

Catholic District School Board Writing Partnership

Course Profile

Biology

Grade 11

University Preparation

SBI3U

• *for teachers by teachers*

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Course Overview

Biology, Grade 11, University Preparation, SBI3U

Prerequisite: Science, Grade 10, Academic

Course Description

This course furthers students' understandings of the processes involved in biological systems. Students will study cellular functions, genetic continuity, internal systems and regulation, the diversity of living things, and the anatomy, growth, and functions of plants. The course focuses on the theoretical aspects of the topics under study, and helps students refine skills related to scientific investigation. University preparation courses are designed to equip students with the knowledge and skills they need to meet the entrance requirements for university programs. Teaching and learning will emphasize theoretical aspects of the course content and will also include concrete applications. Emphasis is also placed on the development and demonstration of both independent research skills and independent learning skills by students.

How This Course Supports the Ontario Catholic School Graduate Expectations

This course seeks to further the achievement of Catholic Graduate expectations through integrating Scripture, Catholic Church teaching, and moral and ethical reflection into the curriculum. Biology becomes authentic when it acknowledges both the material and spiritual dimensions of life. Students use Scripture to reflect on the mystery, wonder and awe, and sacredness of life. They use Church teaching to inform themselves in order to think critically and reflectively about the moral and ethical issues raised in the course. In addition to the informative role that the curriculum plays, there is the formative role of the community within the classroom. When Gospel values are actively witnessed within the classroom community they reveal the deeper spiritual Truth of our creation and are seen as something 'reasonable and worthy of being lived.'

Course Notes

University preparation courses are designed to equip students with the knowledge and skills they need to meet the entrance requirements for university programs. This course provides students with the prerequisite knowledge and skills needed for the Grade 12 Biology University Preparation course. In planning for this course teachers must be aware of, and then emphasize, the theoretical aspects of this course content. Whenever possible teachers must include relevant concrete applications. Emphasis should be placed on the development and demonstration of both independent research and learning skills. Teachers should be aware that certain lab skills, like the proper care and use of the microscope, were previously done in Grade 8 and may require review. Teachers must incorporate the skills essential for scientific investigation that apply to all areas of the course content and must be developed in all the course units. Assessment of the students' mastery of these skills must be included in the evaluation of students' achievement. In this profile these skills expectations have been coded as Scientific Investigation Skills (SIS.01 to SIS.10).

This course is organized into five units to follow the logical development of knowledge, theories, and skills. The units are: Diversity of Living Things; Cellular Functions; Genetic Continuity; Internal Systems and Regulation; and Plants: Anatomy, Growth and Functions. These units match the strands used in *The Ontario Curriculum, Grade 11, Science* document for Biology, Grade 11, University Preparation course. However, they have been re-ordered to provide a meaningful and relevant framework to the study of living things in the Catholic context. Teachers may wish to integrate the strands into units following an arrangement different to that suggested in this course profile, but in doing so they must consider the time allocated to each.

For example, teachers may choose to re-organize the plant related expectations from the Internal Systems and Regulation unit and incorporate them into the Plants: Anatomy, Growth and Functions unit. A suggested emphasis for each of the clustered expectations within each unit is given in bold type and matches the four categories of assessment.

The teacher must provide ample opportunities for students to engage in safe, relevant laboratory activities in all units of this course. The health and safety of teachers and students must be routinely addressed when conducting laboratory activities as outlined in Workplace Hazardous Materials Information System (WHMIS) legislation.

Starting with the Diversity of Living Things, this course fosters an appreciation of the wonders of God's creation and stimulates students' curiosity about the living world and its diversity. This provides the foundation for exploring the unity and diversity of living things in subsequent units. This approach nurtures a world view that envisions the totality of life as being greater than the sum of its parts. It is critical that students develop strong communication skills, including the use of current technology for collecting, organizing and presenting information. Science cannot be taught in isolation but must be linked to other disciplines. By helping students understand connections and interdependence, they will develop an awareness of controversial issues involving science, technology, society, and the environment (STSE). This allows them to become reflective and creative thinkers who examine, evaluate, and apply knowledge of interdependent systems for the development of a just and compassionate society. Students will be expected to use computer technology. Teachers are encouraged to incorporate the use of tools such as computer based simulations, multimedia applications, and computer-assisted laboratory apparatus in the delivery of this course. Care must be taken to ensure that computer-assisted laboratory programs are not used where essential scientific skills should be developed.

Units: Titles and Time

* Unit 1	Diversity of Living Things	18 hours
Unit 2	Cellular Functions	17 hours
Unit 3	Genetic Continuity	25 hours
Unit 4	Internal Systems and Regulation	26 hours
Unit 5	Plants: Anatomy, Growth and Functions	24 hours

* This unit is developed in this Course Profile.

Unit Overviews

Unit 1: Diversity of Living Things

Time: 18 hours

Unit Description

Students investigate the diversity of living organisms through a series of activities. Each of these activities cluster expectations allowing students to sequentially develop the skills and understanding of the rationale for phylogeny and taxonomy. Consequently, the importance of biodiversity in maintaining natural ecosystems is discovered. Finally, students explore the role of micro-organisms in the growing field of biotechnology. Students are asked to integrate Catholic faith traditions in the critical analysis of biotechnology's role in society. Students were introduced to the concept of classification in science in Grade 6. This unit emphasizes the development of research and independent learning skills. Lab skills are introduced but play a more significant role in later units. Students produce a Book of Life, which is the key assessment task for the unit. It incorporates materials from several activities and is a place for personal reflection.

The first activity clusters expectations that help students to develop an understanding of the fundamentals of classification. A series of investigation based activities help students acquire the skills necessary to develop and use a dichotomous key.

The second activity clusters expectations related to the skills needed to collect and classify specimens using currently accepted methods. Students are cautioned on what and how samples are to be collected. In the sample unit, students investigate invertebrates found in an aquatic ecosystem.

In the third activity students investigate the importance of sexual reproduction to variability and they study the use of micro-organisms in the field of biotechnology.

In the fourth activity students participate in a symposium focusing on the connection between biodiversity and species survival.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus/Tasks
1	DLV.01,.02; DL1.01,1.02,1.03,1.04; DL2.01,2.02 CGE2a,2b,2e,3e,7d,7i SIS.04	K I C MC	<i>Classification</i> : develop a dichotomous key and classify figures and organisms; create a Book of Life
2	DLV.01, .02; DL2.03; DL3.02 CGE2c,2d,3e,4a,4b,4f, 5a,5e,5f,7a	I C	<i>Field Trip</i> : participate in and complete a report on a field study (e.g. aquatic study)
3	DLV.01,.03; DL1.05, DL3.01 CGE1e,2b,2c,2d,2e, 3d,3f,4f,5a,5e SIS.05,.10	K C MC	<i>Variability with Populations and Biotechnology</i> : define variability and complete worksheets and critique article(s), create a job ad on biotechnology
4	DLV.03; DL3.01; 3.02 CGE2b,2c,2d,4a,4f,5a,5e,5g SIS.05,.06	K C MC	<i>Symposium</i> : topic relates to the use of biotechnology, complete the Book of Life

K/U = Knowledge/Understanding

I = Inquiry

C = Communication

MC = Making Connections

Unit 2: Cellular functions

Time: 17 hours

Unit Description

The unit is divided into four activities which builds on the Grade 9 Science course expectations by examining the interrelationships among molecular dynamics, the cell membrane, and organelles and their functions. Students move from simple to more complex concepts. Emphasis is placed on student manipulation of materials and student design and testing of experimental procedures. Research-based tasks develop both research and critical thinking skills as students examine the applicability of theory in society, as well as the moral and ethical questions that science and technology raise.

The first activity examines the characteristics of macromolecules. Teachers are encouraged to use available computer software simulations to introduce this concept. The application of computer technology for medical and industrial uses is researched, and students could produce a one-page newspaper article summarizing their findings. Students are encouraged to investigate possible careers related to biology and biochemistry.

In the second activity, students study the characteristics of the membrane and design experiments to study the mechanisms/processes involved in the passage of materials through the membrane.

The third activity relates structure to the functioning of cell organelles. Students could illustrate the interrelationships of cellular processes by creating an energy and materials web. In addition, students could explain the flow of energy between photosynthesis and respiration by developing an energy flow chart. Students research then debate ‘the role of societal need vs. societal bias’ in driving the direction of technological advances by examining diseases such as AIDS. The motives that drive technological advances are studied from a Catholic perspective by having students read articles written by the Catholic Bishops on issues such as AIDS and HIV (see resource list).

In the fourth activity, students compare aerobic and anaerobic respiration. In addition, they explore the benefits of technological applications of cellular processes in industry (e.g., microbiological processes). Students could file a field report (as newscasters) on their position.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus/Tasks
1	CFV.02,.03; CF1.02,2.02,2.04; 3.01 SIS.01,.02,.04,.05,.06,.07 CGE2c, 2e, 5a, 5f	K I MC C	<i>Macromolecules</i> : describe the characteristics of macromolecules (through computer simulations and lab activities); research and report on technology for medical/industrial purposes
2	CFV.02; CF1.03,2.01 SIS.01,.02,.03,.06,.07 CGE 5a,5f	K I C	<i>Cell membrane</i> : fluid mosaic model; lab investigations into the movement across membranes
3	CFV.01,.02; CF1.01,1.04,1.06; 3.03 SIS.05,.07 CGE2c,3f,7e	K C MC	<i>Cell organelles</i> : cell processes and energy flow (photosynthesis and respiration); research technological advancements in this area
4	CFV.03; CF1.05; 2.03; 3.02 SIS.05 CGE2c,4g,5d,7d	K I C MC	<i>Respiration</i> : aerobic and anaerobic; cell metabolism; explore the benefits of technology (microbial action) and design a newscast report

Unit 3: Genetic Continuity

Time: 25 hours

Unit Description

This unit explores the foundations of life as we know them to date. Students explore the basis of heredity and the role of DNA in this process building on the Grade 9 Science curriculum. The predictability of inheritance is studied using a variety of lab-based techniques and simulations (on-line and hands-on). In addition, students review how our current understanding of genetics has impacted on our understanding of ourselves as dynamic beings and on our societies through the impact of biotechnology. Students develop attitudes and values founded on Catholic social teaching and act to promote social responsibility. Students recognize that genetic research and screening give rise to serious ethical issues. Abstracts from Vatican documents should be made available to students.

The primary focus of the first activity is updating student knowledge of DNA and the mechanisms used by the cell to perpetuate this molecule. The role of DNA in the manufacture of protein and how this is controlled is also explored. Using the jigsaw method students could make a presentation about the historical developments that led to the modern concept of the gene.

The second activity introduces the concept of continuity, focusing on the role of DNA replication in ensuring the transmission of information from cell to cell within the body. The process of mitosis is investigated using prepared slides, and the differences between plants and animals is elaborated.

The third activity builds on the concept of continuity and extends it to the species level. How organisms maintain continuity within a species and yet are diverse in their individuality is explored with an emphasis on the processes of meiosis and its role in creating diversity. Students build models, study sample material from representative organisms, and consider various problems using simulations and model building.

The fourth activity returns the student to the practical applications of this information as first shown by Gregor Mendel. Students develop their skills in predicting the outcomes of various genetic crosses using the techniques first pioneered by Mendel. By using simulators like the Virtual Fly Lab, students study the behaviour of various genes in the transmission of traits. Resources and time permitting, students could design and carry out genetic crosses using *Drosophila* cultures.

The last activity deals with how application of our knowledge about the modes of inheritance can lead to an understanding of how various genetic disorders are passed from generation to generation. Through this knowledge, students gain respect for the diversity of the world's peoples. Students research genetic disorders and determine modes of inheritance. In addition, students develop the analytical skills necessary to construct a pedigree and then analyse the information presented to predict the outcome of various crosses.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus/Tasks
1	GCV.01,GCV.03; GC1.02; GC2.05; GC3.01,3.02,3.03 SIS.04,.05,.07,.10 CGE2a-e,3b,4b,4f,7d	K I C MC	<i>DNA the molecule of life:</i> describe its structure, and the processes of protein synthesis; Jigsaw presentation on scientists and discoveries regarding genetics
2	GCV.03; GC1.01; GC2.02 SIS.02,.07,.08,.09 CGE2a-e,3b-d,4d,7d,7i,7j	K I C MC	<i>Genetic Continuity I:</i> investigate through various lab activities
3	GCV.01,.02,.03; GC1.02, 1.04; GC2.01,2.03; GC3.01,3.02,3.03 SIS.05,.06,.07 CGE2a-e,3b-d,4d,7d,7i,7j	K I C MC	<i>Genetic Continuity II:</i> investigate through model building and simulation design
4	GCV.01,.02,.03; GC1.03, 1.05,1.06; GC2.02,2.03,2.04; GC3.01-3.03 SIS.01,.02,.03,.06,.07,.08 CGE2a-e, 3b-d,4d,7d,7i,7j	K I C MC	<i>Mendel: Predicting Heredity:</i> investigate through activities and complete problems on genetic crosses
5	GCV.01 -.03; GC1.05,1.03,1.07; GC2.02,2.03,2.05; GC3.01-3.03 SIS.04,.05,.10 CGE2a-e, 3b-d,4d,7d,7i,7j	K C MC	<i>Disorders:</i> write a report and complete pedigree studies and problem sets Web Scavenger Hunt - Genetic Disorders

Unit 4: Internal Systems and Regulation

Time: 26 hours

Unit Description

Students will continue to develop their knowledge of systems of living things introduced in Grades 5 and 8. This unit focuses on the major processes, mechanisms, and systems including the respiratory, circulatory, and digestive systems in animals and plants. The internal processes that plant and animal systems use for internal regulation will be investigated through laboratory investigations. Through independent research and information sheets, students will evaluate the impact of personal lifestyle decisions on human health and the technologies that are available to help humans maintain good health. The role of Canadians in the development of these technologies will be explored. This unit is organized into four activities. Teachers are encouraged to include numerous and varied lab activities to make this unit personally engaging for the students.

Activity 1 leads students to discover the importance of the concept of homeostasis through teacher-led discussions. Following this, students perform lab investigations, including dissection(s) – either real or virtual – to learn about the structure and functions of animal and plant systems (respiratory, circulatory and digestive systems).

Students discover in Activity 2 the feedback systems involved in maintaining their own body systems. How fitness levels relate to cardiovascular and respiratory systems is explored, and students participate to the best of their abilities in a series of simple cardiovascular activities. These activities could be done in the school gym, outside track field, or at a fitness centre. Teachers are cautioned, and should ascertain, whether any students have heart or respiratory conditions but encourage all students to participate as fully as possible. Students monitor themselves by recording their heart rates and breathing rates. In Activity 2 students describe how the use of prescription and non-prescription drugs can affect their body's homeostasis. Students could produce fact sheets about a specific drug (similar to those available from a local pharmacy).

In Activity 3, the teacher introduces a current issue, such as the use of steroids or amino acid supplements in sports and allows students time to research various aspects of the issue. The students could then debate the use of steroids/amino acid supplements. Alternatively, the teacher could present articles from newspapers and magazines outlining a specific topic and ask the students to read, analyse, and critique the article following the procedure used in the first unit (refer to sample unit: Diversity of Living Things). The teacher may invite the public health nurse or other practitioner to talk to the class about the impact that personal lifestyle decisions such as steroid use have on the health of individuals.

In Activity 4, the role that various technologies have on our understanding of internal systems is explored. This includes devices such as prosthetics, pacemakers, etc. Examples of Canadian contributions should be included (e.g., devices used in nuclear medicine). Students might present their findings in a seminar format. As an extension, students might design a web page for a particular device. Throughout this unit, the activities are designed to help students develop a sense of respect for life, themselves, and others. By critically examining possible lifestyle choices, students are exposed to the ethical and moral dilemmas we all face and are better prepared to make choices for themselves that reflect our faith culture.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus/Tasks
1	ISV.01,.02; IS1.01,.02,.03; IS2.01 SIS.01,.02,.03,.04,.07 CGE1d,2b,7i	K I	<i>Homeostasis and Animal and Plant Systems:</i> define and then describe the structure and function of basic life systems through dissection
2	IS1.04,05; IS2.02,.03 SIS.01,.02,.03,.04,.05,.06,.07 CGE1e,1j,2b,2c,3b,3c,3d,3e	K I C	<i>Feedback Systems and Fitness:</i> conduct personal cardiovascular analysis, and describe the effects of drugs on homeostasis and produce a fact sheet
3	ISV.03; IS3.04 SIS.05 CGE2b,2c,2e,4e,4f,4g,4h,7a,7b,7f	K C MC	<i>Lifestyle Choices:</i> presented with a research topic, complete an analysis of it
4	ISV.03; IS3.01,.02,.03 SIS.05,.10 CGE2c,2e,5e,7g,7i	K C MC	<i>Modern Applications of Technologies:</i> explore how technology is used today following a seminar format

Unit 5: Plant Anatomy Growth and Functions

Time: 24 hours

Unit Description

Students explore the role of plants in our biosphere and our society by studying the various uses of plants in modern life and the way in which plants contribute to the sustainability of ecosystems. In addition, students examine the various structures of plants and how these structures allow plants to survive.

The first activity begins by considering the many ways societies have made use of plants and their products. Students research how various plant-based products are used in food, medicine, and industrial processes, then share their knowledge with their peers. Part of this investigation focuses on the ways in which we manipulate plants in order to enhance their productivity. Students discuss the consequences of gene manipulation and reflect on the ethical issues that result from it.

In the second activity, students use prior knowledge of classification and taxonomy to classify plants into the major phyla. In doing so, students describe the main physiological, anatomical, and metabolic properties of the various plant groups, connecting that knowledge to the information gathered in the first activity.

The third activity focuses on the processes used by plants to acquire and recycle nutrients and the methods by which plants respond to changes in the environment. This activity permits the exploration of plant hormones and their uses in modern agricultural and industrial processes.

The last activity focuses on the natural environment and the role that plants play in changing ecosystems through ecological succession. Students use the information from the previous activities to explore the effects of different plant populations on a specific area or ecosystem.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus/Task
1	PAV.02,.03; PA1.06,1.07; PA2.04; PA3.01-3.04 SIS.01,.02,.03,.05,.06,.07 CGE1d,1e,2a,2b,2c,2d,2e, 3b,3c,3d,3f,4b,4d,4f,5b,7d,7i,7j	K I C MC	<i>Plant Products</i> : research and make a report on plants in food, medicine, etc.
2	PAV.01,.02; PA1.03,1.04; PA2.01 SIS.02,.03,.05,.07,.08,.09 CGE1d,1e,3b,3c,3d,3f, 4b,4d,4f,5b,7d,7i,7j	K I C MC	<i>Classify Plant Types</i> : investigate and compare the organ systems/physiological structures of each of the groups
3	PAV.01,.02; PA1.02,1.05; PA2.01,2.02,2.03; PA3.01,3.02 SIS.03,.04,.05,.07 CGE1d,1e,2b,3b,3c,3d,3f, 4b,4d,4f,5b,7d,7i,7j	K I C MC	<i>Monocots and Dicots</i> : perform lab investigations on plant structures and explore modern agricultural techniques
4	PAV.01,-.03; PA1.01; PA2.02 SIS.03,.04,.06,.09,.10 CGE1d,1e,3b,3c,3d,3f, 4b,4d,4f,5b,7d,7i,7j	K I C MC	<i>Factors Affecting the Growth and Development of Plants</i> : describe ecological succession and investigate nutrient requirements of plants

Teaching/Learning Strategies

In planning this course, consideration should be given to both the course expectations and the needs of individual students. The teacher should provide learning experiences which promote interest, understanding, and excellence. In order for this course to prepare students to meet the university entrance requirements, the teacher must emphasize the theoretical aspects of the course and incorporate relevant applications. The role of the teacher is to establish the conceptual framework to help the students develop specific skills and attitudes while considering the individual student's learning style. By fostering an atmosphere where learning is meaningful, integrative, challenging, active, and value-based, teachers can help their students become excited about learning.

Throughout this course, students should be given numerous and varied opportunities to acquire knowledge and develop skills and attitudes through a variety of teaching and learning strategies. The strategies that the teacher uses should provide students with multiple opportunities to develop and demonstrate their learning and skills across all four categories of the Achievement Chart. The following is a list of suggestions with examples of links to the course expectations.

- Expectations that require Knowledge can be developed through:
 - brainstorming; DV1.01
 - teacher-directed lessons and discussions; CF1.03
 - small group instruction;
 - independent research; GC1.05, CF2.05
 - self-directed learning, etc.; IS2.03
- Expectations that involve Inquiry can be met by:
 - conducting and analyzing experiments; IS2.02, CF2.01, GC2.02
 - designing lab investigations; PA2.02, GC2.01
 - formulating questions; CF2.03
 - solving problems; GC2.02

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- Expectations that encourage Communication can be demonstrated by:
 - written reports; DL2.03, DL3.02
 - group discussions; CF3.01
 - debates; CF3.03, IS3.04
 - seminars; IS3.01
 - student presentations (for example, oral presentations, video and audio presentations, skits, photo essay etc.); DL3.01.
 - Expectations where students expand their Knowledge to Make Connections can be developed through:
 - independent research;
 - exposure to experts in their field (for example, by attending university lectures or doing Internet research);
 - reflective papers; DL3.02;
 - portfolios; DL1.01;
 - participation in science fairs;
 - article critique; DL3.01.

Assessment & Evaluation of Student Achievement

The primary purpose of assessment and evaluation is to improve student learning. Information gathered through assessment helps the teacher determine the student's strengths and weaknesses in their achievement of the curriculum expectations in this course.

In order to allow students to demonstrate that they have mastered the knowledge and developed the skills required for university entrance, the teacher must establish a balanced assessment plan for the course and select appropriate methods, strategies, and tools. Students will be required to demonstrate that they have developed both independent research skills and independent learning skills. Assessment and evaluation must be based on the curriculum expectations for this course and the achievement levels outlined in *The Program Planning and Assessment, 2000* document. In designing and planning this course, the learning expectations were clustered in order to balance the categories within the Achievement Chart. The teacher must, at the beginning and throughout the course, share the assessment criteria with the students and their parents and give feedback that guides the students' efforts towards improvement. The assessment results should be used to motivate students and help them establish next steps in their learning goals. In order to ensure that assessment and evaluations are valid and reliable, the teacher must use assessment and evaluation strategies that:

- address both what the students learn and how well they learn it;
- are based on both the categories of knowledge and skills and on the achievement levels;
- are varied in nature, administered over a period of time, and demonstrate the full range of their learning;
- promote the students' ability to assess their own learning and to set specific goals.

Assessment practices must provide teachers with information on what students write, say, and do throughout this course.

- The corresponding methods of assessment are:
 - paper and pencil;
 - personal communication;
 - performance task.
- Possible assessment strategies include:
 - paper and pencil: tests, quizzes, concept maps, essay, written report/lab reports, research paper;
 - personal communication: interviews, conferences, journals, classroom discussions;
 - performance task: individual presentations, plays/skits, lab performance.

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- The tools used to effectively measure the students' learning and mastery of skills are:
 - checklists;
 - marking scheme;
 - rating scale;
 - rubric.

As a university preparation course, we recommend that teachers carefully consider a balanced weighting of the four categories of achievement throughout each unit and in the final evaluation. This will work to ensure that students have the opportunity to develop and demonstrate their level of achievement of the knowledge, independent research and learning skills necessary for this university preparation course. Knowledge could be assessed through multiple choice type questions, Inquiry through a lab practicum or dry lab question, Making Connections through an extended response, short essay type question, or critique of a journal article.

The Provincial Report Card contains separate sections for reporting on achievement of the curriculum expectations and for reporting on demonstrated skills required for effective learning. The student's final grade for this course will be determined as follows:

- Seventy per cent of the grade will be based on evaluations conducted throughout this course. This portion of the grade should reflect the students' most consistent level of achievement throughout the course, although special consideration should be given to the most recent evidence of achievement. It is recommended that a lab practicum be included in the summative evaluation of particular units rather than at the end of the course (e.g., a lab practical could be part of Unit 3-Genetic Continuity to assess lab skills developed within this unit).
- Thirty per cent of the grade will be based on a final evaluation administered towards the end of the course. The weighting of each of the four categories in the final evaluation should be consistent with the assessment/evaluation practices used throughout the course. It is recommended that the final evaluation for this university preparation course be in the form of a written final examination that consists of a balance of question types and levels of difficulty, not just multiple choice questions. Teachers may consider including an essay, portfolio etc. as part of the summative evaluation for this course.

Teachers may encourage students to design and conduct a Science Fair project which would allow them to further develop their independent research and learning skills. If this is to be used as part of the summative assessment for this course, care should be taken to ensure that a number of expectations from several units are incorporated.

Accommodations

Teachers must consider the needs of exceptional students in the planning of the science curriculum. Accommodation to the program activities and/or the environment may be necessary. Where the student has an Individual Education Plan (IEP), the teacher must meet the needs of the student as outlined in the Plan.

Exceptional students, as well as other students who are not identified as exceptional, but who have an IEP and are receiving special education programs and services, should be given every opportunity to achieve the curriculum expectations set out for this course.

A variety of teaching approaches may need to be used to help exceptional students achieve the learning expectations of this course. Examples of such approaches may include:

- using special resources (e.g., reading material consistent with students' reading levels and learning styles, audio tapes of difficult chapters, adapted computers);
- using a variety of teaching/learning strategies (e.g., special interest groupings for research projects, collaborative groups, mentorship programs, independent study plans);
- collaborating with resource teachers, library staff and other professionals;

- consulting with parents about providing appropriate study environment in the home;
- allowing more time for the completion of assignments or achievement of the learning expectations;
- providing alternative ways of completing tasks or presenting information (e.g., taped answers);
- simplifying the language of instruction;
- providing alternative homework assignments;
- providing alternative tasks for highly motivated and gifted students (e.g., encourage participation in district science fairs, subject specific university founded competitions, attendance at university sponsored activities/lectures).

Assessment procedures and strategies may also need to be altered. Examples include:

- changing the time requirement of assignments or assessment tasks;
- changing the format of the assessment material (e.g., braille);
- simplifying test instructions and the language of questions;
- allowing the use of scribes, tape recorders, word processors etc.

For English as a second language (ESL) students or English literacy development (ELD) students, teachers should provide opportunities for the students to demonstrate their learning by alternate means such as: pairing written instructions with verbal instructions; using key visuals to illustrate definitions; allow extra time for reading or written assignments; encourage the use of first language dictionaries for assignments.

For students with physical or learning impairments, classroom and laboratory activities should be altered to permit maximum participation. If possible, students with physical disabilities should be allowed access to sinks, lab desks, etc. that are appropriate to their needs.

Resources

Print Materials

- Berry, G. and D. Lynn. *Biology of Ourselves*. Toronto: J. Wiley & Sons, 1990. ISBN 0-471-79526-7
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CD-ROM

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Humans as Organisms. Fort Erie: Films for the Humanities and Sciences, 2000.
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Videos

A Journey through the Cell. Fort Erie: Films for the Humanities and Sciences, 2000. 2 part series: 25 min. each.
AIDS: A Biological Perspective. Toronto: kineticvideo.com. 30 min.
Alien Invaders: Biodiversity at Risk. Fort Erie: Films for the Humanities and Sciences, 2000. 30 min.
Animated Neuroscience and the action of nicotine, cocaine, and marijuana in the brain. Fort Erie: Films for the Humanities and Sciences, 2000. 25 min.
Biotechnology. Fort Erie: Films for the Humanities and Sciences, 2000. 23 min.
Genetic Discoveries, Disorders, and Mutations. Fort Erie: Films for the Humanities and Sciences, 2000. 26 min.
Hand-Me-Down-Genes. Fort Erie: Films for the Humanities and Sciences, 2000. 2 part series: 28 min.
Human Body 3. Toronto: National Geographic, 1998.
Human Health. Toronto: kineticvideo.com
Narcotics. Fort Erie: Films for the Humanities and Sciences, 2000. 30 min.
Practical Applications and Risks of Genetic Science. Fort Erie: Films for the Humanities and Sciences, 2000. 24 min.
Steroids. Fort Erie: Films for the Humanities and Sciences, 2000. 24 min.
Surviving AIDS. NOVA, 1999. 60 min.
The Global Impact of AIDS. Fort Erie: Films for the Humanities and Sciences, 2000. 50 min.
The Jungle Pharmacy: Nature's Remedy. Fort Erie: Films for the Humanities and Sciences, 2000. 27 min.
The New Living Body. Fort Erie: Films for the Humanities and Sciences, 2000. 10 part series, 20 min. each.
Understanding the Basic Concepts of Genetics. Fort Erie: Films for the Humanities and Sciences, 2000. 30 min.
The World of Living Organisms. Fort Erie: Films for the Humanities and Sciences, 2000. 10 part series: 15 minutes each.
Web of Life: Exploring Biodiversity. Fort Erie: Films for the Humanities and Sciences, 2000. 1 hour 55 min.

Websites

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.

Aquatic Ecosystems - <http://www.ec.gc.ca/water/index.htm>

Canada's Aquatic Environment - <http://www.aquatic.uoguelph.ca/wetlands.htm>

Cells alive - <http://www.cellsalive.com>

Ducks Unlimited - www.ducks.ca/edu/resource.html

Explorescience (interactive science simulations for students) - www.explorescience.com

Introduction to Aquatic Environments - <http://www.adopt-a-watershed.org/matrix.ae.htm>

Health Canada - <http://hc-sc.gc.ca/hpb/lcdc/bid/respdie>

Prominent invertebrates - <http://www.userpages.embc.edu/rrhudyl/micro.htm>

Virtual Fly Lab - <http://biologylab.awlonline.com>

World Wildlife foundation - <http://www.wwfcanada.org>

Other

Cells Poster Set. Fort Erie: Films for the Humanities and Sciences, 2000. (10 laminated posters)

OSS Considerations

Students can benefit from experiences in biology-related activities through Cooperative Education. They may consider a cooperative education placement related to this course. Students should explore biology-related careers throughout the course and consider them when they are developing their Annual Education Plan (AEP).

Students may choose to job shadow. This gives them an opportunity to observe and gain a better understanding of biology-related careers, for example in the area of health services.

Students should have a safe environment for learning, free from harassment of all types, including violence and expressions of hate. Learning activities should be designed to help students develop respect for human rights and dignity and to develop a sense of personal, social, and civic responsibility.

Students are required to complete forty hours of community involvement activities prior to graduation. They should consult their Board's list of eligible Christian Service activities to complete this requirement.

Students graduating from Ontario schools are expected to be technologically literate. Through the study of this science course, students should be able to understand and apply technological concepts to use computers in various applications and to analyse the implications of technology on individuals and society.

Coded Expectations, Biology, Grade 11, University Preparation, SBI3U

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., use proper techniques in preparing, using, and disposing of bacterial cultures);
- 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 determine the effects of quantity and quality of light on photosynthesis);
- SIS.04** · select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results (e.g., use characteristics of organisms and the principles and nomenclature of taxonomy to classify organisms; use proper terminology related to organs and tissues);
- 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;
- SIS.07** · communicate the procedures and results of investigations and research for specific purposes using data tables and laboratory reports (e.g., report on an experimental investigation of the movement of materials across a cell membrane);
- 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 (units of measurement of the *Système international d'unités*, or International System of Units);
- SIS.10** · identify and describe science- and technology-based careers related to the subject area under study (e.g., biochemist, forester, geneticist, physiotherapist, oncologist, horticulturist).

Cellular Functions

Overall Expectations

- CFV.01** · demonstrate an understanding of cell structure and function and the processes of metabolism and membrane transport;
- CFV.02** · investigate the fundamental molecular principles and mechanisms that govern energy-transforming activities in all living matter, whether it be animal, plant, or microbial;
- CFV.03** · demonstrate an understanding of the relationship between cell functions and their technological and environmental applications.

Specific Expectations

Understanding Basic Concepts

- CF1.01** – describe how organelles and other cell components carry out various cell processes (e.g., digestion, transportation, gas exchange, excretion) and explain how these processes are related to the function of organs;
- CF1.02** – identify and describe the structure and function of important biochemical compounds, including carbohydrates, proteins, lipids, and nucleic acids;

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- CF1.03** – describe the fluid mosaic structure of cell membranes, and explain the dynamics of passive transport (facilitated diffusion) and the processes of endocytosis and exocytosis of large particles;
- CF1.04** – explain the flow of energy between photosynthesis and respiration;
- CF1.05** – compare anaerobic respiration (including fermentation) and aerobic respiration and state the advantages and disadvantages for an organism or tissue of using either process;
- CF1.06** – illustrate and explain important cellular processes (e.g., protein synthesis, respiration, lysosomal digestion), including their function in the cell, the ways in which they are interrelated, and the fact that they occur in all living cells.

Developing Skills of Inquiry and Communication

- CF2.01** – design and carry out an investigation on cellular function, controlling the major variables (e.g., examine the movement of substances across a membrane; measure a metabolic process such as fermentation);
- CF2.02** – view and manipulate computer-generated, three-dimensional molecular models of important biochemical compounds, including carbohydrates, proteins, lipids, and nucleic acids;
- CF2.03** – identify new questions and problems stemming from the study of metabolism in plant and animal cells (e.g., What is the relationship between chloroplasts and mitochondria in plant cells?);
- CF2.04** – carry out, in a safe and accurate manner, biological tests for macromolecules found in living organisms (e.g., use iodine and Benedict’s solution to test for carbohydrates; use Sudan IV to test for the presence of lipids).

Relating Science to Technology, Society, and the Environment

- CF3.01** – present informed opinions on advances in cellular biology and possible applications through related technology (e.g., new treatments for cancer; the possibility of producing ethanol as a fuel; the uses of radioactive labelling, fluorescence of genetic material, or simulations of three-dimensional molecular structure);
- CF3.02** – explain how scientific knowledge of cellular processes is used in technological applications (e.g., how knowledge of a particular microbe is used in biotechnological applications in the pulp and paper industry or in the clean-up of oil spills);
- CF3.03** – analyse ways in which societal needs have led to technological advances related to cellular processes (e.g., document, using newspaper articles, the impact of public awareness on research to detect and treat diseases such as AIDS and hepatitis C).

Genetic Continuity

Overall Expectations

- GCV.01** · demonstrate an understanding of the necessity of meiosis and describe the importance of genes in transmitting hereditary characteristics according to Mendel’s model of inheritance;
- GCV.02** · perform laboratory studies of meiosis and analyse the results of genetic research related to the laws of heredity;
- GCV.03** · outline the scientific findings and some of the technological advances that led to the modern concept of the gene and to genetic technology, and demonstrate an awareness of some of the social and political issues raised by genetic research and reproductive technology.

Specific Expectations

Understanding Basic Concepts

- GC1.01** – demonstrate an understanding of the process and importance of mitosis (e.g., cell division and the phases of mitosis);

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- GC1.02** – explain how the concepts of DNA, genes, chromosomes, and meiosis account for the transmission of hereditary characteristics from generation to generation (e.g., explain how the sex of an individual can be determined genetically; demonstrate an understanding that the expression of a genetic disorder linked to the sex chromosomes is more common in males than in females);
- GC1.03** – describe and explain the process of discovery (e.g., the sequence of studies and the knowledge gained) that led Mendel to formulate his laws of heredity;
- GC1.04** – explain the process of meiosis in terms of the replication and movement of chromosomes;
- GC1.05** – describe genetic disorders (e.g., Down syndrome, cystic fibrosis, muscular dystrophy, fragile X syndrome) in terms of the chromosomes affected, physical effects, and treatment;
- GC1.06** – explain, using Mendelian genetics, the concepts of dominance, co-dominance, incomplete dominance, recessiveness, and sex-linkage;
- GC1.07** – predict the outcome of various genetic crosses.

Developing Skills of Inquiry and Communication

- GC2.01** – explain the process of meiosis, with reference to a computer simulation or to their own investigations with a microscope (e.g., using slides of grasshopper testis, explain what happens in the first and second stages of prophase and metaphase and anaphase 2 in meiosis);
- GC2.02** – solve basic genetic problems involving monohybrid crosses, incomplete dominance, co-dominance, dihybrid crosses, and sex-linked genes using the Punnett method;
- GC2.03** – organize data (e.g., in a table) that illustrate the number of chromosomes in haploid cells and diploid cells, and the number of pairs of chromosomes in diploid cells, that occur in various organisms before, during, and as a result of meiosis;
- GC2.04** – compile qualitative and quantitative data from a laboratory investigation on monohybrid and dihybrid crosses, and present the results, either by hand or computer (e.g., record observations using a “Virtual Fly” laboratory software package);
- GC2.05** – research genetic technologies using sources from print and electronic media, and synthesize the information gained (e.g., describe the Human Genome Project, transgenics, or the process of genetic screening; list the advantages and disadvantages of cloning or the genetic manipulation of plants).

Relating Science to Technology, Society, and the Environment

- GC3.01** – summarize the main scientific discoveries of the nineteenth and twentieth centuries that led to the modern concept of the gene (e.g., the discoveries of Hugo de Vries, W.S. Sutton, Thomas Morgan, J. Muller, Barbara McClintock, Rosalind Franklin, James Watson, and Francis Crick);
- GC3.02** – describe and analyse examples of genetic technologies that were developed on the basis of scientific understanding (e.g., the improvement of an experimental procedure to extract DNA from bacterial or plant cells);
- GC3.03** – identify and describe examples of Canadian contributions to knowledge about genetic processes (e.g., research into cystic fibrosis) and to technologies and techniques related to genetic processes (e.g., the invention of nuclear magnetic resonance [NMR]).

Internal Systems and Regulation

Overall Expectations

- ISV.01** · describe and explain the major processes, mechanisms, and systems, including the respiratory, circulatory, and digestive systems, by which plants and animals maintain their internal environment;
- ISV.02** · illustrate and explain, through laboratory investigations, the contribution of various types of systems and processes to internal regulation in plant and animal systems;
- ISV.03** · evaluate the impact of personal lifestyle decisions on the health of humans, and analyse how societal concern for maintaining human health has advanced the development of technologies related to the regulation of internal systems.

Specific Expectations

Understanding Basic Concepts

- IS1.01** – describe the process of ventilation and gas exchange from the environment to the cell (e.g., describe the pathway of oxygen from the atmosphere to the cell, and the roles of ventilation, haemoglobin, and diffusion in this process);
- IS1.02** – explain the role of transport or circulatory systems in the transport of substances in an organism (e.g., explain how nutrients, respiratory gases, end products of metabolism, and hormones or regulatory chemicals are transported from one area in an organism to another);
- IS1.03** – describe the importance of nutrients and digestion in providing substances needed for energy and growth (e.g., relate the need for carbohydrates in the diet to their role in cellular respiration; describe the many uses of proteins; describe how plants use nutrients);
- IS1.04** – demonstrate an understanding of how fitness level is related to the efficiency of metabolism and of the cardiovascular and respiratory systems;
- IS1.05** – describe how the use of prescription and non-prescription drugs can disrupt or help maintain homeostasis (e.g., describe the effects of acetylsalicylic acid, or ASA, on human systems).

Developing Skills of Inquiry and Communication

- IS2.01** – compare the anatomy of different organisms – vertebrate and/or invertebrate (e.g., carry out a dissection, or use a computer-simulated dissection, of a mammal or a fish to examine the heart, the pulmonary circulation system, the aorta, and other main arteries and veins, and compare the functions of the arteries and veins to those of xylem and phloem in plants);
- IS2.02** – design and carry out, in a safe and accurate manner, an experiment on feedback mechanisms, identifying specific variables (e.g., investigate feedback controls by comparing resting rates of heartbeat and breathing with those after exercise, and then again after rest);
- IS2.03** – select and integrate information about internal systems from various print and electronic sources, or from several parts of the same source (e.g., present information about special diets, such as those for vegans and diabetics; develop a pamphlet on how to treat the accidental ingestion of poisons).

Relating Science to Technology, Society, and the Environment

- IS3.01** – identify examples of technologies that have enhanced scientific understanding of internal systems (e.g., instruments used to monitor biological systems, such as the computer axial tomography [CAT] scanner or the stethoscope, and products used to alter or augment them, such as pharmaceuticals, prosthetics, and pacemakers; the use of radio-isotopes to identify and combat diseases);
- IS3.02** – provide examples of Canadian contributions to the development of technology for examining internal systems (e.g., devices used in nuclear medicine);
- IS3.03** – analyse and explain how societal needs have led to scientific and technological developments related to internal systems (e.g., explain how the need to maintain wellness in humans led to the development of dietary products and fitness equipment; analyse how social awareness of the importance of organ donation has led to improved techniques for transplanting organs, such as the liver);
- IS3.04** – present informed opinions about how scientific knowledge of internal systems influences personal choices concerning nutrition and lifestyle (e.g., explain the advantages and disadvantages of taking steroids or amino acid supplements; explain the scientific reasons for committing personal time to exercise).

Diversity of Living Things

Overall Expectations

- DLV.01** · demonstrate an understanding of the diversity of living organisms through applying the concepts of phylogeny and taxonomy to the kingdoms of life (including Eubacteria and Archeobacteria) and viruses;
- DLV.02** · use techniques of sampling and classification to illustrate the fundamental principles of taxonomy;
- DLV.03** · relate the role of common characteristics and diversity within the kingdoms of life (including Eubacteria and Archeobacteria) to the importance of maintaining biodiversity within natural ecosystems, and explain the use of micro-organisms in biotechnology.

Specific Expectations

Understanding Basic Concepts

- DL1.01** – define the fundamental principles of taxonomy and phylogeny (e.g., provide definitions of concepts such as genus, species, and taxon, and explain how species are categorized and named according to structure and/or evolutionary history);
- DL1.02** – compare and contrast the structure and function of different types of prokaryotic and eukaryotic cells (e.g., compare prokaryotic and eukaryotic cells in terms of genetic material, metabolism, and organelles/cell parts);
- DL1.03** – describe selected anatomical and physiological characteristics of representative organisms from each life kingdom and a representative virus (e.g., describe gas exchange mechanisms and structures, or reproductive processes and components);
- DL1.04** – compare and contrast the life cycles of representative organisms from each life kingdom and a representative virus (e.g., draw and label the life cycles of representative organisms, and make a chart comparing the features of the life cycles);
- DL1.05** – explain the importance of sexual reproduction (including the process of meiosis) to variability within a population.

Developing Skills of Inquiry and Communication

- DL2.01** – demonstrate, through applying classification techniques and terminology, the usefulness of the system of scientific nomenclature in the field of taxonomy;
- DL2.02** – classify representative organisms from each of the kingdoms (e.g., classify organisms according to their nutritional pattern, type of reproduction, habitat, and general structures);
- DL2.03** – use appropriate sampling procedures to collect various organisms in a marsh, pond, or other ecosystem, and classify them following the principles of taxonomy.

Relating Science to Technology, Society, and the Environment

- DL3.01** – explain the relevance of current studies of viruses and bacteria to the field of biotechnology (e.g., give examples of how viruses and bacteria are used in biotechnology);
- DL3.02** – demonstrate an understanding of the connection between biodiversity and species survival (e.g., state the advantages to a population of having genetic variations between individuals – such as the resistance to infection by “new” micro-organisms, the resistance of insects to pesticides, or the resistance of bacteria to antibiotics; explain why some species and not others survive an environmental stress).

Plants: Anatomy, Growth, and Functions

Overall Expectations

- PAV.01** · describe the major processes and mechanisms by which plants grow, develop, and supply various products, including energy and nutrition, needed by other organisms;

PAV.02 · demonstrate an understanding, based in part on their own investigations, of the connections among the factors that affect the growth of plants, the uses of plants, and the ways in which plants adapt to their environment;

PAV.03 · evaluate how the energy and nutritional needs of a population influence the development and use of plant science and technology.

Specific Expectations

Understanding Basic Concepts

PA1.01 – illustrate the process of succession and the role of plants in the maintenance of diversity and the survival of organisms;

PA1.02 – describe the structure and function of the components of each of the leaf, the stem, and the root of a representative vascular plant (e.g., describe the path of water from the soil through the plant);

PA1.03 – explain how non-vascular plants (e.g., multicellular algae, bryophytes) function without a specialized vascular system;

PA1.04 – differentiate between monocot and dicot plants by observing and comparing the structure of their seeds and identifying vascular differences between plants;

PA1.05 – describe the effects of growth regulators (e.g., auxins, gibberellins, cytokinins);

PA1.06 – describe and explain some of the food and industrial processes that depend on plants;

PA1.07 – describe and explain some of the uses of plant extracts in food and therapeutic products.

Developing Skills of Inquiry and Communication

PA2.01 – design and carry out an experiment to determine the factors that affect the growth of a population of plants, identifying and controlling major variables (e.g., examine the effect on plant growth of the quantity of nutrients, or the quantity and quality of light, or temperature, or salinity);

PA2.02 – describe the nutrients required for the development of plants (e.g., describe the uses of nitrogen, phosphorus, and potassium in the plant, and relate them to fertilizer content; consider different stages in the growth of plants, from germination through growth, flowering, and fruit production, and indicate the appropriate fertilizer to be used at each stage);

PA2.03 – identify, using a microscope and models, the plant tissues in roots, stems, and leaves (e.g., use a microscope to identify tissues such as xylem and phloem throughout the plant);

PA2.04 – compile information about the chemical products derived from plants and, either by hand or computer, display the information in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots (e.g., make a chart of plants and their related products).

Relating Science to Technology, Society, and the Environment

PA3.01 – identify various factors that result in trade-offs in the development of food technologies (e.g., explain why vegetable growers might prefer varieties that “travel well” – that is, don’t spoil easily – over those with the most flavour or nutritional value);

PA3.02 – describe and explain ways in which society supports and influences plant science and technology (e.g., analyse the influence on food production technologies of the constant demand for fresh fruit at affordable prices);

PA3.03 – express opinions supported by their own research about the case for funding certain projects in plant science or technology rather than others (e.g., evaluate the relative merits, for funding purposes, of research projects on genetic manipulation of plants over projects related to the development of organic products);

PA3.04 – describe how a technology related to plants functions (e.g., long-term use of pesticides, including herbicides), and evaluate it on the basis of identified criteria such as safety, cost, availability, and impact on everyday life and the environment.

Ontario Catholic School Graduate Expectations

The graduate is expected to be:

A Discerning Believer Formed in the Catholic Faith Community who

- CGE1a** -illustrates a basic understanding of the **saving story** of our Christian faith;
- CGE1b** -participates in the **sacramental life** of the church and demonstrates an understanding of the centrality of the Eucharist to our Catholic story;
- CGE1c** -actively reflects on **God’s Word** as communicated through the Hebrew and Christian scriptures;
- CGE1d** -develops attitudes and values founded on Catholic **social teaching** and acts to promote social responsibility, human solidarity and the common good;
- CGE1e** -speaks the **language of life**... “recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it.” (Witnesses to Faith)
- CGE1f** -seeks intimacy with God and celebrates **communion** with God, others and creation through prayer and worship;
- CGE1g** -understands that one’s purpose or **call in life** comes from God and strives to discern and live out this call throughout life’s journey;
- CGE1h** -respects the **faith traditions**, world religions and the life-journeys of **all people of good will**;
- CGE1i** -integrates faith with life;
- CGE1j** -recognizes that “sin, human weakness, conflict and forgiveness are part of the human journey” and that the cross, the ultimate sign of forgiveness is at the heart of **redemption**. (Witnesses to Faith)

An Effective Communicator who

- CGE2a** -listens actively and critically to understand and learn in light of gospel values;
- CGE2b** -reads, understands and uses written materials effectively;
- CGE2c** -presents information and ideas clearly and honestly and with sensitivity to others;
- CGE2d** -writes and speaks fluently one or both of Canada’s official languages;
- CGE2e** -uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.

A Reflective and Creative Thinker who

- CGE3a** -recognizes there is more grace in our world than sin and that hope is essential in facing all challenges;
- CGE3b** -creates, adapts, evaluates new ideas in light of the common good;
- CGE3c** -thinks reflectively and creatively to evaluate situations and solve problems;
- CGE3d** -makes decisions in light of gospel values with an informed moral conscience;
- CGE3e** -adopts a holistic approach to life by integrating learning from various subject areas and experience;
- CGE3f** -examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society.

A Self-Directed, Responsible, Life Long Learner who

- CGE4a** -demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;
- CGE4b** -demonstrates flexibility and adaptability;
- CGE4c** -takes initiative and demonstrates Christian leadership;
- CGE4d** -responds to, manages and constructively influences change in a discerning manner;
- CGE4e** -sets appropriate goals and priorities in school, work and personal life;
- CGE4f** -applies effective communication, decision-making, problem-solving, time and resource management skills;
- CGE4g** -examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
- CGE4h** -participates in leisure and fitness activities for a balanced and healthy lifestyle.

A Collaborative Contributor who

- CGE5a** -works effectively as an interdependent team member;
- CGE5b** -thinks critically about the meaning and purpose of work;
- CGE5c** -develops one's God-given potential and makes a meaningful contribution to society;
- CGE5d** -finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;
- CGE5e** -respects the rights, responsibilities and contributions of self and others;
- CGE5f** -exercises Christian leadership in the achievement of individual and group goals;
- CGE5g** -achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others;
- CGE5h** -applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

A Caring Family Member who

- CGE6a** -relates to family members in a loving, compassionate and respectful manner;
- CGE6b** -recognizes human intimacy and sexuality as God given gifts, to be used as the creator intended;
- CGE6c** -values and honours the important role of the family in society;
- CGE6d** -values and nurtures opportunities for family prayer;
- CGE6e** -ministers to the family, school, parish, and wider community through service.

A Responsible Citizen who

- CGE7a** -acts morally and legally as a person formed in Catholic traditions;
- CGE7b** -accepts accountability for one's own actions;
- CGE7c** -seeks and grants forgiveness;
- CGE7d** -promotes the sacredness of life;
- CGE7e** -witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society;
- CGE7f** -respects and affirms the diversity and interdependence of the world's peoples and cultures;
- CGE7g** -respects and understands the history, cultural heritage and pluralism of today's contemporary society;
- CGE7h** -exercises the rights and responsibilities of Canadian citizenship;
- CGE7i** -respects the environment and uses resources wisely;
- CGE7j** -contributes to the common good.

Unit 1: Diversity of Living Things

Time: 18 hours

Unit Description

Students investigate the diversity of living organisms. The activities are arranged as a scaffolding of skills and knowledge that will allow students to learn and apply the principles of phylogeny and taxonomy. The importance of biodiversity in maintaining natural ecosystems is studied. Students explore the growing field of biotechnology and its growing impact on our daily lives. Students integrate scripture and Church teaching in the critical analysis of the role of biotechnology in human society and natural ecosystems. Areas of development in this unit emphasize research and communication skills. The skills involved in proper lab procedures will be done in later units.

Students produce a Book of Life, which is the key assessment task for the Unit. It incorporates materials from several activities done in the unit. Teachers may choose to use it as a summative task for Activities 1 and 2 only or may continue its use in Activity 4.

The first activity clusters expectations that assist students in developing an understanding of the fundamentals of classification. The second activity clusters expectations related to the skills needed to collect and classify specimens observed on the field trip. This unit includes a mandatory field study. Therefore, this unit would be most appropriately done when the weather is suitable and students would find the greatest diversity of organisms in a local habitat. The third activity focuses on the role of sexual reproduction in maintaining variability within populations and explains the use of micro-organisms in biotechnology. In the fourth activity students research and then participate in a symposium focusing on the connection between biodiversity and species survival.

Students develop a respect for and understanding of the diversity of life on Earth within a faith-filled context that reflects the sacramental nature of God's creation. Students also explore their role as stewards in maintaining the biodiversity of life.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Tasks
1. Classification and Dichotomous Keys	360 min	DLV.01,02; DL1.01,1.02, 1.03,1.04; DL2.01,2.02 CGE2a,2b,2e,3e,7d,7i SIS.04	K I C MC	- develop a dichotomous key and classify unknown figures - create a Book of Life - classify organisms
2. Field Study: The Organisms in an Aquatic Ecosystem	240 min	DLV.01,.02; DL2.03; DL3.02 CGE2c,2d,3e,4a,4b,4f, 5a,5e,5f,7a SIS.01,.02,.04,.06,.07	I C	Field Trip: participate and complete a report on an Aquatic study
3. How Different are They?	240 min	DLV.01,.03; DL1.05; DL3.01 CGE1e,2b,2c,2d,2e,3d,3f, 4f,5a,5e SIS.05,.10	K C MC	- complete worksheets on population variability - critique articles/video - create a job ad
4. Symposium: Who Let the Genie Out of the Bottle?	240 min	DLV.03; DL3.01; 3.02 CGE2b,2c,2d,4a,4f,5a,5e,5g SIS.05, .06	K C MC	- participate in a symposium on the use of biotechnology

Activity 1: Classification and Dichotomous Keys

Time: 360 minutes

Description

This activity clusters expectations assisting students to develop an understanding of the fundamental principles and concepts involved in taxonomy and phylogeny. A series of lab-based activities take students through a progression of steps that build the skills necessary to develop and use dichotomous keys. Students develop their own Book of Life in which they record a representative organism from each of the major groups, phyla, divisions, or sections of the five kingdoms.

Strand(s) & Learning Expectations

Strand(s): Diversity of Living Things

Ontario Catholic School Graduate Expectations

CGE2a - listens actively and critically to understand and learn in light of gospel values;

CGE2b - reads, understands, and uses written materials effectively;

CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology, and information systems to enhance the quality of life;

CGE3e - adopts a holistic approach to life by integrating learning from various subject area and experience;

CGE7d - promotes the sacredness of life;

CGE7i - respects the environment and uses resources wisely.

Overall Expectations

DLV.01 - demonstrate an understanding of the diversity of living organisms through applying the concepts of phylogeny and taxonomy to the kingdoms of life (including Eubacteria and Archaeobacteria) and viruses;

DLV.02 - use techniques of sampling and classification to illustrate the fundamental principles of taxonomy.

Specific Expectations

DL1.01 - define the fundamental principles of taxonomy and phylogeny;

DL1.02 - compare and contrast the structure and function of different types of prokaryotic and eukaryotic cells;

DL1.03 - describe selected anatomical and physiological characteristics of representative organisms from each life kingdom and a representative virus;

DL1.04 - compare and contrast the life cycles of representative organisms from each life kingdom and a representative virus;

DL2.01 - demonstrate, through applying classification techniques and terminology, the usefulness of the system of scientific nomenclature in the field of taxonomy;

DL2.02 - classify representative organisms from each of the kingdoms;

Scientific Investigation Skills

SIS.04 - select and use appropriate numeric, symbolic, graphical, and linguistic modes of interpretation to communicate scientific ideas, plans, and experimental results.

Planning Notes

- The Book of Life is the central assessment activity for this unit and is introduced in Activity 1.3. Students insert work from Activities 1.3, 1.4 and 1.5 as well as work from Activities 2 and 4 into the Book. Refer to Appendix 3 for a detailed description of the Book of Life. **Note** that Classification Data Sheets (CDSs) are referred to and used in activities 1.3, 1.4, 1.5, and 2 (refer to Appendix 4).

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- Prepare 12 (or one bag per pair of students) classification “grab bags.” Each “grab bag” is to contain 20 items (identical items for each bag) that the students will sort and classify (e.g., paper clip, pencil, eraser, ribbon, button, etc.), (Activity 1.1).
 - Create a sample dichotomous key illustrating the classification of a number of items selected by the teacher. This will serve as a model for students in classifying the figures and creating their own dichotomous keys. There should be space to list the criteria that students use at each fork in the key. (See Appendix 1 and 2), (Activity 1.1).
 - Prepare a separate sheet of 5-10 unknown figures to be classified by the students using their dichotomous keys. The teacher may wish to introduce a heterogeneous figure (consisting of two or more different shapes) to initiate discussion about how keys need to be modified in the light of new information. (See Appendix 1 and 2), (Activity 1.1).
 - Book the computer lab or the library for Activity 1.3. If access to the Internet or a Library/Resource Centre with adequate resources is not available then either students or the teacher need to collect the resources prior to class. See Appendix 3 for teacher notes on The Book of Life (Activity 1.2).
 - The students need to have available the names of the domains, kingdoms, groups, phyla and divisions that they will be searching for a representative organism. This will avoid problems on the Internet of logging onto an unsuitable site using the common names of organisms.(Activity 1.2).
 - Duplicate copies of the Classification Data Sheet (see Appendix 4) or provide students with access to a disc copy of it. (Activity 1.2, Activity 1.3).
 - Provide students with criteria for the size and structure of the Book of Life to be constructed. Provide a list of the major domains, kingdoms, groups, phyla, divisions, and sections, as well as a virus, from which a representative organism (for each group, phyla, division, section or virus) must be selected. Provide an outline of information to be gathered about each organism (e.g., cell type, nutritional patterns, metabolism, reproduction and life cycle, life style, general structures and functions and habitat), key search words (i.e., scientific names of major phyla, etc.).
 - Create an assessment rubric or marking scheme for the Book of Life for Activity 1.2.
 - When designing an introduction to the fundamental principles of taxonomy and phylogeny it is recommended that the three domain, five kingdom system be used (Activity 1.2). Note that Monerans are split between two domains and yet comprise one kingdom. The teacher could address the diversity of Monerans and the difficulty when classifying them.
 - Prepare a chart to compare and contrast representative organisms from each kingdom and domain. The chart could be divided in the following way: across the top list the domains - Domain Archaea, Domain Eubacteria, Domain Eukarya, Kingdom Monera, etc.... and down the side: (1) cell type (eukaryote/prokaryote); and (2) life cycles (drawing & description) - use the Classification Data sheets as a model. (Activity 1.3).
 - Assemble a collection of preserved insects (or plants) from various orders (or divisions) for classification purposes (20 - 30 organisms are recommended). Obtain classification keys for these organisms.(e.g., <http://pc65.frontier.osrhe.edu/hs/science/binsect.htm>), (Activity 1.4).
 - Gather pictures, microslides, preserved or living organisms that represent a variety of taxa for students to observe (Activity 1.2).

Prior Knowledge & Skills

Grade 9, Science, Academic: Classification of Matter

Teaching/Learning Strategies

Activity 1.1: The classification “grab bag” (70 minutes)

The teacher:

- introduces the activity and assigns students to work in groups of two. Provides each group with a classification bag. Students are instructed to group the items in the bag into two to five groups and to record the criteria used;
- allows students to report on the criteria they used and as a class discuss which criteria was most commonly used and why;
- discusses how society uses various classification systems;
- discusses the need for scientists to classify organisms and instructs students to make a web diagram based on the question “What does a modern taxonomist use for characterizing organisms?” (e.g., morphology, physiology, reproduction, behaviour, habitat, etc.);
- introduces the concept of a dichotomous key and demonstrate its use;
- distributes copies of Appendix 1 and Appendix 2;
- provides students with a worksheet containing new figures (five or more, containing ones that are composites, see Planning Notes) and instructs students to use the keys developed to classify these new figures;
- assigns students to groups to compare their dichotomous keys and how well they worked for the new figure set. The teacher allows students time to share findings with the class - what is necessary for a “good” key? Students can do a self-assessment of their keys;
- discusses what scientists would do if they discovered an organism that couldn’t be classified using the known keys.

Students:

- carry out the grab-bag activity and share with the class the criteria that they used for establishing their groups;
- brainstorm and make a web diagram suggesting the characteristics used by modern taxonomists;
- develop a dichotomous key given a template and worksheet (Appendix 1 and 2) then use their key to classify a different set of figures - ones containing composites of shapes found in the original worksheet;
- in groups, compare their keys then share their conclusions with the class - what is necessary for a key to work well? Complete a self-assessment of their keys.

Activity 1.2: The Book of Life (150 minutes)

The teacher:

- introduces the fundamental principles of taxonomy and phylogeny using a phylogenetic tree for a group of organisms (e.g., Darwin’s finches - see Campbell). Describes how scientists determine common ancestors;
- outlines a ‘tree of life’ using the three domains and five kingdoms used by scientists to classify living organisms;
- outlines the ‘Book of Life’ assignment providing an assessment rubric and blank Classification Data Sheets (CDSs). (See Appendix 3);
- makes available pictures, microslides, preserved or living organisms from various taxa for students to observe (see Internet Resources);
- instructs students how and where to begin researching one representative organism from each of the domains and kingdoms discussed and instructs students on how to complete the CDSs. (One sheet for each organism researched). The teacher may provide a resource list for students to use for the Internet. (see Resources);

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- instructs class to arrange their CDSs in their Book of Life according to the principles of phylogeny. (Simple to complex - Archaea, Eubacteria ...);
 - invites students to reflect on the creative power and wisdom of God. (e.g., Ps104: Praise of God the Creator could be used).

Students:

- prepare a Book of Life (See Appendix 3);
- research a representative organism from each of the major groups, phyla, divisions, and sections provided by the teacher and complete a Classification Data Sheet (CDS) for each organism researched;
- observe organisms, pictures, etc. provided by the teacher;
- arrange the CDS in their Book of Life according to the principles of phylogeny (as described by the teacher).

Activity 1.3: Comparing Organisms (75 minutes)

The teacher:

- assists the class in preparing a chart comparing and contrasting representative organisms from each of the domains and kingdoms discussed in Activity 1.2. Names of the domains and kingdoms appear across the top with their characteristics down the side. Students should be instructed to use the CDSs they completed in Activity 1.2 for this activity;
- makes available the pictures/microslides etc. from Activity 1.3 for student observation, if necessary;
- divides class into small groups (three or four students/group) to discuss the findings. (**Note:** students are likely to choose different representative organisms for each domain/kingdom and therefore identify a variety of characteristics). Discuss with the class what increasing complexity means and the importance of increased complexity for survival. Poses the question (or similar one): “Does it follow that the most successful biological organisms are the most complex?”
- collects and assesses student charts.

Students:

- prepare a chart comparing and contrasting various organisms;
- complete the chart using their individual CDSs from Activity 1.2;
- share, in small groups their individual charts, discussing their findings and noting the differences within kingdoms and domains;
- discuss the significance of increasing complexity of organisms within domains and kingdoms and realize that it does not follow that the most complex biological organisms are the most successful;
- submit individual charts for assessment.

Activity 1.4: Classification Of Insects (Plants) to Orders (75 minutes)

The teacher:

- arranges specimens of insects or plants at stations in the room and instructs students to make observations at each station and monitors student movement and assists where necessary. Obtains a classification key for identification of insects (plants) by Order and introduces new terminology and provides a glossary of terms used on the specific key. Students might make an individual glossary of terms and add this to their Book of Life; (<http://pc65.frontier.osrhe.edu/hs/science/binsect.htm>) for insects;
- provides blank Classification Data Sheets, one for each specimen;
- collects and assesses individual CDSs;
- returns CDSs to students and instructs them to insert them in the proper location within their Book of Life (using principles of phylogeny).

Students:

- make observations at each station and use a dichotomous key provided to classify the specimens. Each student completes as much of the CDSs as possible based on their observations;
- research for the remaining information necessary to complete each CDS and submit them for assessment;
- insert the corrected CDSs in the proper location in their Book of Life using the principles of phylogeny.

Assessment & Evaluation of Student Achievement

- roving conferences as a formative assessment of the student's knowledge and teamwork learning skills (Activity 1.1)
- self assessment of the dichotomous key is assessed formatively for knowledge (Activity 1.1) (DLV.02)
- "Book of Life" is assessed for Knowledge/Understanding and Communication using a rubric (Activity 1.2) (DLV.01; DL 1.02; DL 1.03)
- Classification Data Sheets are assessed for Knowledge/Understanding using a checklist (Activity 1.3, 1.4) (DLV.01; DVL1.01,1.04, 2.01, 2.02; SIS.04)
- Compare & Contrast chart can be assessed for Knowledge/Understanding using a marking scheme (Activity 1.3) (DL1.02, DL1.04).

Accommodations

- Provide a key with pictures for students with reading disabilities.
- Reduce the number of steps in developing a dichotomous key by reducing the number of specimens to be classified for some students.
- Provide a key that is partially complete (first step or two done), and ask the student to complete the key with the items left.
- Use an observational checklist to record performance criteria.
- Pair students with visual disabilities with a student of vision in the normal range.
- Make sure that stations are accessible by wheelchair. Otherwise, have the students remain seated and move the specimens in a clockwise fashion at the end of each interval.
- Use the virtual lesson "Classifying Insects Via the Internet."
<http://ericir.syr.edu/Virtual/Lessons/Science/Biological/BIO0113.html>
- Enrichment activities could include: alternative organisms to classify (from another kingdom); classify a select number of insects to the species level; students develop a key for a variety of leaves from various trees. Students can review Stephen Jay Gould's book on baseball and evolutionary success, *Full House: The Spread of Excellence from Plato to Darwin*, 1996.

Resources

Text

Campbell, Neil. *Biology*. Don Mills, Ontario: The Benjamin/Cummings Publishing Company, Inc., 1987. ISBN: 0-8053-1840-2

Catechism of the Catholic Church. Ottawa, Ontario: Publications Service, Canadian Catholic Conference of Bishops, 1994. ISBN: 0-88997-281-8

The Holy Bible

Internet

The Phylogeny of Life - <http://www.ucmp.berkeley.edu/exhibit/phylogeny.html>

Biological Diversity: Classification -

http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookDivers_class.html

Phylogeny Exercise - <http://www.utm.edu/~rirwin/b120lab.htm>
Classification - wysiwyg://100/<http://natureriche.tripod.com/class.html>
A System of Scientific Classification -
<http://www.caosclub.org/nsw/nature/teachdata/path/birdpgs/sciname.html>
Cladistics and Early Hominid Phylogeny - <http://www.encyclopedia.com/articles/02793.html>
Kingdoms of Living Things - <http://daphne.palomar.edu/animal/kingdoms.htm>
Classification of Organisms -
<http://www.fc.peachnet.edu/floyd/academ...ogy/1c/261/261classificationoutline.htm>
Classifying Insects via Internet - <http://ericir.syr.edu/Virtual/Lessons/Science/Biological/BIO0113.html>
Comparing Prokaryotic and Eucaryotic Cells -
<http://heg-school.awl.com/be/companion/tfc6e/study/ol/olch04.html>
Classification and Phylogeny - <http://www.bact.wisc.edu/Bact303/Phylogeny>
Classifying Bacteria - <http://www.bact.wisc.edu/Bact303/TheProkaryotes>
<http://phylogeny.arizona.edu/tree/life.html>
Classification Lab - wysiwyg://26/http://www.sidwell.edu/us/...ssification_Lab/classification_lab.html
Tree of Life - http://www.sidwell.edu/us/science/vlb5/Labs/Classification_Lab/tree2.html
Kingdoms - for example: http://www.sidwell.edu/us/science/vlb5/Labs/Classification_Lab/monera.html
Introduction to Taxonomy - <http://www.phage.org/black09.htm>

Dichotomous Keys

Key to the Insect Orders and dichotomous keys - <http://pc65.frontier.osrhe.edu/hs/science/binsect.htm>
Dichotomous Key for the Identification of Insects by Order -
<http://ckwww.nothville.k12.us/insect/dkey1.html>
Dichotomous Tree Key - <http://www.dnr.state.wi.us/org/caer/ce/eeek/nature/treekey/treeindex.htm>
Fruit Key - <http://130.17.2.215/key/key.html>
Constructing a Dichotomous Key - <http://www.lit.edu/~smile/bi8699.html>
How to Construct and Use a Dichotomous Key -
<http://www.zoo.utoronto.ca/able/volumes/vol-12/7-timme/7-timme.htm>
Dichotomous Key - <http://www.orst.edu/instruc/for241/dk/>

Activity 2: Field Study: The Organisms in an Aquatic Ecosystem

Time: 240 minutes

Description

Students apply their knowledge of invertebrate taxonomy to classify organisms collected in an aquatic ecosystem (or other suitable ecosystem). Students record information about the organisms' habitat and the concept of biodiversity and species survival is explored through the analysis of a food web representative of the site.

Strand(s) & Learning Expectations

Strand(s): Diversity of Living Things

Ontario Catholic School Graduate Expectations

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE2d - writes and speaks fluently one or both of Canada's official languages;

CGE3e - adopts a holistic approach to life by integrating learning from various subject areas and experience;

CGE4a - demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;

CGE4b - demonstrates flexibility and adaptability;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE5e - respects the rights, responsibilities and contributions of self and others;

CGE5f - exercises Christian leadership in the achievement of individual and group goals;

CGE7a - acts morally and legally as a person formed in Catholic traditions.

Overall Expectations

DLV.01 - demonstrate an understanding of the diversity of living organisms through applying the concepts of phylogeny and taxonomy to the kingdoms of life (including Eubacteria and Archaeobacteria) and viruses;

DLV.02 - use techniques of sampling and classification to illustrate fundamental principles of taxonomy.

Specific Expectations

DL2.03 - use appropriate sampling procedures to collect various organisms in a marsh, pond or other ecosystem, and classify them following the principles of taxonomy;

DL3.02 - demonstrate an understanding of the connection of biodiversity and species survival.

Scientific Investigation Skills

SIS.01 - demonstrate an understanding of safety practices consistent with Workplace Hazardous Materials Information System legislation by selecting and applying appropriate techniques for handling, storing and disposing of laboratory materials;

SIS.02 - select appropriate instruments and use them effectively and accurately in collecting observations and data;

SIS.04 - select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results;

SIS.06 - compile, organize, and interpret data, using appropriate formats and treatments, including tables, flowcharts, graphs, and diagrams;

SIS.07 - communicate the procedures and results of investigations and research for specific purposes using data tables and laboratory reports.

Planning Notes

Administrative

This activity will require advance planning for the selection of an appropriate site for a field study. A local pond, stream or creek may be used.

- Check with the local land owners for permission or local conservation authorities for programs.
- Book transportation and complete the appropriate Board permission forms.
- Prepare a rubric to assess student field work and their final field report. The final report might include: an introduction (description of the site, principles of classification, and sampling techniques), materials, procedures, observations (Classification Data Sheets, (CDSs) and other observation sheets), discussion and reflection, and works cited.
- Canvass parents/guardians of students to assist in supervision.

Classroom

- Students will either have to develop their own observation sheets or become familiar with those provided.
- The teacher provides Classification Data Sheets.

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- Equipment includes: hip or chest waders, fine sieve or net, sample tray, specimen bottles, field guides (common trees of the region, common weeds/wild flowers of the region, insects), clipboards, magnifying glasses, classification keys, gloves, and forceps, and emergency medical kit.
 - The teacher develops appropriate checklists for the assessment and evaluation of this field study, including sampling techniques.
 - Students should be organized into groups of three or four.

Field Preparation

- The teacher should be familiar with the chosen site and assign groups to different locations at the site. In addition, familiarity will help to identify potential hazards such as fast or deep water that must be factored into preparations for the field study.
- The teacher should review student health information, noting possible allergic reactions and the appropriate response.

Prior Knowledge and Skills

Grade 10, Science, Academic: The Sustainability of Ecosystems and Food Webs

Teaching/Learning Strategies

Activity 2.1: Planning for the Field Study (75 minutes)

The teacher:

- assigns students to groups and outlines both individual and group responsibilities. Each student must participate in the collection and classification of the organisms and complete CDSs for each organism observed;
- provides the rubric outlining the evaluation criteria (see Planning Notes for suggestions);
- reviews taxonomic principles from Activity 1.3-1.5;
- instructs on the appropriate methods of collecting and safe handling of live specimens;
- cautions students about respect for the environment;
- facilitates group organization process and assigns each group to a particular section of the stream, pond, creek, etc.;
- provides blank Collection Data Sheets (see Appendix 4) and additional observation sheets;
- provides classification equipment, e.g., classification keys and field guides;
- discusses appropriate clothing and supplies needed for field work.

Students:

- identify individual responsibilities within the group (e.g., describing the habitat, who will go into the water, etc.) (**Note:** all students must be involved in the collection and classification of the organisms);
- gather and organize the materials being taken to the field (suggest each group use a plastic grocery bag);
- become familiar with a variety of sampling techniques (insects, plants, etc.) and keys for aquatic organisms, insects and plants.

Activity 2.2: Field Work (1/2 day in the field)

The teacher assists students in the field by aiding them with identification and ensuring proper sampling and safety techniques are followed.

Students:

- carry out the field study by making general observations of the area (size of creek, dominant species, types of trees, etc.) and collecting and classifying organisms found using appropriate tools (nets, taxonomic keys, etc.);
- record observation and complete as much of the CDSs information as possible.

Activity 2.3: Post-Lab – Compilation of Results and Preparation of Report (75 minutes)

The teacher:

- assists students in the classification of the organisms observed;
- explains how to make inferences between biodiversity and species survival using first the food web from the site and then generalizing to predict the impact of loss of biodiversity when organisms become extinct;
- discusses how human activity has impacted the site visited and how we must act as guardians of the Earth and thus take responsibility for our actions in polluting the watershed, or creating weirs, and take action against further destruction on this habitat.
- collects and evaluates their final reports and their individual Book of Life - Section 1 (CDSs).

Students:

- in their groups complete all observation sheets and CDSs;
- create a food web for the site and use it in a discussion of biodiversity and species survival;
- discuss the numbers and types of species found and record their inferences about the relationship between biodiversity and species survival;
- consider and discuss the impact humans have on ecosystems and include in their report reflections on their role as stewards in the maintenance/recovery of the watershed studied;
- add CDSs to appropriate location in their Book of Life (see Activity 1.3) and submit Section 1 of the Book of Life for evaluation;
- prepare individual final field reports.

Assessment & Evaluation of Student Achievement

- Sampling techniques (in the field) assesses Inquiry using a checklist; (DLV.02, DL2.03, SIS.01, SIS.02).
- Student reports evaluate Knowledge/Understanding, Inquiry, Communication, and Making Connections using a checklist (SIS.04, SIS.06, SIS.07, DL2.03, DL3.02).
- Book of Life - Section 1 evaluates Knowledge/Understanding using a rubric or marking scheme (DLV.01).

Accommodations

- Students with physical limitations should be considered when choosing a site. Ensure accessibility to the site.
- For enrichment refer to Appendix 3 – Section 3: Endangered Species. Students could research the development of the region and suggest ways this has contributed to the observed diversity of species seen. In addition, they should be encouraged to forecast future changes based on the history researched and on their collected results. Students could write a letter to the local newspaper outlining their report and suggesting ways the community could work to improve the site. Students could do water analysis of the test site and assess the body of water with respect to its health using a biotic index suitable for the area.

Resources

Internet

<http://www.rst2.edu/masters1999/ECOSYS/bioticindex.html>

<http://dnr.state.il.us/orep/inrin/ctap/bugs/>

<http://zebu.uoregon.edu/energy.html>

<http://www.yorku.ca/faculty/academic/cblanche/nats1760/n17links.html>

http://www.mesc.usgs.gov/pubs/online/ifim-chron/ind_biotic_integ.html

<http://www.wavcc.org/wvc/cadre/WaterQuality/macrobenthos.htm>

<http://www.usu.edu/~buglab/>

<http://www.ncsu.edu/sciencejunction/depot/experiments/water/lessons/macro/macroleesson1.html>

http://google.yahoo.com/bin/query_ca?p=Biotic+Index

Activity 3: How different are they?

Time: 240 minutes

Description

Students study the importance of sexual reproduction to variability within a population. The affect of biotechnology on natural populations will be introduced and the role of viruses and bacteria in the field of biotechnology is explored. By collecting and critiquing articles on biotechnology and its applications, students become aware of both the widespread use of biotechnology in today's world and its moral and ethical implications.

Strand(s) & Learning Expectations

Strand(s): Diversity of Living Things

Ontario Catholic School Graduate Expectations

CGE1e - speaks the language of life... "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith);

CGE2b - reads, understands, and uses written materials effectively;

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE2d - writes and speaks fluently one or both of Canada's official languages;

CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology, and information systems to enhance the quality of life;

CGE3d - makes decisions in light of gospel values with an informed moral conscience;

CGE3f - examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical);

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE5e - respects the rights, responsibilities and contributions of self and others.

Overall Expectations

DLV.01 - demonstrate an understanding of the diversity of living organisms through applying the concepts of phylogeny and taxonomy to the kingdoms of life and viruses;

DLV.03 - relate the role of common characteristics and diversity within the kingdom of life to the importance of maintaining biodiversity within natural ecosystems and explain the use of micro-organisms in biotechnology.

Specific Expectations

DL1.05 - explain the importance of sexual reproduction (including the process of meiosis) to variability within a population;

DL3.01 - explain the relevance of current studies of viruses and bacteria to the field of biotechnology.

Scientific Investigation Skills

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.10 - identify and describe science and technology based careers related to the subject area under study.

Planning Notes

- Students to begin a collection of newspaper/magazine articles on the current uses of biotechnology. One article collected might be summarized and critiqued, and then presented to a small group of students (three to four) (Activity 3.2).
- The graphing of data on a single characteristic (e.g., student height) will, if the class is large enough, be an example of a standard curve for variability within a population (Activity 3.1). (Teachers must be sensitive to the fact that some students may feel “below average” and the language used in this activity should be chosen carefully).
- Locate and preview a video on population variability (see resource section for suggestions).
- Prepare a diagnostic quiz on mitosis and meiosis (Activity 3.1) and be prepared to address misconceptions surrounding the processes of mitosis and meiosis, e.g., differentiate between the roles of mitosis and meiosis in eukaryotic cells.
- Prepare an outline on how to summarize and critique an article/video. Possible questions could include the following: What is biotechnology? Who does it? What role do bacteria/viruses have in biotechnology? What characteristics of bacteria/viruses make them valuable in the field of biotechnology? How does this technology benefit individuals? society? corporations? Could biotechnology ever pose a threat to a species? If so which one? Give examples. Predict the ethical implications of the widespread use of biotechnology in this century. (Activity 3.2).
- Locate a sample article(s)/videos on the use of viruses or bacteria in the field of biotechnology (Activity 3.2).
- Teachers must become familiar with the Church’s teaching on biotechnology (see Resources and Appendix 5) and/or invite a religion teacher for a class discussion.
- Collect and make available job ads from newspapers or magazines (e.g., *New Scientist* magazine) for students to review while doing Activity 3.2.

Prior Knowledge & Skills

Grade 9, Science, Academic – Biology Strand sexual and asexual reproduction: mitosis, and biotechnology

Teaching/Learning Strategies

Activity 3.1: How do changes occur within a population? (75-90 minutes)

The teacher:

- reviews the types of cellular reproduction verbally and with a diagnostic quiz. (**Note:** students may be confused about the differences between meiosis and mitosis and their roles in cell and organism reproduction. Remedial work sheets or computer programs/videos should be made available, if necessary);

- gathers data on the height of all students in the class and calculates an average height for this group. Discusses why few individuals are the average height and graph the number of individuals of each height. Discusses the significance of the shape of this curve (**Note:** for a standard curve the class size must be large and a heterogeneous group of students present);
- explains that this phenotypic variation (height variances observed) is produced by a combination of genetic instructions and environmental influences and discusses the role of meiosis and sexual reproduction in variations within populations;
- leads a brainstorming session where students identify other examples where organisms show variation within populations (e.g., stripes on a zebra);
- asks students to suggest reasons why, in nature, variation is common and what factors might affect variability within populations;
- shows a video on population variability and provides students with a work sheet to accompany it.

Students:

- review the types of cellular reproduction by completing a diagnostic quiz. Students requiring remediation should complete remedial worksheets or computer program provided and may be allowed to attempt the quiz again;
- discuss variability within a population (their class) with respect to one characteristic (height);
- recognize the role of meiosis and sexual reproduction in variations within populations;
- participate in a brainstorming session to identify examples in nature where organisms show variation within populations and make a list of factors that affect population variability;
- view the video and complete the worksheet given.

Activity 3.2: The Biotech World We Live In (50-75 minutes)

The teacher:

- leads a discussion on how biotechnology affects natural populations with specific reference to agricultural applications, (Connects with Activity 4), e.g., “There is a concern that genetically altered crops may pass genes on to natural populations and change them - super weeds which are resistant to most conventional pesticides may affect biodiversity by producing organisms which can outperform natural populations and therefore eradicate them;
- introduces either a video or newspaper article on the role of bacteria or viruses in biotechnology. Attempts should be made to use Canadian examples of biotechnology (see Internet Resources);
- provides an outline on how to summarize and critique a newspaper article or other media source (e.g. video) (See Planning Notes for suggestions.);
- assigns article(s) or video on biotechnology for students to read/watch and as a class leads them through the process of how to summarize and critique it;
- instructs each student to choose one article from those they have gathered to summarize and critique;
- organizes the class into groups of three students. In these groups each student presents their article summary and critique;
- collects and assesses student work;
- discusses, if necessary, with the aid of article(s) from Catholic Journals, the Church’s teachings on the use of biotechnology (see Resources for related articles/texts). Appendix 5 is written as a teacher resource and could be modified for student use. A religion teacher could be invited as a guest speaker.

Students:

- using the outline provided, as a class summarize and critique the newspaper article/video provided by the teacher on the role of bacteria and viruses in the field of biotechnology;
- choose from those they collected one article/media to individually summarize and critique. In a small group (three students), each student presents their summary and critique;

-
- participate in a class discussion on the Catholic Church's view on biotechnology and the importance of biotechnology to society, and then each student makes a personal reflection in their Book of Life.

Activity 3.3: Looking for a Career? (50 minutes)

The teacher:

- discusses possible career opportunities in research and biotechnology and assigns students to research the education and training needed for one of the careers discussed. Each student chooses a specific job relating to scientific research and biotechnology and creates a job ad for it using the information gathered;
- collects and assesses the job ads.

Each student researches the education and training needed for a job related to research and biotechnology and compiles a "job ad" for such a position. The ad must specify the nature of the position, location (hospital, research centre, etc.), salary range, education requirement, and any other relevant information/requirements.

Assessment & Evaluation of Student Achievement

- completion of video worksheets assess Knowledge/Understanding using an appropriate marking scheme (DL1.05);
- the summary and critique assesses Knowledge/Understanding, Communications, and Making Connections using a rubric (DL3.01, SIS.05);
- the job ad assesses Knowledge and Communication using a checklist (SIS.10).

Accommodations

- students with physical and learning impairments are encouraged to use the computer. Peer assistance should be encouraged;
- for enrichment: Students could interview either in person or online a researcher at an industry, university, or college on the use of micro-organisms in biotechnology. Students with computer expertise could develop a simulation activity on population variability within a species not considered in this unit. Students could write an essay on the ethical use of biotechnology. Students could review the references to biotechnology found in literature by reading a book, for example *Brave New World*, and critique it in light of our current knowledge of biotechnology.

Resources

Internet

Biotechnology for the 21st Century - <http://www.nalusda.gov/bic/bio21>

Catholic World News - <http://www.cwnews.com>

Catholic Information Network - <http://www.cin.org>

Microbes: Building blocks for biotechnology - <http://www.agwest.sk.ca>

Plant biosafety - <http://www.cfia-acia.ca>

The Centre for the Study of Technology and Society - Biotechnology - <http://www.tecsoc.org/biotech.htm>

The Catholic Times - <http://www.ctonline.org/currentissue.html>

Video

The Meiotic Mix. Films for the Humanities and Sciences, Fort Erie, On. DMJ3694

Sexual Reproduction. Films for the Humanities and Sciences, Fort Erie, On. DMJ6113

Careers in Science. Films for the Humanities and Sciences, Fort Erie, On. DMJ8243

Technoscience: blurring the Line between man and machine. Films for the Humanities and Sciences, Fort Erie, On. DMJ10464

The Genetic Takeover. National Film Board of Canada. 1999.

Biotechnology: Issues and answers. Films for the Humanities and Sciences, Fort Erie, On. DMJ6201

Science and Ethics. Films for the Humanities and Sciences, Fort Erie, On. DMJ5625

Overview of Biotechnology. Films for the Humanities and Sciences, Fort Erie, On. DMJ10889

Activity 4: Symposium: Who Let the Genie Out of the Bottle?

Time: 240 minutes

Description

Through their participation in a symposium students investigate the use of micro-organisms in biotechnology. Students reflect on the ethical issues resulting from the application of biotechnology in today's society.

Strand(s) & Learning Expectations

Strand(s): Diversity of Living Things

Ontario Catholic School Graduate Expectations

CGE2b - reads, understands, and uses written materials effectively;

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE2d - writes and speaks fluently one or both of Canada's official languages;

CGE4a - demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE5e - respects the rights, responsibilities and contributions of self and others;

CGE5g - achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others.

Overall Expectations

DLV.03 - relate the role of common characteristics and diversity within the kingdoms of life (including Eubacteria and Archaeobacteria), to the importance of maintaining biodiversity within natural ecosystems, and explain the use of micro-organisms in biotechnology.

Specific Expectations

DL3.01 - explain the relevance of current studies of viruses and bacteria to the field of biotechnology;

DL3.02 - demonstrate an understanding of the connection between biodiversity and species survival.

Scientific Investigation Skills

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.

Planning Notes

- Arrange for access to resource centre and the Internet and encourage a multimedia presentation where possible.
- choose a case study involving an application of biotechnology, e.g. genetically engineered corn seed activity for details, gather background information in it and/or provide the students with specific Internet sites for referencing.
- Prepare a rubric to evaluate individual student's contribution to the Symposium.

-
- Because more than one student will have the same role/position, it is recommended that students discuss before the date of the symposium which points each student will present to avoid repetition. Note that each student must submit a complete report but they should be encouraged to work as a team during the presentation. The teacher may include peer assessment as a formative assessment for knowledge and communication during the presentations. The Book of Life - Section 3 may be used as a journal/organizer for this activity.
 - The symposium could run on a jigsaw format where the 10 roles are done by three groups simultaneously. The teacher could rove and listen to each group using a checklist to assess student's success. Alternatively, each group could videotape themselves and show it to the class.

Teaching/Learning Strategies

The teacher:

- identifies and provides some background information on the issue to be researched: the use of micro-organisms to produce genetically engineered foods like corn;
- reviews the ethical use of the Internet for research purposes;
- outlines the activity: what a symposium is, what role each student will play, the rubric that will be used to evaluate individual students. The following example and format could be used: "The situation that is being discussed involves a company which has researched and developed a gene that codes for a toxic pesticide which they inserted into a micro-organism and then transferred to a food plant (corn)." Students are now assigned a role and position which they research for the class symposium on Genetically Altered Foods.

The possible roles and positions might include:

- CEO of the company;
- a farmer who uses the newly modified seed and is concerned about the effects of traditional pesticide use on the family;
- an organic farmer whose corn crop has been cross pollinated by the new seed;
- an etymologist who is an expert on the effects of pesticides on arthropods;
- an ecologist concerned about the effects of the genetically modified corn on local food webs;
- a botanist who is an expert on cross-pollination within the grass plant families of which corn is a member;
- the chair of a local citizens group concerned about 'genetic pollution,' the possibility of the gametes cross-pollinating with other species.
- gives students time to research the issue from their perspective;
- students may choose to work individually or in small groups to do the research portion of this assignment. Each student must prepare a summary of their research which includes documented facts supporting their position;
- organizes the symposium allowing each student time to present their information. Students will need time to organize themselves and should be instructed to, within each expert group, divide up the points/facts so repetition of information is minimal during the symposium;
- instructs students to summarize how each individual/group portrayed would be affected by this product-genetically engineered corn. Students include a statement about the impact biotechnology has on the survival of some species over others;
- invites students to participate in a further discussion and question period if necessary to clarify information;
- gives time for individual reflection on the future of biotechnology. Can there ever be anything "all natural" again?

Students:

- become informed about the nature of the activity and the issue being discussed;
- conduct research on the issue from their assigned role and position. Individually, they produce a summary report which includes facts and a works cited. The following are a list of questions that should be investigated. What are genetically engineered foods? What is the advantage for the species to have this “new” gene? What is the role of micro-organisms in the production of genetically engineered corn? How can you tell if the corn is genetically engineered? What effects does this corn have on the person who eats it? What are the effects on animals and insects that eat it? Other crops that are cross pollinated with it? What are the cost advantages of genetically engineered corn? How do GMFs affect biodiversity, and why is this important?;
- participate in a Symposium as part of a Panel of Experts. The presentation is to be computer based and multi-media wherever possible. Submit an individual report for evaluation, which includes documented facts and a works cited;
- may add a summary of the positions described, including their own into their Book of Life;
- write a personal position paper stating their own opinion on the use of the biotechnology discussed (i.e., students might choose a position other than the one assigned), and include a statement about the impact biotechnology has on species survival. Students may choose to include this in their Book of Life - Section 3;
- if new work has been added to the Book of Life, submit it for final evaluation.

Assessment & Evaluation of Student Achievement

- Individual presentations evaluate Knowledge/Understanding, Communication and Making Connections using an appropriate rubric. (SIS.05, SIS.06, DL3.01);
- Summary paper evaluates for Knowledge/Understanding, Communication, Inquiry and Making Connections using a rubric or rating scale. (SIS.05, DL3.01, 3.02);
- Personal Position paper evaluates for Communication and Making Connections using a rubric. (SIS.05, DL3.01, 3.02);
- The Book of Life - Section 3 is evaluated for Knowledge/Understanding, Communication, and Making Connections using a rubric or rating scale. (SIS.05, SIS.06, DLV.03, DL3.01, 3.02).

Accommodations

- Students with physical and learning impairments are encouraged to use the computer. Peer assistance should be encouraged, if necessary.
- Students may video tape their position statements for their presentations.
- For enrichment, students may design, conduct, and evaluate a peer poll designed to determine the opinions of the school’s general population on the effects of biotechnology and its related ethical issues.

Resources

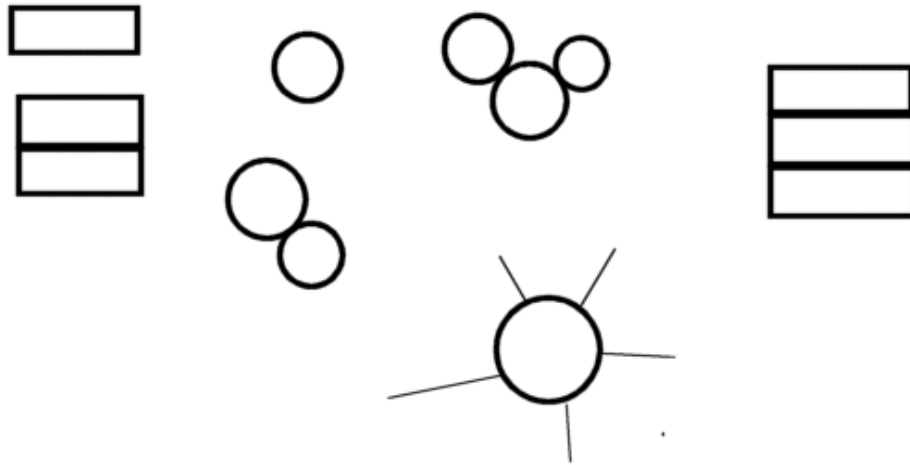
Video

High-Tech Foods: Is Genetically Engineered Food Safe? Films for the Humanities and Sciences, Fort Erie, ON. DMJ10873

Transgenesis: Agricultural Biotechnology. Films for the Humanities and Sciences, Fort Erie, On. DMJ17158

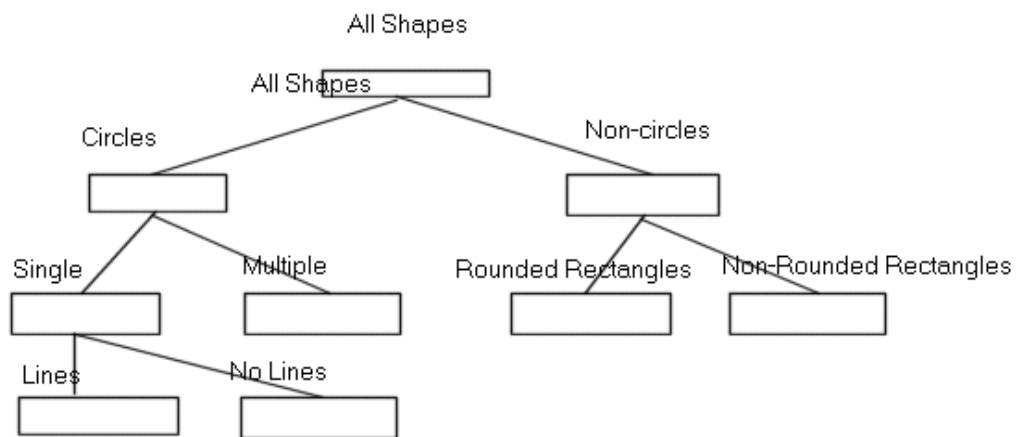
APPENDIX 1

Classifying Shapes



APPENDIX 2

Sample Dichotomous Key (Partial-Students complete)



Appendix 3

Teacher's Notes: The Book of Life

Purpose

The Book of Life is an ongoing assignment for this unit and becomes a major part of the culminating task found in Activity 4. It is the body of evidence that the students present at the end of the unit for evaluation of their achievement of the expectations listed in the Unit Synopsis Chart.

Structure

The Book of Life should be a folder, binder, or duotang that permits students to add items as they are created throughout the unit. The teacher provides the students with blank Classification Data Sheets (CDS) which will be inserted into the Book of Life and used throughout this unit. The Book itself is divided into 4 sections: (1) Survey of The Living World; (2) Reflections; (3) Symposium on Biotechnology; (4) OPTIONAL: Endangered Species. Each student will complete their own individual Book of Life.

(1) The first section is the Survey of the Living World. The students insert the CDS in this section after they have completed Activities 1.3, 1.4, and 2. The students organize the order of the sheets according to the three domains and five kingdoms of classification. The teacher should note that kingdom Monera spans two of the domains, which allows for discussion of the evolutionary nature of the classification system. Please note that viruses are also to be included in the Book of Life. This will also allow for discussion as to the appropriateness of including viruses with living organisms. Within each domain the students are to organize the order of their CDS according to the principles of phylogeny, and the teacher assesses their understanding of these principles.

(2) The second section of the Book is simply called Reflections. In this section the students reflect on the meaning of creation and the importance of diversity as part of God's plan of life. A few samples of reflective prompts are included and may be changed to suit the class.

(3) The third section of the Book is for the Symposium. In this section students explore various aspects of biotechnology, including a one minute position statement to be made during a class Symposium (Activity 4) on a specific application of biotechnology, e.g., the use of a particular genetic modification technology. The students assume a role that is assigned to them by the teacher. This section also includes a personal statement of position on the technology after the Symposium is finished. This can be used for student self-assessment.

(4) The final section of the Book is an optional section called Endangered Species and extends from Activity 2 and focuses on the negative effect of extinction of species on species diversity. In this section students profile several endangered species, two of which should reside in Canada for some part of their life cycle. The profile includes a description of the living range, breeding or reproductive habits, niche, and the reason for its being on the endangered list. The students select one organism (Canadian) and prepare an impact statement for the organism. The impact statement would be composed as if it were the organism itself, speaking on behalf of its species, to a judiciary body composed of representative organisms from the world's living organisms who are trying to assess the culpability of the human species.

Appendix 3 (Continued)

Methodology: Section 1

During Activity 1.3, students record the relevant information on their CDS for the Survey of the Living World. It is suggested that a representative organism from each of the following taxa be used. (Note the strong bias toward the animal kingdom, a balanced approach may be used or another kingdom may be emphasized as reflected by local needs):

Domain Archaea: Kingdom Monera: one of the three main groups; **Domain Eubacteria:** Kingdom Monera: one of the phyla; **Domain Eukarya:** Kingdom Animalia: Phyla: Annelida, Arthropoda, Chordata, Cnidaria, Echinodermata, Mollusca, Nematoda, Platyhelminthes, Porifera; Kingdom Plantae: one of the Divisions; Kingdom Fungi: one of the Divisions; Kingdom Protocista: one of the Sections; a **Virus**.

During Activity 1.4, students use a key to classify the organisms and record as much of the relevant information as they can on the CDS. (Make sure to include the number of the organism for later identification). Some information will require access to other resources such as the Internet or text materials. These CDS are assessed by the teacher and returned to the students who insert them in the proper location (as determined by their criteria) in The Book of Life.

During Activity 2, students use the CDS to classify the organisms they identified during the field study. The students use either the Internet or field guides to complete the CDS. These sheets are submitted for assessment with the field study report and are then placed in the appropriate section of The Book of Life.

Section 2

Section 2 contains student reflections on the religious/spiritual dimensions of the diversity of life. Listed below are some suggestions for reflection. Teachers are free to add, delete, or create their own.

Reflection 1. (De-creation) Many cultures in the world revere nature as being sacred. Our culture has desecrated (removed any sense of the sacredness of creation) nature and subjugated it to the whims of our desire for material wealth. In this sense, modern man and woman have become alienated (emotionally detached) from the rest of creation in the same way that Adam and Eve became alienated from the Garden of Eden. Do you agree with this analysis? Why or Why not?

Reflection 2. (De-creation) The first creation story in the Bible reveals how God was driven by goodness to create the universe. Humankind has been responsible for much of the destruction (de-creation) of the natural world. Write a myth (story) of the 7 nights of de-creation.

Reflection 3. (Re-creation) You are Moses and have just climbed the mountain of spiritual enlightenment and communed with God. God has asked you to record the 10 commandments for the protection of the diversity of life on the planet. Write out the 10 commandments.

Reflection 4. (Re-creation) You are Noah, and God has asked you to create an ark to protect one pair of animals that are endangered in Canada. Which pair of animals will you select, and what will your ark look like?

Reflection 5. (Re-creation) On the seventh day God rested and looked at all that was created with wonder and awe. Describe your own personal experience of the wonder and awe of creation.

Appendix 3 (Continued)

Section 3

This section may be used as a student journal or organizer for the preparatory and the summary statements for Activity 4, the Symposium. It is in this activity that the knowledge gained throughout the unit is applied and students are given opportunity to reflect on the future of living organisms. See Activity 4 for an example that could be used as the topic for the Symposium.

Section 4 (Optional)

The goal of this section is for students to link biodiversity to stability. Students create a profile of several endangered species in this section (two of which should be Canadian). Students create an impact statement for one of the species. This activity will require access to the Internet or other resources listing endangered species. The teacher may assign this early in the unit and have students collect newspaper or magazine articles to form the basis of the profile. The purpose of the task is for students to link biodiversity to stability using Canadian examples.

Appendix 4

Classification Data Sheet

Domain Kingdom Phylum/Division Sub-phylum Class Order Family Genus Species	Illustration of the organism
Source (Internet address, text, lab., magazine)	
Cell Type (Prokaryotic or Eukaryotic) Description of cellular characteristics:	Characteristic Structures
Nutrition (absorptive, photosynthetic, chemosynthetic, ingestive) Description:	
Oxygen Metabolism (poisonous, tolerated, required) Description:	Type of Reproduction/Life Cycle Diagram
Lifestyle/Habitat (solitary, unicellular, filamentous, colonial, mycelial, motile, non-motile, multicellular) Description:	

Appendix 5

Teacher Resource: Identity and Integrity

A Catholic perspective of biotechnology, transgenic manipulation, and evolution.

Many of the connections and logical extensions of expectations covered in this course profile raise ethical questions and moral dilemmas. The discussion that follows is intended to identify some of the issues that are raised in the course and outline some reflections based on the Catechism of the Catholic Church (CCC).

The biotechnology of transgenic manipulation (i.e., transplanting genes from one species to another) raises a number of ethical issues. One is that of the fundamental relationship of the human person to the rest of creation. Does creation exist simply to serve the insatiable appetite of modern ‘economic man’? Are there legitimate uses of transgenic technologies? Who ‘owns’ the genes that are being transferred? What access will the poor or disadvantaged have to these new technologies?

While the Church has many clear and specific teachings on the artificial manipulation of human life, its teachings on the manipulation of other species are less clear. Wisdom dictates that we use our understanding of God’s Providential action to assess the legitimacy of the biotechnology of transgenic manipulation.

Identity, integrity, and idolatry are three important factors to be considered when analyzing transgenic ethical issues. Identity is of paramount importance. In the process of creation, every species developed its own unique genetic identity in accordance with the Divine plan of God. Do we as human beings have the right to alter the identity of an organism? How many genes would have to be altered/transferred before the fundamental identity of the organism would be altered?

Integrity is another factor in analysing transgenic ethical issues. While the genetic identity of a species may continue to change over time, the rate of change is intimately linked with constraints that are built into all of nature. Evolution is a slow process and the success of any genetic change is determined by its interactions with the rest of its environment. In such a scheme, the time frame for change in a species is linked to the time frame for change in the environment. As such, the rest of creation can adapt to the changes that the new organism introduces into the environment. Biotechnology threatens the integrity of creation by accelerating the time frame for change. Other organisms may not be able to adapt to the accelerated time frame for change, and the balance of entire ecosystems may be disrupted. How extensive should the testing process be, before a genetic change is determined to be safe? Who will do the risk-benefit analysis? In a global economy, will the same rules safeguard creation in all countries?

In secular society the power of science and technology have taken on quasi-religious and mythical proportions. Many people believe that science offers humankind the only real form of salvation. Science does not occur in a value-free context. As a consequence, Catholics, have a responsibility to insure that the applications of science occur within the context of a value system that seeks to build up the Kingdom of God. This occurs through the formation of political, social and economic policies that seek the good of all of creation.