasis (317-1) Note: Immune
- identify and predict the impact of viruses, diseases, and environmental factors on the homeostasis of an organism and propose alternate solutions (317-4, 317-6, 214-15)
- design and perform experiments, identifying specific variables, to investigate how body systems work based on scientific understandings (212-6, 116-4)
- identify and describe the role of chemicals, including elements, compounds, biochemicals, and water on the structure and function of various body systems (314-1, 314-2, 314-3)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Suggest a hypothesis and design an experiment to investigate one of the following. Alternately, propose a different option, however it must be submitted for approval. Investigate the antimicrobial nature of substances such as mouthwash, extracts from a variety of plants (garlic, ginger, and aloe). Compare the effectiveness of soaps or other cleaning products labelled antibacterial with those of the same brand that are not labelled as such. (212-6, 116-4)

Paper and Pencil

- To supplement your study of the allergic process, prepare and conduct a survey of the prevalence and variety of allergies within the school population and the remedies used to alleviate symptoms. Data is to be tabulated, graphed and will be presented via a display to the school population in general. (317-4, 317-6, 214-5)

Presentation

- Investigate the natural response of the body to a bacterial infection or a viral disease such as a cold or the flu. Investigate the mechanism of transplant rejection or a selected auto-immune disease (rheumatoid arthritis, myasthenia gravis, multiple sclerosis, rheumatic fever, systemic lupus erythematosus (“lupus”), or thyroiditis). You will be expected to present to the class how this results in the symptoms of the disorder. (317-1, 314-1, 314-2, 314-3)
- Select an herbal supplement or vitamin and investigate its effect on the functioning of the immune system. Prepare a display. Be sure to include both natural and synthetic sources of these products. (314-1, 314-2, 314-3)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should discuss 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 able to explain the meaning and role of the terms *antigen* (*allergen*) and *antibody* in an allergic reaction and 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 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 labelling 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. A survey taken within the school and analysis of data relating to the most prevalent allergies and the frequency of allergies themselves among the student population may yield some interesting information. Data can be collected, analyzed, and reported.

A study of the non-specific first line defences would include both physical and chemical barriers such as skin, tears, mucous, cilia, sweat, and stomach acids. The inflammatory response and phagocytes as second line defenders and the immune response involving lymphocytes such as T-cells (initiated by a virus-infected cell or tumour cell), and B cells (initiated by bacteria) 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 as well as comparing the mechanisms of various forms of acquired immunity including passive (breast milk) and active (exposure, vaccines). Students should 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. Students may research or investigate the antioxidant (chemical altering of free radicals) nature of Vitamins E, C, and beta-carotene, and the relevance of this to the health of the human population (e.g., link with cancer and cardiovascular disease).

RESOURCES/NOTES

Videos from LRT

- *Coming to Grips with the Grippe*, 21950, 46 min.
- *Fighting Disease*, 21543, 50 min.

Video from Rental Outlets

- *Osmosis Jones* (Feature length animation with Chris Rock as the voice of Osmosis Jones)

STSE Issues

- Social Issue: Compulsory AIDS Testing, *Nelson Biology*, p. 293

- Biotechnology: Defending against Thousands of Antigens, *Biology Living Systems*, p. 664
- Organ Transplants: Who Decides?, *Biology Living Systems*, p. 665

{heading??}

- Body's Lines of Defence, Sect. 10.1, *Biology 12*, pp. 462–465
- The Immune Response, Sect. 10.2, pp. 466–470
- Malfunctions of the Immune System:
 - Allergies, p. 473
 - AutoImmune Disease, p. 474
 - MS, p. 474
 - Bubonic Plague, p. 476
 - HIV AIDS, pp. 480–81
- Matching Tissues for Organ Transplant, p. 471

Interactions among Living Things (10%) (Advanced, 5%)

Introduction

During the extent of this unit, students will investigate the geographical regions of Canada through the study of major Canadian biomes. 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 interactions between living things connects with other clusters in the science curriculum primarily in Science 4 and Science 7 and building to the grade 10 level. Previous to this, Science 1 students talk of how humans and other living things depend on their environment. Science 2 expands on this by describing features of environments that support the health and growth of animals. The major focus in grade 4 is on habitats and community including the identification of regional and local habitats and how the removal of plant or animal populations would affect the remainder of the community. The life science portion of the curriculum in Science 7 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 10 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 11, they have a broad background through which to pursue their study of interactions among living things.

Curriculum Outcomes

STSE

Students will be expected to

116-7, 118-10, 318-10, 318-11 propose courses of action on social, economic, and cultural issues related to Earth's carrying capacity and demands on natural resources, referencing the energy pyramid

Skills

Students will be expected to

214-5, 318-7 compare and interpret patterns of North America's biomes with another continent in terms of climate, vegetation, physical geography, and location

Knowledge

Students will be expected to

215-3, 318-8, 319-9 synthesize information from multiple sources to describe and explain factors that influence population growth and interactions within and between populations

Biomes

(6 hours)

OUTCOMES

Students will be expected to

- compare and interpret patterns of North America's biomes with another continent in terms of climate, vegetation, physical geography, and location (214-5, 318-7)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Paper and Pencil

- Research a Canadian biome using library and electronic research tools and prepare a class presentation. Prepare a handout sheet for your class members to facilitate their recording of the pertinent features of your biome during your presentation to them. Be sure to include information on climate, vegetation, geography and location, and any other features that make your biome interesting and distinct. (214-5, 318-7)
- Create posters/displays on each biome based on your research. (214-5, 318-7)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should identify and explain the ecological hierarchy of an organization of living systems, from the level of the individual organism to the entire biosphere and be able to describe the categories of abiotic and biotic into which ecological factors are classified. Biomes, regions with a particular combination of abiotic factors, are an important component of this system.

Students can hypothesize and discuss the ecological role of some additional abiotic factors such as seasonal snow cover and flooding. Students should be given an opportunity to compare Canadian biomes and explain how abiotic factors such as latitude, temperature, precipitation, and photoperiod determine the Canadian biomes of tundra, boreal coniferous forest, temperate deciduous forests, and grassland.

The study of the Canadian biomes is one that can be approached utilizing student library and electronic research and class presentations. Students can indicate the location of their selected biomes on a large classroom map of the country. Alternately, students can prepare a chart or grid to facilitate the recording of information on these biomes under each category. Students can prepare climatograms for a Canadian biome, and evaluate the collection, verification and use of climatogram data for the benefit of society and the environment. Climate, vegetation, geography, and location should be addressed in student research.

RESOURCES/NOTES

Experiments

- Investigating a Microecosystem, *Nelson Biology*, p. 51
- Acid Rain and Aquatic Ecosystems, *Nelson Biology*, p. 76

Videos from LRT

- *MacFarlane Woods: A Special Place*, V1596, 22 min.
- *World's Biomes: Desert to Rainforest*, 23292, 28 min.

STSE Issues

- Considering the Environment: Wetlands, *Biology Living Systems*, p. 837

- Friendly Fires, *Biology Living Systems*, p. 839

Population Dynamics

(8 hours)

OUTCOMES

Students will be expected to

- synthesize information from multiple sources to describe and explain factors that influence population growth and interactions within and between populations (215-3, 318-8, 319-9)
- propose courses of action on social, economic, and cultural issues related to Earth's carrying capacity and demands on natural resources, referencing the energy pyramid (116-7, 118-10, 318-10, 318-11)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Separate the class into two opposing sides and have a debate on the pros and cons of mandatory birth control. (116-7, 118-10, 318-10, 318-11)

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? (116-7, 118-10, 318-10, 318-11)

Paper and Pencil

- Select a species of interest within an ecosystem and investigate its niche. Sketch a food web within which this species plays a role and hypothesize the potential effects should this organism be removed from the ecosystem it inhabits. Present orally and visually your research. (215-3, 318-8, 319-9)
- Investigate a threatened or endangered species and prepare a visual display on this organism. Try to find a local species. Include a diagram, estimated current population and reasons for endangerment. Include the interventions necessary to alleviate the problem and any difficulties there may be with their implementation. (116-7, 118-10, 318-10, 318-11)
- 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. Report on your findings to the remainder of the class, and will add this information in abbreviated form to a global map prepared by members of the class. This will serve to illustrate in a dramatic fashion some of the population issues that exist within the world today. Be prepared to participate in a discussion to follow. Organizations such as CIDA have produced both maps and brochures that outline this information. Be sure to have included in this survey a range of both developing and developed countries that represent all areas of the globe. (116-7, 118-10, 318-10, 318-11)
- Given demographic data from various regions of the world, produce graphs that show different population growth patterns. (116-7, 118-10, 318-10, 318-11)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should discuss the dynamics involved in intraspecific and interspecific competition. Factors such as natural resources, ability to reproduce, food chains, and symbiotic relationships of commensalism, mutualism, and parasitism should be included.

Students could select a species and investigate its niche and importance within the sustainability of an ecosystem through the relationships that exist between it and other members of its own species and

between it and other species within the same ecosystem (e.g., honeybees, wolves, ground squirrel) and hypothesize potential effects should this organism be removed from this system. Students have completed sustainability of ecosystems from Science 10 and should draw upon those experiences to extrapolate further on the factors that influence populations.

Students should recognize that as the feeding level within a food web increases, available energy decreases (only about 10% of available energy is passed on to the next level). Students should brainstorm ideas and discuss where the energy goes based on the concept of the conservation of energy. The concept of this decreasing pyramid of energy can then be extended to the growth, preparation and distribution of food resources.

Students should discuss the population determiners of mortality, natality, immigration and emigration and be given an opportunity to analyze and describe the factors that regulate population size within ecosystems, and their dynamics, including competition, environmental quality, disease, parasitism, and predation. Students should identify the term *carrying capacity*.

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 “Should we be concerned about the Earth’s carrying capacity for the human population? Explain.” and “How has human population growth affected the carrying capacity of other species?” (habitat degradation and destruction).

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. This can be connected to the body systems and to the biomes.

Students should investigate and discuss the factors that are specific to the limiting of the human population. Students should explain, in general terms, population density, rates of growth, and phases of growth curves.

Students should examine and label the sections of an S-shaped (logistic) growth curve and explain how it describes the general population growth patterns observed in animal populations. Students should recognize that the shape of the “S” varies depending on the growth strategy of the species (many offspring with little parental investment, few offspring with much parental investment).

Students should research and determine the current growth rate of the human population and the projected growth rate and investigate the demands that will be placed upon the Earth’s natural resources by future population growth.

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. They should identify that technological developments have raised, and continue to raise, the carrying capacity of the earth. 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, level of health care. They may discuss the reasons 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 planet 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.

Students may 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, use of advanced technologies and changed lifestyles may help a population meet its energy/material needs.

RESOURCES/NOTES

Experiments

- How Does Crowding Affect Plant Growth? *Biology Living Systems*, p. 774
- How Do Root Node Bacteria Benefit Clover Plants? *Biology Living Systems*, p. 793
- Limiting Factors for Duckweed Growth, *Biology Living Systems*, p. 764
- Why do Newts Survive Their Parasites? *Biology Living Systems*, p. 769
- Factors Involved in Grass Seed Germination, *Biology Living Systems*, p. 818
- How do Physical Factors Affect Zebra Mussels? *Biology Living Systems*, p. 24
- Density Problems, *Nelson Biology*, p. 582

Software

- Riverdeep, Logal
- Riverdeep, Logal: Population Biology (simulations)

Websites

WWW keywords:

- zebra mussel
- purple loosestrife
- English sparrow
- eastern bluebird
- moose
- caribou
- p. tenuous

[Heading??]

- *Nelson Biology 12*, pp. 646–647
- *Nelson Biology 12*, pp. 648–688

STSE Issues

- Old Versus Young in America, *Biology Living Systems*, p. 780
- Pile It On? *Biology Living Systems*, p. 781

Biology 12 Outcomes

Maintaining Dynamic Equilibrium II (20%) (Advanced, 16%)

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 and this unit will identify and introduce the role of some of those plant and animal systems. The systems that will be studied include the nervous (electrochemical) and endocrine (chemical) systems.

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 electrochemical and chemical control systems.

Science Curriculum Links

Biology students have studied the components of body systems at a number of different levels prior to Biology 12. Students in Science 2 are introduced to the importance of maintaining a healthy lifestyle. When they reach the level of Science 5 they begin to discuss the role of specific body systems in growth and reproduction. The major components of the structure and function of the digestive, excretory, respiratory, circulatory, and nervous systems are introduced. The skeletal, muscular, and nervous systems and their contributions to movement are also integrated into this study. In addition, body defences against infection and nutritional requirements to promote health are discussed. When students reach Science 8, they begin to consider the basic factors that affect the functioning and efficiency of the human respiratory, circulatory, digestive, excretory, and nervous system and are encouraged to discover and describe examples of the interdependence of various systems of the human body. This provides a good background for the study of the role of systems in the maintenance of homeostasis within an organism. A cross-curricular link exists between the life sciences and physical sciences in the discussion of dynamic equilibrium incorporated into APEF Chemistry and Physics.

Curriculum Outcomes

STSE

Students will be expected to

116-7, 213-5 analyze the nervous system and compile and organize data to interpret its structure and dynamics

115-5, 317-7 analyze how and why technologies and drugs developed and improved over time can affect homeostasis

116-4, 317-5 evaluate and describe examples of treatments and technologies for visual and auditory functions

117-11, 115-5 analyze contributions, including Canadian, to science and technology and how these have improved over time

Skills

Students will be expected to

212-6 design an experiment to investigate and collect data on aspects of the nervous system and identify specific variables involved

212-6, 213-5 design and do an experiment, identify variables, and compile and organize data on selected aspects of the endocrine system

Knowledge

Students will be expected to

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

314-3 identify and describe the structure and function of important biochemical compounds, including protein and steroid hormones

314-4 explain the critical role of enzymes in cellular metabolism

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

317-2 analyze homeostatic phenomena to identify the feedback mechanisms involved

317-4 evaluate the impact of viral, bacterial, genetic, and environmental diseases on an organism's homeostasis

Nervous System: Neurons and Structure

(8 hours)

OUTCOMES

Students will be expected to

- explain how different plant and animal systems maintain homeostasis (317-1)
- identify the role of some compounds, such as water, glucose, and ATP, commonly found in living systems (314-2)
- design an experiment to investigate and collect data on aspects of the nervous system and identify specific variables involved (212-6)
- analyze the nervous system and compile and organize data to interpret its structure and dynamics (116-7, 213-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform the available experiments provided to illustrate some aspects of the nervous system. These may include microscopic examination of components of the nervous system, dissection of specimens, or observation of models in order to observe the structure of the nervous system, reflex times, observation of the behaviour in response to stimuli of specimens like Planaria or the effect of the stimulant caffeine on Daphnia. Allow students the opportunity to design their own investigations from questions that these activities. (317-1)
- Perform the available activities provided to illustrate some aspects of the nervous system. These may include activities to investigate the sensitivity of the touch receptors of the skin and/or the taste receptors of the tongue. Some of these activities involve collection of data that may be tabulated and graphed. (212-6)

Journal

- With a partner, test each others' reflexes (e.g., knee jerk test or reaction time). What do you think can be learned from tests like this? (314-2)
- What happens to your body when you are faced with a stressful situation (e.g., danger, fright, and so on)? How long does it usually take for your body to return to normal? (116-7, 213-5)

Paper and Pencil

- Research the effects of drugs (such as codeine, heroin, and caffeine) on the synapse. Write up your findings in the form of a magazine article. (317-1)
- Construct a flow chart that shows the path of a reflex arc. (314-2)
- Nervous control in other organisms: Not all organisms have a nervous system as sophisticated and complex as the human nervous system. Explore the types of nervous systems found in other organisms. Using the Internet, your text or other references, research: paramecium, hydra, planarian, and earthworm to describe the type of nervous control found in the organism, to write a description of the organism, and to contrast the type of nervous control in the planarian and the hydra. Is there an advantage to having a brain at the anterior end of the body? (116-7, 213-5)
- Prepare a chart to visually contrast the sympathetic and parasympathetic components of the autonomic nervous system on the various parts of the body (e.g., heart, digestive tract, blood vessels, bladder, bronchi, eye). (116-7, 213-5)

Presentation

- Working within your assigned groups, select a nerve poison to investigate. Report to the class on the physiological effect it has on the nervous system, its source, and the historical and/or current reasons for its use. (317-1)

- Working within your assigned groups, select a substance (chocolate might be an example) or procedure (acupuncture) that affects the nervous system. Report to the class on its physiological effect on the nervous system. (317-1)
- Have students work in pairs. Instruct each team to use outside sources (media, Internet, etc.) to find out how drugs affect the central nervous system. Discuss student findings and create a class chart that summarizes the effects of common drugs. (317-1)
- Invite a radiologist/x-ray technologist to give a presentation on MRI, CAT scan, or EEG. Research and prepare questions related to the topic. Working in groups, questions should be reviewed and revised. The questions selected should be asked during the presentation. Following the presentation prepare a brief summary of the answers given. (116-7, 213-5)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should describe how the nervous system helps maintain homeostasis. Students should describe the basic structure and function of sensory neurons, motor neurons, and interneurons. Students should explain, in general terms, the ion distribution on the membrane of a neuron and the influence of myelin. Students should describe the transmission of an impulse along the length of a neuron, across a synapse or neuromuscular junction, and the effects of transmitters involved. Discuss the terms *acetylcholine* and *noradrenaline*.

The nervous system is responsible for receiving information from internal and external stimuli and the quick response to that information. While bacteria, protists and some plants are capable of nervous response, animals are the only organisms that possess true nervous systems. Four requirements are necessary for a nervous response to occur: sensory receptors to detect a stimulus (skin, eye, ear); method for impulse transmission (neurons); interpretation and analysis of impulses (brain, spinal cord); response carried out by an effector (muscle, gland). A comparative study of nervous mechanisms within a range of organisms would illustrate the diversity and varying levels of complexity in the animal kingdom. Sample organisms may include flatworms, earthworms, Hydra, grasshopper.

Students should describe how the nervous system helps maintain homeostasis. Students should describe the basic structure and function of sensory neurons, motor neurons and interneurons. Students should explain, in general terms, the ion distribution on the membrane of a neuron and the influence of myelin. Students should describe the transmission of an impulse along the length of a neuron, across a synapse or neuromuscular junction, and the effects of transmitters involved.

Students can observe microscopically the structure of neurons and neuromuscular junctions on prepared microscope slides within the laboratory.

Students may investigate the neurological and physiological basis behind the effectiveness of acupuncture and the production of a “runners high.” Students can investigate how nerve poisons interfere with synaptic transmission (curare, botulism, tetanus, organophosphate pesticides, nerve gas).

Students should be able to relate compounds such as oxygen, glucose, ATP and sodium ions to their role in neuron function.

Cells within the nervous system require enormous amounts of energy to function. This energy is provided by the processing of glucose and the production of ATP within these tissues, requiring an adequate supply of carbohydrates and oxygen.

Students should be introduced to the reflex arc and identify the various types of neurons involved and their functions. Include sensory neurons, motor neurons, and interneurons. Students can design and/or

perform experiments to investigate the physiology of reflex arcs (pupil dilation, knee jerk reaction, reaction time).

Enrichment may be provided by allowing students the opportunity to design their own investigations from questions that these activities may generate.

Students should observe the principal features of the brain, using models, dissected mammalian brains or computer simulations, and to identify and label major physical structures and their functions from drawings or photos of that organ. Structures should include the cerebrum, cerebellum, medulla, and spinal cord.

Students may investigate and discuss how advances in science and technology influence our ability to explore the human brain (e.g., MRI, CAT scan, and EEG).

Students should discuss the basic functions of the peripheral nervous system including the sympathetic and parasympathetic. Students can prepare a chart to visually contrast the sympathetic and parasympathetic components of the autonomic nervous system on various parts of the body (e.g., heart, digestive tract, blood vessels, bladder, bronchi, and eye).

Investigations of the touch receptors of the skin and the taste receptors of the tongue can be used to illustrate their differential distribution. Students could also design and/or perform experiments to further investigate this sensitivity to heat, cold, pressure, touch, taste, or reflex arcs and display and interpret any data collected.

Allow students the opportunity to design their own investigations from questions that these activities may generate.

RESOURCES/NOTES

Experiments

- Reflex Arcs and Reaction Rates, *Nelson Biology*, p. 355
- The Effect of Stimulants on Daphnia, *Biology Living Systems*, p. 716
- How Do Distractions Affect Your Reaction Time? *Biology Living Systems*, p. 719
- How Sensitive Is the Skin to the Sense of Touch? *Biology Living Systems*, p. 706
- Can Brain Cells Regenerate? *Biology Living Systems*, p. 714

[Heading??]

- Stimulus and Response in Planaria
- Reflex Arcs and Reaction Rates, *Nelson Biology*, p. 452
- Reflex Ruler (Sight, Tactile, Touch)

Videos from LRT

- The Mind Series, 30 min. each (loan)
 - *Thinking*, 21533
 - *The Two Brains*, 21525
 - *Learning and Memory*, 21526

Case Study

- Phineas Gage, *Nelson Biology*, p. 432

Influences on the Nervous System

(4 hours)

OUTCOMES

Students will be expected to

- evaluate the impact of viral, bacterial, genetic, and environmental diseases on an organism's homeostasis (317-4)
- analyze how and why technologies and drugs developed and improved over time can affect homeostasis (115-5, 317-7)
- evaluate and describe examples of treatments and technologies for visual and auditory functions (116-4, 317-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Design an experiment to investigate the effect of light intensity on pupil diameter. Show your procedure to your teacher for approval. Include all safety precautions and procedures. (116-4, 317-5)
- Following the procedure outlined, dissect the sheep eye provided, and identify the parts. Complete the table that relates the structure of the parts of the eye with their function. (116-4, 317-5)

Journal

- Birds of prey often have much greater visual resolution (the ability to distinguish between objects at great distances) than humans. What is it about a bird's eye that gives it this ability? (116-4, 317-5)

Paper and Pencil

- Select a nervous system disorder or injury. Research the modern treatments for it. Make a brief presentation to the class and submit a report. (115-5, 317-7)
- Select a particular pharmaceutical or drug to investigate. Include the sources of the chemical, medical or non-medical uses, effects of use, and any other appropriate information. Present your information to the class. (115-5, 317-7)
- Research the impact any two of these four disorders have on the ability of our nervous system to maintain homeostasis. Using any resources available, including the Internet, report on each of the two disorders you chose.
 - *Encephalitis*—a viral disorder of the nervous system
 - *Pneumococcal meningitis*—a bacterial disorder of the nervous system
 - *Parkinson's disease*—a genetic disorder of the nervous system
 - *Carpal tunnel syndrome*—an environmental disorder of the nervous systemFor each report, include cause, how the disorder affects the nervous system, symptoms, and treatment. For each choice, discuss how advances in science and technology influence our ability to explore the human brain (e.g., MRI, CAT scan, EEG, DNA analysis). (115-5, 317-7)
- Construct a flow chart that shows the path of sound energy through the auditory system. (116-4, 317-5)
- Investigate the development of new technologies for the correction of malfunctions of the sense organs and/or the potential health effects of environmental factors such as noise pollution and extended wear contact lenses. Be prepared to present your findings to the class. (116-4, 317-5)
- Using the Internet, the public library, and your textbook, briefly describe each of the following eye disorders: glaucoma, cataracts, conjunctivitis. Include in your answer a definition of the condition, symptoms, and treatment. (116-4, 317-5)
- Explain what causes each of the following vision defects: astigmatism, myopia (near-sightedness), hyperopia (farsightedness), and macular degeneration (116-4, 317-5)

- Laser surgery is used to treat vision. Briefly explain the effectiveness of this surgery and the methods used to correct vision using laser surgery. Evaluate the procedure by identifying the risks and benefits of this surgery. (116-4, 317-5)
- There are five pathways in the hearing process. Briefly explain how hearing loss can occur at the following pathways: air must be conducted from the external ear to the ear drum, sound waves must be conducted through the bones of the middle ear, sound waves must be conducted through the water of the inner ear, sound waves must be conducted along the auditory nerve to the brain, and sound waves must be interpreted by the brain. (116-4, 317-5)

Presentation

- Invite guests to speak to the students. These speakers may be knowledgeable in nervous system pathologies by using community resources such as physicians, organizations (Alzheimer's Society, Parkinson's Foundation, Heart and Stroke Foundation, Canadian Mental Health Association, Multiple Sclerosis Society), sufferers of, or caregivers of those who possess these disorders. (317-4)
- Invite guests to speak. These guests may be knowledgeable in the influence of the use of prescription and non-prescription, legal, and illegal drugs on the maintenance of homeostasis within the human system by using community resources such as physicians, pharmacists and available organizations. (317-4)
- 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, prepare a brief summary of it or of the answer to your questions. (317-4)
- Invite a guest speaker who is knowledgeable in sensory organ pathologies by using community resources such as physicians, organizations (Canadian National Institute for the Blind, Eye Banks, Canadian Association for the Deaf and Blind), corneal transplant recipients or sufferers of these disorders. 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, prepare a brief summary of it or of the answer to your question. (116-4, 317-5)
- Construct a chart of eye disorders (e.g., cataracts, crossed eyes, sty). Describe the disorder and the possible medical treatments. This could be done individually or in groups, with each group completing one eye disorder and the results combined to make a class display. (116-4)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Specific pathologies of the nervous system created by digestive disorders should be discussed or researched along with the capability of technology to diagnose, treat or cure the problem. During this discussion students should investigate the physiological basis and causes of neurological diseases and discuss the effectiveness and the ethics of new innovative treatments (e.g., transplant of fetal brain tissue into patients as a treatment for Parkinson's). Disorders should include multiple sclerosis, Alzheimer's disease, Parkinson's disease, epilepsy, and meningitis. Students may be interested in other conditions related to nervous function, such as polio, stroke, Bell's palsy, or mental disorders related to chemical imbalances.

Students may evaluate the consequences of damage or injury to the nervous system (e.g., stroke, spinal injury). Students may investigate the research being done on treatments for the conditions of stroke and spinal injury and the potential these have for the improvement of the lifestyle of victims of these conditions.

Students may analyze evidence concerning the influence of anaesthetics, drugs and chemicals, natural and synthetic, on the functioning of the nervous and endocrine systems and their relationship to

addiction theory (e.g., nicotine, morphine, and LSD). Students may compare the relative physiological and societal impacts of chemical and drug use on adult development as compared to fetal development.

The investigation of sense organs serves as a cross-curricular link with the waves/sound/light sections of high school physics. Students should observe the principal features of the mammalian eye and ear, using models, dissected structures or computer simulations, and identify and label major visible structures and their functions from drawings or photos of those organs. The structures of the eye should include lens, iris, retina, choroid, fovea, rods, cones, and blind spot. The structures of the ear should include tympanic membrane (eardrum), ossicles (hammer, anvil, stirrup), eustachian tube, semi-circular canals, and cochlea.

Student activities dealing with the sensory organ of the eye can illustrate binocular vision, dominant eye, focusing, resolution, blind spot and retinal fatigue. Students could design and/or perform experiments to distinguish objects visually and to hear a range of sounds.

Students may discuss causes and treatments for the common visual defects of near-sightedness and farsightedness. Students may also research the development of new technologies for the treatment of sensory malfunctions (e.g., corneal laser surgery, cochlear, and digital implants). Students should research and discuss the potential health effects of repeated exposure to loud noises (noise pollution) and extended wear contact lenses.

RESOURCES/NOTES

Videos from LRT

- The Mind Series, 30 min. each (loan)
 - *Addictions*, 21527
 - *Aging*, 21528
 - *Depression: Bipolar Disorder*, 21531
 - *Madness*, 21524
 - *Pain and Healing*, 21530

STSE Issues

- A New View of Drug Addiction, *Nelson Biology*, p. 376
- Alzheimer's: The Disease That Takes Everything, *Biology Living Systems*, p. 725
- Hope for Spinal Cord Injury Patients, *Biology Living Systems*, p. 193
- Fighting Noise Pollution, *Biology Living Systems*, p. 724
- Rock Concerts and Hearing Damage, *Nelson Biology*, p. 402

Experiments

- The Senses, *Biology 12 Appendices*
- Vision, *Nelson Biology*, p. 394
- Hearing and Equilibrium, *Nelson Biology*, p. 400

[Heading??]

- Hearing Damage, p. 449

Endocrine System: Maintaining Homeostasis

(4 hours)

OUTCOMES

Students will be expected to

- identify and describe the structure and function of important biochemical compounds, including protein and steroid hormones (314-3)
- explain the critical role of enzymes in cellular metabolism (314-4)
- explain how different plant and animal systems maintain homeostasis (317-1)
- design and do an experiment, identify variables, and compile and organize data on selected aspects of the endocrine system (212-6, 213-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform the activities provided to illustrate some aspects of the endocrine system. These may include dissection of specimens, or observation of models in order to observe the structure of the endocrine system. Some activities involve collection of data that can be tabulated and graphed. (314-3)
- Design investigations from questions that these activities may generate. (314-3)
- Design an experiment to show the effects of the removal of the thyroid gland in mice. Identify the physiological characteristics that should be observed and explain how the data should be recorded. (212-6, 213-5)
- Perform the activities provided to illustrate some aspects of the endocrine system. These may include the following:
 - microscopic examination of pancreas to distinguish endocrine tissue from digestive enzyme producing tissue
 - effect of epinephrine on the heartbeat of Daphnia
 - metamorphosis of tadpoles
 - development of models to illustrate visually the concept of negative feedback
 - growth of plants in response to hormonal stimulation
 - investigate the activity of an inorganic catalyst and/or an enzyme
 - design experiments to determine the optimum pH or temperature for enzyme activity

Some of these activities involve collection of data that maybe tabulated and graphed.

Design investigations from questions that these activities may generate. (212-6, 213-5)

- Develop a visual model that illustrates enzyme function. The design of these models may range from physical ones to visual animations. (212-6, 213-5)

Paper and Pencil

- Select one of the following ethical issues and present reasoned arguments to support or refute the use of the hormone in the situation:
 - Doctors prescribing Human Growth Hormone (HGH) as a treatment for individuals who have normal levels of HGH in their systems yet are genetically shorter than average. The prescription is to increase height.
 - Hormones used in beef and dairy cattle to increase production. (314-3)

Presentation

- Within a debate format display the results of research and “argue” against other stakeholders concerning issues such as, “Should doctors prescribe HGH as a treatment for individuals who have normal levels of human growth hormone in their system yet are genetically shorter than average, simply as a means to increase their height?” “Should steroids (performance enhancing drugs) be legalized for use by all athletes?” “Should random drug testing of athletes be permitted or is it an invasion of privacy?” “Should hormones be used within the beef industry to increase production?” (314-3)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

The endocrine system of animals releases chemical hormones into the blood to be circulated that help maintain homeostasis by causing or preventing change in specific organs or tissues of the body. Students should be able to describe this process. The endocrine system is slower in producing an effect than the nervous system; however it is a more sustained effect. It is important for students to realize that the nervous system and endocrine system work together in a coordinated fashion. Students may investigate the role of chemical communication in controlling the metamorphosis of insects (egg-larva-pupa-adult) and in amphibians (frogs).

Students should discuss the relationship between a hormone and its target cell or organ.

Students should observe the principal features of the endocrine system, utilizing models, dissection, or computer simulations and to identify and label those structures through the use of drawings or photographs and record the function of each. Endocrine glands should include pineal, hypothalamus, pituitary, thyroid, adrenal, pancreas islets, ovaries, and testes.

Review the basic biochemical structure of carbohydrates, proteins and lipids/steroids. Students should examine diagrams that illustrate the location of receptors for protein hormones compared to steroid hormones and explain how these target cells are changed by the hormone. In doing this, they should discuss the importance of the solubility of steroid hormones in the cell membrane and the critical nature of the shape of protein hormones. Students should identify the following hormones, their source gland, and explain their general effect on the human organism (melatonin, thyroxine, adrenaline, somatotropin (HGH—human growth hormone). Additional hormones may also be of interest to students (ADH—antidiuretic hormone, cortisol, aldosterone). Students can discuss the social, ethical, and health issues associated with hormone therapy for the treatment of humans (e.g., growth hormones, steroid use in sports, hormone use to slow the effects of aging or to minimize jet lag). This may lead to questions such as “Should physicians provide HGH as a treatment for individuals who have normal levels of human growth hormone yet are genetically shorter than average, simply to increase their height?” Students may investigate the hormonal connection with biorhythms, seasonal affective disorder syndrome (SADS). Students may investigate the abuse among athletes of steroid hormones as they attempt to build body tissue quickly and increase their athletic prowess, and the long-term side effects that result.

Teachers may refresh the role of enzymes as protein molecules that regulate all living systems through their function as biological catalysts. Students should be aware of models of enzyme action (lock & key/induced fit) and of the importance of the shape of these molecules to their function. Activities can illustrate the effectiveness of enzyme function within living systems. Comparisons of the effectiveness of an inorganic catalyst such as manganese dioxide (MnO_2) with an organic one such as catalase (or peroxidase, found in fresh liver cells) on the breakdown of hydrogen peroxide can be easily performed in a laboratory situation. Conditions under which these catalysts will operate can be varied (temperature, pH, concentration). Students may subsequently investigate the role of the development of a slight fever during illness as a defence mechanism and its effect on proteins, compared to a high fever with its

potential to denature proteins. The catalytic activity of plant tissue such as potato can also be compared to that of liver tissue.

Students should identify the role hormones play in a plants response to light and gravity. Students can research and discuss the use of hormones for agricultural or forestry purposes (e.g., pheromones for insect control).

Investigations can be used to illustrate some of the effects that hormones have. In season, tadpoles (preferably bullfrog tadpoles with legs) can be placed in a solution of one part thyroxine to five million parts water at room temperature. The first metamorphic changes induced by the hormone, which would normally take two to three years under natural conditions, may occur after two days. The effect of epinephrine on the heartbeat of *Daphnia* can be investigated and data collected. Treatment of additional *Daphnia* with substances like alcohol, and regular and caffeine-free cola may provide quantitative or qualitative data that can be compared, interpreted, and extrapolated via the question “Based on the results of this experiment, what effects might you expect these chemicals to have on the heartbeat of humans?”

Students should design an experiment to investigate and collect data on selected aspects of the endocrine system and identify specific variables involved. Display and interpret data from the completed endocrine activity.

RESOURCES/NOTES

STSE Issues

- Growth Hormone–The Antiaging Drug, *Nelson Biology*, p. 346
- Considering the Environment–The Pesticide Tree, *Biology Living Systems*, p. 693
- Steroids and Athletes, *Biology Living Systems*, p. 695
- Social Issue: Athletes and Performance Enhancing Drugs, *Nelson Biology*, p. 173

[Heading??]

- Protecting Athletes, p. 391
- Nelson 12, p. 371

Endocrine System: Feedback Mechanisms

(3 hours)

OUTCOMES

Students will be expected to

- analyze homeostatic phenomena to identify the feedback mechanisms involved (317-2)
- analyze contributions, including Canadian, to science and technology and how these have improved over time (117-11, 115-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Observation

- Within your groups develop a concept map for the electrochemical and chemical control systems that will illustrate their close integration and interconnected nature. (117-11, 115-5)

Performance

- Develop a physical working model to illustrate visually the concept of negative feedback. (317-2)

Paper and Pencil

- Using the provided, partial flow chart to illustrate hormones and feedback systems within the human body, within your groups, complete the chart. When this is complete, develop partial charts of your own design for completion by other groups within the class. (317-2)
- Analyze and interpret the data provided on blood or urine composition. Use it to determine the role of hormones in homeostasis. (317-2)
- Select a hormone and investigate the effects of its over secretion and under secretion in the body. Prepare a visual display to illustrate this. Hormones may include HGH, Aldosterone, Cortisol, Thyroxine, Insulin, or Glucagon. (117-11, 115-5)
- Select a hormone and investigate the effects of its over secretion and under secretion in the body. Prepare a visual display to illustrate this and write a 500 word, double-spaced paper reporting your findings. Hormones may include: human growth hormone, aldosterone, cortisol, thyroxine, insulin, or glucagon. (117-11, 115-5)
- Prepare a report on the roles played by Canadian researchers Frederick Banting and Charles Best in the discovery of insulin. (117-11, 115-5)

Presentation

- 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, prepare a brief summary of it or of the answer to your question. (117-11, 115-5)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should use flow charts to describe representative positive and negative feedback mechanisms in living systems. They may compare technological feedback control systems with the natural electrochemical control systems of organisms and discuss sensitivity, response time, effectiveness. Representatives that should be covered include the hypothalamus-pituitary complex and the regulation of blood sugar by controlled release of insulin and glucagon.

Within the discussion of the hypothalamus-pituitary complex include RF (releasing factor), pituitary hormones and target tissues (e.g., TSH on thyroid). The discussion of blood sugar/insulin should explain the consequences of any malfunction.

Sample data concerning blood and/or urine composition can be analyzed and interpreted in order to infer the role of hormones in homeostasis. Students may perform an experiment to investigate the presence of sugar in simulated urine samples, and compare the results with other urinalysis data. Using a table, students may compare the conditions of juvenile diabetes and adult-onset diabetes. Headings may include age of onset, cause, severity, method of treatment. Students may research and present modern approaches to the detection, treatment and control of diabetes.

Students should describe an example of neural and endocrine control systems acting together in animals.

Students may research, identify and summarize the main hormonal and nervous components of reactions to stress. They may discuss why some individuals may experience the following symptoms when they are nervous: cool hands, knots in their stomach, dilated pupils, dry mouth, rapid heart rate.

Students may hypothesize the effect on organisms of the over secretion (hypersecretion) or under secretion (hyposecretion) of hormones. This should be followed by research to confirm or deny their hypothesis. A list or table should be created to describe disorders linked to the secretions of the endocrine system and their effect on the homeostasis of the system and the organism as a whole.

Students should investigate and discuss the development and use of technologies to maintain, prolong, sustain or terminate life and the resulting social, moral, ethical and legal issues. Within this context, students should identify questions that are scientific, technological, and social in nature.

Individuals knowledgeable in endocrine system pathologies may be invited to speak in class. Use community resources such as physicians, organizations (Canadian Diabetes Association) or sufferers of these disorders.

Students should identify the importance of Canadian researchers Frederick Banting and Charles Best in the discovery of insulin and the control of diabetes.

Students may look at plants. Plants, like animals, have cells that produce hormones. An understanding of plant hormones has conferred benefits on farmers, plant scientists, and the food industry. The study of pheromones led to improved control of detrimental infestations.

RESOURCES/NOTES

Experiments

- Identification of Hypoglycemia, *Nelson Biology*, p. 343

STSE Issues

- Insulin without the Sting, *Biology Living Systems*, p. 694

[Heading??]

- ID of Hyperglycemia, p. 400
- Effects of Hormones on Blood Sugar, p. 401
- Hormonal Control of Metamorphosis, pp. 402–3
- Hormone Levels During the Menstrual Cycle, p. 404

Case Study

- The Effects of Hormones on Blood Sugar, *Nelson Biology*, p. 346

Reproduction and Development (16%) (Advanced, 15%)

Introduction

This unit helps the student to understand the principles of how living organisms reproduce and develop at both the cellular and individual levels. The primary emphasis is placed on mammalian systems. Students should begin to appreciate the complexity and importance of reproductive technologies and be able to discuss and analyze from a variety of perspectives the relative risks and benefits these technologies create.

Focus and Context

This unit has its primary focus on scientific inquiry and observation. However, through its review of reproduction and development there are numerous opportunities to meet curriculum outcomes utilizing decision-making (STSE). Discussions concerning the potential impacts of reproductive technologies lead into problem solving and technology.

Science Curriculum Links

Students begin as early as the second grade of their studies to discuss life cycles of familiar animals and the changes that humans undergo as they grow, and in Science 3 to investigate the life cycle of some plants. At the Science 5 level students begin to relate body changes to growth and development and the role played by body systems in helping both humans and other organisms grow and reproduce. During the Science 8 year students are asked to explain that growth and reproduction depend on cell division. The Science 9 reproduction unit introduces the topics of cell division, asexual, and sexual reproduction. Consideration is also given to the structure and function of the human reproductive systems, pregnancy and the major stages of human development from the moment of conception through to early infancy. This discussion provides a foundation for a more expansive study in Biology 12.

Curriculum Outcomes

STSE

Students will be expected to

116-2, 116-3, 116-7, 213-5, 215-2 investigate, analyze, and communicate genetic techniques, giving examples from organized data, that use technologies that have been developed based on cells
115-1, 313-6 distinguish between scientific questions and technological problems to evaluate the use of reproductive technologies for humans

Skills

Students will be expected to

212-3, 213-3, 212-8, 213-5 design, perform, compile data, and evaluate experiments on plant materials, using instruments effectively, controlling major variables, and selecting appropriate processes
214-9, 214-18, 313-4 identify and apply criteria, including potential applications, chemicals, and diseases, to explain the human reproductive cycles
231-7, 313-5 select and integrate information from various sources and explain current reproductive technologies for plants and animals

Knowledge

Students will be expected to

313-2 describe in detail mitosis and meiosis
313-3 analyze and describe the structure and function of female and male mammalian reproductive systems
313-4, 116-2 explain the human reproductive cycles, including analyzing examples of the effects of technology and science on reproduction
317-5 evaluate the physiological and ethical consequences of medical treatments such as radiation therapy and chemotherapy

Cell Division

(9 hours)

OUTCOMES

Students will be expected to

- design, perform, compile data, and evaluate experiments on plant materials, using instruments effectively, controlling major variables, and selecting appropriate processes (212-3, 213-3, 212-8, 213-5)
- describe in detail mitosis and meiosis (313-2)
- investigate, analyze, and communicate genetic techniques, giving examples from organized data, that use technologies that have been developed based on cells (116-2, 116-3, 116-7, 213-5, 215-2)
- evaluate the physiological and ethical consequences of medical treatments such as radiation therapy and chemotherapy (317-5)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform the available activities to illustrate some aspects of the process of cell division. These may include examination of prepared microscope slides of chromosomes, preparation of squashes of *Drosophila* salivary glands, examination of prepared microscope slides of animal and plant cell mitosis and cytokinesis or growth of onion root tips and preparation of squashes to observe chromosomes. Design investigations from questions that these activities may generate. (212-3, 213-3, 212-8, 213-5)
- Using a prepared root tip slide, predict the amount of time spent by these cells in each stage of mitosis. (212-3, 213-3, 212-8, 213-5)
- Observe the examples of the reproductive processes including prepared slides or wet mounts of budding in yeast, budding in *Hydra*, or wet mounts of mould spores. In your report, include diagrams with your answers to the questions. (116-2, 116-3, 116-7, 213-5, 215-2)

Performance/Presentation

- Create a moving image, using a flip-chart book, slide show, video, or digital animation to show the sequence of events in cell division. Present your finished product to the class. (313-2)
- Provide students with a selection of versions of human karyotypes. Pair and arrange the chromosomes in the manner of a karyotype. analyze the resulting karyotype for any inherent abnormalities and provide a brief written summary as to causes of the abnormality and what its possession means to the individual involved. (313-2)

Journal

- Select a website that contains activities on meiosis and/or mitosis. Perform an activity that interests you and do a report, including the web address, activity, and any comments about it. (313-2)

Paper and Pencil

- Research a method of the treatment of cancer that is currently being developed. Examples you may choose from include monoclonal antibodies, immunotherapy using tumour infiltrating lymphocytes, hyperthermia—utilizing heat, cryotherapy—cold, photodynamic therapy—light, or you may choose an alternate as appropriate. Discuss the pros and cons of each method of treatment. (212-3, 213-3, 212-8, 213-5)
- Develop a glossary of new terms that you discover and will use during your discussions in this reproduction unit. (212-3, 213-3, 212-8, 213-5)
- With sufficient pipe cleaners of two opposing colours (or other appropriate materials), construct models of a pair of homologous chromosomes for the process of meiosis. (313-2)

- Using the materials provided, construct models of a pair of homologous chromosomes and follow their progress through the stages of meiosis (reduction-division). Construct one member of the pair from one colour, the second from another. Illustrate an example of crossing over and follow its transmission. (313-2)
- Select an aspect of biotechnology related to cell division that is of interest to you (e.g. regeneration of lost limbs) or a type of cancer for which you will study causes, treatments, and statistics. Be sure to investigate the topic using more than one source of electronic or print information. Prepare a summary and to present the topic to the class. (116-2, 116-3, 116-7, 213-5, 215-2)
- Select a reproductive strategy found within the animal or plant kingdom and present the information collected to the class in the form of charts, tables, diagrams, visual animation, or any other appropriate format. Find and present unusual or interesting reproductive strategies. (317-5)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students can observe some chromosomal detail and banding patterns from an observation of prepared slides of chromosomes. The common fruit fly, *Drosophila*, with its large chromosomes is useful for this study. Should apparatus and materials be available, students can prepare, squash and stain slides of the salivary gland chromosomes that they extract themselves from *Drosophila*.

Students should observe and investigate the stages of the cell cycle and cytokinesis within both plant and animal cells through laboratory or computer simulations, diagrams, photographs, laserdisc or time lapse video technology. Stages of mitosis can be observed using prepared slides of plant cells (onion root tips) or animal cells (whitefish blastula). Some comparisons between the process of mitosis in plant and animal cells may be demonstrated by careful examination of these prepared slides. Students should identify, sketch, and discuss what is occurring during each of the stages. Use of a video microscope display can assist the teacher in initially illustrating as a class activity how to distinguish between cells in each of the different stages. Good videos and laser disc clips are available to show mitosis and meiosis. The importance of maintaining chromosome number throughout the process should be stressed.

Students should research the biological basis behind the use and effectiveness of radiation and chemotherapy for the treatment of cancers in particular, and evaluate both the positive and negative aspects of these treatments. Students may research some alternative methods of the treatment of cancer that are currently being developed.

A complimentary approach would be to have the students propagate fast growing plant tissue (onion root tips) and prepare their own slides for viewing by fixing, squashing, and staining the fresh tissue.

Invite a guest speaker to talk about the diagnosis, treatment, and recovery from the various types of cancer. Suggestions include a representative from the Canadian Cancer Society, a palliative care nurse, or oncologist.

Students should analyze and describe, in detail, the events of meiosis and cytokinesis and explore the reason for the necessity of chromosome reduction during the production of sex cells.

Students should prepare, analyze, and interpret models of human karyotypes. Classroom simulations of the processes of mitosis or meiosis may also be useful. Students may use pipe cleaners to simulate chromosomes and follow the process by preparing pipe cleaner models of chromosomes during each stage in mitosis or meiosis. Crossing over (chiasma) in meiosis can also be illustrated through this activity if different pipe cleaner colours are available. This provides the student with a visual confirmation of the exchange of genetic information and its effect on randomizing gene combinations within the chromosomes.

Students should examine and describe the crossing-over process and explain its role in helping randomize the gene combinations for sex cells.

Students should investigate and describe the process of non-disjunction and evaluate the significance on organism development using the examples of Down Syndrome and Turners Syndrome.

Students should prepare and interpret models of human karyotypes.

Students could investigate fetal abnormalities or deficiencies that can be diagnosed through prenatal genetic techniques such as amniocentesis, CVS (chorionic villus biopsy) and evaluate the ethical considerations affected parents potentially face.

Students can investigate the role of biotechnology in cell growth and the potential it may hold for the regeneration of damaged tissues or parts of organisms. They may evaluate the role of cell division in the development of cancer and how knowledge of cell division might be applied to limiting cancerous growth in plants and animals. They may investigate the newer approaches to the chemical treatment of cancer, and the bases upon which they are effective.

Investigation of the range of reproductive strategies found within the plant and animal kingdom serves to reinforce the concept of biodiversity. This information can be presented to the class in the form of charts, tables or diagrams (e.g., budding, binary fission, spore production, fragmentation, alternation of generations, sexual and asexual, parthenogenesis). Students can investigate or research the strategy involved in the use of reproductive technologies with an agricultural plant like canola, an aquaculture animal like the salmon, or any other appropriate example.

Teachers may invite to speak to the students individuals knowledgeable in the importance of cell division and the effects on the homeostasis of an organism should it be disrupted. Use community resources such as physicians or available organizations (Canadian Cancer Society). Students may 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. Students may prepare a brief summary of it.

RESOURCES/NOTES

Experiments

- Math Connection: Why Cells Divide, *Biology Living Systems*, p. 174
- Growth of Onion Root Tips, *Biology Living Systems*, p. 178
- How is Animal Mitosis Different from Plant Mitosis? *Biology Living Systems*, p. 181
- Mitosis, *Nelson Biology*, p. 436
- How Can You Make a Model of Meiosis? *Biology Living Systems*, p. 186
- Comparing Meiosis and Mitosis, *Nelson Biology*, p. 454
- Human Karyotypes, *Nelson Biology*, p. 459
- Crossing over as a Tool to Determine Gene Location on Chromosomes, *Biology Living Systems*, p. 216
- What Conditions Favour Buddings in Yeast? *Biology Living Systems*, p. 485
- Identification of a Cancer Cell, *Nelson Biology*, p. 444

Video from LRT

- *Mitosis and Meiosis: Cell Reproduction*, 23009, 23 min.
- *Cancer*, 22560, 30 min.
- *Cancer*, 21457, 1993

[Heading??]

- Cell Cycle, p. 86, *Biology 11*
- Comparison Mitosis/Meiosis, pp. 103–109
- Activity: Comparing Surface Area to Volume (Small to Large Cells), p. 85
- Activity 3.3.1: Frequency of Cell Division, p. 91
- Cloning from a Plant Cutting, p. 95
- Abnormal Meiosis: Non-Disjunction, *Biology 11*, pp. 116–118
- Karyotype Charts, pp. 119–121 (Technology)
- *Biology 11*, p. 84
- Genetic Engineering, *Biology 12*, p. 293
- Explore an Issue, Take a Stand: Genetic Engineering
- Guidelines and Regulations, p. 295
- Egg Cell Production, p. 396
- Cancer Cells, *Biology 11*, p. 100
- Research and Frontiers in Technology, p. 120–121
- Reproduction Strategies, p. 528

Reproductive Systems: Regulation and Technologies

(5 hours)

OUTCOMES

Students will be expected to

- analyze and describe the structure and function of female and male mammalian reproductive systems (313-3)
- identify and apply criteria, including potential applications, chemicals, and diseases, to explain the human reproductive cycles (214-9, 214-18, 313-4)
- select and integrate information from various sources and explain current reproductive technologies for plants and animals (231-7, 313-5)
- distinguish between scientific questions and technological problems to evaluate the use of reproductive technologies for humans (115-1, 313-6)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform the available activities to illustrate some aspects of the reproductive process. These may include examination of prepared microscope slides of ovaries and testes (egg and sperm cells), examination of the reproductive parts of a flower, comparison of a monocot and dicot seed, examination of a composite flower (daisy, dandelion). Design their own investigations from questions that these activities may generate. (313-3)
- Dissect a flower from the lily family. Draw a picture of each part, label it, and reconstruct the flower using your individually drawn sketches. (313-3)

Paper and Pencil

- Clothing manufacturers and fashion designers may consider male and female reproduction when designing clothing. Write a one page conversation between a fashion designer and a health practitioner on a style of snug, form-fitting pants for men and women that will require tight undergarments. Be sure to consider the repercussions on the reproductive systems of both men and women. (313-3)
- Jonathan, a man with four children, approaches his doctor. He and his spouse are content with the children they have and want to be 100 per cent certain that they will not conceive again. His doctor gives him a list of semi-permanent and permanent options, including one of the most popular, a vasectomy.
 - Why would vasectomies be more prevalent than forms of permanent female sterilization?
 - Jonathan is a haemophiliac and his doctor strongly advises him against a vasectomy. What other permanent options could he and his spouse explore? (313-3)
- Use a case study to analyze data on blood hormone levels and physiological events during a female menstrual cycle. Investigate how the cycle is regulated using positive and negative feedback and the roles of pituitary and ovarian hormones. (214-9, 214-18, 313-4)
- Trace the path of a sperm cell from where it is formed to the point of fertilization. (214-9, 214-18, 313-4)
- Select a suitable article from a publication, electronic, or media source for critique and analysis. Complete the checklist. (214-9, 21418, 313-4)
- Research and evaluate the use of currently available plant and animal reproductive technologies. The following are potential options:
 - Artificial Insemination
 - Superovulation using gonadotrophins
 - In-vitro fertilization
 - In-vitro maturation (IVM)

- Surrogate motherhood
- Hormonal treatment allowing pregnancy after menopause

Present a brief summary of your topic to the class. (115-1, 313-6)

- Research and evaluate types of contraception that are being promoted for the use of population control within developing countries. Present a brief summary of the topic to the class. (115-1, 313-6)
- Use a case study to analyze moral and ethical implications of new reproductive technologies. (231-7, 313-5)
- As a class, create a list of world wide web sites useful for information concerning reproductive technologies. (231-7, 313-5)

Presentation

- Cloning is a procedure that produces an identical copy of an organism. It does not involve the union of male and female gametes; it is an asexual process. This controversial process is used to reproduce organisms that normally reproduce sexually. Research cloning thoroughly. Write about cloning using the following headings.
 - Introduction—a brief explanation of cloning
 - Scientific Techniques—a brief description of how it works
 - Pros and Cons—develop a minimum of five arguments to support cloning as a reproductive process. Develop a minimum of five arguments to refute cloning as a reproductive process
 - Personal View—take a position on the issue and explain in detail why you feel the way you do
 - Bibliography—use a variety of sources: texts, Internet, EBSCO articles (313-3)
- You may be aware of the names of the famous (or infamous) Canadians athletes, Ben Johnson, Ross Reblati, or Silken Laumann. All of these individuals suffered some consequence of a doping test found to be positive for a banned chemical substance. In groups, prepare an argument in support of or against one of the following statements:
 - Doping tests should be mandatory for all professional and amateur athletes.
 - A positive doping test should result in a lifetime ban from his/her competitive sport for the athlete involved.

Research and confer on the approach taken on your position on this statement. A class debate will ensue. (214-9, 214-18, 313-4)

- Research and prepare questions related to the topic being presented by the guest speaker. Prepare a brief summary of it or of the answer to your question. (214-9, 214-18, 313-4)
- 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. Prepare a brief summary of it or of the answer to your question. (115-1, 313-6)
- Investigate a variety of chemical and physical methods of contraception. Explain how these contraceptives work, their effectiveness in prevention of pregnancy and STDs, and societal implications of their use from various perspectives. (115-1, 313-6)

Portfolio

- Research information and prepare a risk/benefit analysis on topics such as steroid use in sports or hormone treatments for women. (214-9, 214-18, 313-4)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should observe the male and female reproductive structures of a flowering plant through the use of models, charts, computer simulations, or the dissection of a flower by doing investigations.

The pistil, including the stigma style ovary and ovules as well as the stamen including the filament, anther, and pollen, should be identified.

Students should compare the structure of monocot and dicot seeds by examining corn kernels, peanuts, beans, and other samples.

Students should be able to distinguish eggs and sperm from their supporting structures, using prepared slides of ovaries and testes.

Students should compare the structure of egg cells and sperm cells. Relative sizes, energy reserves, motility, numbers produced, and the importance of the enzyme cap and numerous mitochondria within a sperm cell should be included.

Students should be provided with the opportunity to observe and discuss the function of the principal features of the male mammalian reproductive systems using models, dissections, or computer simulations, and to identify and label the major structures from drawings or photos of that organ system. Structures should include testis, scrotum, seminiferous tubules, epididymis, sperm duct (vas deferens), cowpers (bulbourethral) gland, seminal vesicle, prostate, and urethra.

Students should identify the principal reproductive hormones of the human male and explain their interactions in the maintenance and functioning of the reproductive system and the development of primary and secondary sex characteristics, including testosterone, luteinizing hormone (LH), and follicle stimulating hormone (FSH).

Students can analyze sample data on blood hormone levels and physiological events, and infer the roles of the male sex hormones. Students may investigate the role of nurse cells in the protection of developing sperm.

Students can discuss the role of steroid use in sports and run a risk/ benefit analysis. They can debate the issue of mandatory doping tests on athletes to determine the presence or absence of banned substances. They can research and develop a list of these banned substances and answer the questions, “Are any of these substances found in over-the-counter medication?” “If so, for what purpose are they used?”

Students should observe and discuss the function of the principal features of the female mammalian reproductive systems using models, dissections, or computer simulations, and to identify and label the major structures from drawings or photos of that organ system. Structures should include corpus luteum, ovary, follicles, oviduct (Fallopian tube), uterus, endometrium, cervix, and vagina.

Students should identify the principal reproductive hormones of the human female and explain their interactions in the maintenance and functioning of the reproductive system and the development of primary and secondary sex characteristics. Include estrogen, progesterone, luteinizing hormone (LH), and follicle stimulating hormone (FSH).

Students can analyze sample data on blood hormone levels and the physiological events of a single menstrual cycle, and infer the role of the female sex hormones.

Students should research and evaluate the uses and effects of estrogen/ progesterone treatment on the health of women.

This estrogen/progesterone hormone treatment may involve the use of synthetic chemicals, herbal, and natural sources found within the diet or taken as dietary supplements. Students can investigate the purposes of this hormone therapy among menopausal women.

Students should research and evaluate the potential health risks on individuals and society associated with exposure to sexually transmitted diseases.

Students may select from the variety of STDs, such as Chlamydia, herpes, HIV, human papilloma virus, syphilis, gonorrhoea, or hepatitis, to conduct their study. They should consider not only immediate health concerns, but also societal impacts (effects on future children, health care systems).

Teachers may invite individuals to speak to the class who are knowledgeable in topics such as aspects of human reproductive health and sexually transmitted diseases by using community resources such as physicians or available organizations (Sexual Health Centres). 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.

Students should investigate the distinction between the questions, “What are the causes of human infertility?” as a scientific question and “What are the possible solutions to infertility?” as a technological one.

Animal husbandry has revolutionized the use of in vitro techniques. The reproductive rates of valuable livestock have increased dramatically, as have beneficial traits in new breeds. Students should discuss and evaluate the following list of techniques and identify those they have heard about superovulation of donor with gonadotrophins; in-vitro fertilization (IVF); artificial insemination (AI); nonsurgical removal of embryos; transfer of embryo to surrogate; birth after embryo transfer. Information could then be selected and integrated from various print and electronic sources on these techniques and any others of which students are aware.

This may lead to a discussion/debate involving a number of questions that may include, “Should biotechnology be used to rapidly propagate endangered species?” “If the most desirable domestic animals are able to parent an entire herd in each reproductive cycle, could this technique not be applied to endangered species?” (In April 1990, Mary Alice, a rare Siberian tiger, was born as a result of the use of an in vitro fertilization technology.)

Students may interview a reproductive technologist asking questions that may include, “Should endangered species be preserved?” “At what cost?” “Who makes the decision?” “Might this technology result in an uncontrolled monster?” To evaluate the potential application of their findings, students might complete a risk/benefit analysis of the desirability of preserving endangered species by considering the safety, efficiency of practice, quality of life, and cost-effectiveness.

Students should explain how the use of certain procedures and technologies influence the chance of conception. Suggestions may include the pill, Norplant, vaccines, vasectomy, tubal ligation, morning after pill, Viagra, and Depo Provera.

Students may evaluate from published data the relative effectiveness of various methods of contraception and perform a risk/benefit analysis on the implementation of these for various segments of the population.

Students should investigate the importance of utilizing fertility techniques for the human population and consider the following:

- How many of the above techniques are applicable to the human population?
- What are the ethical and practical issues involved when fertility techniques result in multiple births? Is there an argument within society for fetal selection when a multiple birth pregnancy places the fetuses and/or mother at risk?

Students may debate the merits of funding solutions to human fertility problems versus the funding of human population control. Students may investigate the methods of population/birth control (e.g. China’s one child rule per family; selection of one gender—usually male—and abortion of females in

some developing countries) of various countries around the globe and assess the effects of these conception control population technologies on the demographics of these countries.

Teachers may invite individuals knowledgeable in a variety of aspects of reproductive technologies and issues by using community resources such as physicians, reproductive technologists, public health workers or representatives of available related organizations to speak with the students. 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.

RESOURCES/NOTES

Experiments

- Will Seeds Grow without Stored Food? *Biology Living Systems*, p. 519
- The Effect of Microwave Radiation on Seed Germination, *Biology Living Systems*, p. 520
- Microscopic View of the Testis, *Nelson Biology*, p. 412

[Heading??]

- Reproduction Anatomy, *Biology 12*, pp. 393–399
- Reproductive Hormones, Sect. 8.5, *Biology 12*, pp. 393–398
- Cycle, p. 396
- Hormonal Control, p. 398
- Importance of Endocrine System, Sect. 8.1, pp. 372–377
- Pathogens and Disease, Sect. 10.4
 - How to Catch, pp. 477–78
 - Activity: Following an Infection, p. 478
 - HIV, p. 480
- Prenatal Testing, *Biology 11*, p. 121

Video from LRT

- *The Miracle of Life*, 23084, 60 min.
- *Witness: Sex Under Siege*, 21370 (loan), 50 min.
- *Family Tree*, V0187, 13 min. (Discussions on Bioethics)

Case Study

- Hormone Levels During the Menstrual Cycle, *Nelson Biology*, p. 419
- Designer Babies, *Biology 11 and Biology 12: A Teaching Resource*

Websites

WWW Keywords:

- Microsort Sperm Separation
- IVF

STSE Issues

- Social Issue: Limits on Reproductive Technology, *Nelson Biology*, p. 464
- And Baby Makes Three? *Biology Living Systems*, p. 506
- Inbreeding: Helpful or Harmful? *Biology Living Systems*, p. 221
- Gender on Demand, *Biology Living Systems*, p. 298

Embryonic Differentiation and Development

(3 hours)

OUTCOMES

Students will be expected to

- explain the human reproductive cycles, including analyzing examples of the effects of technology and science on reproduction (313-4, 116-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Perform the activities available on the process of development. These might include microscopic examination of prepared slides of stages of starfish cleavage or sea urchin development, observation of embryo development in the frog utilizing a culture of frog eggs, or observation of microslides of frog or chick embryo development. Design investigations from questions that these activities may generate. (313-4, 116-2)

Journal

- If two sets of identical twins marry and have children, what is the genetic relationship among the cousins? (313-4, 116-2)

Paper and Pencil

- Research why the incidence of multiple births is increasing. What are the societal implications of multiple births and what are the ethical considerations attached to fertility techniques that result in multiple birth pregnancies? Develop a newspaper/internet article based on your research to inform the public of new information on multiple births. (313-4, 116-2)
- What are the merits of funding solutions to human fertility versus funding of human population control? Copy the table below and list three merits for each funding option. (313-4, 116-2)

Solutions to Fertility and Populations

Finding solutions to human fertility	Funding human populations control

- Identify two countries with a population control policy. Choose one of the countries and examine its policy's effect on demographics over a five-year period. (313-4, 116-2)
- Collect information on a technique used for monitoring the health and well-being of a fetus. Techniques to consider may include blood tests, non-stress fetal monitoring, ultrasound, and fetoscopy. Present a brief summary of your topic to the class. (313-4, 116-2)
- Research, in depth, a method of birth control and produce an electronic promotional poster or pamphlet which illustrates arguments for and against its use. Describe how the method works, what risks and benefits are associated with it and what segment of the population it would work best with to prevent pregnancy. (313-4, 116-2)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should explain the distinction in the fertilization and initial embryonic development that produce identical and fraternal twins and discuss the mechanism in which multiple births (triplet, quadruplets) may result naturally. Have students consider the question, "How come fraternal twins are no more alike than any set of brothers or sisters?"

Students should trace the journey of sperm and egg from their origin until fertilization. This could be done as a flow chart.

Students should observe the stages of embryo development through the use of preserved materials, prepared slides (starfish cleavage), audiovisual presentations or computer simulations, and extrapolate these events to the development of the human fetus. In addition, there are good websites available on the Internet that illustrate the process of development. The following basic stages should be described: cleavage, blastula, gastrula, germ layers, and neural development.

Students should identify and describe the functions of primary membranes during the embryonic development of animals including yolk, allantois, amnion, and chorion.

Students should research and identify chemical control hormones associated with implantation, embryo development, birth and lactation including progesterone, oxytocin, and prolactin.

Students may investigate the use of hormonal data to determine pregnancy (e.g., Human Chorionic Gonadotropin).

Students should identify the function of the placenta and umbilical cord during pregnancy and the process of childbirth.

Students should discuss the physiological events that occur during and after the process of childbirth (cervical dilation, loosening of pelvic ligaments, rupture of the amniotic membrane, uterine contractions, delivery of fetus and expulsion of the placenta) and the role of hormonal control.

Students should investigate techniques used to monitor various stages of embryonic or fetal development including blood tests, ultrasound, and fetoscopy.

Students should describe how an ultrasound operates. They may investigate the development of fetal surgery techniques to correct biological problems. Students should compare the purposes of these fetal monitoring techniques to those techniques (amniocentesis, CVS) used for genetic testing. Students may investigate the types of diseases/ conditions that can be identified by these monitoring techniques (e.g., structural abnormalities, spina bifida). The societal impact of chemical and drug abuse on fetal development (alcohol, cocaine, cigarettes) may be investigated and discussed.

RESOURCES/NOTES

Experiments

- What Does Sea Urchin Development Look Like? *Biology Living Systems*, p. 515
- What Factors are Important in Sea Urchin Development? *Biology Living Systems*, p. 523

Videos from LRT

- *The Ultimate Journey*, V2199, 55 min.
- *Cell Differentiation: The Search for the Organizer*, 21936, 16 min.
- *Birth, Sex and Death*, 21455, 50 min.
- *Who Should Decide?*, V0185, 15 min.
- *If You Want a Girl Like Me*, V0191, 12 min.

[Heading??]

- Reproductive Hormones, Sect. 8.5, *Biology 12*, pp. 393–399

Other

- In Utero Treatments for Genetic Disorders, *Biology Living Systems*, p. 299
- Aging: Can We Stop the Clock? *Biology Living Systems*, p. 191
- Fetal Alcohol Syndrome, *Nelson Biology*, p. 427
- Fetal Alcohol Syndrome, *Biology Living Systems*, p. 498
- Fetal Surgery—An “Out-of-Body” Experience, *Biology Living Systems*, p. 539
- Dying with Dignity: Who Decides? *Biology Living Systems*, p. 272

Genetic Continuity (40%) (Advanced, 35%)

Introduction

Much of the structure and function of every living organism is determined by deoxyribonucleic acid (DNA). It is important for a scientifically literate person to understand principles and fundamentals about DNA: what it is; how it works; how and for what purposes humans are manipulating it; and why this major area of scientific and technological endeavour has dramatic implications for humans and planet Earth. This unit will provide the Biology 12 student with the basic information required for the comprehension of genetics.

Focus and Context

Within this unit on genetic continuity the primary focus is on problem solving and technology. However, to appreciate the complexity and uniqueness of DNA and how its structure determines protein construction scientific inquiry and observation are required. With the inclusion of information on biotechnology and associated bioethics, there is also ample opportunity for decision-making and STSE components.

Science Curriculum Links

Very early in their study of the life sciences students begin to consider the individuality of organisms. Students in Science 1 are asked to identify variations that make each person and animal unique from each other and their parents. At the Science 2 level students identify traits that remain constant and those that change as organisms grow and develop. The unit Reproduction in Science 9 looks at cell division and develops the idea that the nucleus of a cell contains genetic information and determines cellular processes. Biology 11 continues this theme with its discussion of the nucleus as a critical component of cellular structure.

Curriculum Outcomes

STSE

Students will be expected to

118-2, 315-9, 118-6 analyze the risks and benefits to society and the environment and construct arguments concerning the use of genetic engineering, using examples and evidence from various perspectives

116-4, 116-6 analyze, describe, and evaluate genetics-based technology development, design, and solutions

Skills

Students will be expected to

212-4, 214-5, 315-3, 214-12 using Mendelian genetics, state a prediction, perform, and interpret patterns and trends in genetic data of monohybrid and dihybrid crosses and explain how the data supports or refutes the situation

215-5, 117-7, 213-7 investigate, perform, and defend a position or course of action on genetic modification, integrating various sources and science- and technology-based careers

Knowledge

Students will be expected to

315-1, 114-2 summarize the discoveries, including the role of evidence, that led to the modern concept of the gene

315-2 identify and describe the roles of chromosomes in the transmission of hereditary information from one cell to another

315-4, 315-5, 115-3 explain how the current model of DNA replication, the structure of DNA and RNA, and protein synthesis revolutionized thinking in scientific communities

315-6, 315-7 describe and predict the effects of genetic mutations on a cell's information, including protein synthesis, phenotypes, and heredity

315-8 explain the circumstances that lead to genetic diseases

315-10, 117-2 explain and analyze, from a variety of perspectives, the risks and benefits of the influence of the Human Genome Project

Molecular Level

(5 hours)

OUTCOMES

Students will be expected to

- summarize the discoveries, including the role of evidence, that led to the modern concept of the gene (315-1, 114-2)
- identify and describe the roles of chromosomes in the transmission of hereditary information from one cell to another (315-2)
- explain how the current model of DNA replication, the structure of DNA and RNA, and protein synthesis revolutionized thinking in scientific communities (315-4, 315-5, 115-3)
- describe and predict the effects of genetic mutations on a cell's information, including protein synthesis, phenotypes, and heredity (315-6, 315-7)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Design and construct a three-dimensional model of a DNA molecule following these structural guidelines:
 - include a minimum number of six base pairs
 - show all possible base pair combinations
 - make model self-supporting
 - include a key for part identification (315-2)
- Using model kits, construct various organic compounds including proteins and nucleic acids. (315-4, 315-5, 115-3)
- Extract DNA experimentally from the source provided following the guidelines given in the laboratory. (315-4, 315-5, 115-3)
- Design an experiment to investigate the effect of influences such as chemicals or radiation (e.g., microwave, ultraviolet) on the germination of seeds. (315-6, 315-7)

Journal

- Give an example of how the discovery of one technology broadened the circle of knowledge for other areas of science. (315-1, 114-2)
- Discuss the role of carbon as a versatile building block for all organic compounds. (315-4, 315-5, 115-3)

Paper and Pencil

- Pick a name of a scientific investigator and/or an achievement that has contributed historically to the concept of the gene. Prepare a brief summary of the date, names of appropriate individuals and the contributions made on a large index card and present this information to the class. Following this, add your information card to the chronological timeline at the front of the classroom. (315-1, 114-2)
- Develop a glossary of new terms that will be used during discussions in this genetics unit. (315-1, 114-2)
- Using the processes of transcription and translation, convert the DNA strand given into its resulting protein. (315-4, 315-5, 115-3)
- Investigate and report on the effects on the developing human embryo of exposure to a specific environmental influence. The following are suggestions:
 - thalidomide
 - alcohol (Fetal Alcohol Syndrome)
 - tobacco/tobacco smoke

- DES (diethylstilbesterol)
- radiation
- drugs such as cocaine, LSD, marijuana
- viruses (Rubella/German measles, HIV)
- caffeine
- antibiotics (Streptomycin, acne drugs)
- streptococcus bacteria (315-6, 315-7)
- Using the processes of transcription and translation, convert the DNA strand given into its resulting protein. Investigate what effect a change in one base in the DNA sequence might have on the resulting protein. DNA/protein synthesis and mutations. (315-6, 315-7)

Presentation

- After you have conducted your experiment, present your data and conclusions to the class. Compile and organize your data using appropriate formats (e.g., numeric tables, graphs). (315-6, 315-7)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students may research and produce a historical time line to illustrate the most significant scientific discoveries leading to the concept of the gene. Among others, these may include the following:

- Mendel (1865)—study of heredity
- Weismann & Bovari (1880s)—implication of chromosomes
- Sutton (1903)—chromosomes as physical carriers
- MacLeod, McCarty & Avery (1940s)—DNA is transforming substance
- Watson & Crick (1953)—structure of DNA
- Arthur Kornberg (1957)—purification and analysis of DNA polymerase
- 1960s—use of synthetic mRNAs to break genetic code
- Barbara McClintock (1983)—“transposition” of genes
- 1990s—Human Genome Project

Another approach to making historical timelines more meaningful is to relate the time frame to an event that has some relevance to the student.

Example:

- 1953—Watson & Crick discover the structure of DNA
- 1953—the year of the birth of the students’ mother/father Students should discuss, in general terms, the gene-chromosome theory of inheritance.

Students can brainstorm ideas about DNA and discuss their preconceptions, organize their ideas and, based on their current level of understanding, show the interrelationships between them on a concept web. Students should explain how knowledge of the structure, function and replication of DNA revolutionized the understanding of heredity. Students may design and/or construct models of DNA to illustrate the general structure and base arrangement of the Watson and Crick double helix model of DNA.

Analogies may be useful in illustrating how the amino acids in foreign proteins can be reorganized into a variety of human proteins (for example, the rearrangement of the letters of the alphabet into different words, or Lego blocks into different structures.)

Students should identify and describe the structure and function of nucleic acid—DNA and RNA.

Students should describe, in general, how genetic information is contained in a DNA molecule (chromosome); how each DNA molecule replicates itself during cell division; how information is

transcribed into the base sequences of RNA molecules and is finally translated into the sequence of amino acids in cell proteins. Students may perform simulations to demonstrate the replication of DNA and the transcription and translation of its information. Students could investigate the rarity of mistakes made during replication of DNA by discussing the role of DNA polymerase and its “proofreading” mechanism and the influence of DNA repair enzymes.

Students may experimentally extract DNA from bacteria or other suitable organisms. Alternately or in addition to this, they may be asked to design/implement an improvement on the experimental procedure used to extract this DNA.

Students should explain what is meant by a gene mutation and predict, in general, their effect on protein synthesis. Students should compare and contrast the process and effects of gene mutations versus chromosome mutations.

Students should draw the connection between mutations in genetic information and how they may be expressed through human conditions (e.g., cancer, sickle cell anemia, human thalassemia). The critical role of proteins as the link between the gene and the human condition should be emphasized.

Students may also investigate the discovery by Barbara McClintock of “jumping genes” and how they are another potential source of variation within organisms.

Students should investigate and describe mutagenic agents (mutagens) including chemicals, viral agents, and ionizing radiation.

In particular, students could discuss the dangers of UV radiation as a carcinogenic agent. Students can hypothesize how an alteration may ultimately affect the individual involved. Students may investigate and discuss sources of embryo deforming (teratogenic) chemicals found in the environment (thalidomide, alcohol) and the responsibility of society, science, and technology to ensure all children have a good quality of life.

Mutation has been and continues to be the force behind the abundance of biodiversity seen on the Earth. Students should describe how a random change (mutation) in the sequence of bases provides a source of genetic variability and how the probability of a mutation resulting in a positive variation is very rare. The effect of mutations in somatic cells versus sex cells should also be addressed.

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?

RESOURCES/NOTES

Experiments

- A Classroom Model of DNA, *Biology Living Systems*, p. 230
- DNA Extraction, Biology 11 and Biology 12: A Teaching Resource
- Lab Aids–DNA Kits available through Ward’s, Boreal, NorthWest, and other supply companies
- Mapping Chromosomes, *Nelson Biology*, p. 506
- Exploring DNA Replication, *Nelson Biology*, p. 525
- Antibiotics and Protein Synthesis, *Nelson Biology*, p. 538
- Modeling Cell Processes, *Biology Living Systems*, p. 258
- Can Mutations be Observed? *Biology Living Systems*, p. 263

Videos from LRT

- *We Are One*, 21454, 50 min.
- *Genetics and Heredity: The Blueprint of Life*, 23293, 20 min.

Case Studies

- Evidence of Hereditary Material, *Nelson Biology*, p. 518

Activities

- Activity 10: Designer Babies
- Activity 11: DNA Extraction
- Activity 12: DNA Fingerprinting
- Activity 19: Mendelian Genetics
- Activity 20: Genetics

[Heading??]

- Mendel, *Nelson Biology 11*, pp. 130–134
- Watson and Crick and other scientists, *Nelson Biology 12*, pp. 206–212
- Lipids, Carbs and Proteins, *Nelson Biology 12*, pp. 24–57
- Organic Compounds, *Nelson Biology 11*, pp. 32–47
- DNA Replication and Repair, *Nelson Biology 12*, pp. 217–222
- DNA Mutations, *Nelson Biology 12*, pp. 259–263
- DNA and RNA, *Nelson Biology 12*, pp. 237–238
- Types of RNA Chart, *Nelson Biology 12*, p. 239
- Mutations, *Nelson Biology 12*, pp. 259–263

Scientists

- Jumping Genes, *Biology Living Systems*, p. 264

Mendelian Genetics

(10 hours)

OUTCOME

Students will be expected to

- using Mendelian genetics, state a prediction, perform, and interpret patterns and trends in genetic data of monohybrid and dihybrid crosses and explain how the data supports or refutes the situation (212-4, 214-5, 315-3, 214-12)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Performance

- Make a model and demonstrate the events of meiosis. The model should include homologous chromosomes, dominant and recessive alleles. Illustrate the randomness of allele assortment during meiosis. Sample materials that may be used include marshmallows, pipe cleaners, Plasticine, Popsicle sticks, Velcro, toothpicks, push pins, etc. (212-4, 214-5, 315-3, 214-12)
- Perform the activities provided that deal with the concept of heredity. Possibilities include examination of ears of genetic corn or performance of crosses of the fruit fly *Drosophila* to investigate the inheritance of particular characteristics. (212-4, 214-5, 315-3, 214-12)
- Human ABO blood type is an example of the expression of multiple alleles. Determine the blood type of the simulated blood sample provided and list the potential genotypes that would correspond to this type. (212-4, 214-5, 315-3, 214-12)
- Within the fruit fly *Drosophila*, the vestigial gene produces larger wings in flies bred at 29°C. At less than 29°C, offspring are produced with smaller wings. (212-4, 214-5, 315-3, 214-12)
- Primrose plants produce red flowers when raised at room temperature (20°C) and white flowers when raised at temperatures greater than 30°C. (212-4, 214-5, 315-3, 214-12)

Journal

- Is there a relationship between the number of chromosomes and the mass of a species? Explain. (212-4, 214-5, 315-3, 214-12)
- Is there a relationship between the number of chromosomes and the complexity of the species? Explain. (212-4, 214-5, 315-3, 214-12)
- Reflect and respond to the following statement. True or False: Males are biologically stronger than females. Defend your position. (212-4, 214-5, 315-3, 214-12)

Paper and Pencil

- Solve the monohybrid and dihybrid genetics questions prepared for you. In each case analyze the data as requested. (212-4, 214-5, 315-3, 214-12)
- analyze the genetic clues presented in the “murder mystery” provided and determine the name of the murderer. Write down in point form the logic that was used to come to your conclusion. (212-4, 214-5, 315-3, 214-12)
- Predict the general location or arrangement of genes within a chromosome from the analysis of crossing over data with which you have been provided. (212-4, 214-5, 315-3, 214-12)
- Solve the sex-linked genetics questions. In each case analyze the data as requested. analyze the pedigree charts provided and determine the mechanism of inheritance. Determine the unknown genotypes and phenotypes for the indicated individuals. (212-4, 214-5, 315-3, 214-12)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students may investigate their own individual dominance/recessiveness as related to visual/sensory traits (widows peak, dimples, tongue rolling, attached/free ear lobe, the ability/lack of ability to taste PTC).

Data on dominant and recessive characteristics from a class activity of this nature can be collected and discussed in relation to the prevalence within this restricted population sample and the population in general.

Activities can be performed that simulate the chance formation and pairing of gametes (e.g., simulate Mendel's experiments substituting the tossing of coins and heads/tails for plant characteristics).

Students should solve genetics problems that involve a variety of monohybrid and dihybrid genetic crosses, predict the genotypes, phenotypes, and ratios among offspring and/or those of the parental cross, using Punnett squares or the math product rule.

Students can investigate visually the phenotypic ratios evident during a laboratory activity using artificially pollinated ears of genetic corn. Genotypes of the parent ears can be determined and the expected phenotypic ratios predicted.

Students may perform, as an independent study or group project, crosses using fast growing plants or the fruit fly *Drosophila* to investigate the inheritance of various characteristics.

Simulations of forensic investigations or murder mysteries involving clues based on genetic traits (blood type, freckles, etc.) and pedigree information that require students to "solve" a crime based on the information provided are an interesting way to enhance student knowledge and interest in genetic analysis.

Students should be introduced to the concept of the inheritance of certain characteristics (red-green colour blindness, haemophilia, muscular dystrophy) through the sex chromosomes (sex-linkage) and be able to define sex-linkage. Colour blindness analysis charts are useful to illustrate this sex-linked characteristic.

Students should identify autosomal inheritance typically involves pairs of genes, with gender being irrelevant to gene expression. Sex-linked inheritance involves pairs of genes on the X chromosome in the female, and a single gene on the X in the male. In this case, gender is important in gene expression, and gender must be considered a part of the phenotype. A distinction should be made between genotypes and phenotypes evident in autosomal and sex-linked inheritance.

Students should explain the influence of multiple alleles and polygenic traits on inheritance patterns.

Blood types are an example of multiple alleles. Skin colour and eye colour are examples of polygenic inheritance where traits are determined by a number of different contributing genes present at different locations and expression depends on the sum of the influences of all of these. Other examples include animal and plant traits selected by breeders for improving livestock and crops, as well as human characteristics such as susceptibility to cardiovascular disease and athletic ability.

Students should solve genetic problems that involve sex-linked defects, predict the genotypes, phenotypes, and ratios among offspring, and compare specifically genotypes and phenotypes for males and females.

Students should draw and interpret pedigree charts from data on human single and multiple allele inheritance patterns. They should be able to analyze inheritance data and infer the method of inheritance (dominant, recessive, sex-linked). Students may compare pedigree charts for the inheritance of non sex-linked and sex-linked conditions. The pedigree of the haemophilia within Queen Victoria's bloodline is readily available and serves to provide a biological/historical cross-curricular link. Student groups may

design procedures, collect data and prepare family pedigrees to demonstrate the inheritance of autosomal traits determined by single and multiple alleles, and sex-linked traits.

Students should discuss that environmental factors might cause a change in the expression of some of the genetic information of an organism (e.g., the two colour pattern of the Siamese cat involves one hair colour gene producing a temperature sensitive enzyme. The enzyme is active and manufactures dark pigment only on cooler areas of the body—feet, snout, tip of tail, ears; temperature also effects *Drosophila* wing development). Sex may also play a role in gene expression as hormonal factors become involved (e.g., gene for baldness being dominant in males but recessive in females).

RESOURCES/NOTES

Experiments

- Genetics of Corn, *Nelson Biology*, p. 484
- How Does Sample Size Affect Results? *Biology Living Systems*, p. 199
- Predicting Plant Genotypes, *Biology Living Systems*, p. 205
- Which Parent Provides the Genes in Organelle DNA? *Biology Living Systems*, p. 256
- Is Snoring Inherited? *Biology Living Systems*, p. 281
- Variations in Human Hands, *Biology Living Systems*, p. 294
- Human Sex-linked Genes, *Nelson Biology*, p. 502
- What Pattern of Inheritance Allows for the Prediction of a Genotype When Phenotypes are Known?, *Biology Living Systems*, p. 218
- Can Sex Differences Be Observed in Human Body Cells?, *Biology Living Systems*, p. 285

Case Studies

- A Murder Mystery, *Nelson Biology*, p. 147

[Heading??]

- Mendelian Genetics, *Nelson Biology 11*, pp. 128–156

Case Studies

- Tracing the Hemophilia Gene, *Nelson Biology*, p. 558

Implications

(10 hours)

OUTCOMES

Students will be expected to

- explain the circumstances that lead to genetic diseases (315-8)
- analyze the risks and benefits to society and the environment and construct arguments concerning the use of genetic engineering, using examples and evidence from various perspectives (118-2, 315-9, 118-6)
- analyze, describe, and evaluate genetics-based technology development, design, and solutions (116-4, 116-6)
- explain and analyze, from a variety of perspectives, the risks and benefits of the influence of the Human Genome Project (315-10, 117-2)
- investigate, perform, and defend a position or course of action on genetic modification, integrating various sources and science- and technology-based careers (215-5, 117-7, 213-7)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- Vast quantities of human DNA appear to be non-functional. One theory suggests these are ancient archival genes, dormant DNA. Biologists have successfully used human, non-functioning archival genes to carry out basic functions in simple one-celled organisms. What does this imply about our ancestry? (315-8)
- On the advent of the completion of the Human Genome Project, there are a number of important issues that need to be considered. Reflect on these questions and develop, present and defend your position based on scientific thinking.
 - Recently a Canadian futurist, Frank Ogden, applied to the U.S. Patent and Trademark office to have his DNA trademarked, in an effort to protect himself and his identity. He feels that his application is important because it paves the way for others to do the same, especially if they have a talent that may interest researchers wishing to study their DNA, the building blocks of life. Should Frank Ogden be successful? Why or why not?
 - The Human Genome Project began as an agreement between publicly funded research teams to share gene sequence discoveries for the benefit of mankind. A number of corporate interests have recently announced their intention to apply for patents for any genes they discover thereby removing them from the public realm and the use of medical researchers. It is likely that beneficial medical developments will proceed more quickly if pursued within the private sector.

Is it ethical for private biotechnology companies to use research information gained through public funding for private profit? Should the individuals whose DNA was used for public research in the Human Genome Project be compensated for their contribution? (315-10, 117-2)

Paper and Pencil

- In groups, research and report to the class on one of the tools or techniques currently available to study genetics. Areas that may be considered include the polymerase chain reaction (PCR) process, DNA “fingerprinting” and gel electrophoresis, gene probes, recombinant DNA, cloning, genetic markers, and gene mapping. Research and analyze how the cloning of the sheep Dolly in 1997 influenced our understanding of the potential of biotechnology and how knowledge of the cloning of mammals continues to evolve. (118-2, 315-9, 118-6)
- Use a case study to investigate an inherited disease. Examples might include haemophilia, cystic fibrosis, tay sachs, Alzheimer’s and Dystonia. (118-2, 315-9, 118-6)

- Research one chromosome from the human genome to research and map. Prepare, to the assigned scale, a cardboard model of this chromosome, with its most significant genes clearly labelled. Present to the class information about your chromosome and mount it as part of a common genome either within the classroom or as a bulletin board display for the school. (315-10, 117-2)
- analyze the simulation of DNA fingerprinting presented to you and determine which suspect was in the vicinity of the crime scene. Write down in point form the logic that you used to come to your conclusion. (116-4, 116-6)
- Select an area within the topic of biotechnology of interest to you upon which to prepare a class presentation and written report. Internet web sources provide an extensive database for this exercise. Teachers should ensure that at least one individual or group chooses to deal with the Human Genome Project and its implications for human life and health. (215-5, 117-7, 213-7)
- As a class, create a list of World Wide Websites useful for information concerning genetics and genetic screening. (215-5, 117-7, 213-7)
- Create your own webquest that relates to moral and ethical concerns associated with genetics. Generate 10 questions. List a variety of websites that your peers could use to seek answers to the questions. (215-5, 117-7, 213-7)
- Genetic research may offer hope to families and communities with a history of disease, however, it may prove to be a double-edge sword. While genetic research gives us some of the answers to genetic disorders, it also gives rise to major ethical dilemmas. Benefits do exist, but at a cost. Genetic health through gene therapy is expensive and who should benefit, those who can afford the therapy or the community as a whole? There are also other societal issues like privacy, fairness, stigmatization, reproduction, and the commercialization of genetic information and products. In Nova Scotia, *Usher's Syndrome*, *Friedreich's ataxia*, *Niemann Pick Disease*, *Fabry Disease* and *Charcot-Marie Tooth Disease* are genetic conditions that have been isolated. Choose one of these conditions and a corresponding societal issue. Using the library, EBSCO, and the Internet, research the topic and write a two-page report. In your report, include the following:
 - An explanation of the genetic condition.
 - The advantages for individuals with the condition knowing its origin, supported with arguments.
 - The disadvantages for individuals with the condition knowing its origin supported by arguments
 - What conclusions, including ethical implications, you have made as a result of your research.
 - A bibliography of your sources. (215-5, 117-7, 213-7)

Presentation

- Conduct a debate which requires a display of the results of research and “argue” against other stakeholders concerning the merits of the use of the technology for the production of genetically modified foods or any other aspect of relevant biotechnology. Represent various sectors of society depending on the issues selected. They may include individuals such as farmer, politician, activists, consumer, or representative of development agency involved in underdeveloped countries. (215-5, 117-7, 213-7)

Portfolio

- Investigate a career of your choice related to this unit on genetics and heredity. Examples may include biochemist, genetic counsellor, laboratory technologist, geneticist, oncologist, etc. Prepare a small poster on the knowledge and skills required in this career. (315-8)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

There are many current and relevant issues within the realm of biotechnology. Students can evaluate the database on genetic research obtained from Internet websites. Students can evaluate, from a variety of perspectives (e.g., counsellor, prospective parents, potential patient) the role of genetic counselling and gene testing for the identification and treatment of potentially debilitating genetic conditions (e.g., Tay Sachs, PKU, Huntington Disease, Alzheimer's, Dystonia). Discuss the personal and ethical

considerations faced by individuals as the identification of genes, possibility of prenatal diagnoses and predictive ability for particular disorders increases. Students should identify and discuss inherited genetic disorders from various ethnic groups. There are groups that suggest genetic testing of the partners before conception so that they are aware of possible inherited genetic disorders for their offspring. Consider questions like the following:

- Would you, as an individual, want to know if you will suffer from a disabling disease later in life? Do you have a right to know?
- Do insurance companies have a right to accept/reject you for insurance coverage based on the results of voluntary and confidential genetic testing predicting your future health?
- Do employers have a right to know your genetic status determined from voluntary genetic testing? (e.g., Suppose you are a heterozygous carrier for sickle cell anemia; you know there is a belief within the airline industry that carriers are more sensitive to a decrease in cabin air pressure. Do you inform the airline of your genetic status before accepting a job?) As genetic testing becomes more common, and increases in availability, will potential employers have a right to know of your genetic status as a preliminary to hiring?

Students should research and discuss the potential and ethics of biotechnology and somatic cell gene replacement therapy in the treatment of human genetic disorders. What might be the implications of gene therapy on germ or sex cells? Discuss the role of gene banks for the preservation of endangered species and genotypes and whether society has the right or responsibility to preserve these species in this way for future generations.

Students should identify the variety of tools and techniques currently available to study genetics. Areas to be considered include the polymerase chain reaction (PCR) process, DNA “fingerprinting” and gel electrophoresis, gene probes, recombinant DNA, cloning, genetic markers and gene mapping.

Students should investigate through simulations, an understanding of the use of restriction enzymes within biotechnology.

The use of restriction enzymes or biological scissors in DNA fingerprinting can be effectively demonstrated using paper activities on forensics and the matching, based on the activity of a specified restriction enzyme, of a DNA sample found at a crime scene with the DNA of specific suspects. Students could perform simulations to demonstrate the use of restriction enzymes in the creation of new DNA sequences (e.g., electrophoresis).

Students may conduct a major research report on the Human Genome Project. Using a variety of print and electronic sources, they could consider the following areas:

- How and why is the Human Genome Project being conducted?
- What are the implications of decoding the entire human genome?

Individual students or student groups may be assigned an individual human chromosome for which they investigate its mapping. They can prepare a large cardboard model of this structure labelled with its identified genes and the characteristics for which they code. Students can make a presentation on their chromosome as the class builds a human genome to be displayed within the classroom or school.

The completion of the Human Genome Project presents potential risks and benefits to society. Students may brainstorm relevant issues and subsequently research, analyze and discuss a selection of these.

Increasing research is being directed towards using viruses as “genetic bullets.” Students should describe, based on viral structure, the role viruses play as a DNA/RNA vector in the transfer of nucleic acids from one cell to another.

Students could investigate and perform a risk/benefit analysis and defend their position on situations such as

- The use of genetically modified microorganisms (GMO) for drug production, pollution clean-up, environmental monitoring and mining.
- The use of genetically modified food (GMF) in the marketplace. Students should investigate the extent to which genetic manipulation currently pervades the food industry (e.g., processed foods) and how aware or unaware the general public is of this.
- How does our new found ability to move genes around potentially impact allergenicity levels?
- What is the importance of labelling genetically modified foods? What practical issues are involved?

RESOURCES/NOTES

Experiments

- Seed Banks, *Biology Living Systems*, p. 538
- Gene Splicing, *Biology: The Study of Life*, p. 463
- Genetic Screening, *Nelson Biology*, p. 491
- The Potential of Gene Therapy, *Nelson Biology*, p. 513
- Genetic Profiles and Denying Healthcare and Employment, *Biology Living Systems*, p. 244
- DNA Fingerprinting Activity, *Biology 12 Appendices*
- • How Can Crop Plants Be Genetically Engineered to Produce Higher Yields? *Biology Living Systems*, p. 238

Video from LRT

- *Gene Therapy*, 21459, 50 min.
- *Biotechnology*, 21638, 28 min. (loan)
- *Freedom in the Genes*, 21542, 50 min.
- *Seeds: Biodiversity*, 20959, 27 min.
- *Against Nature*, 21458, 50 min.

Case Studies

- Human Immunodeficiency Virus, *Nelson Biology*, p. 541
- Genetic Disorders as Models for Evolution, *Nelson Biology*, p. 567
- Tracking Deadly Medicine, *Biology Living Systems*, p. 292

[Heading??]

- Genetic Diseases, *Nelson Biology 11*, pp. 180–181
- Genetic Engineering, *Nelson Biology 12*, pp. 261, 293, 482, 304
- Explore and Issue, p. 295
- Human Genome Project, *Nelson Biology 11*, p. 180
- Genetic Modification and Bio Technology, *Nelson Biology 11*, pp. 185–186
- *Nelson Biology 12*, pp. 307, 720, 305

Websites

WWW Keywords:

- Human Genome Project
- eugenics
- bioethics

STSE Issues

- DNA Fingerprinting—A New Weapon Against Crime, *Biology Living Systems*, p. 271
- Social Issue: Biotechnology and Agriculture, *Nelson Biology*, p. 446

- Cloning Humans: Is It Possible? *Biology Living Systems*, p. 507
- Non-human Life Forms as Property, *Nelson Biology*, p. 530
- Transgenic Organisms—What Are They and Who Owns Them? *Biology Living Systems*, p. 243

Evolution, Change, and Diversity (24%) (Advanced, 14%)

Introduction

Evolution is a concept in biology that links yesterday with today. This unit focuses on the history, importance and mechanisms of the process of evolution and how a change in the DNA blueprint creates new traits that propel evolution. It builds upon what the students have learned about mutations and genetic variability and shows how these can lead to changes in species based upon natural selection. This unit also outlines evidence and arguments pertaining to the origin, development, and diversity of living organisms on Earth.

Focus and Context

By the consideration of questions generated by students and teachers and the discussion of issues raised, various learning and assessment activities will meet specific curriculum outcomes within this section. The main focus of this unit falls within the realm of scientific inquiry and observation as it transposes from a historical to modern perspective on the scientific thought and techniques involving evolution, change, and diversity.

Science Curriculum Links

The curricular connections for this unit in the Biology 12 exist primarily at the Science 6 level within a unit called Diversity of Life. Students at that point within their life science education are asked to compare adaptations of closely related animals that live in different parts of the world and discuss possible reasons for any differences noted. They are then asked to expand their view of this concept by identifying changes that have occurred in animals over the course of time using the fossil record. These considerations provide a framework upon which further discussions can be built.

Curriculum Outcomes

STSE

Students will be expected to

114-5, 316-1, 316-2 describe and evaluate scientific peer review and evidence that have changed evolutionary concepts and feeds the debates on gradualism and punctuated equilibrium

114-2, 115-7, 116-2 explain and analyze the roles of evidence, theories, and paradigms as these are tested, and subsequently restricted, revised, or replaced

Skills

Students will be expected to

212-1, 213-6, 118-6 identify questions to investigate, collect information, and construct arguments to support the development and diversity of living organisms, using examples and evidence

Knowledge

Students will be expected to

316-4, 214-17 outline evidence and arguments pertaining to the origin, development, and diversity of living organisms on Earth and identify new questions that arise from what was learned

Evidence and Mechanisms

(7 hours)

OUTCOMES

Students will be expected to

- describe and evaluate scientific peer review and evidence that have changed evolutionary concepts and feeds the debates on gradualism and punctuated equilibrium (114-5, 316-1, 316-2)
- explain and analyze the roles of evidence, theories, and paradigms as these are tested, and subsequently restricted, revised, or replaced (114-2, 115-7, 116-2)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Journal

- Compare the theories of LaMarck and Darwin. (114-5, 316-1, 316-2)
- Reflect on this statement and develop, present, and defend your position based on scientific thinking.
 - It has been hypothesized that we are in the midst of a “sixth mass extinction.” Fossil records indicate that global mass extinctions have occurred only five times since complex life emerged, and that each time it was due to a single catastrophic event. It has been said that this apparent “sixth mass extinction” is not however, occurring due to a catastrophic event, but due to the activities of a single species, *Homo sapiens*, called the exterminator species! (114-2, 115-7, 116-2)

Paper and Pencil

- Investigate a career that relates to this evolutionary unit and prepare a presentation, electronic and/or paper on the knowledge and skills required for each profession. Examples may include anthropologist, palaeontologist, botanist, physiologist, entomologist, etc. (114-5, 316-1, 316-2)
- Use your text, library, EBSCO and the Internet to collect information on one of the following topics and do a report.
 - types of evidence supporting the theory of evolution
 - theories on the origin of life on Earth
 - gradualism vs. punctuated equilibrium
 - role of viruses in the evolutionary process
 - exobiology (114-5, 316-1, 316-2)
- Complete one of the following three activities:
 - Select three of the following to explain the major contribution to our knowledge of evolution G. L. Buffon, Georges Cuvier, Charles Lyell, Jean-Baptiste Lamarck, or Thomas Malthus.
 - Develop a list of ten extinctions that have occurred. Research and evaluate the causes of two naturally occurring extinctions and two extinctions resulting from human activity. In your report, include a discussion of current and future extinctions, their causes and hypothesize on the implications of reduced genetic biodiversity.
 - It has been hypothesized that the earth is in the midst of a "sixth mass extinction". Fossil records indicate that global mass extinctions have occurred five times since complex life emerged, and each time was caused by a single catastrophic event. This apparent "sixth mass extinction" is not occurring as a result of a catastrophic event, but from the activities of a single species, *homo sapiens*, called the exterminator species. Do a report with evidence to support your positions with respect to a "sixth extinction". (114-5, 316-1, 316-2)
- Select a modern animal and investigate the evolutionary evidence that exists for its ancestry. The report on this work may be visual (e.g. video tape, poster, models) or written. (114-2, 115-7, 116-2)

- Compare the amino acid and protein sequences of different organisms to compare their similarities (e.g., frog, human, chimp, rabbit, cow). (114-2, 115-7, 116-2)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

The use of time lines may help students visualize historical and/or geologic time frames. One could be developed to illustrate the historical progression towards the theory of evolution. Another option is to create a timeline that illustrates the geologically recent event of human appearance on Earth. Tape a string along the wall to represent the history of the Earth as one single year. Date one end of the string as January 1 (the formation of Earth) and end the string at December 31. Ask the students to place cards marked with crucial events (e.g., single cells, the appearance of dinosaurs, mammals) along the line where they feel it would be appropriate. Then, with a second set of cards, place the events where they actually belong on the string and discuss with the students the discrepancies between their placement and the appropriate location.

Students should identify the contributions of Charles Lyell, Thomas Malthus, Alfred Wallace, and in particular, Charles Darwin to the historical development of the theory of evolution. Students should discuss that there are many explanations for changes in life forms over time (scientific, religious, philosophical).

Students should explore the meaning of the term *evolution*. This could be approached in a historical, geological, and technological sense as well as a biological sense (i.e., the evolution of video games or the evolution of the planet Earth). Students should discuss the theory of evolution and its importance to biological sciences.

Students should discuss the modern theory of evolution and the variety of supporting evidence. Such evidence exists within the areas of fossil evidence supported by radioactive dating, comparative anatomy, comparative embryology, comparative biochemistry, and DNA sequencing.

Students can investigate the evolutionary evidence that exists for the ancestry of a modern animal, such as the horse, cat, dog (and/or other household pet or domesticated animal used in agriculture). This may involve (in the example of the horse) looking at things like the following:

- tracing the ancestry of the modern horse from Eohippus to Equus to determine the historical changes required in its evolution from a small woodland browser to a large, plains-dwelling grazer.
- students may be provided with illustrations (drawings, photos, art) that compare possible changes in anatomy such as size, leg and tooth anatomy that would allow them to evaluate evidence for the theory of evolution. Examination of the diagrams could lead to the question, “How are dietary changes linked to changes in tooth anatomy?”
- further student inquiry could be encouraged by asking and discussing questions such as, “What advantages would a tall horse have as a plains-dweller?” “Why would running be necessary for a plains-dweller?” “How did changes in the environment result in an evolutionary adaptation?”

Groups of students could video tape and share a story of a chosen organism with the class or do this as part of a written research project.

Currently, the greatest percentage of evolutionary research is centred around DNA sequencing. Students should explain how nucleic acid sequences in the nucleus, mitochondria, and chloroplast are being used to provide evidence for evolutionary relationships among species.

Paper activities could be performed that compare amino acid sequences among different organisms to provide evidence to the student of evolutionary relationships. Students may conduct investigations into human development based on mitochondrial DNA evidence.

Students should compare Darwin's views on evolutionary change known as gradualism with those of Steven Gould and Niles Eldridge known as punctuated equilibrium and discuss how the two theories on the one hand oppose each other and yet the newer theory of punctuated equilibrium enhances and further explains the "missing links" of gradualism.

Charts can visually illustrate the differences between these two views. Students can investigate and answer the questions, "How would a scientist who supports gradualism or punctuated equilibrium explain gaps in the fossil record?" and "What sort of evidence would you need to be convinced to accept gradualism rather than punctuated equilibrium or vice versa?"

Students should investigate examples of each of the evolutionary mechanisms listed and present their findings to the class (e.g., breeds of dogs are produced by artificial selection, yet all dogs, including the St. Bernard and Chihuahua, remain members of the same species; natural selection resulting in morphological, behavioural, or reproductive adaptations such as the camouflage of the peppered moth; dwindling of the cheetah population due to inbreeding). Familiarity with the concept of artificial selection can come from studies of pedigrees or student experiments. Artificial selection allows the creation of "breeds" of domestic animals whereas in natural selection, selection is due solely to natural conditions.

Students can use the Internet to access websites and collect relevant information on evolution and biodiversity. Students can brainstorm a list of extinctions that have occurred and research and evaluate the causes of each as naturally occurring or as a result of human activity. This discussion can be expanded into one that extrapolates itself to current and future extinctions, their causes and hypothesizes the implications of this reduced genetic biodiversity.

RESOURCES/NOTES

Experiments

- Can a Calendar Represent Geologic Time? *Biology Living Systems*, p. 327
- Biochemical Evidence for Evolution Kit from Ward's
- Comparative anatomy labs available in lab manuals
- Forming Your Own Fossil, *Biology Living Systems*, p. 310
- How Do Adaptations Aid Survival? *Biology Living Systems*, p. 348

Video from LRT

- *Evolution*, 22517, 10 min. (animation with no script)

[Heading??]

- Evolutionary Theory, Sect 11.1, *Biology 12*
- Early Ideas About Evolution, Sect 11.3
- Darwin's Voyage of Discovery, Sect 11.4
- Rate of Evolution, Sect 13.2, pp. 599–600
- Try This: Gradual? Or Rapid and Punctuated?
- Evidence from the Past, *Biology 12*, Sect 11.2, pp. 511–516
- Explore an Issue, p. 515
- Try This, p. 512
- What Darwin Observed, p. 522
- The Theory of Evolution by Natural Selection, Sect 11.6

Video from LRT

- The Ultimate Journey, V2199, 55 min.

Articles

- Biotechnology: Dating Fossils, *Biology Living Systems*, p. 331

Case Study

- Adaptation and the Peppered Moth, *Nelson Biology*, p. 109

Implications

(3 hours)

OUTCOMES

Students will be expected to

- identify questions to investigate, collect information, and construct arguments to support the development and diversity of living organisms, using examples and evidence (212-1, 213-6, 118-6)
- outline evidence and arguments pertaining to the origin, development, and diversity of living organisms on Earth and identify new questions that arise from what was learned (316-4, 214-17)

TASKS FOR INSTRUCTION AND/OR ASSESSMENT

Presentation

- Use library and electronic research tools to collect information on a topic related to this discussion on evolutionary theory and prepare a class presentation and written report. Sample topics may include
 - contributions of individuals to the theory of evolution
 - types of evolutionary mechanisms
 - types of evidence supporting the theory of evolution
 - theories on the origin of life on earth
 - gradualism vs. punctuated equilibrium
 - role of viruses in the evolutionary process
 - exobiology (212-1, 213-6, 118-6)
- Have a debate on the development and diversity of living organisms on Earth. (316-4, 214-7)

ELABORATIONS—STRATEGIES FOR LEARNING AND TEACHING

Students should analyze the role of sexually-produced genetic variations and mutations on the process of natural selection.

The rapid appearance of new antibiotic resistant microbes and the development of pesticide resistant insects can be considered studies in microevolution—rapid evolution due to intense selection. Students could investigate the causes of the appearance of these new strains and the environmental and societal implications they present. Students may discuss the following questions:

- If mutations play an important role in evolution, why are many scientists concerned about the mutagenic effects of X-rays, radiation from nuclear power plants, chemicals, etc?
- What would be the effect on the offspring if DNA polymerase were absolutely infallible in its proofreading capacity? What would be the long-term effect on biological evolution?
- What are the implications of the cloning process, if any, on evolution?

Students should research, interpret and evaluate data concerning theories on the origin and development of life (e.g., gaia, symbiosis theory of eukaryotic cell origins, heterotroph hypothesis, mass extinction theories, organic spontaneous origin, or chemical evolution (Oparin-Haldane/Miller–Urey) under early conditions.

Students can conduct an activity that allows them to prepare coacervates and observe them under various environmental conditions.

Students should explain, using modern evolutionary theory, the recent appearance of antibiotic resistant bacteria populations.

Students should explain, using modern evolutionary theory, the recent appearance of pesticide resistant insect populations.

RESOURCES/NOTES

Videos from LRT

- *Evolution*, 21456
- *Evolution*, 20964, 30 min. Article for Journal Entries
- Global Connection: The Question of Colour, *Biology Living Systems*, p. 320
- Preserving Genetic Diversity, *Biology: The Study of Life*, p. 667

STSE Issues

- Biodiversity: Which Species Should be Saved? *Biology Living Systems*, p. 330

Case Studies

- Resistance to DDT, *Nelson Biology*, p. 114

[Heading??]

- Genetic Variation, Sect 12.1–12.6, *Biology 12*, pp. 542–579

Appendices

Appendix A: Equipment Lists

The apparatus listed will supply one laboratory for 32 students who are working in groups of two. Equipment needs will vary depending on the labs selected. Some materials are expendable and should be ordered considering the number of classes involved.

This list is, of course, a minimal inventory. We hope that schools will have on hand or be able to budget for a few pieces of apparatus for demonstration and motivational purposes.

BIOLOGY 11 SUPPLY LIST	QUANTITY
ammonium hydroxide	1 L
beakers, 250 ml	18
beakers, 500 ml	18
Benedict's solution	1 L
blood pressure cuff	2
burners	18
clay triangles	
collection of preserved representative specimens from kingdoms	1 set
cover slips, boxes of 100	10
crucibles	18
dialysis tubing	1 roll
dissecting kit—including scissors, scalpel, forceps, dull probe, needle probe	18
dissecting tray	18
Forceps	18
glucose, 500 g bottle	1
hot plate	3
iodine stain	250 ml
lens paper, booklets	10
medicine droppers	18
methylene blue stain	1 L
monocular microscopes	12–18
nitric acid	1 L
Pasco, Vernier or similar probe such as heart rate sensor, EKG sensor, CO ₂ sensor, etc., with appropriate interface boxes (number depends on available computers)	
prepared slides of frog blood	10
prepared slides of anabaena, nostoc or gleocapsa	10
prepared slides of various bacteria	10
prepared slides of penicillium	10
prepared slides of aspergillus	10
prepared slides of human blood	10
prepared slides of various tissues such as kidney, liver, uterus, bowel, spleen, colon, lung, etc.	2 each
preserved frogs	18
preserved earthworms	18
ring stands	18
slides, boxes of 100	2
stereo microscopes	2–3
stethoscopes	2
Sudan IV stain	250 ml
test tube holder	18
test tubes	120–150

test tube racks	18
CONSUMABLES LIST	
bread mould	
brown paper squares, cut up paper bags	several
cooking oil (i.e., canola)	
corn starch	
egg white	
elodea leaves, stems	several
metric ruler	18
milk	
mozzarella cheese	
mushrooms	
onion	
potato	
potting soil	1 bag
rice	
scallop pieces	
seeds: beans, corn or "quick plants"	2 pkg
small plant pots or Styrofoam cups	200
sugar	
yeast culture	
BIOLOGY 12 SUPPLIES	QUANTITY
baking soda (sodium bicarbonate)	1 box
beakers, 125 ml	18
Biochemical Evidence for Evolution Kit (Ward's)	1
digital balance	2
dissecting kits (separately: scissors, scalpels, dull probes, needle probes, forceps, pins)	18
distilled water	4 L
DNA model kits	1
electrophoresis tanks and power supplies	10–12
electrophoresis kits, per class	2
ethanol	1 L
genetic corn, kit	1
graduated cylinders, 10 mL	18
hot plates	3
human ear model	1
human eye model	1
hydrochloric acid	1 L
hydrogen peroxide, 500 mL bottle	3
manganese dioxide 500g	500 g
micro viewer slide sets on mitosis and meiosis	12–18
micro viewers	12–18
microscopes	12–18
mortar and pestle	4
prepared slides of mitosis–onion root tip; mitosis–whitefish blastula or Ascaris; sea star or sea urchin cleavage; budding hydra; and frog or chick embryo (developmental stages)	12–18 each
PTC paper, vials or sheets	2
sheep eye specimens	18
sodium hydroxide	1 L
stirring rods	18

stop watches	12
test tube racks	18
test tubes, medium size	120–150
thermometers	18
weighing paper	5 boxes
wire transfer loops	18
CONSUMABLES LIST	
beef liver	
dish detergent (i.e., Palmolive)	
meat tenderizer (or pineapple juice)	
potato	
sand	1 kg
spinach	
toothpicks	2 boxes
wheat germ (unbaked)	
yeast	

Appendix B: Video Resources

Media Services, Learning Resources and Technology

OUTCOMES	TITLE	DESCRIPTION
Matter and Energy for Life: The Cell		
314-6, 314-7	<i>Introduction to Cells</i> Call Number V2202 24 minutes, 1998	This video defines and illustrates a variety of animal and plant cells. A concise history of the many theories of cells is provided from Hooke to Schleiden and Schwann. In addition, the differences between prokaryotic and eukaryotic cells are discussed. The program then identifies cell structures (organelles) including the nucleus, cytoplasm, mitochondria, vacuoles, and plastids. The video shows how cells maintain a constant environment through processes of diffusion, facilitated diffusion, and osmosis. The program also reviews how cells function in one-celled environments, multicellular organizations, and how they are involved in forming tissues, organs, and systems. Includes teacher's guide.
314-6, 314-7	<i>Cells: The Building Blocks of Life</i> Call Number 23294 20 minutes, 1996	This video is an introduction to cell biology. It discusses living and non-living matter, eukaryote and prokaryote cells, cell structures, cell membrane, photosynthesis, and respiration. Cryobiology is introduced as biologists and physicians work in this area.
115-5, 116-6, 314-8	<i>Cellular Respiration: Energy for Life</i> Call Number V2200 23 minutes, 1995	All life depends on energy. Without energy, living things could not move, reproduce, or engage in any kind of activity. Without energy the different biochemical processes that are necessary for life itself would not be possible. This program provides a basic overview of how the cells that make up living things acquire and use energy. It also explains the basic steps of cellular respiration, the process by which cells convert the energy in glucose and other nutrient molecules to ATP. The video explains the different steps of anaerobic and aerobic respiration and includes simplified explanations of the Krebs cycle and the electron transport chain.
Matter and Energy for Life: Photosynthesis and Respiration		
314-9	<i>Photosynthesis: Light into Life</i> Call Number V2201 24 minutes, 1998	Students are taken, step-by-step through the basic details of photosynthesis as well as respiration. The video reviews the chemical equations for both processes, and highlights the importance of glucose and oxygen. The video also examines the chloroplast cells involved in photosynthesis and discusses the role of chlorophyll and sunlight. Both light and dark reactions are clearly explained, as the Calvin Cycle and its production

OUTCOMES	TITLE	DESCRIPTION
		of phosphoglyceeraldehyde (PGAL).
314-9	<i>Photosynthesis</i> Call Number 20960 28 minutes, 1987	Topics described in this video include Energy, Chemistry of Photosynthesis, The Leaf, Factors Affecting Photosynthesis and Advanced Photosynthesis.
Biodiversity: Classifying Living Things		
214-17, 213-6, 116-2, 215-1	<i>Classification: Bringing Order to Diversity</i> Call Number 23034 28 minutes, 1996	This video introduces classification using the five kingdom approach. The video includes a good survey of invertebrate phyla and vertebrate classes. The plant and animal kingdom are also divided.
214-17, 213-6, 116-2, 215-1	<i>How Organisms Are Grouped</i> Call Number 20669 15 minutes, 1990	The program opens with a discussion of some of the criteria scientists use for classifying organisms, such as body parts and similar structures. Another is to discover how organisms evolve, such as through the study of fossils. The modern system of classification originated with carolus Linnaeus in the 18th century and is still in use today. We are briefly introduced to the five kingdom system of classification.
Biodiversity: Diversity among Living Things		
118-6, 316-6	<i>Kingdom of Animals: From Simple to Complicated</i> Call Number 23297 21 minutes, 1995	Rich live-action imagery excites students as they learn some basic facts about the incredible diversity that exists in the animal kingdom. Starting with one-celled animal-like protists, this program examines a variety of animal phyla: sponges, sea anemones, spiny-skinned animals, flatworms, nemertine worms, segmented worms, molluscs, arthropods, and vertebrates. Includes on-screen video quiz. Also includes brief teacher's guide and blackline masters.
118-6, 316-6	<i>Insect</i> Call Number 22469 34 minutes, c1994	Older than the dinosaurs, and outnumbering people, insects are nevertheless avoided and ignored. Here, you can safely examine the wonders of the insect world through micro photography and startling 3-D graphics that reveal the true importance of these amazing industrious creatures. Part of the Eyewitness series. Closed captioned.
118-6, 316-6	<i>Shark</i> Call Number 22455 34 minutes, c1994	Peer into the murky world of the shark and learn what motivates these fascinating creatures. Discover a shark that can fit in your hand and a shark that eats only plankton, and learn that not all sharks are killing machines. Part of the Eyewitness series. Closed captioned.
118-6, 316-6	<i>Fish</i> Call Number 22468 34 minutes, c1994	Dive into the waters of the world and discover the most exotic creatures in nature. Take the plunge from dazzling coral reefs to the darkest depths to meet fish, a vast and varied group of animals, much closer to humankind than you might imagine. Part of the Eyewitness series. Closed

OUTCOMES	TITLE	DESCRIPTION
		captioned.
118-6, 316-6	<i>Amphibian</i> Call Number 22467 34 minutes, c1994	Imagine leading a double life—on the land and in the water. Leap into the fascinating world of frogs, toads, and salamanders, and get a close-up look at the amazing variety of colours, shapes and sizes in the amphibian family. Part of the Eyewitness series. Closed captioned.
118-6, 316-6	<i>Reptile</i> Call Number 22454 34 minutes, c1994	Experience the alien world of these cold-blooded vertebrates (reptiles) learning the truth about these often misunderstood creatures and uncovering reptilian facts that are stranger than fiction. Part of the Eyewitness series. Closed captioned.
118-6, 316-6	<i>Birds</i> Call Number 22447 34 minutes, c1994	Soar through the sky and around the world in this exciting journey from the bird's prehistoric past to its present astonishing variety. Look close-up at the staggering range of sizes, shapes, and habitats of these feathered creatures and experience the miracle of flight. Part of the Eyewitness series. Closed captioned.
118-6, 316-6	<i>The Earthworm: Darwin's Plow</i> Call Number 22094 13 minutes, 1986	Earthworms are responsible both for the slow burial of ancient cities and monuments and the fertility of the soil. They were one of the many interests of Charles Darwin's inquisitive mind. In recreating that great naturalist's studies, the film demonstrates the role of earthworm castings in soil fertility, relating them to how an earthworm feeds and what it feeds upon. Microscopic views show body structures involved in movement, and we explore an earthworm's eyeless light sensitivity and its distinctive method of reproduction.
Maintaining Dynamic Equilibrium I: Body Systems: Excretory		
116-4, 116-7, 117-4, 214-15	<i>Critical Choice</i> Call Number V1089 12 minutes, 1985	A hospital director is faced with critical choices between keeping his hospital budget under control and prioritizing hospital programs. Lives hang in the balance. A child needs a liver transplant and the hospital needs to decide whether to pay the expenses when the family has only small financial resources. The hospital must send the child to the United States for the procedure and still meet its financial and program needs.
116-4, 116-7, 117-4, 214-15	<i>The Ultimate Gift</i> Call Number V1240 25 minutes, 1991	Fourteen-year-old Carmen Young of Cape Breton needed a lung transplant to live. She dedicated much of her energies to informing Canadians about the need for organ donation. This program profiles the Young family, and their courage and dedication in the face of very great odds. Nancy and Brian Young describe their hopes for their daughter, the support they receive from family, community, and the medical system who have all

OUTCOMES	TITLE	DESCRIPTION
		come together to try to save Carmen's life. Additional profiles of individuals and families who have had to face the difficult medical reality of the scarcity of organ donations and the very real medical need. Interviews with organ donation recipients and families of those who have donated the organs of loved ones allow the viewer to understand the very real need for donations and the powerful affirmation of this ultimate gift. The program addresses the questions "Who can donate?" and "How are organ donation decisions made by individuals and families?" The program encourages the viewer to become an organ donor.
Maintaining Dynamic Equilibrium I: Body Systems: Immune		
317-6, 317-1, 117-2	<i>Coming to Grips with the Grippe</i> Call Number 21950 46 minutes, c1989	More people died in the 1918 flu epidemic than in World War I. Until the appearance of AIDS, influenza was viewed as the last great changing virus. We follow the spread of influenza virus worldwide and observe the body's immune response, note the effect of influenza on various age populations, the historical beliefs about the causes of influenza, the passage of influenza among humans and animals, and early 20th century "remedies." A, B, and C influenza strains, and our current understanding of autogenic drift in viruses, the human and animal infection processes, and the importance of flu vaccination in specific populations are discussed.
317-6, 317-1, 117-2	<i>Fighting Disease</i> Call Number 21543 50 minutes, 1993	The program describes the role of the immune system in fighting disease, the research work that is being done to discover how diseases mutate, and the development of vaccines to assist our immune systems in recognizing and fighting diseases. We visit the Center for Disease Control in Atlanta to learn how influenzas become pandemic, research work on smallpox. We follow research on why the schistosome worm is able to fool the human immune system so that our bodies cannot fight its repeated invasion in communities in Brazil. Multiple Sclerosis and AIDS therapies are described.
Interactions among Living Things: Biomes		
214-1, 116-7, 318-7, 213-6	<i>MacFarlane Woods: A Special Place</i> Call Number V1596 22 minutes, 1993	MacFarlane Woods on Cape Breton Island is a special place that contains a remarkable remnant of the Acadian Forest that once stretched south to the Carolinas. This forest contains all of Nova Scotia's natural tree species and has been under the stewardship of the MacFarlane family for generations. We learn how the family is attempting to preserve this forest for future generations of Nova Scotians.

OUTCOMES	TITLE	DESCRIPTION
214-1, 116-7, 318-7, 213-6	<i>World's Biomes: Desert to Rainforest</i> Call Number 23292 28 minutes, c1996	The various abiotic factors that affect a particular biome are presented and then a summary of the abiotic influences of each of the different biomes on their biotic component is given. Major biomes introduced include tundra, coniferous forest, temperate forest, rainforest, desert, grassland, and aquatic.
Maintaining Dynamic Equilibrium II: Nervous System: Neurons and Structure		
116-7, 212-6, 213-5, 214-10	<i>Thinking</i> Call Number 21533 30 minutes, 1988	The brain constructs representations of the world. Because humans live in a complex social world, a complex brain allows us to cope with the resulting problems. Human thinking is distinct in that we have the capacity to consider the unreal—to imagine and to construct hypothetical situations. We follow a man who spent years in a concentration camp and survived largely because of his capacity to build a rich inner life in a physical environment devoid of stimulation. We also meet a group of inner city elementary students who are working with superior chess players to solve problems by learning strategies of sequencing, analogy, prediction, and mental mapping; and a lawyer who lost his capacity to create and execute complex plans as a result of a frontal lobe aneurism. Issues associated with standardized intelligence testing are identified. Part of The Mind Series.
116-7, 212-6, 213-5, 214-10	<i>The Two Brains</i> Call Number 21525 30 minutes, 1988	The cerebral cortex orchestrates a variety of human talents and skills including mathematics, music, language, and face recognition. The division of responsibilities of the left and right hemispheres makes evolutionary sense. We learn about the various specializations and processing styles of the two hemispheres that normally work in concert. Part of The Mind Series.
116-7, 212-6, 213-5, 214-10	<i>Learning and Memory</i> Call Number 21526 30 minutes, 1988	Learning involves a physical change in the brain. Neural pathways develop and are pared down to permit efficient storage and retrieval of information and to relate ideas to one another. The biological component of memory has implications for the aging brain and recovery from amnesia. Cell implants are being used to improve the memory of aging rats. Short-term memory strategies are demonstrated in research done with people who experience global amnesia. The very human impact of memory loss is discussed by an amnesiac. Part of The Mind Series.
Maintaining Dynamic Equilibrium II: Influences on the Nervous System		
317-4, 115-5, 317-7	<i>Addictions</i> Call Number 21527 30 minutes, 1988	For thousands of years people have been conducting an uncontrolled experiment on the human mind. Anyone can become addicted to

OUTCOMES	TITLE	DESCRIPTION
		alcohol and other drugs. The program describes early stimulus/ response—satiation experiments in rats to reveal to what lengths the rat will go for brain stimulation of areas of the brain. The dopamine circuit is identified. The long-term effects of alcohol and other drugs on the nerve cells of the brain are described. Heritability of addiction disposition and the triggers that need to be extinguished to avoid drug use relapse in addiction treatment are discussed through individual profiles. Part of The Mind Series.
317-4, 115-5, 317-7	<i>Aging</i> Call Number 21528 30 minutes, 1988	The effects of aging on brain functioning in the areas of memory, perception, and understanding are explored. Why individual differences among people exist help to reveal the impact of both genetics and environment. A summary of some American research observations on human and animal aging identifies points of intervention to allow continued new learning as we age. Alzheimer's disease is explored in a set of 82-year-old twins. One twin has the disease, the other does not. Scientists are looking for the trigger that causes brain cell degeneration. Part of The Mind Series.
317-4, 115-5, 317-7	<i>Depression: Bipolar Disorder</i> Call Number 21531 30 minutes, 1988	Biologically-controlled manic depression is explored through a series of individual profiles. The viewer learns the factors that influence inheritance, the intensity of manic depressive episodes, how the disease governs the lives of those with the disease, and how the medical community manages the disease to allow manic depressives to lead normal lives. Part of The Mind Series.
317-4, 115-5, 317-7	<i>Madness</i> Call Number 21542 30 minutes, 1988	Through interviews with medical doctors and patients, we see the manifestations of chronic schizophrenia, a disorder of the highest functions of the brain that produces severe confusion in thinking and emotions. The frustration, sadness, and anger experienced by blocking the effects of brain produced dopamine are studied. Part of The Mind Series.
317-4, 115-5, 317-7	<i>Pain and Healing</i> Call Number 21530 30 minutes, 1988	The power of the mind to control pain and to heal sickness in the body is explored. The transport of the pain signal to the brain is mapped by one researcher. Chronic pain sufferers use a combination of physical and behavioural therapies to regain normal function. The placebo effect is demonstrated, and the role of brain produced endorphins in the relief of pain associated with a wisdom tooth extraction is highlighted. Part of The Mind Series.

OUTCOMES	TITLE	DESCRIPTION
Reproduction and Development: Cell Division		
313-2, 213-3, 317-5, 212-3, 212-8	<i>Mitosis and Meiosis: Cell Reproduction</i> Call Number 23009 23 minutes, c1995	The first part (15 minutes) of the video is devoted to the subjects of the interphase state, DNA replication, chromosome structure, and offers a detailed look at each stage of mitosis. The second part (8 minutes) looks at the diploid and haploid states, at fertilization, and at the various stages of meiosis. A short, optional video quiz follows each portion of the program. Through the entire program, microscopic images are interwoven with animated sequences to allow the processes of mitosis and meiosis to be more easily understood. Includes brief teacher guide and blackline masters.
116-2, 116-3, 213-7, 215-2, 116-7	<i>Cancer</i> Call Number 22560 30 minutes, 1994	This program focuses on the cancer experiences of several teens—when they were diagnosed, the treatments they received, and how they were affected both physically and mentally. They talk about the importance of support from family, friends, and hospital staff in their recovery process and the desire to be treated like everyone else. Experts explain what cancer is, how it manifests itself in the body, how it is detected and what kinds of treatments are available. Closed captioned. NOTE: <i>This program should be previewed by a teacher prior to student viewing and students should be supervised by a teacher during viewing. Please consult the enclosed teacher's guide.</i>
116-2, 116-3, 213-7, 215-2, 116-7	<i>Cancer</i> Call Number 21457 1993	The program deals effectively with this interesting topic. Excellent photography of a tumour on an eye and discussion of retinal blastoma. Control genes and oncogenes are explained. A good portion of the program deals with breast cancer studies and the search for the gene that causes this major disorder.
Reproduction and Development: Reproductive Systems: Regulation and Technologies		
313-3, 313-4	<i>The Miracle of Life</i> Call Number 23084 60 minutes, 1982	This program from the Nova series looks at human reproduction using micro photography to show inner workings of the male and female reproductive systems. Teacher preview required.
115-1, 118-8, 213-7, 313-5, 313-6	<i>Witness: Sex Under Siege</i> Call Number 21370 50 minutes, 1994	Could some of the most commonly used substances around us today be responsible for the marked increase in reproductive disorders in men and breast cancer in women? And how can the androgyny in water creatures be explained? This documentary follows the investigative path of scientists in Europe and North America who hypothesize that there may be a direct link between the exposure of fetuses to high levels of estrogenic chemicals and the dramatic increase of

OUTCOMES	TITLE	DESCRIPTION
		testicular cancer, male infertility, and penile deformity. An accidental discovery in a Boston laboratory has led these scientists to believe that everyday plastics and other common industrial and household products may be responsible for the increased cancers and deformities.
118-4, 118-6, 117-4	<i>Family Tree</i> Call Number V0187 13 minutes, 1985	A single mother of three is neglectful of her children. Abuse of the children is suspected but has not been confirmed. She is brought to the hospital with an ectopic pregnancy and her cynical doctor wants to sterilize her “for her own good.” She refuses to agree to a tubal ligation, and the doctor feels he should perform it anyway, disguised as a necessary medical procedure. Her social worker and doctor argue the issue. Students are encouraged to discuss individual rights and social responsibility.
Reproduction and Development: Embryonic Differentiation and Development		
313-4	<i>The Ultimate Journey</i> Call Number V2199 55 minutes, c1996	This video presented by Nova gives an astounding glimpse into the mysteries of life before birth. Stunning microphotography shows how the human embryo reveals links to other species—chick, pig, fish—reflecting an evolution or a shared ancestry that goes back to the dawn of creation.
313-4	<i>Cell Differentiation: The Search for the Organizer</i> Call Number 21936 16 minutes, c1985	When do permanent differences appear among an embryo’s cells? The recreation of Spemann’s and Vogt’s work is enhanced by emphasis on the original thinking that determined the design of the experiments and the control of variables that permitted verifiable conclusions. The importance of three developmental processes—cell division, cell migration, and cell differentiation—is clarified and development traced through the blastula, gastrula, and neurula states.
313-4, 116-2	<i>Birth, Sex, and Death</i> Call Number 21544 50 minutes, 1993	Excellent photography of the development of a chick embryo. The program poses good questions about this area of life and answers the questions in an easily understood manner. Good explanations in particular of cell differentiation, sex determination and aging.
313-4, 116-2	<i>Who Should Decide?</i> Call Number V0185 15 minutes, 1985	A husband and wife have learned that their unborn child will have spina bifida. Ultrasound tests reveal that the risk of profound disability is quite low but difficulties are expected. The mother herself has spina bifida. The mother wants to carry the child. The father is struggling with the logistics of caring for his wife and a disabled child. Their discussions and struggle to make a decision whether to abort the fetus or not encourage students to try to examine the abortion

OUTCOMES	TITLE	DESCRIPTION
		issue from many viewpoints. Students are encouraged to discuss and examine the values that inform decisions of this nature.
313-4, 116-2	<i>If You Want a Girl Like Me</i> Call Number V0191 12 minutes, 1985	A young couple with a newborn having spina bifida needs to decide whether to allow an operation for the child to relieve fluid pressure on the brain. The mother feels overwhelmed and unable to deal with the reality of the child and its disabilities. The father wants the operation. What should happen?
Genetic Continuity: Genetics: Molecular Level		
315-1, 114-2, 315-2, 115-3	<i>We Are One</i> Call Number 21454 50 minutes, 1993	An excellent program for use within the grade 12 biology program when studying genetics, DNA, the Genome Project. The program demonstrates how humans share a gene pool with other living organisms. The program is accessible and lends itself to discussion.
315-1, 114-2, 315-2, 115-3	<i>Genetics and Heredity: The Blueprint of Life</i> Call Number 23293 20 minutes, c1996	This video presents an overview of genetics, looking at DNA, genes, chromosomes, genetic counselling, and genetic engineering. Brief history with references to Mendel and Darwin are also presented.
Genetic Continuity: Implications		
315-8, 317-4, 315-9, 118-2, 118-6	<i>Gene Therapy</i> Call Number 21459 50 minutes, 1993	An excellent discussion of some familiar genetic disorders cystic fibrosis, and Alzheimer's. The significance of advances in gene therapy are demonstrated. The fact that we can test for some specific genetic diseases leads to thought-provoking ethical discussions.
116-4, 116-6, 315-10, 117-2, 118-2	<i>Biotechnology</i> Call Number 21638 28 minutes, 1995	Scientists explain their work in the field of genetics and the business of biotechnology and also discuss the moral and ethical questions involved in this controversial subject. Closed captioned.
116-4, 116-6, 315-10, 117-2, 118-2	<i>Freedom in the Genes</i> Call Number 21542 50 minutes, 1993	How we behave springs from a complex interaction among our genes, culture, experiences, and chance. In that complexity lies our freedom. Why do people behave as they do? Sometimes we have to say, "That is what they choose." The program, hosted by Dr. David Suzuki, explores this complexity by examining studies of fruit flies, sheep dogs, polar bears, eugenics theory, observational studies of laboratory mice, fraternal and maternal twins, and the Amish.
116-6, 118-2, 118-6, 215-5, 117-7, 213-7	<i>Seeds: Biodiversity</i> Call Number 20959 27 minutes, 1987	As industry pervades agribusiness, agriculture has become dependent on hybrid seeds and the various chemicals needed to grow them. This alarming trend has caused some experts to begin collecting and preserving seeds that can grow under "natural" conditions.
116-6, 118-2, 118-6,	<i>Against Nature</i>	Biotechnology and genetic engineering are well

OUTCOMES	TITLE	DESCRIPTION
215-5, 117-7, 213-7	Call Number 21458 50 minutes, 1993	developed topics in this program. The program discusses protein manufacturing, the use of gene transplant from human to mouse, the use of sheep in the manufacture of drugs, the manufacture of human hemoglobin, the controversy of genetic crop engineering and the ethical issues associated with tampering with Mother Nature.
Evolutionary Change: Evidence and Mechanisms		
316-1, 114-5, 316-2	<i>Evolution</i> Call Number 22517 10 minutes, 1971	What better subject for the cartoonist than the story of how life came into being on this planet? Michael Mills describes the process in this animation piece. We witness evolution from the time when single-celled amoeba romped about the ocean depths, until the first amphibious creatures crawled onto land, eventually to become the progenitors of homo sapiens. As the program conveys its message without words, but not without sound, it is a useful resource for both French and English classes.
316-2, 114-2, 115-7, 116-2	<i>The Ultimate Journey</i> Call Number V2199 55 minutes, c1996	This video presented by Nova gives an astounding glimpse into the mysteries of life before birth. Stunning microphotography shows how the human embryo reveals links to other species—chick, pig, fish—reflecting an evolution or a shared ancestry that goes back to the dawn of creation.
Evolutionary Change: Implications		
212-1, 213-6, 316-4, 214-17	<i>Evolution</i> Call Number 21456 1993	The program provides good examples of evolution without lots of terminology. Emphasis is placed on mutations, their significance, importance and success. The evolution of the eye is well illustrated. The program makes strong connections to the students' developing understanding of DNA.
212-1, 213-6, 316-4, 214-17	<i>Evolution</i> Call Number 20964 30 minutes, 1987	Topics described in this video include Records in the Rocks, Evidence for Living Things, Theory of Evolution, and Variation and Evolution.

Appendix C: The Research Process

The research process involves many different skills and strategies grouped within phases or stages. The process is cumulative in nature, each stage laying the groundwork for the next. The phases or stages are commonly identified as

- planning (or pre-research)
- accessing and gathering information (or information retrieval)
- evaluating and interacting with information
- organizing information
- creating new information
- preparing, sharing, and presenting information
- evaluating the research process

Students' use of the information process is not linear or purely sequential. A new piece of information, artifact, or conversation with a resource person may lead a student to revise a question under consideration, determine a perspective or point of view from which to examine critically the information available, or develop an alternative plan.

Planning

During the introductory stage of the research process, students usually

- identify the topic or question—decide on a general area of interest that warrants further investigation, then clarify or narrow the area of focus to make it manageable
- formulate broad and specific questions to guide their research
- identify a variety of potential sources of information
- decide what strategies they will use to record information and keep track of the materials they use

Accessing and Gathering Information

Students access appropriate resources (print, non-print, information technology, human, community). The actual resource is located, and the information is found within the resource. Students will need to learn and apply several important skills:

- search (with direction) a card catalogue, electronic catalogue, the World Wide Web to identify potential information resources such as books, journals, newspapers, videos, audios, databases, or other media
- locate resources (e.g., community, text, magazines, artifacts from home, World Wide Web sites) and determine appropriate ways of gaining access to them
- select appropriate resources in a range of media
- use organizational tools and features within a resource (e.g., table of contents, index, glossary, captions, menu prompts, knowledge tree for searching electronically, VCR counter to identify video clips for specific relevance)
- skim, scan, view, and listen to information to determine the point of view or perspective from which the content is organized/presented
- determine whether the content is relevant to the research question
- determine whether the information can be effectively shaped and communicated in the medium the student will use to complete the project

Teachers should help students realize that fewer appropriate resources are better than a multitude of inappropriate resources.

Interacting with Information

Students continue critical evaluation of the information they find to determine if it will be useful in answering their questions. Students apply reading, viewing, listening, and critical thinking skills to

- question, skim, read (QSR)
- use text features such as key words, bold headings, and captions
- use navigation features or software
- use pause points or topic shift points in video
- read and interpret charts, graphs, maps, and pictures
- listen for relevant information
- scan videos, bookmark and highlight Web sites
- compare and evaluate content from multiple sources and media
- determine accuracy, relevance, and completeness of information

Teachers should help students develop a range of strategies for recording the information they need to explore their topic and answer their guiding questions. Simple point form notes (facts, key words, phrases) should be written or recorded symbolically (pictures, numerical data) in an appropriate format, such as a concept map, Web site, matrix sheet, chart, computer database, or spreadsheet. Teachers may also need to assist students in citing sources of information accurately and obtaining appropriate copyright clearances for images, data, sounds, and text they intend to reference or include in their work.

Organizing Information

Students may use a variety of strategies to organize the information they have collected while exploring their topics and answering their guiding questions:

- numbering
- sequencing
- colouring, highlighting notes according to questions or categories
- establishing directories of files
- creating a web page of annotated links to relevant Internet sources
- archiving e-mail collaborations using subject lines and correspondents' names
- creating a database of images and sound files using software such as ClarisWorks

Students should review their information with regard to their guiding questions and the stated requirements of the activity to determine whether they need additional information or further clarification before creating their products, planning their performances or presentations, or exhibiting their work. They may need to re-frame the research in light of information and sources gathered.

Sharing Information

Students review and reflect on the information they have collected, connecting new ideas with their prior knowledge and evaluating new information that may not fit with their previous understandings. As they integrate new information into their current knowledge, students develop new understandings and draw conclusions. Teachers may need to assist students in deciding how best to convey the results of their research process to the intended audience. Students should have many opportunities to share with a variety of audiences what they have learned, discovered, and created, and opportunities to examine carefully the responses of those audiences to their work.

Evaluating the Research Process

Students should reflect on the skills and learning strategies they are using throughout activities and examine and discuss their learning processes. Teachers and library professionals can help students with evaluation by

- providing time and encouragement for reflection and metacognition to occur (e.g., What did we/you learn about gathering information?)
- creating a climate of trust for self-assessment and peer-assessment of process, creation, or performance (students tend to be realistic and have high expectations for their own work)
- asking questions, making observations, and guiding discussions throughout the process
- conferencing
- monitoring and providing feedback on student progress (e.g., demonstrated ability to organize notes)

Media Analysis

The development of media analysis skills is an important component of Biology 11 and Biology 12. Media studies can be integrated into the curriculum as a source of current information, as a means to stimulate student interest and discussion, and as a vehicle to present real-world issues and situations to students. It is important for students to be able to evaluate media critically. Students should be able to distinguish fact from opinion and propaganda from responsible, objective reporting. Analysis of media products requires students to consider the following:

- the purpose and qualification of the author(s)
- the type of source and how that source is monitored (e.g., an established newspaper as opposed to an article appearing on an interest group's site on the Internet)
- the type of audience that the information is directed toward
- the reasons a particular target audience was chosen
- the ways the author(s) chose to reach that audience
- identification of inaccuracies, contradictions, or illogical reasoning
- the presentation of opinions
- evidence of bias in the work
- the source(s) of information and the interpretation of that information by the author
- the presentation of unsupported ideas and/or conclusions

When analyzing advertising, students should focus their attention on the use of unsupported conclusions, testimonials by unknown or unqualified people, and the use of unsubstantiated events or quotes to draw conclusions.

Evaluation of Media Analysis

The evaluation process for a media assignment in Biology 11 and Biology 12 will depend on the nature of the assignment and the criteria established by both the teacher and students. Criteria might include the following:

- the inclusion of appropriate physics-related materials
- the use of a wide variety of relevant sources
- sources properly identified
- appropriate biology concepts identified
- purpose(s) of material properly identified
- target audience identified
- point of view identified
- open, unbiased approach to analysis

Appendix D: Communication Tools

Photography: Individual students might create a photo documentary of a theme, concept, person, place, or event and with it also show consideration for how this documentary can affect its audience through various ways in which can be presented.

Photoshop or Corel Photopaint: pairs of students might walk through the tutorials that accompany one of these programs. They might also follow tutorials created by their teacher or from quality publications. Such tutorials could be designed so that by the end of this tutorial students have significantly altered the text of an image exhibiting thoughtful consideration for the elements and principles of design.

Adobe Illustrator or Corel Draw: Pairs of students might walk through tutorials that accompany one of these programs. They might also follow tutorials created by their teacher or from quality publications. Such tutorials could be designed so that, by the end of a tutorial, students have

- created a series of drawings that render a form in a variety of finishes
- developed a complex rendering of a form where a combination of graphic tools and filters has been used
- created a range of non-representational forms that illustrate the essential character of various principles of design

PageMaker or Quark Express: Pairs of students might walk through the tutorials that accompany one of these programs. They might also follow tutorials created by their teacher or from quality publications. Such tutorials could be designed so that by the end of this tutorial, through the incorporation of several devices unique to layout computer applications, students have

- created a pamphlet promoting an event or place
- designed a poster which promotes an event, idea, business, or place
- produced a mock magazine layout that could be convincingly inserted into an existing publication

HTML editors: Pairs of students might walk through the tutorials that accompany one of these programs. They might also follow tutorials created by their teacher or from quality publications. Such tutorials could be designed so that, by the end of this tutorial, students have

- created a personal web page
- developed a web page for a local business
- significantly and convincingly altered existing web pages

PowerPoint or Director: Pairs of students might walk through the tutorials that accompany one of these programs. They might also follow tutorials created by their teacher or from quality publications. Such tutorials could be designed so that, by the end of a tutorial, students have

- created a slide show that illustrates interests particular to the student
- created a small interactive game
- incorporated video tools to produce a small video project

Video: Teams of students could write, star in, and produce a short video that focuses on one or more basic video styles.

Avid Cinema: Pairs of students might walk through the tutorials that accompany one of these programs. They might also follow tutorials created by their teacher. Such tutorials could be designed so that, by the end of a tutorial, students have

- recorded, edited, and arranged a short video
- manipulated found video and sound footage to create a coherent production

Printmaking: individual students could use a conventional hands-on printmaking tool to create a consistent edition of ten prints using one or more colours or plates.

Sculpture: individual students could create text in a three-dimensional form through

- an additive sculpture made out of wire, clay, or Plasticine
- a subtractive sculpture from a block of plaster, soapstone, clay, or Styrofoam
- the alteration of existing three-dimensional forms to create new coherent texts

Performance Art: Individual or teams of students could observe and identify the essential elements of existing examples of quality performance art work and create their own short performance piece.

Drawing: Individual students might

- examine the styles of great biological illustrators and artists (e.g., Audubon, da Vinci, Harvey, etc.) and execute his or her own series of portrait works
- create a journal of marks. Students could investigate various mediums and marks used to construct texts in drawing, from which students might create their own drawings in the visual languages they have observed and made their own.

Painting: Students might use professional-quality paints to

- interpret, through paint, an STSE theme
- represent a biological theme in an interpretive way or with coherent aesthetic likeness
- create a series of paintings that permit students to investigate how paints and colours relate (e.g., students could create a painting in purely analogous hues, another in complementary hues, one in earth tones, and perhaps one using a high key or low key palette)

Notes: Using layout software may provide a good opportunity for students to extend their learning beyond the classroom by undertaking projects for other classes, school clubs and organizations, or local businesses and community groups.

Considering potential time, safety, and economic restrictions, screen printing or block printing are recommended for printmaking activities.

A good subject for sculpture can be the human form or simple physical objects. Students could also design a formalist sculpture that clearly illustrates one or more of the elements or principles of design.

Good examples of performance art can be found in the works of Joseph Beuys, the General Idea, Suzy Lake, happenings from the 1960s and 1970s, Russian constructivist performances, Holly Hughes, Michael Snow, Laurie Anderson, etc.

Other great examples of drawing through a variety of mark making styles can be found among the works of: traditional English landscape artists, Egon Schiele, Giorgio Morandi, Alberto Giacometti, Claes Oldenburg, Vincent Van Gogh, traditional Japanese artists, Jean-Michel Basquiat, Anselm Kiefer, Betty Goodwin, etc.

Though paints do tend to place stress on classroom finances, it is suggested that teachers do not resolve this by providing poor-quality paints. Painting can be very frustrating, especially to those engaging in it for the first time. Poor-quality paints tend to compound the negative aspects of painting for the student. Good and inexpensive paints are available from many suppliers, though often not in famous brand names. Consult suppliers who specialize in providing artists with materials.

There are many user-friendly HTML editors available for purchasing and as shareware. Netscape Communicator, for instance, provides a good, though basic, composer.

Students can experiment in one or a combination of the following video styles: expository, personification, dramatic, and documentary formats.

Appendix E: Journals and Logbooks

Logbooks and journals are a part of many occupations and as such are highly reflective of the world of work. Many highly successful people keep a daily journal as a habit that helps them develop insights into their work. A journal can include sketches, diagrams, notes, quotes, questions, excerpts, and drafts. The logbook or journal may be used to develop a final product, such as a report, design, profile, fictional text or dramatization, or it may be a way of tracking progress and developing ideas and insights.

Students need to see the value of their journal writing, not only through frequent responses from the teacher, including assessments that “count,” but also through assignments that provide linkages to previous and subsequent learning or that meet specific learning and/or personal needs for the student. Since the logbook or journal can contain very personal thoughts and ideas stimulated by thought-provoking questions, the teacher must make provisions to honour the confidentiality of students’ work, except where legally required to do otherwise.

Elements of the following journal assessment rubrics can be used in various combinations.

Journal Comment Rubric

Name	Comments
Ideas	
<ul style="list-style-type: none"> interprets and analyzes issues describes new insight(s) 	
Critical Thinking	
<ul style="list-style-type: none"> identifies assumptions underlying an issue, problem, or point of view probes beneath the surface for layers of significance explains an issue from multiple perspectives 	
Ethical Reasoning	
<ul style="list-style-type: none"> uses rules or standards of right/wrong or good/bad to guide debate/reflection 	
Personal Experience	
<ul style="list-style-type: none"> connects insights/thoughts to personal experience 	
Development	
<ul style="list-style-type: none"> develops content thoroughly 	

Journal Scoring Rubric

	1	2	3	Assessment	
				Student	Teacher
Ideas	states facts	interprets and/or analyzes an issue	interprets, analyzes, and describes a new insight/new insights		
Critical Thinking	identifies a stated issue, problem, or point of view	identifies assumptions underlying an issue, problem, or point of view	questions assumptions underlying an issue, problem, or point of view		
Critical Thinking	responds to a stated issue, problem, or point of view	identifies more than one layer of significance	probes beneath the surface for multiple layers of significance		
Critical Thinking	describes a single response to a situation or problem	describes several responses to a situation or problem	sees the implications of alternative responses to a situation or problem		
Critical Thinking	explains an issue from one perspective	explains an issue from more than one perspective	explains an issue from multiple perspectives		
Ethical Reasoning	does not consider ethical aspects of issues	recognizes and often applies standards/rules	uses rules or standards of right/wrong or good/bad to guide the debate/reflection		
Personal Experience	does not personalize his/her journal	makes some connection to personal experience	connects insights and thoughts to personal experience		
Development	develops the content minimally	develops the content adequately	develops the content thoroughly		
Name:			Score:		

Appendix F: Examples of Instructional Strategies and Approaches

Teachers recognize that an effective learning environment is one in which students interact with each other co-operatively, construct meaning, and confirm understanding through conversation. Such a learning environment is dynamic. It is one in which teachers guide students in searching for meaning, acknowledging and valuing uncertainty, and assuming a large measure of responsibility for their own learning. Particular strategies and approaches have been developed that foster such a climate. Brief descriptions of a number of these follow.

Group Discussion

TURN TO YOUR PARTNER AND (TTYPA)

This strategy is used frequently in interactive classrooms. As a concept or idea is presented to the class, students are asked to turn to a partner and talk about it. Students explore personal connections to the topic under discussion.

THINK/PAIR/SHARE

By articulating ideas to each other, students enhance their learning. These short interactions are followed by a transition to a small-group or full-group discussion. In the think/pair/share design of co-operative interaction, a teacher's question is deliberately followed by 3–10 seconds of silence, called “wait time” by its original researcher, Mary Budd Rowe. After giving students sufficient wait time to think through a question and make some personal connections, the teacher asks the members of the pairs to share their thinking with each other. As students share their ideas, each partner can benefit from the other's perspective. Partners examine their statements, searching for examples and clarifying their thinking. The teacher may ask the partners to synthesize their ideas into one.

TRIADS: OBSERVER FEEDBACK

In this strategy, partner work is complemented by a third role, that of an observer. While partners engage in the learning task, the observer outside the interaction records observable behaviours and later provides feedback to the pair.

TRIADS: THREE-STEP INTERVIEW

Students work in triads. Each group member assumes, in turn, one of three different roles: interviewer, interviewee, or recorder. Usually the teacher provides a number of open-ended interview questions and a form for recording responses. Though the initial questions are pre-established, interviewers are encouraged to use their own questions to prompt and probe.

TRIADS: CAROUSEL ACTIVITY

In this activity, students have the opportunity to develop a collective knowledge base and respond to one another's ideas and opinions. Open-ended questions are written on pieces of chart paper. The questions are placed in accessible locations around the classroom, and student triads move in rotation to these sites. They record their knowledge and/or viewpoints and respond to the ideas of prior groups. Triads may prepare for this activity in a variety of ways (e.g., by reading related material or watching a video). Through full-class critical dialogue, students review their ideas and opinions.

CO-OPERATIVE LEARNING IN GROUPS

Co-operative learning occurs when students work together in groups of three to five to accomplish shared goals. The co-operative groups work on a particular task. Participants work over a period of days or weeks on a shared assignment. The co-operative “base group,” heterogeneous in nature, may be in place for a long term, possibly the duration of the course. Its members help, encourage, and support one

another over the long term. Formal co-operative learning groups may work together for several weeks to complete specific tasks and assignments. Informal co-operative learning groups are temporary, ad hoc groups that work together for a few minutes or a single class period to process information through, for example, three-to five-minute focused discussions or two- to three-minute turn-to-your-partner discussions. Key elements for co-operative groups include positive independence, individual accountability, group processing, social skills, and face-to-face interactions. Assigned roles may include timekeeper and recorder.

JIGSAW ACTIVITY

This activity involves students in learning and teaching. In essence, individual students become familiar with a portion of an assigned task and “teach” the selected material or skill to a small group of their peers. Two types of groupings are involved: base and expert. Each member of the base group selects or is assigned a different portion of the task (e.g., one aspect of curriculum content). Students with the same materials meet as an expert group, review their task, and decide what to teach and how to teach it. Students then return to their base groups and provide a series of mini-lessons as each student shares his/her information and knowledge. To perform the jigsaw effectively, students need explicit instructions on how to select and share information.

RED TAG TECHNIQUE

This technique is designed to encourage some level of participation from all students and to ensure that individual students do not monopolize group discussions. Each member of the group is given four red tags (the teacher may vary this number). Each time a member makes a contribution, he/she must discard one tag. The group cannot finish the discussions until all the participants have used up their red tags. A student asking a question for clarification does not have to discard a tag. Teachers may wish to have students practise this technique on a topic that generates vigorous discussion such as “gender issues in the hospitality sector.”

COMMUNITY CIRCLE

A circle provides a supportive setting for a sharing of ideas. In the circle, one person is the speaker. All other group members should listen carefully and respectfully to the speaker. When finished, the speaker turns to the student beside him/her and that student becomes the speaker. This procedure is followed until all students have had an opportunity to speak. Students may pass if they do not wish to speak at that time. This activity is effective in allowing students to share their feelings and ideas. Initially, the teacher may have to take an active role to ensure that individual students in the circle speak in turn and that other students listen carefully. Often a decorated talking stick or South American rain stick is helpful in focusing both speakers and listeners.

Other Strategies

ORAL PRESENTATION

Oral presentations are a means by which students communicate ideas, concepts, stories, and research findings to their peers. Oral presentations are important in this course as they allow students to practice and enhance communication skills. Students need to understand the importance of body language (showing confidence and making eye contact with the audience), voice and projection (clear and strong voice), and organization (use of interesting visuals, involving the audience by inviting and answering questions, and keeping within the time frame) in conducting a successful presentation. This process is easier for some students than others, and sensitivity, especially to cultural differences, is required in modelling and coaching.

DRAMATIC REPRESENTATION

Drama is a powerful learning tool. It may take many forms and is a particularly important means by which we acknowledge and strengthen varying learning styles and intelligences. In all modules of

Physics 11 and 12, opportunities exist for students to represent their understandings through this medium. Many recommended strategies are available in the Drama 10 and 11 curriculum guide. A few follow.

Role-playing is an activity in which students assume a character role in a simulated situation. Role-playing allows students to build on and apply prior knowledge and skills while developing their communication, co-operative, and interpersonal skills.

Readers Theatre is a forum in which students read aloud from scripts (commercial or adapted versions from literature) with no special costumes, sets, props, or music. The whole class or partners can participate in this strategy, which encourages students to reflect on the story, the characters, the author's intent, or the theme.

Dance drama is expressive movement through which ideas, stories, sounds, and music can be interpreted.

A *tableau* is a still image, a frozen moment, or a photograph created by posing still bodies. It communicates a living representation of an event, idea, or feeling and can be a powerful statement to initiate discussion or reflection.

Flash-backs and flash-forwards can be used effectively to help build belief, challenge the students to consider the consequences of their decisions, and support periods of reflection.

VISUAL ARTS, DANCE, AND MUSIC

Many students have strengths in art, dance, and music that can enhance learning in any subject area. These students can be encouraged to share their expertise and invited to express their understandings through these media.

DEBATE

A debate is a formal discussion that begins with a statement of one point of view on a particular issue. Participation in debates allows students to explore different points of view and to respond critically to a range of issues.

The three standard forms of formal debate are

- *Cross examination*—modelled after courtroom procedures; in addition to presenting various points, debaters question or cross-examine their opponents.
- *Academic*—the most basic form, where two teams of two or three members each debate the resolution point by point; emphasis is placed on the debating skills of each team.
- *Parliamentary*—modelled after parliamentary procedure; after the prime minister and the leader of the opposition have spoken, members of the government and the loyal opposition take turns debating various points of the bill before the House.

Choose an interesting, two-sided topic that is relevant to the interests and abilities of the students. Avoid broad or complicated questions or propositions that can never be proved or disproved.

FIELD STUDY

Field studies provide the opportunity for students to gain a first-hand impression of an ocean site. The local community often provides an excellent forum for students to investigate a range of experiences. Field studies can be teacher-directed, student-directed, or expert-led experiences. Examples of field studies are

- a walking tour of a local historic area
- a field trip to a museum, attraction, celebration, or cultural site

- a travel experience that focuses on a particular cultural experience such as a milling frolic or a local dance
- a project that includes data gathering, observation, and analysis such as the interviewing of industry professionals

CASE STUDIES

Case studies are written narrative scenarios that typically relay a particular problem or dilemma centred around a set of issues or concerns. Case studies are useful in the study of physics as they allow students to consider situations that they would not normally encounter in class, and they provide a forum for students to practise the skills and knowledge they have gained through classroom instruction.

Students can work individually, in small groups, or as a class to analyze, interpret, and respond to the material. Students should be encouraged to utilize and expand on their knowledge base and skills as they formulate their responses.

INTERVIEWING

The process of preparing and participating in an interview provides a range of learning opportunities and experiences for students to apply and develop their reading, writing, speaking, listening, and critical-thinking skills. Interviews help students gain a better understanding of concepts developed in the classroom setting as well as helping them to build important links among themselves, their community, and their school.

Planning for an interview is crucial for its success and usefulness. Students should research their topic in advance and prepare a list of questions to review with their teacher before the interview. Decisions on the date, time, place, and method of recording should be confirmed well in advance of the interview. A well-prepared and confident student will gain from most interviews a wealth of information and an important connection to their community.

JOURNAL WRITING

The use of personal or interactive journals provides an effective means by which students can reflect upon most classroom proceedings and activities. Reflective journals assist students in articulating what they have learned, how they have learned it, and what they want to learn next. The form and content of journals can be tailored to suit the particular activity and the needs of the individual student. It is important that the journal be an interactive means by which teachers can respond to students' questions, concerns, and ideas.

Appendix G: Portfolios

A portfolio is a selection of work samples and other items that demonstrate students' interests, talents, skills, and achievements. The purpose of a portfolio is to show others teachers, counsellors, parents, peers, and possible employers what students have learned, accomplished, and/or produced. Students should frequently update their portfolios and reflect on their progress and growth. Reflective writing is a key component of portfolios.

Portfolios at the high school level can be used to display and summarize a range of achievements and can serve to help students

- identify and acknowledge personal growth and achievement
- demonstrate their achievements to families, potential employers, and others
- apply to post-secondary institutions
- apply for scholarships and bursaries
- obtain a volunteer position
- make decisions concerning career path choices

Creating Portfolios

Four basic types of portfolios are the following:

Student Portfolios demonstrate the skills, accomplishments, and achievements of a student's academic career over a specific time period. The portfolio can represent one area of study, or it can encompass a broad range of disciplines. Students are often encouraged to include materials that represent accomplishments and interests outside of the classroom.

Project Portfolios are designed to outline the steps or progress of a specific project or independent study. Students are required to record and comment on the process and outcome of their efforts.

Expert and Professional/Employability Portfolios identify students' skills and accomplishments related to their career interests. This type of portfolio is becoming popular as a useful addition to the standard résumé.

A *Personal Portfolio* is designed in a format similar to a scrapbook or a personal journal. It reflects the personal interests, ideas, and aspirations of the student. The most important factors for a successful portfolio format are durability, accessibility, and presentability. Whether a portfolio is in a binder, scrapbook, or folder, on computer disks, multimedia CD-ROMs, videotapes or audiotapes, it must be easy to transport, showcase, and understand.

Students must be able to organize and maintain their portfolios effectively. The decision of what to include in a portfolio entirely depends on the purpose of the portfolio. Following are some of the materials that could be included:

- essays, position papers
- reflective writing
- awards
- evaluations/reviews
- articles, newspaper clippings
- rubrics, test results, assessment information
- photographs
- letters of invitation, thanks
- art and design work

- poems, tunes, stories
- certificates

Assessing Portfolios

The assessment of portfolios should be discussed and negotiated with students before the process of their creation is initiated. Assessment criteria often reflect the design and purpose of the portfolio. The most important form of feedback to students may be in the form of dialoguing and conferencing.

General qualities that students should be aiming to achieve include the following:

- clean format—easy to read and understand
- creativity
- thoughtful organization
- thoughtful self-evaluation
- clear representation of learning goals and achievements

Appendix H: Introduction to the Microscope

Students should know that the microscope is an important biological tool. They should develop the techniques and skills required for its efficient use. Students will arrive in Biology 11 with varying levels of competency in the use of the microscope and accommodations will need to be made for this.

Students should be provided with hands-on opportunities to become acquainted with the proper use of the microscope, 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. Should both a compound microscope and dissecting (stereo) microscope be 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. 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. A beaker of water with a bit of hay or leaf litter left for several weeks will readily start a culture of “pond water.” 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.

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 selection of commercially prepared slides may be the optimum choice for this introductory work or alternately other specimens such as the letter “e” cut from a newspaper may provide a clear object upon which to focus. 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.

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. Students must perceive depth of field.

Sample Experiences

Performance

Prepare and stain a wet mount slide. A visual scan of your product will allow an assessment of your slide preparation and focusing techniques. Be prepared to answer questions on the parts of the microscope, their purposes, focusing techniques (including depth of field), and safety concerns.

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. Prepare a wet mount. Position the slide on the stage in its normal orientation. Observe. Sketch the image of the letter as viewed through the microscope. Repeat with the letter “A” and letter “F.” Make a summary statement describing how the microscope influences the orientation of all images produced.

Groups will be given a variety of samples of fibres (e.g., linen, wool, cotton, silk, nylon). Students will make wet mounts, examine, and sketch. Groups will develop a crime scene scenario using one or a number of these fibres. These will be exchanged between groups to be solved. Alternatively, a number of hair samples might be considered for use.

Paper and Pencil

Draw a diagram of a specimen provided. Label it, title it, and estimate size and/or scale.

Experiments

- The Microscope, Biology 11 and Biology 12: A Teaching Resource
- An Introduction to the Microscope, Nelson Biology, p. 127
- Why Are Stains Used When Observing Cells? Biology Living Systems, p. 130