

Public District School Board Writing Partnership

Course Profile

Biology

Grade 11

College Preparation

SBI3C

- *for teachers by teachers*

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Course Overview

Biology, Grade 11, College Preparation, SBI3C

Course Description

This course focuses on the processes involved in biological systems. Students will learn concepts and theories as they conduct investigations in the areas of environmental science, cellular biology, animal anatomy and physiology, plant structure and physiology, and microbiology. Throughout the course, applications of biology to everyday life as well as educational and career opportunities related to biology are emphasized and noted in student journals. Skills needed for further study in various branches of the life sciences and related fields are developed.

This Profile offers one set of suggestions for achieving the learning expectations of the SCH3U curriculum document. Teachers must adapt the profile to suit their circumstances and to match the students' needs while ensuring that all Learning Expectations of the Guideline are addressed fully.

Course Notes

The Goals of Grade 11 Biology

As in the Grade 1 to 8 Science and Technology courses and the Grade 9 and 10 Science courses, SBI3C is directed toward three goals:

- To relate science to technology, society, and the environment;
- To develop skills, strategies, and habits of mind required for scientific inquiry;
- To understand basic concepts of science.

The activities and assessment tasks in this profile reflect the *importance* of the three goals and have been developed around clusters of Specific Expectations that encompass all three goals.

Scientific Literacy for All Students and Preparation for Further Study

The paramount task of science education is to equip all students with scientific literacy – the combination of values, knowledge, and skills that enable them to think creatively, reason logically, evaluate information critically, and communicate effectively. This is an essential basis for making productive and ethical decisions, not only about scientific and technological issues but in all areas of life.

This is emphasized in *The Ontario Curriculum, Grades 11 and 12: Science, 2000*: “The newer aspects of the science curriculum – especially those that focus on science, technology, society, and the environment (STSE) – call for students to deal with the impacts of science on society and the environment, which includes both the natural environment and the workplace environment. This requirement brings in issues that relate to human values. Science can therefore not be viewed as merely a matter of “facts”; rather, it is a subject in which students learn to weigh the complex combinations of fact and value that developments in science and technology have given rise to in modern society.”

At the same time, SBI3C must adequately prepare those students who will opt for further study of the subject beyond high school. Knowledge and skills must be learned and assessed at a standard, which enables students to realistically assess their aptitude and chances for success in further studies in biology and possible employment in a related field.

Policy Requirements

The curriculum document contains recommendations regarding teaching approaches and curriculum expectations that must be reflected in all courses based on it. Among them are the following statements:

- “The expectations in science courses call for an active, experimental approach to learning, and require all students to participate regularly in laboratory activities.”

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- “Where opportunity allows, students might be required, as part of their laboratory activities, to design and conduct research on a real scientific problem for which the results are unknown.”
 - “Where possible, concepts should be introduced in the context of real-world problems and issues.”
 - “In all courses, a list of expectations is given that precedes the strands. These expectations describe skills that are considered to be essential for scientific investigation (e.g., skills in research, in the use of materials, and in the use of units of measurement), and skills required for investigating possible careers in the subject area. These skills apply to all areas of course content and *must be developed in all strands* of the course. Assessment of students’ mastery of these skills must be included in the evaluation of students’ achievement of the Expectations for the course.” In this profile, these Expectations will be called Science Investigative Skills. For SBI3C, they are found on p. 23 of the curriculum document. These skills serve as a lens through which all learning expectations in the profile are interpreted. In addressing the Learning Expectations, the Science Investigative Skills must also be addressed.

Considerations for Planning and Implementing Grade 11 Biology

SBI3C requires an emphasis on inquiry skills. Through a variety of investigations, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. Direct experience with organisms, materials and laboratory equipment is necessary to illuminate theoretical concepts and develop skills.

Learning activities in this profile are set in a context that relates science to technology, society, and the environment.

A number of activities in this profile have a research focus that requires accessing information beyond the laboratory or field trip. Students should be taught how to use all available sources of information – people, print, online sources and other media, both within the school and in the community. They should also be given opportunities to use those skills, and to experience the challenges that invariably accompany the location and acquisition of valid information. However, care must be taken that *student time is spent primarily on processing information rather than accessing information*, so that the research does not become an end in itself.

The expectations are central to all aspects of this profile. The context in which each unit is delivered, the skills and concepts developed and the assessment tasks used must be interconnected, and linked to the expectations. The assessment data accumulated throughout the course must be sufficient (in kind and number) to permit teachers to evaluate the *consistent level of performance* for each student in each of the four categories in the Achievement Chart for Science (curriculum document, pp. 174-175).

Some of the expectations are given emphasis in learning activities and are often revisited. These are expectations that are taught, assessed, evaluated and where necessary revisited using alternate instructional strategies in a cyclic process that stops only when students have *achieved* them.

Each student interprets new information in terms of what he or she already knows. The student tries to make sense of what is taught by trying to fit it with his or her experience. A key concept is understood when the student examines significant examples, which represent the concept, then creates a generalization from those personal experiences. Teachers must be aware of the experiences that students have had prior to Grade 11 and use them as the basis for new and more complex concepts. Students may also arrive with misconceptions from prior experience that will interfere with their ability to understand new concepts. Identifying misconceptions and revising them using concrete examples may be required at times.

Terminology should be viewed by students as a tool for describing observations and communicating ideas, not as an end in itself. Assessment should focus on the application of terminology to explain concepts and phenomena, not on terms and definitions in isolation. It is essential that students understand the concept before acquiring the vocabulary.

This profile describes a biology course in which students are encouraged to ask their own questions and, in many cases, find their own answers by inquiry (experiment or research). Fundamental to the skill set of a scientifically literate person/citizen is the ability to ask incisive questions and to interpret the answers critically, including identifying unstated assumptions.

In this profile, there is a reduced emphasis on traditional laboratory activities in which students are provided step-by-step instructions and more emphasis on developing students' abilities to devise and carry out their own procedures within well-defined limits. The teacher's role is to decide what knowledge and skills students must have to proceed safely and successfully in a laboratory setting, then provide that information without making students passive followers of recipes with entirely predictable results.

In addition to a conventional notebook (lab reports, summaries of content, solved problems, etc.), students will also assemble a Portfolio (beginning in Activity 1.5, adding to it at intervals throughout the course). The Portfolio will include student reflections of two main types:

- information that could be used as part of a college or workplace application, including reflections on knowledge and skills acquired in this course and their future usefulness in education and career preparation; and
- reflections on how things learned in this course will be useful in life beyond college and career.

The Portfolio will be assessed near the end of the course and will account for 10 per cent of the overall grade.

Rationale for the Unit Sequence of the Course Profile

In this profile, each unit is clustered around expectations drawn mainly (but not exclusively) from one strand of the *Guideline*. This is done to facilitate the implementation of this course. The Environmental Science Unit is placed first so that field studies can be carried out in autumn while weather permits. (In semester 2 of a semestered school, this unit would be best done at the end of the course for the same reason.) Regardless of the placement of the Environmental Science unit, the Cellular Biology unit should always precede the Plant, Animal and Microbiology units since it develops foundational concepts needed in those units. The Plant, Animal and Microbiology units could be done in any order, as equipment and facilities dictate but consideration may be given to doing them in order of ascending complexity – micro-organisms, plants, animals. The Final Summative Assessment of the course includes submission of a student portfolio, which is initiated in the first unit and developed throughout the course.

Units: Titles and Times

Unit 1	Environmental Science	20 hours
Unit 2	Cellular Biology	20 hours
Unit 3	Animal Anatomy and Physiology	22 hours
* Unit 4	Plant Structure and Physiology	22 hours
Unit 5	Microbiology	20 hours
	Final Assessment Tasks	6 hours

* This unit is fully developed in this Course Profile.

Unit Overviews

Key to Abbreviations	
<p>AC = Achievement Chart</p> <p>K = Knowledge/Understanding I = Inquiry C = Communication MC = Making Connections</p>	<p>LS = Learning Skills</p> <p>WI = Works Independently WH = Work Habits/Homework I = Initiative O = Organization TW = Team Work</p>

Unit 1: Environmental Science

Time: 20 hours

Unit Description

Students renew and expand their understanding of ecosystems by visiting and analysing a different system than the one studied in Grade 10. Concepts developed in this study of an ecosystem are then applied in an independent study of adaptations in contrasting biomes. Feeding relationships are analysed to understand recycling of matter and flow of energy in ecosystems; the implications of one-way flow of energy are considered. Population growth and competition are studied through laboratory experiments and case studies. As a culminating activity, students are invited to consider the implications of what they have learned for the decisions they will make as individuals and citizens. (Expectation ES1.04 has been moved to the Microbiology Unit – Activity MB 5.4)

Unit Overview Chart

Activity	Time	Expectations	Assessment	
			AC	LS
1.1 Analysis of a Local Ecosystem*	5 hours	ESV.01, ESV.02, ES1.01, ES2.01, PS2.01	K, I, C, MC	T, O, WH, WI
1.2 Independent Research: Canadian Biomes❖	3 hours (plus out of class time)	ESV.01, ES1.09	K, I, C	T, WH, O
1.3 Food Chains and Energy Flow	4 hours	ESV.01, ES1.03, ES1.05, ES1.06	KC	W, WH, O
1.4 Populations and Carrying Capacity	6 hours	ESV.01, ESV.02, ESV.03, ES1.02, ES1.07, ES1.08, ES2.02, ES2.03, ES2.04, ES2.05, ES3.02	K, I, MC	T, O, WH
1.5 Personal Action Plans	2 hours (plus out of class time)	ESV.02, ESV.03, ES2.05, ES3.01, ES3.03	MC, C	WI, O, WH, I

Details of Activities

* Choose a different ecosystem in Activity 1.1 from the one studied in Grade 10

- Act. 1.1.1 Teacher-led lesson: Brief review of ecosystems – abiotic and biotic components; niches; microhabitats; trophic levels and food chains
- Act 1.1.2 Teacher-led lesson: Principles of taxonomy and use of taxonomic keys
- Act 1.1.3 Field trip: Identify biota; correlate occurrence of species with abiotic conditions and other biota; infer feeding relationships, if possible
Document signs of human impact (pollution, encroachment, abandonment)
- Act 1.1.4 Students do additional research (Library/Resource Centre, Internet) to supplement data from field trip.

Act 1.1.5 Students prepare reports on the field trip ecosystem – organisms present and factors affecting their distribution; food chains and other species interactions; evidence for and results of human interference.

Assessment: Quiz on reviewed material; Reports from the field trip should be assessed after being peer reviewed for quality and completeness; Ecosystem report.

❖ Include oceans and the Great Lakes system in Biomes of Activity 1.2

Act 1.2.1 In small groups, students research two contrasting Canadian biomes (e.g., tundra and deciduous forest, grassland and temperate rain forest, etc.). For each, students use the Library/Resource Centre, media and the Internet to compile information on:

- Climatic conditions (extremes, means, seasonal cycles)
- Soil structure and composition
- Occurrence of water
- Species present and their ecological roles; adaptations of species for survival in those conditions
- Human activity (e.g., exploration, resource extraction, tourism, agriculture, etc.) and its impact on that biome, noting particular sensitivities of that biome

Act 1.2.2 Class Presentations (later in course) by each group: A comparison of organisms and their adaptations to differing conditions in the two biomes. Environmental issues in that biome

Assessment: Class test on adaptations and factors affecting distribution of biomes

Act 1.3.1 Teacher lesson: Review and extension of prior knowledge of food chains and material cycles.

Patterns of food chains: producers to consumers; role of decomposers as final consumers; recycling of matter.

Biogeochemical cycles: review/extend nitrogen cycle with emphasis on the symbiosis of nitrogen-fixing bacteria; carbon and phosphorus cycles; significance of recycling.

Act 1.3.2 Teacher lesson: Review and extension of prior knowledge of food chains and one-way flow of energy.

Producers convert light energy to chemical energy, some of which is passed to consumers.

Consumers convert received chemical energy to heat (lost to environment), pass a small amount of chemical energy to next-order consumers if eaten; succeeding trophic levels receive progressively less energy

Pyramids of biomass and energy illustrated and explained; result is scarcity of and competition for food; implications for human diet (vegetarian vs. meat-rich)

Assessment: Quiz

Act 1.4.1 What is a population?

Act 1.4.2 Patterns of population growth

Experimental inquiry: culturing laboratory populations e.g., yeast, fruit flies, in closed systems; population density sampled, growth curves plotted and analysed; concept of carrying capacity, identification of factors (food supply, space/volume, waste build up) that limit carrying capacity in both closed (finite) and open (renewing) systems.

Discussion: Is the human population/exceeding the carrying capacity of Earth?

Experimental inquiry: Culture of Competing Populations e.g., two species of Paramecia in a closed system; analysis of results

- Act 1.4.3 Discussion: What forms does competition take in a real population?
Competition for food, space; predation of various types; disease; climatic changes which limit habitat or food/water supply; human activity (pollution, encroachment on habitat)
- Act 1.4.4 Case studies (by individuals or small groups, shared with class)
- Impact of Introduction of New Species (rabbits to Australia, pathogens to indigenous populations by explorers, transfer of drug-resistant strains of diseases by air travellers, transfer of plant pathogens on food, etc.)
 - Loss of Species Diversity: causes of ecosystem simplification, effects on ecosystem resiliency and carrying capacity
 - Domestic and Agricultural Use of Pesticides and Herbicides, etc.

Assess the presentation of data from one of the population growth inquiries – quality of data tables, graphs, and trends analysis. This activity also provides an opportunity to assess oral communication skills during class discussions. The format of the sharing of the case study could vary depending on student choice from a limited set of options provided by the teacher, and could be assessed using a rubric developed collaboratively in advance of 1.4.4. Options could include poster presentations, oral reports supported by handouts, computer presentations.

Activity 1.5: Personal Action Plans

- Research and report/presentation
- Students discuss in groups, but write as individuals, a position paper that answers this question: *What can I do as a citizen (voter and social being), consumer (purchaser, user and disposer of goods and services) and possible future parent do to minimize the drain I make on the carrying capacity of Earth?*
- Among other considerations, support your choices with ecological principles and factual information.
- Where there are no clearly preferable courses of action, discuss the cost/benefit analysis on which your choice is based.

Assess the quality of the group research for Learning Skills and the individual products as persuasive writing. Consult with the English department for a rubric suitable for the writing assessment or modify one of the generic rubrics referenced in the section on Assessment & Evaluation of Student Achievement later in this profile. A sample cost benefit format is in the Appendix to Activity 4.3.

Unit 2: Cellular Biology

Time: 20 hours

Unit Description

Using a factory as an analogy, students examine the role that each organelle plays in the overall function of the cell. They explore the biochemical compounds and reactions necessary for cell functions. Students design and perform labs to investigate factors that affect the rate of diffusion and the action of enzymes. The processes of respiration and photosynthesis are examined as examples of biochemical reactions necessary for cell function. Students research a medical technology related to the study of cells. As the end-of-unit task, students design and perform an experiment investigating the effect of one factor on the rate of photosynthesis or respiration.

Unit Overview Chart

Activity	Time	Expectations	Assessment	
			AC	LS
2.1 How does the cell resemble a factory?	2 hours	CBV.01, CBV.02, CB1.01, CB1.02, CB2.02, CB2.03, CB2.04	K, I, C	WH, WI, O, TW

2.2 How do cells move materials around?	4 hours	CBV.01, CBV.02, CB1.05, CB2.01, CB2.04	K, I, C	O, WH, TW
2.3 What are the components of cell organelles?	2 hours	CBV.01, CBV.02, CB1.03, CB2.06	K, I, C	O
2.4 What are the roles of enzymes in cells?	3 hours	CBV.01, CBV.02, CB1.04, CB2.04, CB2.05	K, I, C	O, TW, WH
2.5 How do chemical reactions occur in cells?	3 hours	CBV.01, CB1.06, CB1.07	K	
2.6 What careers and technologies require an understanding of cells?	1 hour	CBV.03, CB3.01, CB3.03	MC, C	WI, O
2.7 What factors affect the rate of respiration or photosynthesis?	4 hours	CBV.01, CBV.02	I, C	WI, O

Details of Activities

- Act 2.1.1 Students build on their previous knowledge of organelles and the function each performs in the cell (diagnostic opportunity) and review the cell theory through a class discussion or mini-lecture.
- Act 2.1.2 Students prepare wet mounts of cells (e.g., onion and cheek cells) and identify organelles in diagrams including the approximate size and magnification.
- Act 2.1.3 Each student chooses an organelle as the focus of the end-of-unit task [factory focus - departments of the factory].

Assess microscopic technique and knowledge of organelles.

- Act 2.2.1 Students build definitions of diffusion, osmosis and active transport through examination of diagrams, skits, etc.
- Act 2.2.2 Students design and perform labs investigating factors affecting the rate of diffusion (e.g., Use dialysis tubing under various conditions, or potassium permanganate in water under various conditions).
- Act 2.2.3 Students participate in a teacher-led discussion of where each process is used in biological systems [factory focus - gossip or information spreading through the factory].
- Act 2.3.1 Students use model kits to build molecular models of biochemical compounds.
- Act 2.3.2 Students perform lab tests to identify these in living organisms and explain, according to their functions, why these molecules would be present [factory focus - components of the factory building and the contents of storage rooms within the factory].
- Act 2.4.1 Students participate in a teacher-led discussion of the role of enzymes in biochemical reactions.
- Act 2.4.2 Lab investigating factors affecting the action of enzymes [factory focus - workers in the factory moving the product along, or providing the energy required].

Assessment: If students are required to develop the laboratory procedure in Activity 2.4.2, this would be an opportunity to assess the quality of the investigative design – were variables identified and controlled? was appropriate data collected and summarized? etc.

Act 2.5.1 Students examine respiration and photosynthesis as examples of specific reactions.
 Act 2.5.2 Students discuss the roles of organelles, diffusion, active transport and osmosis, enzymes and other compounds in respiration and photosynthesis, noting how key compounds (metabolites, coenzymes, etc.) contribute to the overall result of releasing or storing energy [factory focus - identify each step in the reaction as a step necessary to produce the final product of the factory i.e., ATP or glucose].

Act 2.6.1 Students research a medical technology related to cell biology, explaining how that technology incorporates scientific principles. The impact of that technology on the quality of life is also explored. They produce an information pamphlet about one specific career or technology related to cell biology.

Assessment: Prior to embarking on this activity, lead a discussion to generate criteria for assessment of the final product (i.e., a simplified rubric). Have students self-assess their brochures and submit their assessments with the brochures for teacher evaluation.

Act 2.7.1 Given a specific question, students design and perform an experiment investigating the effect of one variable on the rate of respiration or photosynthesis. Suggested questions include the effect of: light intensity; light colour; temperature; pH; type of sugar; concentration of sugar.

Assess lab design and lab report.

Unit 3: Animal Anatomy and Physiology

Time: 22 hours

Unit Description

In this unit, students are introduced to the structure, function and interaction of the major internal systems of the human body. Students use their research, organization, and presentation skills to examine one system in detail. The detailed study includes the anatomy and physiology of the system, an examination of a disorder affecting the system, a study of a medical technology and a career related to that system, and the completion of an inquiry activity. Students share their understanding of the anatomy and physiology of their particular system with the class. The dissection or simulation activity at the end of the unit is used to tie the systems together and to compare the human to one or more other mammals.

There is a danger that this unit will expand beyond the allotted time – to the detriment of all other units in the course. It might be better to include this unit later in the course so that students have had ample opportunity to practise the skills that are necessary for successful completion of this unit. The amount of structure needed to complete these tasks will vary from class to class. In some instances, a timeline for completion of individual components should be established.

Unit Overview Chart

Activity	Time	Expectations	Assessment	
			AC	LS
3.1 The Organization of the Human Body	2.5 hours	AAV.01, AAV.03, AA1.01, AA3.01	K, MC	WH
3.2 Researching, Inquiring, Organizing, Communicating	9 hours (includes research time and prep time for final product)	AAV.01, AAV.02, AAV.03, CBV.03, AA1.01, AA1.02, AA1.03, AA1.04, AA2.01, AA2.02, AA3.01, CB3.02	K, I, C, MC	WH, WI, I, O, TW

3.3 Show and Share	6 hours	AAV.01, AAV.02, AAV.03, CBV.03, AA1.01, AA1.02, AA1.03, AA1.04, AA3.02, CB3.02	K, I, MC, C	WH, WI, I, O, TW
3.4 Mammalian Dissection	4.5 hours	AAV.01, AAV.02 AA1.01, AA2.03	K, MC	TW, I, O, WI, WH

Details of Activities

- Act 3.1.1 Overview of the Human Organism: Students participate in a teacher-led discussion focussing on the role of cells within an organism (cells> tissues> organs> systems). Cellular respiration and characteristics of life are also reviewed. The concept of homeostasis is introduced.
- Act 3.1.2 The Role of Media: Students examine the role media play in providing the public with information on healthy lifestyles, especially in the area of nutrition. Students read articles, watch news features, or view webpages that present conflicting information on the same issue and then develop their critical analysis skills as they determine which set of ideas is most accurate.
As an extension, students could examine the conflicting messages often given in the same newspaper, e.g., an article on anorexia in the same newspaper as photographs of slender super-models. Through teacher-led discussion, students learn the format employed in writing news stories (who, what, when where, why, and how). Each student collects and examines an article (website or pamphlet) related to nutrition, focussing on the structure of the media source and accuracy of the information.
- Act 3.1.3 Systems Project: The major activity for this unit is introduced. Students, working in small groups, complete a series of experimental and research activities focussing on one of these systems: digestive, respiratory, circulatory, excretory, skeletal/muscular, reproductive, and immune. The final product can take a number of forms, including a newspaper or magazine layout, a newsletter, a TV program, or a webpage. Each group completes the following for their assigned system: background information on the system (to be shared later with rest of the class); an experimental inquiry activity related to the system; research and reporting of a disorder affecting the system; a technology related to diagnosing or treating disorders within the system; and an examination of a related career that requires college preparation.

Assessment: This major activity will be evaluated for all areas of the Achievement Chart using a series of rubrics and checklists. Any systems not assigned to student groups should be taught by the teacher during the next activity. A quiz could be used to evaluate knowledge of the concepts reviewed and extended in Activity 3.1.1.

- Act 3.2.1 Students complete their major assignment using classroom and Library/Resource Centre resources, print and electronic. The following are suggested topics, system by system:
- Digestive: Disorder: ulcer
Lab Activity: enzyme activity
Technology: barium x-ray Career: dietician
- Circulatory: Disorder: heart attack, or hypertension
Lab Activity: heart rate, blood pressure, and caffeine
Technology: pacemakers Career: ECG technologist
- Respiratory: Disorder: emphysema, asthma, or lung cancer Lab Activity: breathing rate and exercise
Technology: lung transplants Career: x-ray technologist
- Reproductive: Disorder: infertility Lab Activity: starfish egg lab
Technology: in vitro fertilization Career: ultrasound technician

Skeletal/muscular:	Disorder: break, strain or osteoporosis Technology: arthroscopic surgery	Lab Activity: reflexes Career: sports medicine, or geriatrics
Excretory	Disorder: kidney stones, kidney failure Lab Activity: dialysis tubing Technology: dialysis	Career: nurse
Immune	Disorder: AIDS Lab Activity: bioassay Technology: antibiotics	Career: laboratory technician

The list above is not to be considered exhaustive and should only serve as a guide. As much as possible, students should decide on the various topics being studied. There are a number of potential safety issues associated with the suggested laboratory activities that will require teacher attention. Standard texts and laboratory manuals should be consulted.

Act 3.2.2 Nervous and Endocrine Systems: The teacher presents a lesson describing the anatomy and physiology of the nervous and endocrine systems with a focus on homeostatic mechanisms. Students participate in a number of demonstrations related to the nervous systems.

This activity is presented as a way of breaking up long periods of research and preparation of the major assignment. The way the lessons are presented should serve as a model of how the students will later present the information from their own research. Any systems not covered in student assignments should be taught by the teacher during this activity.

Assessment: The understanding of these concepts is evaluated by a series of quizzes now and in the next unit.

Act 3.3.1 Looking at the other systems: Students teach the background to the rest of the class. At the end of each student lesson, the teacher provides a summary to clear up any misconceptions and to fill in additional details.

Act 3.3.2 Sharing the final product: Students share their presentations (newspapers, magazines, websites, newsletters, TV documentaries) with the class.

Assessment: The understanding of these concepts in Activity 3.3.1 can be evaluated by a series of quizzes. A checklist or rubric could be used by peers to assess communication skills of presenters in 3.3.2 and submitted as data for the teacher to use in making evaluations.

Act 3.4.1 Dissection: Students, working in small groups, perform a mammalian dissection (rat, fetal pig, mink) or participate in a simulation activity, comparing the features of each specimen to the others and to the human. Students should focus on developing their observation and dissecting skills.

Act 3.4.2 Reflection: Students reflect on what they have learned from the dissection, with focus on the interactions of the various systems. Other areas of reflection could focus on the use of animals in research.

Act 3.4.3 Bellringer: Students complete a bell ringer type test, as part of their unit evaluation.

End-of-Unit Tasks: Observation and dissecting skills should be assessed and evaluated through checklists. The reflection piece can be evaluated for communication skills. A final test or quiz can be given, focussing on how the systems work together within the organism. Consider permitting students to use the notebooks, or an open textbook, for components of the test, to bring focus to thinking skills and away from memorization.

Unit 4: Plant Structure and Physiology

Time: 22 hours

Unit Description

Depending on the time of year, this unit may or may not be preceded by Environmental Science, which includes sampling procedures for plants and may involve a field trip that could be used to meet Expectations in Activity 4.3. A germination/growth activity is the focus of the unit – providing information about growth and development and samples for plant tissue analysis. The Germination/Growth activity is part of the unit assessment, along with presentations in the form of a gallery walk and a knowledge-based test. The unit introduces plant classification, surveys life cycles, morphology and physiology, and presents conditions necessary for growth and development. The role of plants in our lives and in the environment is researched as a part of this unit and also as part of the preparation of each student’s personal action plan portfolio – a component of the course Final Assessment Tasks for the course. This unit is developed fully in this profile.

Unit Overview Chart

Activity	Time	Expectations	Assessment	
			AC	LS
4.1 Introduction to Plants/Brainstorming	1.5 hours	PSV.01, PSV.03, PS1.04, PS1.05	MC, C	TW, O, WH
4.2 Plant Growth and Development/ Experimental Inquiry	4 hours	PS2.02, PS2.04, PS2.05, PS3.01, PSV.02, PSV.03	K, I, MC, C	TW, O, I, WH, WI
4.3 Uses of Plants/Gallery Walk	2 hours	PS2.03, PS2.04, PS3.01, PS3.02, PS3.04, PS3.05, PSV.02, PSV.03	K, MC, C	WI, I, O
4.4 Diversity and Structure of Plants	10 hours	PS1.01, PS1.02, PS1.03, PS1.04, PS2.06, PS2.07, ES1.01, CBV.01, PSV.01, PSV.02	K, I, MC, C	WI, O, I, WH, TW
4.5 Role of Plants in their Environment	2 hours	PS3.03, PS3.04, PS3.05, PSV.03	K, MC	WH, O, WI
4.6 End-of-Unit Tasks	2.5 hours	PSV.01, PSV.02, PSV.03	K, I, MC, C	

Unit 5: Microbiology

Time: 20 hours

Unit Description

In this unit, students develop an understanding of the characteristics of various micro-organisms (bacteria, protists, fungi and viruses). These characteristics include anatomy and physiology, role in the environment, reproduction, effect on humans, and biotechnological applications in medicine, industry and the environment. The unit has been sequenced so that all microbes can be studied collectively for a particular process or characteristic. Students design and conduct a long-term bacterial culture investigation while recording their observations and analysis in a log.

Unit Overview Chart

Activity	Time	Expectations	Assessment	
			AC	LS
5.1 Beyond the Eukaryotic Cell	2 hours	MBV.01, MBV.02, MB2.02 MB2.03 MB2.04	K, I, MC, C	TW, WH, I

5.2 Anatomy and Physiology of Various Microbes	3 hours	MBV.01, MBV.02, MB1.01, MB1.02, MB1.04, MB2.01	K, I, C	WI, I, WH, TW
5.3 The Reproduction and Lifecycles of Microbes	1 hour	MBV.01, MB1.03	K, I, MC, C	WI, TW, I, O, WH
5.4 Ecological Role of Microbes	2 hours	MBV.01, MBV.03, MB1.02, MB1.05, MB3.05, ESV.01, ES1.04	K, MC, C	WI, I, WH
5.5 Role of Microbes in Human Disease	4 hours	MBV.01, MBV.03, MB3.01	K, I, MC, C	WI, O, WH, I
5.6 Role of Microbes in Society	4 hours	MBV.01 MBV.03, MB1.06, MB3.02 MB3.03 MB3.04	K, I, MC, C	TW, WH, WI, O
5.7 End-of-Unit Task	4 hours	MBV.01, MBV.02, MBV.03	K, I, MC, C	TW, WI, WH, O, I

Details of Activities

Act 5.1.1 Teacher-led discussion to recall the structure/function of animal/plant cells and to consider the question “What other cellular forms of life can you name?” Students brainstorm answers to “How do bacteria, fungi, protists, viruses differ from the animal/plant cells in structure, in relative size, in reproduction, in genetic make-up?” Students correct misconceptions.

Act 5.1.2 Introduction to the end-of-unit task for Unit 5. Students design and conduct a long-term study of the effect of an environmental variable on the growth/behaviour of a particular microbe (likely bacterial). Students must consider growth conditions for culturing and define control and dependent/independent variables. An introductory agar preparation and source collection is performed as a practice session. Refer to Activity 5.7.1.

Diagnostic assessment with respect to preparedness for Activity 5.2.

Act 5.2.1 Prokaryotic cells- Teacher-led discussion to examine the diversity of the Kingdom Monera. Students compare Eubacteria (Bacillus, Escherichia, Streptomyces) and Archaeobacteria (halophiles, methanogens), discuss ancestry and describe structure using terms such as coccus, bacillus, spirilla, pilus, capsule, cell wall (and plural forms), gram positive, gram negative.

Act 5.2.2 Eukaryotic cells revisited - Students describe, in general terms, the diversity in structure and morphology of representatives of: Kingdom Fungi, e.g., yeasts, moulds, lichen (hypha, mycelium, septum); Kingdom Protista, e.g., Euglena, Paramecium, Amoeba, diatoms; and Viruses, e.g., HIV, retrovirus, poxvirus.

Act 5.2.3 Viruses - Students recall the characteristics of life and discuss the applicability of each to viruses. Students write a reflective essay commenting on Viruses: Living or Non-living?

Act 5.2.4 Viewing of prepared or wet-mount slides. Students produce a portfolio of proper lab diagrams of representatives of bacteria, fungi, protozoa, algae and viruses. Electron micrographs can be used in support (diatoms, viruses, dinoflagellates, slime mould).

Act 5.2.5 Model-building-Students design and build 3-D models of microbes to hang as mobiles in the classroom (staphylococcus, streptobacillus, spirillum, bacteriophage, Euglena, Paramecium).

Assessment of knowledge of physiology and anatomy of various microbes. Peer assessment of models. Assess lab diagrams skills.

Act 5.3.1 Students create a comparison of reproductive strategies of prokaryotes (binary fission), fungi (basidia, spores, nuclear fusion), protists (asexual and sexual diversity, Plasmodium) and viruses (lysogenic and lytic cycles). Students develop this by examining teacher-provided charts/posters/diagrams/videos illustrating the life cycle and reproductive strategy of a representative from each of Monera, Fungi, Protista and viruses.

Assessment: Unit test of knowledge.

Act 5.4.1 Symbiosis - Harmful and helpful microbes. Teacher lesson to distinguish among mutualism (gut enterobe *Escherichia coli*, mycorrhizal fungi), commensalism (phototrophs in coral polyp colonies) and parasitism (lytic cycle of viruses).

Act 5.4.2 Teacher-led discussion of the importance of each of the following to the environment: prokaryotes (as decomposers, cyanobacteria, methanogens, nitrogen fixation, genes from *Bacillus thuringiensis* produce insecticidal proteins in plants, oil spill clean-up); fungi (as saprophytes, as decomposers, in dry rot, as plant pathogens); protists (photosynthetic alga of plankton); and viruses (viral genes acting as ‘vaccines’ against viral attack in tomato and tobacco plants). Students address the impact of these relationships on diversity.

Assess the knowledge of importance of various microbes to the environment and the symbiotic relationships therein

Act 5.5.1 Students brainstorm names of diseases/disorders caused by each microbe and include any personal experiences with each of: chicken pox, strep throat, athlete’s foot, acne, botulism, influenza, ‘hamburger’ disease, ‘mad cow’ disease, malaria, sleeping sickness, multi-drug-resistant tuberculosis, pneumonia, amoebic dysentery, meningitis, hepatitis. Students correct misconceptions.

Act 5.5.2 Using electronic and print media, students research the impact of a particular microbe infection (see Activity 5.5.1) on the health and well-being of a human host.

Act 5.5.3 Microbes as Defenders against Disease - Students examine the importance of production of antibiotics by bread mould *Penicillium*, cyclosporin as an anti-rejection drug, examples in plants (Activity 5.4.2), advancements in biotechnology (Activity 5.6.2).

Peer-assessment of research on impact of microbial infections on society. Quiz on knowledge of disease.

Act 5.6.1 Students view a video or visit a local factory highlighting the importance of microbes in development of consumer products - e.g., edible fungi, bacteria converting milk to yoghurt and cheese, moulds adding flavour to Roquefort and Camembert cheeses, antibiotics (zones of inhibition on agar), methanogens to create fuels from manure.

Act 5.6.2 Cooperative Learning - Using teacher-provided resources, students investigate the uses and development of microbes in the areas of biotechnology and genetic engineering. This may include bacteria as vectors for cloning and as hosts for protein production (insulin and growth hormone), retroviruses as vectors for gene therapy (ADA and SCID), research on viroids, large scale use of fungicides and pesticides on diversity using a variety of electronic and print media. Students may present their findings.

Peer-assessment of cooperative learning experience

(**Note:** Activity 5.7 should begin near the start of the unit).

Act 5.7.1 Bacterial Culture (Long-term) Lab - Students design and conduct an experiment to determine: the type/shape of bacteria cultured, the rate and pattern of growth of non-pathogenic bacteria on agar from a variety of sources, the effect of antibacterial agents on different bacterial cultures (antibiotics, mouthwashes). Changes should be limited to one variable and chosen by the student. Included for consideration are: aseptic techniques; conditions for growth (temperature, pH, humidity), dependent variable, control, gram testing and morphology for identification purposes. Students prepare a log of observations and analysis.

Final Assessment Tasks

By curriculum Policy, the Final Summative Evaluation of the course accounts for 30 per cent of the final grade recorded for the course. This summative evaluation is based on an assessment of achievement in *all four Categories* of the Achievement Chart for Science and of expectations from *all units* of the course.

Time	Assessment Focus		Assessment Activity
	AC	LS	
3 hrs	K, MC	WH, O	Written Test to assess knowledge and skills developed in all units of the course
3 hrs	I, C	TW, C, I	Practical Test such as a timed response or the design and/or execution of an experiment
	MC, C	WH, O, WI	Portfolio This portfolio is initiated in Unit 1 with the Personal Action Plan and is assembled throughout the course. It includes student reflections of two main types: (1) information that could be used as part of a college or workplace application, including reflections on knowledge and skills acquired in this course and their future usefulness in education and career preparation; and (2) reflections on how things learned in this course will be useful in life beyond college and career.

Teaching/Learning Strategies

Need for Variety and Balance

Since the over-riding aim of this course is to develop scientific literacy in all students, a wide variety of instructional strategies is needed to provide learning opportunities that accommodate a variety of learning styles, interests and ability levels.

In planning activities, make sure that your students have:

- opportunities to work individually, in pairs, in small groups, and in large groups;
- direct-instruction as well as open-ended exploration;
- opportunities to develop concepts themselves from observed data;
- tasks in which they define some of the parameters (such as scope or procedure);
- opportunities to acquire knowledge and apply that knowledge in a variety of contexts; and,
- opportunities to communicate using standard formats (such as lab reports) as well as opportunities to choose and develop the format.

Skills are Developed through Experience and Refined with Practice

Many of the Learning Expectations describe **Inquiry Skills**. Give students repeated opportunities to carry out genuine inquiries in which *they* are responsible for defining one or more of the components of the inquiry: the topic or question, the methodology, the mode of presentation, the criteria of success. Students should have multiple opportunities to practise a variety of inquiry styles, including the following.

- **Research** involves *accessing* information that has already been gathered elsewhere, *selecting* what is needed, and *analysing* that information for patterns and meaning. This will require instruction and practice in techniques for effective use of Library/Resource Centre resources, searching the Internet and interviewing experts.
- **Experimentation** involves *identifying* controls and variables, *designing* the experimental procedure, *observing*, *measuring* and *analysing* the data for patterns and meaning. This may occur in laboratories or the field. Laboratory techniques and safety procedures must be taught and assessed.

Every inquiry should be driven by a clear *question* that is manageable and has relevance to the students. Students must be given instruction and repeated practice in: identifying and refining good inquiry questions; developing testable hypotheses; setting the parameters of the solutions to be sought; assessing results.

All forms of inquiry as well as other activities throughout the course develop **Communications Skills**. Although the traditional written report is one form of communication, students need to describe what they do and what they learn in other formats – poster presentations, computer presentations, video, oral presentations, music, etc. Through various forms of cooperative learning they discuss, debate and reflect on their own thinking and learning.

In addition to key biological concepts, every learning activity should identify a technique or skill that will be taught or reinforced and assessed during the course. Over the length of the course, all skills required to meet the Expectations should be practised repeatedly in a variety of contexts. In addition, students should receive practice and feedback for all skills to be demonstrated in the final assessment.

Use of Computer Technology

Computer applications should be taught and used whenever they enhance learning by enabling students to do something more efficiently or that they could not otherwise do. A wide variety of software tools should be used to record and display information, including *word-processing* (e.g., for reports), *spreadsheets* (e.g., to display and manipulate class data from population studies), *graphics* (e.g., to generate flow charts, concept maps, diagrams in place of written reports of investigations), *databases* (e.g., to collect and organize class observations of biota on field trip), and *presentation* programs (e.g., as an alternative for reporting on investigations, particularly by groups). *Probe-ware* should be used to collect data (e.g., to carry out experiments where data must be collected at intervals over several days). *Simulations* may substitute for experiences that would not otherwise be feasible but should not be used to replace direct experiences that are safe, ethical and available. The portability of calculator-based laboratory systems makes them useful for work outside the classroom.

Learning Skills

While not evaluated for marks, learning skills - *Works Independently*, *Teamwork*, *Organization*, *Work Habits/Homework*, *Initiative* – are keys to success in school and beyond. As with other skills, they should be taught, practised, and assessed in the classroom. Variety is essential: individual assignments foster independence and initiative; lab work done in pairs and small-group cooperative learning provides opportunities to develop teamwork. (**Note:** Small Group Cooperative Learning (SGCL) structures are discussed in some detail in Appendix OV-3, in the Overview to the Grade 9 Essential Science Profile - <http://www.curriculum.org/occ/profiles/9/9essential.htm#science>)

Making Connections

The knowledge expectations of this course have intrinsic worth as useful information, but they also serve as vehicles for Making Connections. Connecting biological concepts to social and environmental issues develops the habits of mind for Making Connections;

Applying scientific knowledge to practical problems makes connections to technology; considering how scientific knowledge is acquired brings understanding of the role that technology plays in scientific discovery.

Assessment & Evaluation of Student Achievement

Assessment is a systematic process of collecting information or evidence about student learning.

Evaluation is the judgment we make about the assessments of student learning based on established criteria.

The purpose of assessment is to improve student learning. This means that judgments of student performance must be **criterion-referenced** so that feedback can be given that includes clearly-expressed next steps for improvement. This can be facilitated by tools of varying complexity.

- Where completion or non-completion is the issue, a *checklist* is sufficient;
- Where quality of performance is easily identifiable, a *rating scale* can be used;
- For more complex tasks, the criteria may be incorporated into a rubric where levels of performance for each criterion are stated in *language that can be understood by students*. Rubrics can describe performance of a generalized skill (such as Inquiry) or can be task-specific.

Checklists, rating scales, and rubrics become powerful tools for improving learning *when students understand the criteria and levels of performance before they undertake the task*. Discussion of the criteria for success should be part of every learning task. Wherever possible, involve your students in the development of the rating scale or rubric (identifying criteria and setting levels of achievement in terms they understand).

Note: The following references are useful in expanding both teacher and student understanding of rubrics as a powerful tool in assessment.

1. The course profile for SCH3U includes an Appendix with samples of generic rubrics, which can be adapted for use in science courses across the curriculum. The Appendix is a modified version of one included in the *Teacher Support Materials, Grade 9 Academic Public Science Profile*, pp. x-xviii. The Appendix: Rubric Development (at the end of the developed unit on Hydrocarbons) includes brief suggestions for teacher use of the contents, and the following sample/ model rubrics. Each sample relates to a section of the Achievement Chart for Science and to the goals of this science course.
 - Rubric for Declarative Knowledge (Knowledge/Understanding of concepts, generalizations, facts - related to the first goal in this course)
 - Rubric for Procedural Knowledge (Knowledge/Understanding and Inquiry – related to the second goal in this course which focuses on the skills required for performance using manipulative, thinking and reasoning skills.)
 - Rubric for Collaborative Group Work (Learning Skills)
 - Partial Rubric for an Experimental Inquiry
 - Partial Rubric for a Research Inquiry
 - Rubric for a Written Report

2. *Task-specific rubrics* See TSM 5C: Developing Task-Specific Rubrics, p. 16 of the Teacher Support Materials in the Grade 10 Public Science Academic profile.

Assessment must be embedded within the instructional process throughout each unit rather than being an isolated event at the end. Often, the learning and assessment tasks are the same, with formative assessment provided throughout the activity. In every case, the desired demonstration of learning is articulated at the beginning and the learning Activity is planned to make that demonstration possible. When planning learning activities, this process of beginning with the end in mind helps to keep focus on the Expectations and to reduce the inclination to expand what is taught beyond what is required by the guideline.

*Assessment, Evaluation and Reporting are tied to the **Learning Expectations and Achievement Chart for Science*** (pp. 172-175 in the *Ontario Curriculum, Grades 11 and 12: Science, 2000*). Every Learning Activity and its assessment should collect data for making judgments about performance in one or more of the Achievement Categories: Knowledge/Understanding, Inquiry, Communications and Making Connections. Within each unit and across the course, teachers must collect sufficient data (in kind and number) to make valid judgments about each student's performance in all categories.

In the end, whether the evaluation of the assessment data is expressed as Levels of Achievement or as a percentage based on those Levels, that judgment must be based on each student's performance based on the criteria, not relative to other students' performances. Final evaluations should reflect the teacher's informed, professional judgment of each student's most consistent level of performance in each category of the Achievement Chart.

A wide and balanced range of assessment strategies is needed to accommodate the varied learning styles of all students, to meet the needs of students with special needs, and to encompass a broadened range of knowledge and skills expectations.

There must be opportunities for students to demonstrate learning at all levels of the Achievement Chart.

Strategies include:

- diagnostic, formative and summative assessments;
- performance tasks and pencil-and-paper instruments (both are needed to assess the full range of Expectations);
- both teacher assessment and student (self- and peer) assessment (With clearly articulated criteria, students become partners in the assessment process);
- both individual and group assessment (When students are engaged in group tasks it is appropriate to consider group interaction as an indicator of each student's learning skills. However, assessment must focus primarily on each student's individual demonstration of the learning expectations.).

Accommodations

Students with special needs, whether identified formally or not, need additional supports to succeed in Grade 11 Biology. For each identified student, read the Individual Education Plan (IEP) for information about specific accommodations designed to compensate for specific disabilities. Teachers will consult individual student IEPs for specific direction on accommodation for individuals. The following are examples of accommodations and aids that may be helpful for students with special needs.

- Ensure that peer helpers are available when students are working in small groups.
- Provide handout sheets with sample calculations and specific skill instructions.
- Help students create data charts into which they record information.
- Advise special education staff in advance when students are working on major assignments.
- Record key words on the board when students are expected to make their own notes.
- Allow students to report verbally to a scribe (teacher or student) who can then help in note making.
- Permit students a wide range of options for recording and reporting their work to utilize student strengths (e.g., drawings, diagrams, flow charts, concept maps).

- Timelines may need to be extended to give students more time to process language and put their thoughts into words.
- Where an activity requires reading, give it in advance to students or provide a selection of materials at different reading levels.

Students in English as a Second Language/English Literacy Development programs may require additional supports.

- Have students keep a science dictionary of terms using pictures and first language words.
- Where an activity requires reading, give it in advance to students.
- Permit the use of a translation dictionary on assessments.
- Provide additional time on assessments for dictionary use and processing language.
- Have the teacher-librarian identify resources with appropriate reading level when research is required.
- Advise ESL/ESD staff in advance when significant written work is required.

Resources

Instruction and Assessment

Armstrong, Thomas. *Multiple Intelligences in the Classroom*. Alexandria, VA: Association for Supervision and Curriculum Development. 1994. ISBN 0-87120-230-1

Brown, John L. *Observing Dimensions of Learning in Classrooms and Schools*. Alexandria, VA: Association for Supervision and Curriculum Development. 1995. ISBN 0-87120-255-7

Burke, Kay. *How to Assess Thoughtful Outcomes*. Palatine, Illinois: IRI/Skylight Publishing, Inc., 1993. ISBN 0-932935-58-3 (1-800-348-4474)

Herman, Aschbacher and Winters. *A Practical Guide to Alternative Assessment*. Association for Supervision and Curriculum Development. 1992. ISBN 0-87120-197-6

McDonald, Joseph P. et al. *Graduation by Exhibition: Assessing Genuine Achievement*. Alexandria, VA: Association for Supervision and Curriculum Development. 1993. ISBN 0-87120-204-2

Zemelman, Daniels and Hyde. *Best Practice: New Standards for Teaching and Learning in America's Schools*. Portsmouth, NH: Heinemann. 1993. ISBN 0-435-08788-6

Internet Resources

Note: The URLs for the websites have been verified by the writers prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Schools should develop and maintain websites on which selected resources are listed, particularly those that have links to other science references. One excellent site with very extensive links is The Internet Public Library - <http://www.ipl.org>

Other useful science sites include:

American Association for the Advancement of Science - <http://www.aaas.org/>

Association for Supervision and Curriculum Development -- variety of high quality publications and videos on a wide variety of topics – many principals and superintendents have memberships and can purchase materials at reduced rates. Also the home of Educational Leadership magazine.

– <http://www.ascd.org/>

Canadian government and research sites related to science and engineering

– <http://www.nserc.ca/relate.htm>

CBC Educational Resources – <http://www.cbc.ca/insidecbc/educational/>

Education Network of Ontario – <http://www.enoreo.on.ca/>

Education resources on the web (Canadian site)

– <http://www.educ.uvic.ca/depts/snsc/pages/weblinks/weblinks.htm>

EDU Web Index – to find anything on the Ministry’s website.
– <http://www.edu.gov.on.ca/eng/webmap.html>

Gateway to Educational Materials – <http://www.thegateway.org/>

Great Canadian Scientists – <http://www.science.ca/reference.html> – brief biographies of over 100 Canadian scientists and inventors

Kathy Schrock’s Guide for Educators. – <http://discoveryschool.com/schrockguide/>

Midwest Mathematics and Science Consortium (MSC) – <http://www.ncrel.org/msc/msc.htm>

National Science Foundation (USA) – <http://www.nsf.gov/>

National Staff Development Council – issues of implementation – <http://www.nsd.org/>

Online Resources for Assessment – <http://www.rmcdenver.com/useguide/assessme/online.htm>

Ontario Ministry of Education (EDU) – curriculum documents page
– <http://www.edu.gov.on.ca/eng/document/curricul/curricul.html>

Regional Education Laboratories in the USA – focus on educational research
– <http://www.sedl.org/RELS.html>

Science Teachers Association of Ontario (STAO) links to science sites
– <http://www.stao.org/hotlinks.htm>

STAR Centre for Academic Renewal (Texas) – <http://www.starcenter.org/>

USA National Academy of Sciences – <http://www.nas.edu/>

OSS Policy Considerations

- Students can apply and refine the skills, knowledge and habits of mind they acquire in SBI3C through Cooperative Education, work experience and service placements within the community. They also have the opportunity to explore various science related careers related to the course and consider them when they are developing their Annual Education Plan (AEP).
- A work site placement must be directly connected to the Expectations of SBI3C if it is to contribute to a student’s perspective of future careers or educational opportunities. The wording in the document *Cooperative Education and Other Forms of Experiential Learning (Ontario, Ministry of Education, 2000)* provides clear direction, and should be the focus of the personalized learning plans for students. “The personalized learning plan **must** include the following: the curriculum expectations of the related course that describe the knowledge and skills the student will **extend and refine** through application and practice at the workplace” (p. 23, emphasis added). The placement is not intended to introduce the student to the expectations, but should connect closely enough that significant Expectations are clearly extended and refined in a workplace setting. Both workplace and community experiences may offer unique opportunities for students to achieve the goal of SBI3C “To relate science to technology, society, and the environment” and to gain experience in the *Science Investigative Skills* defined at the beginning of the course description in the guideline. The personalized placement-learning plan of a student who has an Individual Education Plan (IEP) must be developed with direct reference to the IEP.
- Students are required to complete 40 hours of community involvement activities prior to graduation. Volunteer work in hospitals, retirement residences, nursing homes, municipal health units, conservation authorities, humane societies, or with groundskeepers in school boards or municipalities would provide connections to the goals of SBI3C while supporting the intent of the service to encourage students to develop awareness and understanding of civic responsibility and the role they can play in supporting and strengthening their communities.
- Students graduating from Ontario schools must be technologically literate. Through the study of this science course students must come to understand and apply technological concepts, use computers in various applications, and analyse the implications of technology on individuals and society.

Coded Expectations, Biology, Grade 11, College Preparation, SBI3C

Scientific Investigation Skills

- SIS.01** · demonstrate an understanding of safety practices consistent with Workplace Hazardous Materials Information System (WHMIS) legislation by selecting and applying appropriate techniques for handling, storing, and disposing of laboratory materials (e.g., follow safety procedures in handling, storing, and disposing of acids, bases, bacterial cultures, and bio-hazardous waste);
- SIS.02** · select appropriate instruments and use them effectively and accurately in collecting observations and data (e.g., microscope, laboratory glassware, stethoscope, dissection instruments);
- SIS.03** · demonstrate the skills required to plan and carry out investigations, using laboratory equipment safely, effectively, and accurately (e.g., conduct an experiment to investigate gas production in the metabolic processes of plants);
- SIS.04** · select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results (e.g., identify chemical formulae for some important biochemical compounds; use correct terminology to describe the internal systems of organisms);
- SIS.05** · locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet sites;
- SIS.06** · compile, organize, and interpret data, using appropriate formats and treatments, including tables, flow charts, graphs, and diagrams (e.g., construct a flow chart to describe representative mechanisms in living organisms, or a chart on the uses of microbes in biotechnological applications);
- SIS.07** · communicate the procedures and results of investigations and research for specific purposes using data tables and laboratory reports (e.g., describe appropriate sampling techniques for classification of specimens in a local environment);
- SIS.08** · express the result of any calculation involving experimental data to the appropriate number of decimal places or significant figures;
- SIS.09** · select and use appropriate SI units;
- SIS.10** · identify and describe science- and technology-based careers related to the subject area under study (e.g., cell technologist, chef, nutritionist, medical laboratory technician).

Cellular Biology

Overall Expectations

- CBV.01** · demonstrate an understanding of the basic processes of cellular biology, including membrane transport, cellular respiration, photosynthesis, and enzyme activity;
- CBV.02** · investigate the factors that influence cellular activity using appropriate laboratory equipment and techniques;
- CBV.03** · demonstrate an understanding of the importance of cellular processes in their personal lives, as well as in the development and application of biotechnology.

Specific Expectations

Understanding Basic Concepts

- CB1.01** – state the principles of the cell theory;
- CB1.02** – describe how organelles and other cell components carry out various cell processes;
- CB1.03** – identify and describe the structure and function of important biochemical compounds, including carbohydrates, proteins, lipids, and nucleic acids (e.g., use models to represent the molecules or monomers of the polymers);

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- CB1.04** – describe the critical role of enzymes in biochemical reactions (e.g., describe the function of deaminase in the breakdown of amino acids; explain the role of enzymes as biological catalysts);
- CB1.05** – identify cell processes and functions that use facilitated diffusion, osmosis, and active transport (e.g., describe the importance of facilitated diffusion in the movement of glucose across the membrane in the liver; describe the need for energy in the sodium-potassium pump);
- CB1.06** – compare the chemical changes and energy transformations associated with the processes of respiration (aerobic and anaerobic) and photosynthesis;
- CB1.07** – identify the role of compounds present in cellular respiration and photosynthesis (e.g., water, glucose, oxygen, carbon dioxide, and adenosine triphosphate [ATP]).

Developing Skills of Inquiry and Communication

- CB2.01** – analyse, based on their findings from a laboratory experiment, the effect of various factors (e.g., pH, temperature, and concentration of solute) on the rate of diffusion across a plasma membrane;
- CB2.02** – prepare a wet mount of a stained specimen and, using a light microscope, identify some of the organelles of a cell (e.g., view with a light microscope nuclei and chloroplasts – ribosomes and mitochondria are more difficult to see);
- CB2.03** – apply mathematical models to answer questions related to cell processes (e.g., calculate the magnification of a specimen; use the concept of exponential growth to explain the growth of cells);
- CB2.04** – perform common laboratory procedures needed for the study of cell processes, using appropriate techniques (e.g., prepare buffer solutions needed for laboratory investigations into enzyme and membrane activity);
- CB2.05** – investigate, through experimentation, the effect of environment on the action of enzymes (e.g., the effect of temperature or pH on the digestion of starch by saliva);
- CB2.06** – conduct biological tests to identify macromolecules found in living organisms (e.g., use iodine and Benedict’s solution to test for carbohydrates; use biuret solution to test for proteins).

Relating Science to Technology, Society, and the Environment

- CB3.01** – collaboratively or individually, research ways in which knowledge of cell processes and related technologies is relevant to their personal lives and the life of their community (e.g., investigate the effects of good nutrition on health using knowledge of metabolic processes and how they are clinically measured);
- CB3.02** – identify medical technologies based on cellular biology that are used in the diagnosis and treatment of disorders, and describe their benefits;
- CB3.03** – apply scientific principles in describing and analysing the function of laboratory equipment and techniques used in cell biology.

Microbiology

Overall Expectations

- MBV.01** · demonstrate an understanding of the characteristics of various micro-organisms, of their role in the environment, and of their influences on other organisms, including humans;
- MBV.02** · analyse the development and physical characteristics of micro-organisms, using appropriate laboratory equipment and techniques;
- MBV.03** · explain the role of micro-organisms with respect to human health and in technological applications in medicine, industry, and the environment.

Specific Expectations

Understanding Basic Concepts

- MB1.01** – compare the structure and properties of the genetic material of viruses and bacteria with those of eukaryotic cells;
- MB1.02** – illustrate the differences between representative bacteria (including Eubacteria and Archeobacteria), protists, viruses, and fungi by comparing their shape, motility, ecological role, and connection to human diseases;
- MB1.03** – analyse and explain the different methods of reproduction in various types of viruses, monera, and fungi;
- MB1.04** – describe the anatomy and physiology of representative organisms from monera, protists, fungi, and viruses;
- MB1.05** – demonstrate an understanding of the vital role micro-organisms play in symbiotic relationships (e.g., gut enterobes, mycorrhizal fungi, and commensal phototrophs in coral polyp colonies);
- MB1.06** – describe the role of viruses and bacteria in genetic manipulation, using their knowledge of DNA.

Developing Skills of Inquiry and Communication

- MB2.01** – identify specimens of monera, protists, and fungi by using prepared slides or wet mounts;
- MB2.02** – prepare a laboratory culture of micro-organisms on agar using aseptic techniques;
- MB2.03** – design and conduct an experiment to determine the effect of antibacterial agents on different bacterial cultures (e.g., determine the efficiency of various mouthwashes by observing the growth of bacteria on a nutrient agar);
- MB2.04** – analyse the conditions needed by micro-organisms for growth, through laboratory activities (e.g., determine the optimal temperature for a particular bacterium to grow);
- MB2.05** – work cooperatively to compile and organize data on micro-organisms from print and electronic sources, and communicate questions and results (e.g., research and describe how an industry uses microbes to make a product such as yoghurt or hormones).

Relating Science to Technology, Society, and the Environment

- MB3.01** – evaluate the impact of viral, bacterial, and fungal infections on the health of host organisms, and on humans in particular (e.g., examine the relationship between the emergence of new species of bacteria and viruses and the use of antibiotics, and determine the health implications for human populations);
- MB3.02** – describe some ways in which viruses, bacteria, and fungi are used in biotechnology (e.g., describe the use of viruses as vectors and as restriction enzymes);
- MB3.03** – explain and illustrate the roles of viruses and bacteria in genetic engineering;
- MB3.04** – evaluate the effects of large-scale use of fungicides and pesticides on the diversity of micro-organisms;
- MB3.05** – describe some beneficial functions of micro-organisms in an ecosystem (e.g., the role of bacteria as decomposers).

Animal Anatomy and Physiology

Overall Expectations

- AAV.01** – onstrate an understanding of the structure, function, and interactions of the main internal systems of humans and other animals;
- AAV.02** – tigate, with the aid of laboratory procedures, the physiological mechanisms of animal systems that are responsible for the physical health of the individual;
- AAV.03** – onstrate an understanding of the connections among health, preventive measures, and treatment, and of their social and economic implications.

Specific Expectations

Understanding Basic Concepts

- AA1.01 – describe the anatomy and physiology of the digestive, circulatory, excretory, respiratory, reproductive, and locomotion systems of humans and one other animal;
- AA1.02 – explain mechanisms of interaction between animal systems (e.g., describe the exchanges between capillaries and tissues; explain the emulsification of lipids by bile);
- AA1.03 – explain how the endocrine system and central nervous system help maintain homeostasis (e.g., describe how blood sugar levels are maintained by the liver and the pancreas);
- AA1.04 – describe the causes and effects of common disorders of each system (e.g., explain the effects of lactose intolerance; describe the causes of heart murmurs).

Developing Skills of Inquiry and Communication

- AA2.01 – use instruments accurately to collect data (e.g., use a stethoscope to find heart rate under various conditions; use blood simulation activities to determine blood types using antigens; use a sphygmomanometer to measure blood pressure);
- AA2.02 – design and carry out an experiment related to animal physiology, identifying specific variables (e.g., demonstrate feedback controls by comparing resting heart rate with that after exercise, and then again after rest);
- AA2.03 – carry out a dissection, or use a computer-simulated dissection, of a vertebrate to identify organs and establish relationships among structure, function, and health (e.g., dissect a mammal to identify and examine the components of the digestive system).

Relating Science to Technology, Society, and the Environment

- AA3.01 – evaluate the influence of the media on attitudes towards nutrition (e.g., explain changing perspectives on dietary practices, such as awareness of the potential benefits of oat bran, or the desirability of unsaturated fats over saturated fats);
- AA3.02 – describe how a technology related to the treatment of internal systems functions (e.g., kidney dialysis, the use of artificial hearts and artificial blood) and evaluate it on the basis of identified criteria such as safety, cost, availability, and impact on everyday life and the environment.

Plant Structure and Physiology

Overall Expectations

- PSV.01 – onstrate an understanding of the diversity of plants, and of their internal transport systems, reproduction, and growth;
- PSV.02 – analyse factors influencing the growth and maintenance of plants, using appropriate laboratory equipment and techniques;
- PSV.03 – evaluate the roles of plants in the urban community, in various technologies and industries, and in natural ecosystems.

Specific Expectations

Understanding Basic Concepts

- PS1.01 – illustrate how plants are classified by identifying similar and different characteristics of different types of plants (e.g., make a chart to demonstrate the unique structure and development of plants; examine the life cycle of plants);
- PS1.02 – describe the structure and physiology of plant tissues;
- PS1.03 – describe in words and/or diagrams the life cycle of plants, and differentiate between such divisions of plants as ferns and horsetails;

PS1.04 – describe the processes of growth and differentiation in plants (e.g., describe the differentiation of germ cells in various tissues; compare meristem cells with elongated cells);

PS1.05 – explain the role of tropisms in plants (e.g., describe the reaction of a plant to light, to gravity, or to humidity).

Developing Skills of Inquiry and Communication

PS2.01 – apply appropriate sampling procedures when collecting specimens of plants (e.g., collect specimens to illustrate the diversity of fallen cones in a selected coniferous stand);

PS2.02 – identify new questions or problems arising from the study of the growth and maintenance of plants (e.g., What organic growing methods are both reliable and cost efficient? How can biotechnology be used in the cultivation of plants?);

PS2.03 – on the basis of information gathered from print and electronic sources, develop, present, and defend a position or course of action related to the maintenance of plants (e.g., justify or argue against the use of pesticides to control insect infestation);

PS2.04 – analyse the chemical and physical elements that contribute to plant production in the agriculture and forestry industries;

PS2.05 – investigate tropisms by growing plants from seeds;

PS2.06 – analyse plant metabolic processes, in a laboratory environment, by measuring the volume of gases produced and absorbed;

PS2.07 – distinguish between monocot and dicot plants, using appropriate instruments and sources.

Relating Science to Technology, Society, and the Environment

PS3.01 – identify personal activities that may be influenced by their scientific study of plants (e.g., investigate the many issues involved in choosing to use chemical fertilizers and pesticides on the lawn; describe the scientific, psychological, and aesthetic benefits and/or drawbacks of maintaining plants in living spaces and classrooms);

PS3.02 – outline the use of plants in the food, textile, pharmaceutical, and fresh produce industries;

PS3.03 – explain the vital role of aquatic and marsh plants in the purification of urban, industrial, and agricultural waste or run-off water;

PS3.04 – evaluate the importance of plant diversity both in maintaining natural ecosystems and in providing sources of medicines;

PS3.05 – analyse the risks and benefits to society of using various agricultural technologies (e.g., genetically altered plants or growth hormones), and propose actions that can be taken to minimize risks.

Environmental Science

Overall Expectations

ESV.01 · demonstrate an understanding of factors that influence the sustainability of the natural environment and evaluate their importance;

ESV.02 · analyse how various factors influence the relationships between organisms and the natural environment;

ESV.03 · explain why it is important to be aware of the impact of human activities on the natural environment.

Specific Expectations

Understanding Basic Concepts

- ES1.01 – demonstrate an understanding of the fundamental principles of taxonomy by classifying organisms from a local ecosystem;
- ES1.02 – assess the impact of agriculture on the natural environment;
- ES1.03 – use energy pyramids to explain the production, distribution, and use of food resources in a food chain (e.g., draw energy pyramids that illustrate human consumption of corn, of cattle, and of salmon);
- ES1.04 – explain the ecological role of representative organisms from each of the kingdoms of life (including Eubacteria and Archeobacteria);
- ES1.05 – describe and explain examples of symbiotic relationships (e.g., explain the mutual benefits of nitrogen-fixing bacteria in the root nodule of legumes, or the negative impact of a parasite on its host);
- ES1.06 – describe the flow of matter through the biogeochemical cycles (e.g., describe and illustrate the carbon, nitrogen, phosphorus, and water cycles);
- ES1.07 – describe and evaluate factors contributing to environmental resistance and a change in the carrying capacity of ecosystems;
- ES1.08 – define population growth and identify the factors that influence it;
- ES1.09 – compare the major Canadian biomes (e.g., tundra, taiga, deciduous forest, grasslands, and temperate rain forest) in terms of vegetation, climate, type of soil, agriculture, and forestry.

Developing Skills of Inquiry and Communication

- ES2.01 – use appropriate sampling techniques to collect specimens in a local environment, and classify the specimens by applying the principles of taxonomy;
- ES2.02 – conduct a laboratory investigation into competition between species and evaluate the findings (e.g., investigate the competition for food among the different species of paramecium);
- ES2.03 – investigate and explain how a change in one population can affect the entire food web (e.g., explain how the killing off of species of fish by the lamprey eel affects fishing communities; explain the effects of the introduction of zebra mussels into the Great Lakes);
- ES2.04 – represent the growth of populations using mathematical calculations, graphs and charts of population growth and life cycles, and survivorship curves;
- ES2.05 – investigate, independently or collaboratively, the effect that human population growth has on the environment and the quality of life (e.g., examine effects, such as the movement or elimination of wildlife and plants, that are caused by the encroachment of human populations on ecosystems).

Relating Science to Technology, Society, and the Environment

- ES3.01 – independently or collaboratively, synthesize and evaluate information from a variety of sources about an environmental and population-related issue, and propose a course of action (e.g., analyse a natural preserve as to its *raison d'être*, such as the species being conserved);
- ES3.02 – evaluate the local use of natural and technologically engineered pesticides and herbicides;
- ES3.03 – analyse, from a variety of perspectives, the risks and benefits to society and the environment of applying scientific knowledge of ecosystems or introducing a particular technology (e.g., examine the effects of recycling programs, or of introducing a species into an environment).

Unit 4: Plant Structure and Physiology

Time: 22 hours

Unit Description

The unit introduces plant classification, overviews life cycles, plant morphology and physiology, and investigates conditions necessary for growth and development. The role of plants in our lives and in the environment will be researched as a part of this unit and also as part of the preparation of the personal action plan portfolio, the course final assessment task. The Portfolio assembled throughout the course includes student reflections on knowledge and skills acquired in this course and their future usefulness in education and career preparation, and reflections on how information learned in this course will be useful in life beyond college and career. A germination and growth activity is the focus of this unit providing information about growth and development and providing samples for plant tissue analysis. The germination and growth Activity 4.2 will be assessed as part of the end-of-unit task along with the gallery walk presentations (see Activity 4.3) and a formal knowledge-based test.

This unit may or may not be preceded by Environmental Science (depending on the time of year) that will include sampling procedures for plants (PS2.01) and may involve a field trip that could be used to meet expectations listed in Activity 4.5. Metabolic processes are looked at in the cell unit and applied here specifically to plants.

Unit Synopsis Chart

Activity	Time	Expectations	Focus	Task Focus
4.1 Introduction to Plants and Unit	75 min	PSV.01, PSV.03, PS1.04, PS1.05	MC, C	Small group work; reading assignment; gallery walk
4.2 Germination and Growth Activity	225 min	PSV.02, PSV.03, PS2.02, PS2.04, PS2.05, PS3.01	K, I, MC, C	Students design and carry out laboratory investigation; long term record keeping begins; research.
4.3 Uses of Plants-Gallery Walk	150 min	PSV.02, PSV.03, PS2.03, PS2.04, PS3.01, PS3.02, PS3.04, PS3.05	K, MC, C	Students do individual research and present to class.
4.4 Diversity and Structure of Plants	600 min	PSV.01, PSV.02, PS1.01, PS1.02, PS1.03, PS1.04, PS2.06, PS2.07, ESV.01, ES1.01, CBV.01	K, I, MC, C	Teacher lessons; student laboratory activities; small group jigsaw process.
4.5 Role of Plants in their Environment-Case Study	150 min	PSV.03, PS3.03, PS3.04, PS3.05	K, MC	Case study with optional field trip; students work individually or in groups.
4.6 End-of-Unit Task	150 min	PSV.01, PSV.02, PSV.03	K, I, MC, C	Student presentations; test and written reports.

Unit Planning Notes

- Start germinating seeds (for Activity 4.2) before Unit 4 begins to allow for longer growth period. The following suggestions will work in the time frame of the unit but you may consider the option of turning this into a semester long project and starting the seed germination in the timeframe of the first unit. Seed suggestions: radish, bean, corn, rye seeds all commercially available and quick growing – other ideas include commercial Fast Plants, coleus stem cuttings and plantlets from spider plants.
- Because Activity 4.2 will extend throughout much of this unit and requires independent work by students, tracking sheets and checklists should be prepared to monitor and guide their work.
- Secure equipment and space for unit long plant growth experiments.
- Prepare samples ahead of time for tropism/growth demonstrations.
- Book access to Internet, Library/Resource Centre for research component of Activities 4.2 and 4.3, and virtual lab or field trip of Activities 4.4 and 4.5.
- Field trip preparation may be required for Activity 4.5

Unit Resources

Plant sections of general biology textbooks previously used for the Grade 11 Biology course.

Online text resources – <http://www.ukltranet.com/~jkimball/biologypages/>

Online labs – <http://biologylab.awlonlin.com/> **Note:** requires a subscription to access

Activity 4.1: Introduction to Plants-Brainstorming

Time: 75 minutes

Description

This activity introduces the key concepts to be covered in the unit and at the same time provides an assessment of prior knowledge in those areas. The course portfolio is re-introduced and the unit summative task is described as a follow-up discussion to the brainstorming activity. This also acts as preparation for the germination and growth activity.

Strand(s) & Learning Expectations

Strand(s): Plant Structure and Physiology

Expectations

PS1.04 - describe the processes of growth and differentiation in plants;

PS1.05 - explain the role of tropisms in plants;

PSV.01 - demonstrate an understanding of the diversity of plants. (specifically: introduction to plant diversity)

PSV.03 - evaluate the roles of plants in the urban community, in various technologies and industries and in natural ecosystems. (specifically: introduction to the roles of plants).

Prior Knowledge & Skills

- Draw on information about plants from Grade 9 Reproduction Unit and Grade 10 Ecology Unit.
- Graffiti activity may have been used previously as a format for cooperative learning.

Planning Notes

- Introduce graffiti activity format. (see Appendix for full explanation.)
- Prepare focus questions for activity on chart paper. (see Teaching/Learning Strategies).
- Prepare reading assignment for Activity 4.1.2.

Teaching/Learning Strategies

4.1.1 Student Activity: Students work in small groups brainstorming answers to the focus questions provided by the teacher. The information is recorded in the form of graffiti on large chart paper. After a given period of time, they move from one focus question to the next and add to the graffiti from the last group. At the end of the graffiti session groups return to their original station and organize the graffiti for presentation to the class. Students make notes to summarize the information presented.

Teacher Facilitation: Present the focus questions to the groups. Concepts represented in these questions could include: types or diversity of plants, factors affecting growth, structure of plants, human uses of plants, role of plants in the environment – include plants from all areas of the globe. Time at each station should be dictated by student involvement in the activity. Encourage students to organize information creatively for presentation to their classmates.

4.1.2 Student Activity: Students complete a reading assignment from their text as preparation for the next activity. Specific information to cover includes tropisms, general pattern of growth and differentiation, and factors (both natural and man-made) that affect plant growth.

Teacher Facilitation: Assign readings on one or more of the following topics from the course text: tropisms, factors affecting growth, plant reproduction, or any other topic that serves as appropriate background for the next day's inquiry activity.

Assessment & Evaluation of Student Achievement

There is no formal assessment of the expectations in this activity; however, learning skills such as work habits, teamwork and organization may be monitored. Prior knowledge is informally assessed in Activity 4.1.1 to allow an appropriate assignment of readings in Activity 4.1.2.

Accommodations

- It may be necessary to assign work groups based on behaviour or ability of students.
- Provide several options for presentations to maximize participation of students.

Appendix

Brainstorming is used to accumulate the collective information held by the entire group. There are a number of brainstorming techniques. Graffiti is one of these ways. The next step after brainstorming could include categorizing or summarizing the data students have collected. The following rules improve this process:

DOVE Rules For Brainstorming

- **D**efer judgment – accept all ideas, list everything, and evaluate later.
- **O**pt for original and offbeat, anything goes, especially different and crazy ideas.
- **V**ast numbers of ideas are best – get many ideas, the more the better.
- **E**xpand by association – piggyback off each other's ideas, substitute ideas, combine ideas.

Graffiti is a cooperative small-group learning structure that can be used as an energizer and facilitates brainstorming. It is a suggested teaching/learning strategy in Activity 1. The students are creating a mindmap as a record of their work. The purpose of the product (mind map) is to provide the teacher with the opportunity to assess prior learning while allowing the students to re-establish some concepts, skills and vocabulary.

Procedure for Graffiti

1. Teacher outlines the DOVE rules of brainstorming and why they are used.
2. Students are put in teams of three or four.
3. Each member of one team has a marker of the same colour for tracking each group's contribution. Each team has one large piece of chart paper or butcher paper.
4. Each team is given a different question, topic, issue, or statement to which they respond.
5. Briefly demonstrate what is meant by a mind map and recording a variety of ideas as words, graphics, phrases
6. For a short period of time each team in the room writes their graffiti (words, phrases, graphics) about their topic or issue.
7. Each team then passes their graffiti sheet to the next team, who then add their ideas to it.
8. Continue to rotate until all teams have added to each sheet.
9. When the graffiti sheet returns to the originating team, they read, discuss, and summarize or categorize all of the information on their sheet. Each group selects a reporter.
10. Share this information with other groups by having a "gallery walk" to quickly look at the different posted sheets, then give an oral presentation.

Resources

Galbraith, Don. *Understanding Biology*. Toronto: John Wiley and Sons, 1989. ISBN 0-471-79654-9, Background information resource for topics such as growth, regulation and reproduction of plants found in Chapters 13 and 14.

Activity 4.2: Plant Growth and Development – Experimental Inquiry

Time: 225 minutes

Description

In groups of two or three, formulate a question regarding a variable that may affect plant growth or germination. Design an experiment to answer their question, collect and analyse data, and report their findings. Research on the use of fertilizers, growth regulators, and propagation techniques will provide background information for completion of their analysis. This activity serves as one of three culminating tasks within this unit.

Strand(s) & Learning Expectations

Strand(s): Plant Structure and Physiology

Overall Expectations: PSV.02, PSV.03.

Specific Expectations

PS2.02 - identify new questions or problems arising from the study of the growth and maintenance of plants;

PS2.04 - analyse the chemical and physical elements that contribute to plant production;

PS2.05 - investigate tropisms by growing plants from seeds;

PS3.01 - identify personal activities that may be influenced by the scientific study of plants.

Prior Knowledge & Skills

- Inquiry process from previous units in this course and from the Grade 9 and 10 Science courses.
- Experience with Internet research from prior activities.

Planning Notes

- Check with students regarding any plant allergies.
- Prepare tracking sheets and checklists to monitor and guide student research activities over an extended period of time.
- Secure an undisturbed, well lit area for plant growth.
- Obtain a variety of seeds and growth media.
- Some groups may use simple propagation from root or stem cuttings.
- Obtain variety of fertilizers and growth regulators.
- For research purposes, book access to the Internet in advance, or gather reference materials for in class use.
- To minimize the search for appropriate research sites and resources, teacher should bookmark or list appropriate websites.

Teaching/Learning Strategies

Act 4.2.1 Student Activity: Students work in small groups or pairs to formulate a question or focus for their inquiry and develop an appropriate experiment. The method should begin with either seed germination or tissue propagation and continue through monitoring of growth under specific conditions. Accurate observations and analysis of data should also be considered in the inquiry design.

Teacher Facilitation: It is important that both the question and the method of inquiry be approved before the next activity begins so that each investigation is rich enough to cover all the specified learning expectations. Possible topics to be explored include: the effect of gravity on growth, the effect of light (colour, intensity or direction) on growth, the use of hydroponics, the role of chemical fertilizers, the role of natural fertilizers, the role of plant hormones, the effect of watering patterns, the effect of different growth media, the effect of crowding of seedlings (looks at optimal spacing in nurseries), and the effect of temperature on germination and growth. The inquiry method must include controls, sufficient number of tests to validate results, quantitative as well as qualitative observations, and a reasonable hypothesis. The result analysis will include an explanation of how the results can be used in plant maintenance, will identify new questions or problems arising from this study, and should indicate how this information might change personal activities around plant growth and use.

Act 4.2.2 Student Activity: Students set up their experiments and organize logs to record observations on a regular basis. Initial observations are recorded at this point.

Teacher Facilitation: Discuss evaluation criteria with students and provide an assessment rubric for the activity. Monitor student activity on a regular basis using checklists or tracking keys and provide feedback to students. It may be helpful to assist students in making their initial observations in order to set a standard for acceptable observations. Give students an opportunity to revise logbooks prior to final submission at the end of the unit.

Act 4.2.3 Student Activity: Students conduct research on their inquiry problem using available resources. This information will be incorporated into the final analysis of the result section of the inquiry activity.

Teacher Facilitation: Assist with the information search so that research time is spent primarily on accumulating information (see Planning Notes). Direct students to research information related to the question and the hypothesis used to design the lab.

Assessment & Evaluation of Student Achievement

Track student performance and provide feedback on this activity throughout the unit. This may involve checklists, periodic conferences, or tracking keys. Learning skills may be evaluated in the same way. Final assessment of the activity will involve a rubric provided to the students early in the implementation of the inquiry. All four achievement levels should be fairly represented and criteria clearly laid out.

Accommodations

- Work groups should be designated to accommodate students with special needs.
- Permit students a wide range of options for recording and reporting their work to utilize student strengths (e.g., drawings, diagrams, flow charts, concept maps)
- Provide options for assignments that require handling of plant materials (avoid materials known to cause sensitivity reactions). Students with allergies that limit contact with plants can be involved in the research, design, recording and analysis activities.
- Provide options for assignments that require precision dissection of tissues in the case of students having disabilities that limit dexterity or focus
- Teacher should maintain a supply of prepared samples and germinating seeds in the case where student labs are unsuccessful or students are unable to maintain activity on their own

Resources

Soils and Plant Nutrients – http://www.abs.sdstate.edu/plantsci/teaching/ps213/soil_N&P/index.htm - website for a college program which describes many factors related to plant growth and health. This may be a source of ideas for students from which experiments could be designed.

A Review of Factors Affecting Plant Growth –

http://www.hydrofarm.com/content/articles/factors_plant.html - a commercial site, somewhat technical, but well written. Introduces methods of measuring plant growth; distinguishes between vegetative and reproductive growth.

Appendices

A: Observation Chart Rating Scale (on going)

Criteria	Level 1	Level 2	Level 3	Level 4
Observations	Entries are somewhat complete; some items are labelled	Entries are mostly complete and neat; some items are labelled and some changes outlined	Entries are complete, mostly accurate and neat; most items are drawn with care, labelled and changes outlined	Entries are complete, accurate and neat; all items are drawn with care, labelled and changes clearly outlined
(insert date for each entry)				

B: Germination and Growth Activity Rubric

Criteria	Level 1 (50 – 59%)	Level 2 (60 – 69%)	Level 3 (70 – 79%)	Level 4 (80 – 100%)
Inquiry proposal	- both the question and the hypothesis are clear	- both the question and the hypothesis are clear and indicate some understanding of the purpose of the activity	- both the question and the hypothesis are based on sound science principles and indicate some understanding of the purpose of the activity	- both the question and the hypothesis are based on sound science principles and indicate a clear understanding of the purpose of the activity

	- hypothesis is somewhat developed and shows a connection to the purpose of the activity	- hypothesis is well written with some spelling and grammar errors	- hypothesis is well written and complete, with few spelling and grammar errors	- hypothesis is well written and complete, with no spelling or grammar errors
Procedure	- procedure design tests problem and is complete - few safety concerns are indicated and most language is clear - some required materials are indicated	- procedure design tests problem and is mostly complete and organized - some safety concerns are indicated and most language is clear with few spelling or grammar errors - most required materials are indicated	- procedure design tests problem and is both complete and organized - most safety concerns are indicated and most language is clear with few spelling or grammar errors - most materials are indicated and use of equipment explained	- procedure design thoroughly tests problem and is both complete and organized - safety concerns are indicated and language is clear with no spelling or grammar errors - all materials are indicated and use of equipment fully explained
Observations	- one of either quantitative or qualitative results are clearly shown - appropriate SI units are used.	- both quantitative and qualitative results are clearly indicated - appropriate SI units are used	- both quantitative and qualitative results are clearly indicated and organized - appropriate SI units are used	- both quantitative and qualitative results are clear, organized and attractively presented - appropriate SI units are used
Results and analysis	- analysis indicates a basic understanding of the results - some research connecting the results to the real world is evident; - work is rarely written in precise language	- analysis indicates a fairly clear understanding of the results and some of their implications - some connections to the real world are shown; - some work is written in precise language	- analysis is thorough and indicates a fairly clear understanding of the results and their implications - several connections to the real world are clearly shown and some potential lab extensions provided; - most work is written in precise language with few spelling or grammar errors	- analysis is thorough and indicates a clear understanding of the results and their implications - connections to the real world are clear and potential lab extensions provided; - work is written in precise language with no spelling or grammar errors

Note: A student whose achievement is below level 1 (50%) has not met the expectations for this assignment or activity.

Activity 4.3: Preparing For the Gallery Walk – Uses of Plants

Time: 150 minutes

Description

Students are introduced to the second end-of-unit task, an individual research project focusing on the uses of plants. Each student researches and prepares a presentation in the form of a pamphlet, webpage, presentation software, poster, video, or other format, which will be shared in a gallery walk. This task provides opportunities to develop and assess students' problem solving skills.

Strand(s) & Learning Expectations

Strand(s): Plant Structure and Physiology

Overall Expectations: PSV.02, PSV.03.

Specific Expectations

PS2.03 - on the basis of information gathered from print and electronic sources, develop, present and defend a position or a course of action related to maintenance of plants;

PS2.04 - analyse the chemical and physical elements that contribute to plant production;

PS3.01 - identify personal activities that may be influenced by the scientific study of plants;

PS3.02 - outline the use of plants in the food, textile, pharmaceutical, and fresh produce industries;

PS3.04 - evaluate the importance of plant diversity both in maintaining natural ecosystems and in providing sources of medicine;

PS3.05 - analyse the risks and benefits to society of using agricultural technologies.

Prior Knowledge & Skills

- Experience with Internet research from prior activities.
- Gallery walk presentation format introduced in Activity 4.1 should be expanded upon.

Planning Notes

- This task should take place sometime during or just prior to Activity 4.4 to space out the use of class time for research and also to ensure that there is sufficient preparation time for students to prepare their presentations.
- Introduce gallery walk format (see Appendices for full explanation).
- Provide assessment-rating scale and discuss the responsibilities of peer evaluation (see Appendices for example).
- Provide and clearly review cost benefit analysis method (see appendices for example).
- Arrange access to Internet/Library/Resource Centre ahead of time.
- Provide exemplars (when possible) of final products.

Teaching/Learning Strategies

Act 4.3.1 Student Activity: Students research a topic related to human use of plants. Each student researches a different topic. Topics include a variety of plants used in the food, textile, and pharmaceutical and fresh produce industries. Presentation of the research may be in a variety of formats. The research should include an outline of the plant use, a discussion on the control of the plants production, the physical and chemical elements that contribute to production and maintenance, an evaluation of the plants role in the natural ecosystem and in industry, and a cost and benefit analysis. Encourage students to look at plants found in various parts of the world and not just in the local environment.

Teacher Facilitation: Select one mode of presentation or allow student choice. Provide more information on use of rubrics and peer evaluation in preparation for the end-of-unit task in Activity 4.6.1. A list of potential topics should be provided to guide students in choosing appropriate topics to address the expectations. Students should be instructed to formulate a personal course of action regarding the need for balance in harvest and the maintenance of natural ecosystems. This may be used for the personal action plan portfolio at the end of the course.

Assessment & Evaluation of Student Achievement

Learning skills and problem solving may be monitored and evaluated during the research time. Both peer assessment and teacher evaluation will be used in this activity. A test is used to assess knowledge of the uses of plants as presented by the students to the class.

Accommodations

- Research could be presented orally to the class or in an individual teacher conference.
- Access to the Internet can be arranged outside of class time to ensure that all students have sufficient research time, especially if they do not have home Internet access.
- Advise the special education staff in advance that students are working on major assignments.

Resources

Potential sites for research links:

Access Excellence – <http://www.accessexcellence.org/>

Biology by John Kimball – <http://www.ukltranet.com/~jkimball/biologypages/>

Canadian government and research sites related to science and engineering
– <http://www.nserc.ca/relate.htm>

CBC Educational Resources – <http://www.cbc.ca/insidecbc/educational/>

CSU Stanford Botany Links – <http://arnica.csustan.edu/site.asp>

Education Network of Ontario – <http://www.enoreo.on.ca/>

Education resources on the web (Canadian site)

– <http://www.educ.uvic.ca/depts/snsc/pages/weblinks/weblinks.htm>

Gateway to Educational Materials – <http://www.thegateway.org/>

Internet Public Library – <http://www.ipl.org>

Science Teachers Association of Ontario (STAO) links to science sites
– <http://www.stao.org/hotlinks.htm>

Appendices

Gallery Walk: Students do a tour to read posted sheets or research and make personal notes or records of the information. This could also include each person orally presenting at each poster to answer questions and explain the main ideas of the research. The teacher should provide an outline as to what information should be gathered from the posters.

Cost-Benefit Analysis

Introduction: A cost-benefit analysis is a way of comparing the negative social consequences of a planned project with the positive social consequences, usually in economic terms. At this level however it may prove both difficult and discouraging to become too embroiled in quantifying the dollar value of the costs, rather than just recognizing the existence of monetary restraints. In that respect a cost-benefit analysis could compare to a “plus-minus-interesting” assessment (PMI).

Example: The mandated use of safety helmets when riding bicycles.

Cost (negative aspects)	Benefit (positive aspects)
Good helmets are expensive.	Protects rider from injury.
Helmets vary in quality.	Saves provincial health bills
Helmets do not look “cool”.	Reduces possibility of family distress
A family will tend to “hand down” helmets to younger members, without having them fitted.	Increases safety awareness and may promote responsible cycling.

Teacher and Peer Assessment – Uses of Plants

Evaluation Criteria	Marks			
	0 – 4 not at all	5 – 6 some	7 – 8 most	9 – 10 always
Content: Research is organized and clear. Bibliographic information is present and properly formatted, including annotation. Spelling and grammar are correct and language is appropriate.				
Expectations: Activity expectations have been addressed in the research and are clearly outlined.				
Presentation: Format is interesting, informative and easy to follow. Appropriate questions are answered with relative ease.				

Activity 4.4: Diversity and Structure of Plants

Time: 600 minutes

Description

This activity involves a variety of approaches, both teacher and student centred, to examine the diversity of plants, their structure and physiology, reproduction and life cycles. Throughout the teacher led lessons on plant structures, students will be making a plant sandwich. (see Description in Activity 4.4.2.) This is a collection of diagrams of plant tissues at different layers in the plant. It may be used as an aid in the activity bell ringer assessment.

Strand(s) & Learning Expectations

Strand: Plant Structure and Physiology

Overall Expectations: PSV.01, PSV.02.

Specific Expectations

PS1.01 - illustrate how plants are classified by identifying similar and different characteristics of different types of plants;

PS1.02 - describe the structure and physiology of plant tissues;

PS1.03 - describe in words and/or diagrams the life cycle of and differentiate between such divisions of plants as ferns and horsetails;

PS1.04 - describe the processes of growth and differentiation in plants;

PS2.06 - analyse plant metabolic processes, in a laboratory environment, by measuring the volume of gases produced and absorbed;

PS2.07 - distinguish between monocot and dicot plants, using appropriate instruments and sources.

Strand: Environmental Science

ES1.01 - demonstrate an understanding of the fundamental principles of taxonomy by classifying organisms from a local ecosystem.

Strand: Cellular Biology

CBV.01 - demonstrate an understanding of the basic processes of cellular biology as they apply to the plant-including cellular respiration, photosynthesis and enzyme activity.

Prior Knowledge & Skills

- Students should know how to use microscopes.
- Students will have used taxonomic keys in the Environmental Unit. If this unit has not yet been completed, students will require some background information on taxonomy before completing Activity 4.4.1. Time may be transferred from the environmental unit to complete this task.
- Jigsaw activities format may have been previously introduced.
- Photosynthesis and cellular respiration were studied in the Cell Unit.
- Inquiry process should be established in earlier units and Grade 9 and 10 courses.

Planning Notes

- Gather plant specimens (leaves, needles, cones, seeds, etc.) or photos downloaded from the Internet for use with the classification activity. Plant specimen may be pressed or simply stored in zip lock bags.
- Review jigsaw activity format. (see Appendices for full explanation)
- Microscopes and the following slides are needed for this activity: monocot and dicot roots, stems, and leaves; root tips, life cycles of mosses, ferns and horsetails.
- Micro viewers, models and diagrams can also be used.
- Online access for the class could be booked for the virtual lab (Activity 4.4.5) or alternatively as demonstration by teacher.

Teaching/Learning Strategies

Act 4.4.1 Student Activity: Students work in small groups to organize a variety of different plant samples (or photos of plant samples) into groups based on structure. Students prepare a dichotomous key that illustrates the steps used to organize their samples. Each group will present their key and a rationale for its use to the class.

Teacher Facilitation: A brief activity classifying nuts, bolts, washers, nails and screws may be used as an example of making a dichotomous key. Organize the plant material and explain how any classification system is arbitrary and that there are many different bases for classification beyond gross morphological features.

Act 4.4.2 Student Activity: Students participate in a jigsaw (home-expert groups) activity to examine life cycles of various plants including mosses, ferns, horsetails, gymnosperms, and angiosperms. Notes on the basic cycles should be generated and questions written out for the class discussion to follow.

Teacher Facilitation: Provide resources necessary for the completion of this activity. Student textbooks will likely provide most of the information. This should be a survey, focusing on life cycles as a method of classification, rather than an in depth study. The activity follow-up includes a question and answer session where students are able to ensure a clear understanding of the information.

Act 4.4.3 Student Activity: Students will begin to create a “plant sandwich” that will summarize all the important structural information presented in the next activity. The “plant sandwich” is a compilation of pictures of the various layers of the plant, starting with outer morphology as the top page and moving inwards layer by layer covering organ and tissue structure. The sandwich will be part of the practical assessment of Activity 4.4. Work will continue on the plant sandwich throughout all of Activity 4.4.4.

Teacher Facilitation: Provide the students with the diagram outlines for the plant sandwich. The bread of the sandwich would be diagrams of outer structure and the sandwich inside are the diagrams showing structures within a plant (plant organs, tissue arrangement, cell specialization). Explain the format for the sandwich and assist students with completing the first layer. This may not take much time to set up but should be referred to and worked on throughout all of the lessons presented in Activity 4.4.4.

Act 4.4.4 Student Activity: Students participate in a series of teacher-directed lessons covering plant organs and tissues – roots, stems and leaves. The structure and function of each organ is described, followed by a microscope activity where tissue types (epidermal, meristem, conductive, fundamental) are examined and compared. The different arrangements of these tissues in monocot and dicot plants should be noted. Throughout this activity students will work on their “plant sandwich”.

Teacher Facilitation: By starting with the root tip, focus on cell differentiation and the formation of tissues. Students should be directed to note the different zones in the root tip from enucleated root cap through undifferentiated meristem to elongated and then specialized cells. Teachers may wish to set up a demonstration to track root growth and illustrate growth patterns. This should not duplicate any student project. The structure and function of each organ of the plant should be described followed by microscope observations. Biological diagrams of microscope specimens may be assigned but should not be the primary focus of this activity. By ending with the leaf, metabolic processes, photosynthesis and cellular respiration, can be reviewed in preparation for Activity 4.4.5. Students should be reminded of the bell-ringer evaluation at the end of Activity 4.4.

Act 4.4.5 Student Activity: Plant Metabolic Activity Lab. Following an introductory discussion on the role of enzymes in chemical processes, students (with teacher guidance if necessary) formulate a question regarding plant physiology. (e.g., about enzyme activity, factors affecting photosynthesis or cellular respiration) Students then take part in a quantitative lab activity analysing that aspect of plant cell metabolism. The lab activity may be hands-on or virtual, i.e., online where students manipulate lab parameters and assess results.

Teacher Facilitation: Hands-on lab suggestions include peroxisome lab where the catabolic activity of the enzyme on hydrogen peroxide (in potatoes) is analysed under different conditions, or rate of water loss from leaf stomata is correlated with specific factors. (Examples of both are available online and in most senior biology lab manuals.) Many other excellent quantitative plant metabolism lab activities may be found in older botany and biology textbooks. Virtual labs may include Enzyme activity, Mitochondria lab or Leaf lab all found at Biology Labs on-line (see Resources, below). This website requires a subscription but may be useful for this unit and in the 11U and 12U courses as well. Assignments and assessments are included with the subscription.

Assessment & Evaluation of Student Achievement

Students will complete a bell ringer activity covering plant morphology and physiology. The bell-ringer should include both pencil-and-paper, identification- and performance-based questions to evaluate knowledge and skills. Students may use the plant sandwich as they rotate through a series of stations containing various models and plant specimens. The plant sandwich should be collected as part of this assessment. Making Connections questions can also be included depending on the depth of coverage in the activities above. Learning skills and problem solving can be evaluated throughout the activities.

Accommodations

- Work groups should be designated by teachers to accommodate students with special needs
- Use enlarged diagrams for student who cannot use the microscope.
- Provide options for assignments that require precision dissection of tissues in the case of students having disabilities that limit dexterity or focus.
- Provide options for assignments that require handling of plant materials (avoid materials known to cause sensitivity reactions) Students with allergies that limit contact with plants can be involved in the research, design, recording and analysis activities.

Resources

Galbraith, Don. *Understanding Biology*. Toronto: John Wiley and Sons, 1989. ISBN 0-471-79654-9

Background information on plant structure and physiology found in Chapters 11 and 12.

Access Excellence – http://www.accessexcellence.org/AE/AEC/AEF/1996/bowersox_frog.html

Activity called frog sandwich from which Activity 4.4.3 was adapted.

Juniata College – <http://services.juniata.edu/chemvan/bio/plants.htm>

Lab activities found by plant physiology site search.

Biology Labs Online – <http://biologylab.awlonline.com/leaflab>

Virtual (online) lab activities requiring a subscription but offering a variety of activities.

Appendices

Jigsaw is a sophisticated CSGL structure that is best not used until students have mastered cooperative learning as a strategy in simpler structures. Cooperative Small Group Learning (CSGL) or “Cooperative Learning” is an instructional strategy in which students work in small groups or teams to help one another master a skill or academic material. Each student on the home team becomes an “expert” on one topic by working with members from other teams assigned the corresponding expert topic. Upon returning to their home team, each person in turn teaches home team members and the students are assessed on all aspects of the topic. This structure requires considerable planning and emphasizes positive interdependence.

Size and Selection of Groups

Students work in groups. *To be effective, the group has to be small enough so that all members can contribute to the task.* The maturity and skill of the students, class size, size of your facilities, and complexity of the task all have a bearing on the group size chosen. Time is also a factor; the shorter the time to complete the task, the smaller the group should be.

Start out with small groups when introducing cooperative learning to students with little experience in this strategy. As the teacher and students become more skilled, the size of the group can increase. Groups of two or three are best until students become skillful at including everyone. Groups should never be larger than groups of five or six. *Remember the larger the group, the more sophisticated the students' social skills have to be and the simpler the group's task has to be.*

Activity 4.5: Role of Plants in the Environment – Case Study

Time: 150 minutes

Description

This activity emphasizes the role of plants, specifically those found in swamps or marshes, in the purification of urban, industrial and agricultural waste or runoff water. Students may participate in an actual field trip, a virtual field trip, or a simulation of a wetland ecosystem.

Strand(s) & Learning Expectations

Strand(s): Plant Structure and Physiology

Overall Expectations: PSV.03.

Specific Expectations

PS3.03 - explain the vital role of aquatic and marsh plants in the purification of urban, industrial, and agricultural waste or run-off water;

PS3.04 - evaluate the importance of plant diversity both in maintaining natural ecosystems and providing sources of medicines;

PS3.05 - analyse the risks and benefits to society of using various agricultural technologies.

Prior Knowledge & Skills

- Students will have studied ecosystems in the environmental unit of this course as well as the Ecology Unit in Grade 10 Science.

Planning Notes

- It is possible to include this activity in the Environmental Unit if a wetland ecosystem is selected for study.
- Prepare appropriate resources for this activity (will depend on format).
- Make up a series of factual and open-ended, supported opinion questions (risk/benefit analysis). Questions may need to be modified depending on student topics in the two final assessment tasks. Ideas and analysis coming from the case study should be included in the portfolio.
- Field trip preparations specific to school or board.
- Book online access if virtual field trip is to be substituted.

Teaching/Learning Strategies

4.5.1 Student Activity: Students participate in an experience that focuses on a wet land ecosystem and the role of the plants that inhabit it. Case study questions can be completed individually or in groups. The activity may be an actual field trip to a wetland ecosystem or a virtual experience.

Teacher Facilitation: Design the case study, based on resources available, with a focus on the role of plants in the purification of water sources and the impact of human activities on this type of ecosystem. Examples of topics to be covered include: how marsh plants purify, the importance of plant diversity in maintaining healthy ecosystems, the risks and benefits of various agricultural practices, possible suggestions for minimizing damage to aquatic ecosystems. It should be pointed out to students that aquatic ecosystem plant life would be relatively similar globally allowing their local wetlands to act as a model for wetland ecosystems around the world.

Assessment & Evaluation of Student Achievement

Various portions of the case study, particularly the risk/benefit analysis, can be collected and evaluated at the end of the activity. Learning skills can be monitored.

Accommodations

- Students could present their risk/benefit analysis orally.
- Students could relate applications of their findings to local environmental concerns. Any such extensions would be a valuable inclusion in their portfolio/personal action plan.

Resources

Virtual Wetland Software such as Illinois Wetlands

– <http://www.twingroves.district96.k12.il.us/Wetlands/Wetlands.html>

Nearctica - The Natural World of North America - Table of Contents for “W” has wetland links

– http://www.nearctica.com/content/table_w.htm

Other sources through links at – <http://www.sws.org/wetlandweblinks.html>

Access Excellence – <http://www.accessexcellence.org/IRC/virtual.html/>

Activity 4.6: End-of-Unit Tasks

Time: 150 minutes

Description

There are three parts to the final assessment of this unit. The first is the gallery walk presentations of researched material highlighting the important roles of plants. Preparation for this activity begins in Activity 4.3 and continues throughout the unit to allow sufficient time for research and organization of materials. Sufficient time should be allotted for students to see all presentations, make notes and conduct peer evaluation. The Germination and Growth Activity 4.2 is initiated near the start of the unit and is an ongoing process that will end at this time. This inquiry activity is to be collected and evaluated by the teacher and should not require appreciable class time at this point. The final assessment activity is a written test that incorporates the basic concepts presented in this activity.

Strand(s) & Learning Expectations

Strand(s): Plant Structure and Physiology

Expectations

PSV.01 - an understanding of the diversity of plants, their internal transport systems, reproduction and growth;

PSV.02 - an analysis of the factors that influence plant growth and maintenance;

PSV.03 - an evaluation of the roles of plants in communities, technology, industry and ecosystems.

Prior Knowledge & Skills

- Gallery walk format (if used) may require explanation as will peer assessment expectations.
- The Inquiry process should be understood at this level but final review of the rubric and specific classroom expectation may need addressing.
- Students should be familiar with the use of written evaluation that includes the use of multiple choice questions.

Planning Notes

- Clear area will be needed for students to move around room from project to project. Ensure copies of peer evaluation forms are available and any presentations requiring audiovisual equipment are planned for.
- Remind students to hand in rubric with assignments.
- Prepare knowledge-based written test to be completed in class.

Teaching/Learning Strategies

Act 4.6.1 Student Activity: Students display their research projects (Activity 4.3) around the room and the class circulates from project to project to see the work. Students may ask question of each other and the information displayed and are expected to evaluate each other's projects.

Teacher Facilitation: Evaluate projects and circulate with students to monitor class activities and evaluate learning skills.

Act 4.6.2 Student Activity: Students submit formal lab reports (Activity 4.2) including statement of problem, hypothesis and procedure, observations recorded in log books and result analysis.

Teacher Facilitation: Collect work and evaluate according to rubric.

Act 4.6.3 Student Activity: Students take part in a pencil-and-paper test that incorporates basic knowledge questions as well as questions that require students to apply the knowledge to new situations.

Teacher Facilitation: Monitor progress of students and assist where appropriate.

Assessment & Evaluation of Student Achievement

The first two activities are evaluated using rubrics found in the Appendices of the relevant activities. The gallery walk is designed to evaluate the Making Connections and Communication portions of the Achievement Chart and the Germination and Growth Activity will address the Inquiry process. The written assessment may be marked on a per question basis primarily addressing the Knowledge portion of the Achievement Chart. Learning Skills should be evaluated throughout the unit on an ongoing basis.

Accommodations

- Permit students a wide range of options for recording and reporting their work to utilize student strengths (e.g., drawings, diagrams, flow charts, concept maps, computer use).
- Permit the use of a translation dictionary on assessments for ESL students.
- Provide additional time on assessments for dictionary use and processing language for ESL and learning disabled students.
- Allow the option of oral assessment in lieu of the written test.
- Allow the option of alternate location for written assessment where behavioural students are involved.

Resources

EDU Web Index as an assessment link – <http://www.edu.gov.on.ca/eng/webmap.html>

Online Resources for Assessment – <http://www.rmcdenver.com/useguide/assessme/online.htm>