Catholic District School Board Writing Partnership

Course Profile

Science

Grade 9
Academic

· *for teachers by teachers*

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Unit 3: Biology: Reproduction - Processes and Applications

Time: 27.5 hours (22 periods of 75 minutes each)

Unit Developer(s)

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Development Date: July 31, 1999

Unit Description

In this unit, students describe and apply the cell theory to the reproductive processes of plants and animals (including humans). Students investigate and analyse cell division and the factors affecting cell reproduction within a context that recognizes God as the author of life. They examine (study) scientific research and technological developments in the area of reproduction from a Catholic perspective and evaluate the implications for decision making.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations: CGE 1c,d,e; 2a,c,e; 3b,c,d,e,f; 4a,g; 5e; 6b,c.
Strand(s): Biology
Overall Expectations: BYV.01, BYV.02, BYV.03.
Specific Expectations: BY1.01 to BY1.10, BY2.01 to BY2.10, BY3.01 to BY3.04.

Activity Titles (Time + Sequence)

Activity 1	Mitosis	375 minutes
Activity 2	Asexual Reproduction	375 minutes
Activity 3	Sexual Reproduction	225 minutes
Activity 4	Human Reproduction	375 minutes
Activity 5	The Can Do Redactor	300 minutes

Unit Planning Notes

This unit has been divided into five activities, three of which (Mitosis, Asexual Reproduction, and Human Reproduction) build to a final product. In the cases of Mitosis and Asexual Reproduction, the final product comes out of the design and performance of an investigation. The sequencing of lessons allows students to acquire the knowledge and skills necessary to be successful in their investigations. It is recommended that the teacher provide the requisite skills training and that the students design their experiments on the basis of these skills. Activity 4 culminates in students deducing the cell theory on their own. While this represents the final product of this activity, it is in fact a culmination of the first four activities. Teachers will, in all likelihood, be asked where did the first cell come from? This presents the teacher with a 'moment' in which to share both the limits of scientific empiricism and the value of theological insight and revelation into creation and meaning. The creation stories from Genesis (Appendix C6) provide a foundation for such a discussion. The fifth activity involves the creation of a magazine called "The Can Do Redactor." The students work in groups to research the topics and then report their findings as a column in a magazine. Research topics are taken from expectations BY 3.01 to 3.04; in addition, students include a section called "From the Pulpit", dealing with the ethical dimensions (Appendices C4 and C5) of their research. The key to achieving the desired expectations and enriching the students' educational experiences lies in the opportunity to relate the concepts studied to the real world. It is highly recommended that the teacher set up the classroom as a living exposition of reproduction. Stations could be created that would demonstrate many forms of reproduction. Students could be provided with the

opportunity to enrich and extend their understanding through either guided or open-ended investigations (Appendix D5). These activities could be included in student ScienceWorld portfolios. Where possible, it is also recommended that this unit be taught in the spring (fall for semester 1 in semestered schools) when the reproductive activity of the natural world is at its peak.

Prior Knowledge Required

The students require a general knowledge of the cell (Grades 5, 6, and 8).

Teaching/Learning Strategies

Students are given the skills and context in which to conduct investigations of their own design. In this process, students fill out a lab proposal form which is used in conferencing with the teacher. The stations provided meet the needs of students who are looking for enrichment or requiring program accommodations, as well as for possible ScienceWorld ideas portfolios. The science logs provide an opportunity for students to reflect and synthesize their own thoughts about the "wonder and awe" of a world that reflects the goodness of its Creator.

Assessment/Evaluation

Assessment becomes a key tool in ensuring student success. Teacher-student conferencing is a key component in helping students successfully design and conduct investigations. It is also recommended that the teacher use portfolios as a method of student assessment in this strand. The portfolio could be based solely on process or a combination of process and final product. The final evaluation of the strand could be based on the portfolio alone or on a combination of portfolio and paper/pencil test. Assessment that is both varied and linked directly to the achievement of expectations becomes an authentic method for evaluating students. Other assessment strategies recommended for this strand include: formal teacher observations, roving conferences, role-play, science logs, peer conferences, self-and-peer assessment, pencil and paper assessment.

Resources

Moroholt, E., P. Brandwein., and A. Joseph. *A Sourcebook for the Biological Sciences*, 2nd Edition. New York: Harcourt Brace & World, Inc.

The Bio Sci II Videodisc. Videodiscovery Inc., 1990.

CD-ROMs, videos, web sites for viewing mitosis

Northwest Scientific Supply Ltd. Fission and staining of Protista. Fax number: 604-946-3837

Web Sites

Asexual reproduction
http://easyweb.easynet.co.uk/~middlecroft/biology/rangeof.htm

Propagation of house plants
http://www.agric.gov.ab.ca/agdex/200/8502007.heml

Reproduction
http://www.ug.cs.dal.ca/dispproj/reprod.html

Reproduction in plants
http://gnome.agrenv.mcgill.ca/breeding/apoxixis.htm

Sexual reproduction
http://easy web.easynet.co.uk/~middlecroft/biology/sexplant.htm

CD-ROMs

DNA: Molecule of Life (Boreal)

Mitosis (Boreal)

Protista (Boreal)

Fungi (Boreal)

Activity 1: Mitosis

Time: 375 minutes (5 periods)

Description

In this activity students study mitosis as part of the reproductive process rather than just another function of a cell. Video and CD-ROM resources are used to present mitosis as a process rather than an event. Once they have observed the entire process, students study each phase of mitosis in detail. Students are provided with different venues to demonstrate their understanding of mitosis. Through the examination and preparation of slides, students develop microscope skills essential for the final evaluation of the activity: to design and conduct an experiment enabling them to observe and report on mitosis in onion or bean cells.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be:

Strand(s): Biology

Overall Expectations: BYV.01, BYV.02.

Specific Expectations: BY1.02❖, BY2.02❖, BY2.05❖, BY2.07❖, BY2.08❖.

Planning Notes

- There may be a problem in presenting mitosis before the student has been exposed to chromosome function. Be prepared to briefly discuss nuclear and chromosome structure as required. This may include the mention that when a cell divides, its chromosomes duplicate and divide.
- Worksheets to support the AV materials used in the unit should be prepared in advance.
- Photomicrographs of each stage of mitosis should be copied onto one set of cards and descriptions of each event onto another set of cards.
- Materials for the dramatization of mitosis should be made available.
- Ensure that the kits required for slide preparation are available at least two weeks prior to the activity.
- Be prepared to review the proper handling of the microscope and slides as required.
- Insist on clear, large, and neat scientific drawings.
- It may be necessary to use large models of the cell to help students locate chromosomes in the stages of mitosis other than interphase.

Prior Knowledge Required

The student is able to:

- identify parts of the cell (Grade 5 Life Systems);
- identify the parts and function of a compound microscope (Grade 8 Life Systems);
- use a compound microscope to observe microscopic structures (Grade 8 Life Systems).

Teaching/Learning Strategies

1. Students view a moving sequence of mitosis using video or CD-ROM resources. Worksheets prepared by the teacher should focus on key terms and structures (chromosome, nucleus, interphase, cell cycle, etc.).
   - Students identify and sequence the stages of mitosis. This is accomplished in groups of four working with two sets of cards:
     i) diagrams of each stage of mitosis;
     ii) descriptions of each stage of mitosis.
     Students match the diagram with the description, identify the stage, and sequence the events.
   - In groups of six, students demonstrate the process of mitosis through a dramatization. Students will decide as a group what is important for a successful dramatization. They also establish a set of criteria that they use to evaluate their peers.
   - Students prepare a visual representation of mitosis using pipe cleaners on Bristol board.
2. Student complete a hands-on teacher-directed activity in which they learn and practise microscope calculations, the rules for preparing scientific drawings, calculating the field of view, and the preparation, staining, and handling of slides. Students examine commercially prepared slides of mitosis in order to locate, identify, and accurately draw to scale cells undergoing each stage of mitosis.
3. Students work in groups of four to design an experiment in which they prepare their own slides of mitosis. A list of materials and a proposed sequence of steps are submitted to the teacher during a conference prior to the experiment.
   - Students carry out their proposed experiment to make prepared slides of mitosis. (Commercial kits are available if required.)
   - Students may extend this activity by:
     i) continuing their research on mitosis
     ii) experimenting on various antibiotics used to study the cell cycle and the aging process. (Possible ScienceWorld idea)
4. Student complete the following science log reflection:
   The nucleus of the cell contains its "memory" (how to make a copy of itself). Chromosomes could be compared to a complete library of books containing all the information needed to make a complete physical copy of the organism. Each gene on the chromosomes could be compared to a book in the library. If we search this library, we find sections that could be classified as antique because they contain the memory (sequences of DNA) of the very first forms of life on Earth. This is very similar to the written record of our memory of God. The Bible contains a written record of our first conversations with God. It not only contains our memory of God, but God's promises to remember us (covenants). To know who God is, we need to read all the books in the Bible. Jesus used the books of the Bible to provide us with more insightful Truths that were recorded in a new library (the Gospels of the New Testament).
   It seems to me that God has been writing to us for a long time… after all, God wrote the messages in our chromosomes and some of the pages in those books go back over 4 billion years. Take some time to think about how God has communicated with you and write them down.

Assessment/Evaluation

Knowledge/Understanding: can be evaluated by:

- using a product rubric (Appendix A3) to evaluate the pipe cleaner on Bristol board project;
- quiz on identifying the stages of mitosis (either written or lab);
- quiz on understanding concepts such as field of view, and preparation of slides.

Inquiry can be evaluated by:

- written lab proposal for preparing the slides of mitosis assessed through teacher conference;
- observation checklist during microscope activities using process rubric (Appendix A1);
- final lab report for the activity on mitosis (Appendices A1 and A2).

Communication can be evaluated by:

- Dramatization of mitosis - the students assess their peers through the use of criteria they developed. The teacher can assess the drama by comparing it to the video clip or CD-ROM sequence viewed in class.
- Written lab report for the mitosis activity - the students' design can be evaluated using lab product rubric (Appendix A2).
- Making connections can be evaluated through an extension of the mitosis activity and how it relates to the aging process. This can be evaluated using the product assessment rubric (Appendix A3). (Possible ScienceWorld idea)

Resources

Moroholt, E., P. Brandwein., and A, Joseph. *A Sourcebook for the Biological Sciences*, 2nd Edition. New York: Harcourt Brace & World, Inc.

The Bio Sci II Videodisc. Videodiscovery Inc., 1990.

CD-ROMs, videos, web sites for viewing mitosis

Accommodations

1. Where the student has an IEP, this activity accommodates the modification(s) outlined in the IEP.
2. ESL/ELD students are given opportunities to demonstrate their learning by means suitable to their language comprehension and abilities.
3. Classroom/laboratory facilities are modified to facilitate participation of all students in group and individual activities wherever possible.
4. Provide handouts with sample calculations and specific lab instructions as required.
5. Students with weak drawing skills should be provided with alternative reporting options.

Activity 2: Asexual Reproduction

Time: 375 minutes (5 periods)

Description

In this activity students are introduced to asexual reproduction through the creation of exploration stations around the perimeter of the classroom. Creating such a dynamic classroom atmosphere serves as an invitation to students to explore, inquire, and perhaps even extend their research to a Science World activity. While exploring the stations students learn the five types of asexual reproduction and their characteristics. After observing asexual reproduction, students research one type of asexual reproduction that interests them. The activity concludes with the student designing an experiment to observe, analyse, and report on the binary fission of paramecium.

Strand(s) and Expectations:

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 2b, j.

Strand(s): Biology

Overall Expectations: BYV.01, BYV.02.

Specific Expectations: BY1.04❖, BY2.01❖, BY2.02❖, BY2.03❖, BY2.04❖, BY2.05❖, BY2.08❖, BY2.09❖.

Planning Notes

- In order to create a rich learning atmosphere stations can be set up around the perimeter of the class so that they can be visited throughout the unit. Charts of life cycles for each station would be beneficial.
- If you teach in different classrooms, arrange for your classes to switch rooms.
- *Paramecium* and *Hydra* can be ordered from a science supply house and must be grown in advance.
- Plant cuttings should be started well in advance of the activity (*Coleus* or ivy).
- Prepared slides of yeast, spores, and *Paramecium* are required.
- Preserved specimens of crayfish with different size pincers are required.
- A video camera can be attached to the microscope to facilitate viewing paramecium undergoing fission.
- Review the proper handling of live specimens (*Hydra*, *Paramecium*, and *Amoeba*).
- Well-fed *Paramecium* reproduces by fission two or three times a day. Therefore, it would be advantageous to connect a video recorder to the microscope using a flex camera and pre-record the event.
- Book the computer lab for the Internet activity on types of asexual reproduction.

Prior Knowledge Required

The students are able to:

- manipulate a microscope and prepare a slide;
- understand mitosis;
- interpret slides, pictures, models, and specimens;
- use electronic resources.

Teaching/Learning Strategies

1. Students examine and describe various types of asexual reproduction by studying the samples laid out at a series of stations. The stations and expectations are outlined below

Station	Type Asexual Reproduction	Description of Station	Possible Questions (prepared by teacher)
1	Binary Fission	Live specimens of *Amoeba, Paramecium* along with visuals (attach a video cam to a microscope for viewing)	Describe the process you are seeing. Define daughter cell. List the stages the organisms undergo to divide. Number of parents involved. Description of offspring as compared to parent. Importance or significance of this process to living things.
2	Budding	Yeast budding under a microscope. *Hydra* budding. Charts of each process	Define budding. How many parents are involved? Description of offspring as compared to parent. Importance of this process.
3	Spore Formation	Bread mold, mushrooms, fern leaves, and charts of life cycles. Dissecting microscope to view specimens. Grow ferns from sporophytes kit	Describe spore formation. Why is it considered asexual reproduction. Description of offspring as compared to parent. Importance of spore formation.
4	Regeneration	Preserved specimen of crab with different size pincers. Picture of a wound healing. *Planaria* visual showing regeneration	Why is regeneration asexual? What is regeneration? List advantages of regeneration. What is the importance or significance of regeneration?
5	Vegetative Propagation	Leaf cutting of begonia. Potato with tuber. Geranium propagating. Visual aids showing labels of parts. Charts showing different forms of propagation	What is vegetative propagation? Explain each type. Name some uses for vegetative propagation. Why is vegetative propagation asexual reproduction? What is the importance of vegetative propagation? Describe the offspring and the parent.

2. Students examine prepared slides of *Paramecium caudatum* (WM) and produce scientific biological drawings. Students identify the mitotic changes as they examine the slide.
3. Students research one example of asexual reproduction using electronic and print resources. Each type of reproduction is represented in a self -contained circle and is displayed in a gallery. The students then perform a gallery walk. After observing the summary of each type the students are asked to represent the five types of asexual reproduction in a Venn diagram. The final diagram illustrates the parts of each process that overlap and as a result summarize the characteristics of asexual reproduction (i.e., one parent, offspring same as parent).

4. Students design, conduct, and analyze an experiment, that enables them to observe *Paramecium* undergoing binary fission and predict the size of the population after a specified period of time (once every three hours). Students brainstorm in-groups of four an experimental design and submit to teacher a record of their discussion. Students conduct their experiment in groups of four. Technique and lab procedure are observed and assessed. Each student submits a written report of his or her findings for evaluation.
5. Students reflect on the following question:
   Where did the first cell come from? It really came from the heavens. Did you know that the chemical elements that make up your cells were formed in the stars billions of years ago? We all have stardust in our bodies! There is another part of each of us that came from the heavens and that is our soul. Our souls bear the image of our heavenly Creator. The next time I look up into the heavens at night and see the stars, I'll be thinking about how God is still busy creating. What will you be thinking?

Assessment/Evaluation

Knowledge/Understanding is evaluated by:

- worksheet submitted for the five stations on asexual reproduction;
- Venn diagram for the gallery walk summarizing asexual reproduction;
- scientific drawings of prepared slides of *Paramecium* at different mitotic stages.

Inquiry is evaluated by:

- observation checklist during microscope activities;
- lab proposal for the preparation of a *Paramecium* slide;
- final lab report for the activity on *Paramecium.*

Communication is evaluated by:

- use of electronic and print resources in research on asexual reproduction assignment;
- the final product of their research displayed in the gallery walk (Appendix A4).

Making Connections is evaluated by:

- reflection in Science log.

Resources

Northwest Scientific Supply Ltd. Fission and staining of Protista. Fax number: 604-946-3837

Web Sites

Asexual reproduction
http://easyweb.easynet.co.uk/~middlecroft/biology/rangeof.htm

Propagation of house plants
http://www.agric.gov.ab.ca/agdex/200/8502007.heml

Reproduction
http://www.ug.cs.dal.ca/dispproj/reprod.html

Reproduction in plants
http://gnome.agrenv.mcgill.ca/breeding/apoxixis.htm

Accommodations

- See Accommodations section in Activity 1 for general accommodations.
- Possible ScienceWorld Idea:
  - Given the replication rate of a specific bacterium, the student uses a spreadsheet to model and graph population growth of the species under ideal conditions for a fixed period of time.

Activity 3: Sexual Reproduction

Time: 225 minutes (3 periods)

Description

In this activity, as in the previous one, a dynamic classroom atmosphere greatly enhances the students' achievement of the expectations. Exploration stations set around the perimeter of the classroom include examples of conjugation, hermaphroditism, and external fertilization by plants and animals. Once students have gained an understanding of sexual reproduction they can compare the two types of reproduction, listing the advantages and disadvantages of each.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 2b, 3c, 5a.

Strand(s): Biology

Overall Expectations: BYV.01.

Specific Expectations: BY1.05❖, BY1.06❖ , BY1.07.

Planning Notes

- In order to create a rich learning atmosphere, stations are set up around the perimeter of the classroom so that they can be visited and revisited throughout the unit.
- Provide videoclips of *Paramecium* conjugating as well as undergoing mitosis. This links activities 2 and 3.
- Provide specimens of clams and earthworms (either alive or preserved). If the season and location permit, obtain specimens of tadpoles and display them in an aquarium.
- An aquarium with guppies could be set up as a ScienceWorld activity before this activity has begun.
- As many specimens as possible should be obtained ahead of time for each of the stations.

Prior Knowledge Required

- understanding of mitosis
- understanding of asexual reproduction

Teaching/Learning Strategies

1. Students examine and describe various types of sexual reproduction by studying the samples laid out at the stations around the perimeter of the room. Sample stations and questions (prepared by the teacher) are listed below. As the students circulate about the classroom they complete a worksheet that summarizes the different types of sexual reproduction.

Station	Type of Sexual Reproduction	Description of Station	Questions
1	Conjugation	Visuals of P*aramecium* and spirogyra undergoing conjugation.	What is conjugation? How does conjugation differ from binary fission? What role does the nucleus play in conjugation? How do *Paramecium* conjugate? What is the advantage of conjugation?
2	Hermaphroditism	Specimens of clams, earthworms. Visuals describing life cycles.	What is hermaphroditism? Describe how an earthworm reproduces. What advantage does hermaphroditism have over asexual reproduction?
3	External fertilization by plants	Model of flower and its parts. Table that lists the functions of the parts of the flower. Assortment of different flowers, dissected and labeled. Apple cut in half and a bean cut in half. Chart of a Plant life cycle. Text available for information.	What is external fertilization? Why are flowering plants the most successful group of plants? Name and state the function of the parts of the flower. What is pollination and how does it take place? What is a seed? Why is it important? What is a fruit? Why is it important?
4	External fertilization by animals	Prepared specimen of fish (male and female) with diagrams and labels. Text available for information about spawning. Illustration to show the development of the egg after spawning. Prepared specimen of a frog with life cycle	Identify the reproductive structures of the fish. How do some animals reproduce by external fertilization? What were the observable differences between the parents and the offspring of organisms that reproduce sexually?
5	Internal fertilization by animals	Aquarium with guppies. Life cycle of guppies chart Insects which undergo internal fertilization, eg, grasshopper. Diagram of fruit fly life cycle and some fruit flies on ripe fruit. Prepared specimen of a garter snake and a text to describe how snakes reproduce	Describe the life cycle of one of the specimens observed. What is the advantage of internal fertilization?

2. Students brainstorm, in-groups of three, the characteristics of an organism that would make it successful. The students should compare organisms that reproduce asexually and sexually. Students evaluate each organism using their characteristics as benchmarks.
3. Students prepare a report card for evaluating the success of an organism in a specific environment that will be simulated by the teacher. They list the criteria (one parent, two parent) and assign a score (5 as good and 1 as not good). They should also include an anecdotal comment about each one.
4. Students work in groups of four and prepare a chart that summarizes the differences between asexual and sexual reproduction and list the disadvantages and advantages of each.
5. Students answer the following question in their science log.
   Did you know that when bacteria undergo sexual reproduction, they form a conjugation tube and exchange genetic information? Now that is intimate! Bacteria exchange a part of their most intimate physical selves. How much more intimate could you get than giving someone else a copy of how you were made? We are capable of much more intimacy than bacteria. God intended sexual reproduction to be an expression of who we are as persons. God wanted sexual reproduction to be a giving of our entire selves - both physically and spiritually. God's love for us was expressed through covenants with the Israelites (Noah, Abraham, Moses and David). When we enter into a covenant (marriage) with another person, our love can express itself as a total self-giving, both physically and spiritually. Do you see yourself as being worthy of a covenantal relationship?

Assessment/Evaluation

Knowledge/Understanding is evaluated by:

- worksheet submitted for the five-station activity;
- chart comparing asexual and sexual reproduction.

Inquiry is evaluated by:

- observation checklist during the handling of lab specimens.

Communications is evaluated by:

- students anecdotal comments on the report card ;
- science log reflection.

Making Connections is evaluated by:

- ScienceWorld activity if selected.

Resources

Web Sites

Sexual reproduction
http://easy web.easynet.co.uk/~middlecroft/biology/sexplant.htm

CD-ROMs

DNA: Molecule of Life (Boreal)

Mitosis (Boreal)

Protista (Boreal)

Fungi (Boreal)

Accommodations

1. See Accommodations section in Activity 1 for general accommodations.
2. Possible ScienceWorld ideas:
   - Investigate the breeding of guppies and comment.
   - Build a home incubator and hatch chicks
   - Examine the life cycle of fruit flies and perform some crosses.

Activity 4: Human Reproduction

Time: 375 minutes (5 periods)

Description

In this activity students describe, in general terms, the roles of hormones in human reproduction where there is no conception, and where conception, development, and parturition occur. Students formulate questions about the different factors that affect fetal development. Once the role of hormones in reproduction is understood, students use models to describe, in general terms, human development from conception to the growth of human organs and body proportions. The culminating task is the development of cell theory.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1d, e, 2a, c, e, 5a.

Strand(s): Biology

Overall Expectations: BYV.01, BYV.02.

Specific Expectations: BY1.01❖, BY1.08❖, BY1.09❖, BY1.10❖, BY2.04❖, BY2.01❖.

Planning Notes

- The question of where did the first cell come from may arise and can be used to share with the students both the limits of science empiricism and the value of theological insight into creation and meaning. The creation story (Appendix C6) provides a foundation for this.
- Ensure that appropriate resources are available.
- Formulate questions about the problems the fetus may encounter during development.
- Review the male and female reproductive anatomy.

Prior Knowledge Required

- The students require knowledge of cells from Grades 5, 6, and 8.

Teaching/Learning Strategies

1. Students take notes on the function of the reproductive hormones (progesterone, FSH, LH).
2. Students perform an investigation where they examine data about female hormone levels. They analyse the data and conclude how the level changes affect the uterus and the ovaries. Each group is assigned a diagram to complete for a set number of days in the menstrual cycle (7-12 days, 13-14 days, 15-20 days and 21-28 days). The diagram (female reproductive system frontal view) should show what happens to the ovary and lining of the uterus during their assigned days.
3. Students are assigned a stage in fetal development to research and summarize. The first group focuses on the formation of gametes and a summary of meiosis. The remaining three groups are assigned the first trimester, second trimester and the third trimester respectively. The summary can be

in the form of a narrative, visual or combination of both. Students present their individual stage to the class and individually reconstruct the sequence in fetal development on a time line supplied by the teacher.

Students use their timelines to formulate questions about what, why, and when problems occur during fetal development. They select one question and research it. Some questions that may arise are:

- What is infertility?
- What effect does caffeine have on fetal development?

4. In a group they prepare a visual display stating their question and their findings.
5. As the culminating activity, students discuss the question, "Where did the first cell come from?" As a group they examine theories of natural philosophers (Aristotle and Thomas Aquinas) and early scientists (Needham, Pasteur, Spallanzani). They use what they have learned in the activity to develop their own cell theory. They record the evidence observed in the activity that supports each part of their modern day theory. A summary of their theory is handed in individually.
6. Students complete the following science log reflection.

   We are told in the Bible that man and woman are created in the image of God. That means each one of us, in our maleness and femaleness, is an incomplete image of the wholeness of God. Human sexuality is a gift from God. Like anyone who gives a gift, God is most pleased when we use the gift as it was intended. The act of sexual intercourse has the potential of recreating the image of God in a most holy (whole) way. When two people become one, then they express, as one body, the maleness and femaleness of God. In this holy moment we are also capable, as the most complete replication of the wholeness of God, of creating new life. What a wonderful gift from God! Unfortunately, sexual intercourse can also be unholy (fragmenting). Our society encourages us to separate sex from commitment. Sexual intercourse was intended to be a re-creation of the covenantal love that God had for the Israelites and for us. Sexual intercourse outside of marriage can never express the fullness of love that God intended it to show. In what ways are you preparing yourself for the possibility of a holy marriage?

Assessment/Evaluation

- Knowledge of facts can be evaluated by hormone inquiry sheet, description of cell theory, and the time line of fetal development, quiz on human reproduction.
- Inquiry can be evaluated by observational checklists while microscope slides are being viewed, drawings submitted in cell activity and research skills during the research process.
- Communication can be evaluated by the formulated question and research presented on a Bristol board using a process rubric.
- Making connections can be evaluated through reading the science log reflection.

Resources

Mclaren, James E. and Lissa Rotundo. *Heath Biology*. Toronto, 1989.

Ritter, et al. *Science 9*. Nelson Publishing, 1999.

A.D.A.M.: Nine-month miracle (Boreal)

Accommodations

1. See Accommodations section in Activity 1 for general accommodations.
2. Possible ScienceWorld ideas:
   - extraction of DNA from onions ;
   - construction of a three-dimensional model of DNA.

Activity 5: The Can Do Redactor

Time: 300 minutes (4 periods)

Description

The purpose of this activity is for students to acquire and communicate, in a creative manner, the scientific, technological and theological knowledge required to make informed and ethically responsible decisions as Catholic citizens. Students research the following topics: the history of reproductive biology and the importance of microscopy to its development; the impact of reproductive biology on global and local food production; the importance of Canadian research and technological development in genetics and reproductive biology; the Catholic Church's teachings on reproductive biology; and careers in reproductive biology. Each group is responsible for researching all five and summarizing their results in a magazine called "The Can Do Redactor".

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1i; 2e; 3c,d,e,f; 4g; 5e; 6b,c; 7a,d,e,j.

Strand(s): Biology

Overall Expectations: BYV.03.

Specific Expectations: BY3.01❖, BY3.02❖, BY3.03❖, BY3.04❖.

Planning Notes

- Discuss the assignment with the teacher librarian or library technician at least two weeks before presenting the assignment to the class. Book the library resource centre for four days. If the library facilities are inadequate, collect the required resources (vertical file, journals, magazines, videos, etc.) before the activity begins.
- Ensure that Internet access is available and that students are reminded of the ethical use of the Internet and other information technology resources. Limited Internet access can be overcome using a "webwhacker" program.
- Decide which desktop publishing software package available in your school is most suitable to produce the magazine.
- It may be advantageous for the students to arrange the four days for this activity around a weekend; this would provide additional time for research and collaboration.

Prior Knowledge Required

- Library research skills (Grades 7 and 8)
- Computer research skills

Teaching/Learning Strategies

Teacher Facilitation:

- Introduce the activity to the students (Appendix D6).
- Teach the students magazine formatting skills using any of the common software packages.
- Assign students to groups of four to six or allow students to form their own groups.
- Review pertinent research and computer skills.
- Teach a lesson on Catholic church bioethical teaching (Appendices C4 and C5).
- Conference with students on at least two occasions.
- Timetable a schedule for their presentation and oral defence.

Student Activity:
In-groups of four to six, students work collaboratively to brainstorm their approach to the magazine activity (Appendix D6). They conference with the teacher on at least two occasions. The students are responsible for the process they use, their final product, an oral presentation to the class, and a defence of their magazine.

Assessment/Evaluation

Knowledge, comprehension, inquiry, communication, and making connections can be evaluated using the "The Can Do Redactor" rubric (Appendix D7).

Resources

Desktop publishing software. Consult with your site administrator for further details.

Accommodations

1. See Accommodations in Activity 1 for general accommodations.
2. Possible ScienceWorld ideas include:
    - an excursion to a zoo or university in which endangered animals or plants are the subjects of breeding projects;
    - a science fair project to study asexual propagation.
    - job-shadowing a person involved in a career related to reproductive technologies, e.g., greenhouse technician, biotechnician.

Unit 4: Earth and Space Science: The Study of the Universe

Time: 27.5 hours (22 periods of 75 minutes each)

Unit Developer(s)

Maurice DiGiuseppe, Toronto CDSB
Siria Szkurhan, Hamilton-Wentworth CDSB

Development Date: July 31, 1999

Unit Description

In this unit students focus their attention on the study of the universe and become aware of the wonder and awe of God's creation. Students appreciate how scientific evidence and technological advances support the development of theories about our solar system and the universe. They investigate the appearance and the motion of visible celestial objects and evaluate how space exploration has contributed to our understanding of outer space, the Earth and living things. Emphasis is placed on Canadian contributions to space science.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations: CGE 1a,d,f,h,i; 2a,b,c,d,e; 3b,c,d,e;f; 4a,b,c,d,e;f;g,h; 5a,b,c,d,e,f,g; 7a,b,d,e,f,g,h,i,j.
Strand(s): Earth and Space
Overall Expectations: ESV.01, ESV.02, ESV.03.
Specific Expectations: ES1.01 to ES1.07, ES2.01 to ES2.09, ES3.01 to ES3.04.

Activity Titles (Time + Sequence)

Activity 1	The Universe We Know	150 minutes
Activity 2	SkyWatch	300 minutes
Activity 3	Measuring the Heavens	225 minutes
Activity 4	Our Place in Space	300 minutes
Activity 5	What's What in The Universe?	225minutes
Activity 6	Universal Evolution	150minutes
Activity 7	Blast Off!	300 minutes

Unit Planning Notes

The organization of this unit accommodates a variety of abilities, interests, and learning styles. The suggested timing of the activities may be changed to meet student and teacher needs. It is strongly suggested that students keep a personal science log in which they make notes, generate questions, maintain a personal glossary of terms, record and accumulate data from activities, and make reflections. The teacher should provide direction on the organization of the log at the beginning of the unit. The teacher should also help students become aware of Church documents and the Catholic perspective on the creation of the universe. The teacher should also identify instances where students may engage in scientific inquiry appropriate for their ScienceWorld portfolio (Appendix B). Blastoff! is an on-going activity introduced in Activity 1 and completed in Activity 7. Allow students to meet in their Blastoff! Expert Teams as indicated in the Planning Notes in each activity. Incorporate the Thanksgiving Para-Liturgy towards the end of the unit (see Appendix D10) with the assistance of the school chaplaincy team,

religion teachers, and/or pastor. Planning of the Para-Liturgy should be initiated near the beginning of the unit.

The following are preparation suggestions to assist teachers with limited experience in astronomy:

- read the suggested reference books;
- preview the suggested videos;
- familiarize yourself with software programs such as Starry Night;
- contact the Canadian Space Resource Centre for free or inexpensive resources (1-800-511-3500 or www.spacenet.eybe.edu.on.ca);
- contact local astronomy clubs that might provide assistance;
- check newspapers for articles on astronomical events or space travel, especially those featuring Canadian contributions;
- check both the adult and the children's department of your local library for texts and videos;
- contact a local university for programs, such as Let's Talk Science, or class presentations;
- arrange for guest speakers;
- evaluate the suggested web sites for their appropriateness and usefulness.

Prior Knowledge Required

Students build on prior knowledge from the *Ontario Curriculum Grades 1-8: Forces and Movement* in Grade 3, Structures and Mechanisms from Grade 5 on, Space in Grade 6, and Optics in Grade 8. Students should have a basic knowledge of the terminology needed to describe objects in the solar system. They should also be familiar with knowledge of the proper use of the library, computers and Internet for research work. A review of the ethical use of information from information technologies may be required.

Teaching/Learning Strategies

This unit has been designed to accommodate different learning styles, interests, and abilities, through a variety of teaching and learning strategies (teacher-directed lesson, teacher demonstration, student lab-based inquiry, model building, research activity, independent study, collaborative learning, and group presentations).

Assessment/Evaluation

Student achievement of the expectations is be evaluated using a variety of assessment tools and strategies. Assessment strategies include: teacher-student conferences, formal teacher observations, roving conferences, peer conferences, self-and peer-assessment, pencil and paper assessment, student logs, teacher logs, and wrap-up activities. Sample rubrics and a collaborative group skills rating scale have been included in the appendices for the science process (Appendix A1), lab product (Appendix A2), and generic product (Appendix A3). Rubric A3 is intended to be a framework from which teachers develop specific rubrics to assess research projects and not to be used "as is". In addition, up to one period has been allotted for summative evaluation. The teacher may evaluate students using a pencil and paper test, culminating project, laboratory activity design/practicum and/or extension essay.

Resources

Print

Berry, Thomas. *Befriending the Earth: A Theology of Reconciliation Between Humans and the Earth*. Mystic, Conn.: Twenty Third Publishing, 1991.

Catechism of the Catholic Church. Canadian Conference of Catholic Bishops, 1994. (Should be available in all school libraries.)

Dickinson, Terrence. *From the Big Bang to Planet X*. Camden House Pub., 1993.

Dickinson, Terrence. *Exploring the Night Sky*. Firefly Books, 1998.

Dickinson, Terrence. *Nightwatch*. Firefly Books, 1998.

Link, M. *Path Through Scriptures*. Tabor Publishing, 1987. (Should be available through Religion Department)

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice Hall Science, 1994. Prentice Hall, Englewood Cliffs, N.J.07632 ISBN 0-13-401134-1

Melton, Melanie. *Will Black Holes Devour the Universe? And 100 Other Questions and Answers about Astronomy*. Kalmbach Books, 1994.

Ritter, et al. *Science 9*. Toronto: ITP Nelson, 1999.

Rosen, S. *Science Workshop Series: Earth Science: Volume: The Universe*. Cambridge: Prentice Hall Ginn Canada.

SkyNews: The Canadian Magazine of Astronomy and Stargazing. Publisher: National Museum of Science and Technology, Ottawa.

Swimme, B. *The Universe Story*. New York: Harper Collins, 1994.

Wolfe, E., et al. *SCIENCEPOWER™ 9*. Toronto: McGraw-Hill Ryerson, 1999.

O'Saughnessy, Tam and Sally Ride. *The Third Planet*. New York, New York: Crown Publishers, 1994.

Chandler, David. *Exploring the Night Sky with Binoculars*. P.O Box 309 La Verne, Ca. 91750, USA, 1994

The Royal Astronomical Society of Canada. *The Observer's Handbook*.

Videotapes

Befriending the Earth: Dream of Earth Sciences Series. Thomas Berry in dialogue with Thomas Clarke. Twenty Third Publications. 1990; 13 part series of videos. Mystic Conn.

Environmental Ethics: Ideas for Classrooms Discussion. Durango Col: Group for Telly Productions, 1994.

A Private Universe. Pyramid Film and Video, Box 1048, Santa Monica, Ca, 90406.

National Geographic. *For All Mankind*. Warner Bros. DK EYEWITNESS- "Planets" Dk Publishing, 95 Madison Av-NY. NY. 10016

The New Solar System - An Epic Adventure. Finley- Holiday Film Corp. PO Box 619, Whitter, CA 90608 1-800-845-6707.

Blue Planet IMAX CORP.

Planets. Bill Nye: The Science Guy Series, Magic Lantern(10 Meteor Drive, Toronto, M9W 1A4)

Voyage to the Planets. Amaia Sound and Video Corp. 1-800-869-6379

Destiny in Space. IMAX CORP. 1-800-263-IMAX.

Out of this World "The Apollo Moon Landing." Holiday Film Corp. PO Box 619, Whitter, CA. 90608. 1-800-345-6707.

Powers of Ten, Philip-Morrison version, available from the ASP.

Atkinson, Stewart. *Understanding Science, Astronomy*. Usborne Publishing Ltd. ISBN 0760-13612.

Miles, Lisa and Alistair Smith. *Stars and Planets*. Usborne Publishing Ltd.,1997.

Rackham, T.W. *Atlas of the Moon*. Waukesha, Wisconsin: Kalmbach Publishing Co., 1990.

Dickinson, Terrence and Adolf Schaller. *Extraterrestrials a Field Guide for Earthlings*. Camden, Ont. Canada, Camdem house Publishing, 1994. ISBN 0-921820-86-0

Astronomy Adventures. New York, New York: McGraw Hill Co., 1998. ISBN 0-07-046509-6

Magazines

Larson, R.G. *Astronomy*. ISSN 0091-6358 (www.astronony.com)

Sky and Telescope. Cambridge, MA, USA: Sky Publ. Corp., ISBN 0037-6604.

Dickinson, Terrence. *Sky News*. ISSN 0840-8939.

Mobile Planetarium Resources

Solar Wind
28 Summerheight Dr.
North York ON
M2A 1Y3
416-221-7375

Royal Ontario Museum
Toronto
416-586-5549

Star Charts

The Miller Planisphere. Detalizer Side Charts Inc. 501 Westgate St. Addison, Ill. 60101-4524.

Chandler, David. *The Night Sky Planisphere*. PO Box 999, Springfield, Ca. 93265, USA.

Computer Software

Duffet- Smith, Peter. *Easy PC Astronomy*. Cambridge University Press. ISBN 0-521-56052-7.

Explorer: Earth-Ocean-Atmosphere, ISBN 1-55241-010-2

Starry Night Deluxe. Sienna. www.sienna soft.com

Redshift 3. Planetarium Software. Phranah Interactive Publishing.

Internet

http://www1.tmisnet.com/~abdale/Astronomy/Astronomy.html

http://heasarc.gsfc.nasa.gov/docs/www-info/webstars.html

http:/www.cnde.iastate.edu/staff/jtroeger/astronomy.html

http://www.inspire.ospi. (Athena site)

http://www.wednet.edu.800/sci_edu.sg/ssc.html
(Making an Astrolabe)

http:/www.seds.lpl.arizona.edu/nineplanets/overview.html

http://solstice.crest.org/index.shtml

http://www.ase.org/educators/lessons/index.htm

http://zebu.uoregon.edu/1998/phys162.html

http://www.est.gov.on.ca/english/en/en_renew.ht

http://www.cco.caltech.edu/~newman/sci-faith.html

Canadian Space Resource Centre
www.spacenet.eybe.edu.on.can

NASA web site
www.nasa.gov/
(links to educational resources and to information on space missions, shuttle flights, launch information)

also NASA, JPL, Space Gate, The Planetary Society

Community

Royal Astronomical Society of Canada

McLaughlin Planetarium

McMaster University Planetarium

Activity 1: The Universe We Know

Time: 150 minutes (2 periods)

Description

Students and teacher share what they already know of astronomy. Misconceptions are addressed and clarified as they arise. Students are introduced to the culminating activity of the Unit (Activity 7…Blastoff!) and begin the development of a personal learning log (science log).

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1 a, b, c, d, e, f, g ,h, i, j, 2 a, b, c, d, e, 3 a, b, c, d, e, f, 4 a, b, c, d, e, f, g, 5a, b, c, d, e, f, g, 7a, b, c, d, e, f, g, h, i, j.

Strand(s): Earth and Space Science

Overall Expectations: ESV.01, ESV.02.

Specific Expectations: ES1.01❖, ES1.03❖.

Planning Notes

- Review the basic astronomical facts required to better facilitate the discussions that will take place in this activity (see Teaching/Learning Strategy 1 for details).
- Provide guidance in the organization of student learning logs. A possible structure of the log could be: Questions, Notes, Data & Observations, Reflections, and Glossary.
- Stimulate student interest in astronomy by displaying images of celestial objects and space exploration technology as well as charts providing career directions in space science.
- Discuss Blastoff! with the teacher librarian. Make arrangements to have students visit the library/resource centre as required throughout the unit. If there is no library in the school, assemble the required resources (vertical files, journals, magazines, videos, etc.) in the classroom before the activity starts.
- Ensure that Internet access is available and that students are reminded of the ethical use of the Internet and other information technology resources. Limited access to the Internet can be overcome by the use of a "webwhacker" program.

Prior Knowledge Required

In Grade 6 Earth and Space Systems unit on Space, students studied:

- the tools and techniques that humans use in space exploration;
- how astronauts meet their basic needs in space;
- problems arising from space exploration;
- the ways in which materials and technology for space exploration have led to the use of new technologies and materials on Earth.

Teaching/Learning Strategies

1. Students examine a variety of space-related images/objects displayed around the classroom and complete a question sheet provided by the teacher. (This activity could be modified to become a scavenger hunt.) Possible visuals include: images of celestial objects (comets, galaxies, nebulae, etc.), images of Canadian astronauts, models of spacecraft, and examples of other space technology. Student responses can be taken up through a whole-class discussion. The teacher clarifies misconceptions as they arise. Students will enter significant terms, concepts, and illustrations into their science logs. This activity is useful to demonstrate prior student knowledge of space science.
2. The teacher introduces the Blastoff! activity. Arrange the class into the expert teams listed below; explain the overall goal and structure of Blastoff!; and begin the development of suitable assessment/evaluation strategies with the class. Expert teams meet throughout this unit to research and conference with each other and the teacher. The Blastoff! scenario is as follows:
   The year is 2099. The Earth is seriously overpopulated and polluted. Student expert teams develop a comprehensive plan to colonize a suitable planet within our solar system with a self-sustaining community. The plan is presented to the Minister of Relocation (the teacher) at a series of mock Relocation sub-committee hearings.
   Expert Teams of four or five students determine the details of one component of the colonization process and produce a written brief to be presented in Activity 7. The team must support their component of the overall plan with appropriate audio-visuals such as video clips, three-dimensional models, dramatizations, dioramas, and/or computer-based simulations. Teams are given an opportunity to meet, conduct research, and assimilate information gained in each of the activities of this unit leading up to the culminating activity (the mock sub-committee hearings). One student of each team acts as the spokesperson. This individual delivers the oral brief to the Minister. Another student is selected to be team leader. Leaders from each expert team form the Blastoff! Steering Committee, which meets at various times throughout the unit in preparation for the final presentation.
   Expert teams could include:
   1. The Planet Selection Team
      This group becomes knowledgeable in the physical, chemical, and environmental characteristics of the planets in our solar system and their potential for human colonization.
   2. The Biological/Environmental Team
      This group studies the atmospheric conditions required to sustain life, artificial life support systems, waste disposal/sanitation systems, food production and preservation, and health issues.
   3. The Recreation/Leisure Group
      This group determines the sorts of community and personal leisure activities that settlers require. They develop programs that promote the well-being of the community.
   4. The Transportation Team
      These students design, develop and construct a model of a vehicle suitable to transport settlers to the chosen planet. Their analysis should include: fuel, safety, distance and speed of travel, time, and vehicle design and maintenance.

5. The Architectural Team
   This group designs suitable living structures on the planet. Environmental, material, structural and aesthetic considerations are studied.

Assessment/Evaluation

- Teaching/Learning Strategy 1 is assessed for knowledge and understanding, communication, and making connections by assessing student answers to question sheets using a suitable rating scale developed by the teacher. (ES1.01, ES1.03)
- Student log entries are assessed for communications using a suitable rubric. (ES1.01, ES1.03)
- The Blastoff! activity is assessed for knowledge and understanding, communications, making connections, and inquiry by means of a suitable process rubric (see Appendix A2) and a product rubric (see Appendix A3). The assessment is an on-going process throughout the unit to be completed at the end of Activity 7.

Resources

Astronomy Magazine (news-stands / libraries)

Bennet, B., C. Rolheiser-Bennet, and L. Stevhan. *Cooperative Learning: When Heart Meets Mind*.

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice-Hall.

Sky News Magazine (news-stands/libraries)

Sky & Telescope Magazine photos and illustrations (available at most news-stands and public libraries)

Solar System Lithograph Set for Earth and Space Science, NASA (available from Canadian Space Resource Centre)

Accommodations

1. Modify this activity to meet the student's needs as outlined in the IEP.
2. ESL/ELD students are given opportunities to demonstrate their learning by means suitable to their language comprehension and abilities. At the same time, instruction in written science-specific language continues.
3. For students with physical or learning impairments, classroom/laboratory facilities are modified as much as possible to permit participation in group and individual activities.
4. For the purpose of providing extensions and enrichment, students will have opportunities to investigate the topics presented here in greater detail. Close collaboration between teacher and student is required to ensure appropriate enrichment opportunities.
5. Possible ScienceWorld ideas include:
   - Produce a weekly "Astro Newsletter" for the class. Include news items obtained from newspaper, magazine, and Internet sources.
   - Organize an astronomy club at your school. Make the necessary arrangements with your teacher and assist in the co-ordination of club activities.

Activity 2: Sky Watch

Time: 300 minutes (4 periods)

Description

In this activity students learn how to observe, record, and communicate the relative positions and motions of celestial objects.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1 a, b, c, d, e, f, g, h, i, j, 2 a, b, c, d, e, 3 a, b, c, d, e, f , 4 a, b, c, d, e, f, g, 5a, b, c, d, e, f, g, 7a, b, c, d, e, f, g, h, i, j.

Strand(s): Earth and Space Science

Overall Expectations: ESV.01, ESV.02.

Specific Expectations: ES1.01, ES2.01, ES2.03❖, ES2.05❖, ES2.07❖.

Planning Notes:

- Contact local amateur astronomers and/or astronomy buffs in your school community to assist in day-time and possibly night-time sky-observing sessions.
- During day-time observations, students must be reminded NEVER TO LOOK DIRECTLY AT THE SUN----PERMANENT EYE DAMAGE MAY OCCUR! See Safety Memorandum No. 19, April 20, 1994 (Ministry of Education and Training). Solar filters should be avoided due to potential safety risks. The Sun should always be viewed using indirect methods; (these are indicated later).
- Direct observation of the sky is very important. Planetarium software, although useful for in-class studies and research, should never completely substitute for direct observation. Although the unit may be dealt with in a single block of time, students should be encouraged to continue observing the sky throughout the year and recording observations in their personal science learning logs.
- Gather and display information about significant astronomical events that occur.
- Student Safety Alert: This unit suggests several night-time observation activities. It is suggested that a letter be sent home to inform parents of any such event.
- See "Astronomy Teacher's Guide", item 10 in the Resources section of this activity for how to make a horizon sketch, assistance in organizing night-time stargazing sessions and guidelines for required equipment.
- Provide Blastoff! expert teams with opportunities to meet and assimilate information from this activity into their component of Blastoff!

Prior Knowledge Required

- Grade 5 Science: Weather: air current concepts
- Grade 6 Science: Space: components of the solar system, motion of heavenly bodies, movement of earth, Sun, and moon, constellations, and moon phases
- Grade 8 Science: Optics: properties of light, mirrors and lenses
- Mathematics: the SI metric system of measurement, scientific notation, ratio and proportion
- Geography: mapping skills, compass directions, scale, latitude and longitude

Teaching/Learning Strategies

A. Observing the Sky by Day

Safety Note: NEVER LOOK DIRECTLY AT THE SUN!

1. The teacher leads the class outside on an appropriate sunny day, divides the class into small groups, and provides each group with a compass. While facing due south, students create a horizon sketch in their science logs (see "Astronomy Teacher's Guide" in the Resources section). They locate objects in the sky such as the sun and possibly the moon.
2. With teacher facilitation, students determine the location and direction of relative motion of key visible celestial objects. The position of the ecliptic is demonstrated. The apparent path taken by Sun, moon, planets, and zodiac constellations (if they were visible) is indicated.
   A follow-up activity should take place indoors where teacher and students use physical models, planetarium software, and/or chalkboard drawings to clarify concepts, positions, and motions of celestial objects observed outdoors.
3. Students set up a wall-chart for recording Sun-related data of the area where they live such as date compass direction (azimuth) of sunrise and sunset; the maximum altitude of the sun on that date and the length of daylight (in hours and minutes). Each student in the class could be assigned specific dates for which they must supply data. Students create an equivalent chart in their science logs and record daily entries. Data may be obtained from various sources including: software programs, the Internet, daily newspapers, *Farmer's Almanac*, etc. Periodically, students are required to submit a brief report that describes patterns between time of year and length of day or time of year and maximum altitude of the sun. Suitable graphs of these variables may also be generated.

B. Observing the Sky by Night

1. Students observe the night sky with the unaided eye. (See Accommodations to assist students who live in less than ideal star-gazing locations.)
   Safety Alert! Parents should be notified, in advance of this activity, so that they may supervise their children.
   Students draw a horizon sketch in their personal logs while facing due south. They should identify familiar objects such as the moon, bright stars, possible planets, and a familiar constellation or two. A survey of the students' discoveries and sketches may be conducted during the next class with students exchanging horizon sketches and asking each other questions. The diagrams may be collected for assessment.
2. Students should be introduced to the correct use of star-charts, commonly available in textbooks, software programs, astronomy magazines, or commercially available formats. Star charts may be used to introduce students to key constellations such as Ursa Major, Ursa Minor, the Big Dipper asterism, Cassiopeia, Orion, etc.
3. Using star-charts or astronomy columns in local daily newspapers, students should attempt to locate planets that are visible on clear nights. They should be instructed to look for bright, star-like objects that emit a steady light (i.e., no twinkling), located somewhere along the ecliptic. They should be encouraged to take their personal science logs home with them every day in order to be prepared for nights when visibility is good. Encourage students to draw horizon diagrams and to note questions that arise.
4. Students locate the Big Dipper and Polaris in the night sky at home. They draw two horizon sketches of the Big Dipper and Polaris at two different times of the night, one or two hours apart. They analyse the apparent motion of the Big Dipper and write a brief report outlining their findings. The report is submitted for assessment and evaluation.

5. Pairs of students research and produce a Bristol board-sized poster of a constellation which displays: the name of the constellation, a dot and line diagram with a relative brightness rating for each star, and a brief history of the constellation (or part thereof) as explained by Western or other cultural traditions.
6. Students should view the moon at night in various phases; (a telescope or binoculars may be used if available). They draw sketches of what they see and label the various components of the moon's surface including craters, seas (maria), mountains, etc. They also identify the phases of the moon. Students compare their diagrams to those contained in books, posters, or globes of the moon, and note differences and similarities.

Assessment/Evaluation

- Student participation in small group observing activities may be assessed for knowledge and understanding, communications, and inquiry by use of appropriate process (Appendix A1) and product (Appendix A3) rubrics. (ES1.01, ES1.03, ES2.01, ES2.05)
- Through informal roving conference, teachers assess the recording of observational notes and sketches, and whether students are using tools, equipment, and apparatus safely and properly. (ES2.01, ES2.03, ES2.05, ES2.07)
- Teachers may collect student logs and assess their entries and diagrams for communications using suitable rubrics or checklists. (ES2.05, ES2.07)
- An oral quiz on features of the day and night sky, followed by a paper and pencil test, and would be suitable in this activity. The quiz identifies misunderstandings that may be corrected before the test is administered. The quiz and test may be evaluated for knowledge and understanding, and communications by means of a suitable marking scheme or rating scale. (ES1.01, ES1.03)

Resources

Sky & Telescope Magazine photos and illustrations (available at most newsstands and public libraries)

Sky News Magazine (news-stands/libraries)

Astronomy Magazine (news-stands/libraries)

Solar System Lithograph Set for Earth and Space Science. NASA (available from Canadian Space Resource Centre)

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice-Hall.

Bennet, B., C. Rolheiser-Bennet., L, Stevhan., *Cooperative Learning: When Heart Meets Mind*.

Ritter, et al. *Nelson Science 9*. Toronto: ITP Nelson 1999.

Wolfe, et al. *SCIENCEPOWER™ 9*. Toronto: McGraw-Hill 1999.

Binoculars: any good quality pair (7x50 is best)

Astronomy Teacher's Guide

A: HORIZON SKETCHES

A straight, horizontal line is drawn on a blank piece of paper with the viewer's eyesight assumed to be pointing at the centre of the line. The compass direction corresponding to this view is written over the centre-point, and celestial objects are drawn above the horizon in relative position. The celestial objects are labelled with their names, symbols, altitude (the number of degrees above the horizon), and azimuth (the number of degrees clockwise from due north). The student's name, date, and local time should be placed in a corner of the sketch.

B: NIGHT-TIME OBSERVING

The teacher should make suitable arrangements for night-time viewing. This may be done in a number of different ways that are largely determined by local conditions of class size, resource availability, environmental conditions, and student safety. Teachers must make contingency plans for the possibility of poor weather conditions, and should send a note home to inform parents.

Organized star-gazing sessions may be planned as an outdoor activity on school grounds if the school is located far enough from urban light pollution, or may take place as an overnight camping excursion at a remote site suitable for this sort of activity. Alternatively, a field trip to a local observatory or planetarium, if one is nearby, would be suitable. Local astronomical societies and amateur astronomy clubs organize occasional public viewing sessions at local parks. These are an excellent vehicle for delivering this part of the curriculum. Teachers and students learn much from such an experience. Another option for night-time viewing is for the students to observe on their own. In this case, they have to sharpen their observational skills during the daytime and horizon-sketch drawing skills. The use of star-charts and commercially available planispheres facilitates this activity.

C: BINOCULARS AND TELESCOPES

Day-time or night-time viewing of the sky may effectively be done without the use of telescopes. If a telescope is available (some students may have their own to share), it should be used to enhance the viewing experience. A simple explanation of the type of telescope being used (refractor or reflector) and its proper use, care, and maintenance should be made. Details regarding its structure and operation should be avoided at this time. The use of binoculars is encouraged, however. Any good quality set will do, however, a pair of 7x50 binoculars is ideal for night-time viewing.

Accommodations

1. For general accommodations, see Accommodations in Activity 1.
2. Visually impaired students should participate in all observation activities where possible. They should be partnered with a fellow student who explains, in words, what is observed. Braille sky-charts are available from the Boston Museum of Science.
3. For students living in high rise apartments or locations with excess light pollution, the following star-gazing alternatives are suggested:
   - arrange for a class field trip to a planetarium or have a portable planetarium brought to the school (see Unit Planning Notes for details);
   - arrange for a evening star-gazing activity supervised by parents/teachers.
4. Possible ScienceWorld ideas:
   - Produce a long-exposure photograph of the stars with Polaris near the centre of the image; this project requires a tripod and manually-operated SLR camera. Submit the photograph with a brief explanation of the captured image. Parental permission and supervision is required.
   - Create a replica of the night sky on the classroom ceiling using appropriate materials. Constellations should be labelled; the relative brightness of stars should be illustrated; and the main compass directions should be shown.
   - Produce a photo album of the moon's phases; label each of the photographs.
   - Write a short essay on the "star of Bethlehem" that explains what historians and Bible experts say about the star.
   - Create your own story about one of the constellations or write a poem or rap describing a variety of constellations which could include references to the objects, people, gods, or creatures implied by their names.

Activity 3: Measuring the Heavens

Time: 225 minutes (3 periods)

Description

In this activity students are introduced to the units commonly used to express astronomical distances and gain some appreciation of the enormity of astronomical distances. Students use indirect measurements to calculate the diameter of the sun. Students also research possible careers involving astronomy or space research.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1d, h, i, 2a, b, c, d, e, 3b, c, d, e, f, 4a, b, c, d, e, f, g, 5a, b, c, d, e, f, g, h, 7a, b, d, e, f, g, h, i, j

Strand(s): Earth and Space Science

Overall Expectations: ESV.01, ESV.02.

Specific Expectations: ES1.01❖, ES1.03❖, ES2.02❖, ES2.03❖, ES2.04❖, ES2.05❖, ES2.06❖, ES2.07❖, ES2.08❖, ES3.03❖, ES3.04❖.

Planning Notes

- It may be necessary to review SI metric units and other accepted units useful in the study of astronomy; ratio, proportion, and scaling techniques; the concepts of light ray, converging ray, diverging ray, and limiting ray of an extended source.
- The teacher should become familiar with the program, *Career Explorer* or the CD-ROM *Real Science: Volume 3: Careers in the Physical Sciences* in order to assist students in finding out information about astronomy related careers.
- Provide Blastoff! Teams with opportunities to meet and assimilate information from this activity into their component.

Prior Knowledge Required

- Grade 8 Mathematics: Number Sense and Numeration: Powers and Scientific Notation
- Grade 8 Mathematics: Data Management and Probability
- Grade 8 Science: Optics
- Ethical use of the Internet and other sources of information

Teaching/Learning Strategies

1. Students, working in pairs, construct a pinhole viewer that they use to calculate the diameter of the sun within the limits of experimental error. the need for neatness in drawing mathematical diagrams stress. Students submit a laboratory report written according to a suitable report format. The lab report assessment rubric (Appendix A2) is distributed to students before they write the report.
2. In order to appreciate the enormity of the distances separating celestial objects, students are introduced to convenient distance units used in astronomy: the Astronomical Unit (AU) and Light Year (LY).
3. Students select three celestial objects from a list supplied by the teacher; (the list should not include solar system components). Students research the distance from Earth to their objects, expressing the distance in an appropriate unit. They enter these values into the "notes" section of their logs. The teacher supplies students with rolls of cash register tape or other long strips of paper. Students develop

a suitable scale and draw a scale diagram of the distance from Earth to their celestial objects. These diagrams are submitted for evaluation and may be displayed in the classroom.

4. Students work in pairs to research a space science career they select from a list provided by the teacher. They produce a job want ad that includes: job title, job description, employing agencies, educational requirements, current pay scales, etc. Display the ads on a suitable bulletin board.

Assessment/Evaluation

- The diameter of the sun activity may be assessed for inquiry using a roving conference and making anecdotal comments of the student's participation and co-operation in the small group activity.
- The report on the sun's diameter may be evaluated for inquiry and communications by adapting the lab product rubric (Appendix A2). (ES1.01, ES1.03, ES2.01, ES2.03, ES2.06, ES2.08)
- The relative distance activity may be assessed for knowledge and understanding, communications, and making connections by means of a suitable process rubric (see Appendix A1), and product rubric (see Appendix A2). (ES2.04, ES2.05, ES2.06, ES2.08)
- Students produce a want ad that the teacher assesses for knowledge/understanding and communication by adapting the product rubric (Appendix A3). (ES3.04)

Resources

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice Hall Science, 1994.

Stars and Galaxies. The Weyland Library of Science and Technology.

Powers of Ten. Film/Video: (Phillip-Morrison version available from the ASP).

Starry Night Deluxe CD-ROM.

Ritter, et al. *Science 9*. Toronto: ITP Nelson, 1999.

Wolfe, et al. *SCIENCEPOWER™ 9.* Toronto: McGraw-Hill, 1999.

Real Science Volume 3: Careers in the Physical Sciences. CDROM

Career Explorer

Accommodations

1. See Accommodations in Activity 1 for general accommodations.
2. Possible ScienceWorld idea:
    - Use the parallax method to indirectly measure the sun’s diameter. Submit a lab report outlining your methods, calculations, results, and conclusions. Compare your results with the accepted value.

Activity 4: Our Place In Space

Time: 300 minutes

Description

In this activity students research, construct models, and present the characteristics of the components of the solar system. They also outline the theory of the formation of the solar system, and describe the Sun and its effects on Earth.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1a, d, h, i; 2a, b, c, d, e; 3b, c, d, e, f; 4a, b, c, d, e, f, g, h; 5a, b, c, d, e, f, g; 7a, b, d, e, f, g, h, i, j.

Strand(s): Earth and Space

Overall Expectations: ESV.01, ESV.02.

Specific Expectations: ES1.03❖, ES1.05❖, ES1.06❖, ES2.01❖, ES2.02❖, ES2.09❖.

Planning Notes

- Discuss the solar system project Teaching/Learning Strategy 1 with the teacher librarian or library technician at least two weeks before presenting the assignment to the class.
- Ensure that numerous resources including the Internet are available.
- Remind students of the ethical use of the Internet and other information technology resources. Limited access to the Internet can be overcome by the use of a "webwhacker" program.
- Ensure that community links are made (e.g., tours, phone interviews, presentations, guest speakers).
- Help students become aware of Church documents and the Catholic perspective on the creation of the universe (Appendix C6). Consult with the school chaplain, pastor or religion teachers for further assistance.
- It is suggested that two consecutive periods be used for research on the solar system.
- The Planet Selection expert team of Blast Off! should survey the class for the most suitable planet for colonization. Combining this information with their own research they should finalize a decision on the planet chosen for colonization and then meet with the Blast Off! Steering Committee to share this information. The rest of the Blastoff! expert teams should then meet and assimilate this information into their component of Blastoff! and plan for Activity 7.

Prior Knowledge Required

1. Library research skills.(Grades 7 and 8)
2. Grade 6 Earth and Space Systems unit on Space:
   - the physical characteristics of the solar system
   - the causes for night and day and the seasons
   - the relative motions of Earth, moon, Sun and planets

Teaching/Learning Strategies

1. a) The teacher introduces the solar system research project and gives suggestions and guidance as students work in small groups to produce a poster of one of the nine planets or the sun. Planet posters should include: a picture or drawing, distance from the sun, average diameter, mass, density, period of revolution or orbital period in Earth time, period of rotation (hours or days), number of moons, temperature ranges (°C) (low, high), surface gravity, orbital velocity (km/s), nature of the atmosphere, and other significant characteristics. The sun poster should include: a qualitative and quantitative description, importance of the sun as an energy source, types of radiation emitted, the effect of the sun on Earth and its atmosphere and a description and explanation of the Aurora borealis.
   b) Each group presents their poster and then display it in an appropriate place in the room.
   c) The class circulates through the Planet poster gallery and compiles an information database for all the planets.
   d) Each group constructs a three-dimensional model of their planet, relative in size to the other planets and the sun. These models can be suspended in an appropriate location for the remainder of the course. Students should note that the distances between planets are not being to scale.
2. The teacher shows a video or software package that introduces the formation of the solar system. Students imagine going back in time in a protected time capsule and observe the formation of our solar system from clouds of gas and dust drifting through space. Each student should write:
   a) a description of the formation of the sun, the planets, and their moons;
   b) a reflection on
      i) the role of God in this creation (see Appendix C2);
      or
      ii) the realization that when you pick up a flat stone that you intend to throw in order to make it skip on the surface of the still lake you are really holding star dust!

Assessment/Evaluation

- Students ability to research, work collaboratively with peers and teacher, focus and solve problems, and recognize relevant information, can be assessed for inquiry using a process rubric (Appendix A1) and rating scale (Appendix A4). (ES1.03, ES2.01, ES2.02, S2.09)
- The Planet poster can be assessed for knowledge/understanding and communication by adapting the product rubric (Appendix A3).
- The presentation of the poster can be assessed for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3). (ES1.01, ES1.03, ES2.01, ES2.02)
- The models of the planets can be assessed for inquiry using an appropriate rating scale. (ES1.01, ES1.03, ES2.01, ES2.02)
- The description of the formation of the solar system can be assessed for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3). (ES1.05)
- A pencil and paper test on the solar system is appropriate at the end of this activity in order to assess knowledge and understanding. (ES1.01, ES1.03, ES1.05, ES2.01, ES2.09)

Resources

Sky & Telescope Magazine photos and illustrations (available at most news-stands and public libraries)

Sky News Magazine (News-stands/libraries)

Astronomy Magazine (News-stands/libraries)

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice-Hall.

Bennet, B., C. Rolheiser-Bennet, L. Stevhan. *Cooperative Learning: When Heart Meets Mind*.

Fraknoi, Andrew. *The Universe at Your Fingertips*. Astronomical Society of the Pacific, 1995.

Wolfe, E., et al. *SCIENCEPOWER™ 9*. Toronto: McGraw-Hill Ryerson, 1999.

Ritter, et al. *Science 9*. Toronto: ITP Nelson, 1999.

Appropriate web sites in Unit Resources

Accommodations

1. See Accommodations for a list of general accommodations in Activity 1
2. Possible ScienceWorld ideas include:
   - Write a letter to an alien from another star system describing our solar system. In addition, write a response letter that the alien would send, describing how our solar system appears to them.
   - Create a board game that tests the player's knowledge and understanding of the solar system.
   - One of the early spacecrafts carried a plaque that described life on Earth. What would you tell another civilization about Earth?
   - Keep a log of the significant astronomical events that occurred during the year or semester.

Activity 5: What's What in the Universe?

Time: 225 minutes (3 periods)

Description

In this activity, students travel beyond our solar system to discover objects usually too far or too dim to observe with the unaided eye. They continue their study of stars by learning about their composition, brightness, and basic structure. They explore several physical methods used to determine the composition, temperature, and motion characteristics of stars and other distant sky objects.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1 d, h, i; 2 a, b, c, d, e, f; 3b, c, d, e, f; 4a, b, c, d, e, f, g; 5a, b, c, d, e, f, g, h; 7a, b, d, e, f, g, h, i, j.

Strand(s): Earth and Space Science

Overall Expectations: ESV.01, ESV.02.

Specific Expectations: ES1.01❖, ES1.07❖, ES2.03❖, ES2.05❖, ES2.07❖, ES2.09❖.

Planning Notes

- Provide students with construction materials such as construction paper, markers, cellophane, and masking tape.
- Display a variety of book, poster, video, and software resources that vividly illustrate the structure and beauty of deep sky objects such as star clusters, nebulae, galaxies, etc.
- Student-quality spectroscopes and a variety of gas discharge tubes with holders and power supplies are required.
- Provide Blastoff! teams with opportunities to meet and assimilate information from this activity into their component.

Prior Knowledge Required

- Grade 4 Science: Light and Sound: sources of light, luminous objects, straight line path
- Grade 6 Science: Space: stars, surface temperature of stars
- Grade 8 Science: Optics: visible light and other forms of electromagnetic radiation
- Science safety rules regarding the use of electric devices

Teaching/Learning Strategies

1. Working in pairs, students design and construct a Pocket Guide to the Universe. The final product may take a variety of forms such as a booklet or multi-page pamphlet; a pullout pocket guide; or a series of "playing cards" with images and information on the backs (see *Astronomy Adventures*, NatureScope, for ideas and instructions). Celestial objects that should be included in the guide are: asteroid, black hole, comet, galaxy, meteor, meteorite, nebula, neutron star, nova, supernova, star, variable star, and quasar. Students exchange their completed guides with classmates to see what others have done.
2. Through a teacher-led, large group activity, students are introduced to the basic chemical composition of a typical star; the process by which it generates light and heat; its temperature characteristics; and the methods used to determine its composition and surface temperature. Students add new terms and definitions to their science logs.
3. Students examine the line spectra of various gases (hydrogen, helium, etc.), and identify the gases by comparing the observed line spectra with spectrum charts (available in senior chemistry or physics textbooks or commercially available wall charts). If a gas tube discharge apparatus is not available, students may complete an activity such as Investigation 14-A on page 465 of McGraw-Hill's *SCIENCEPOWER™ 9* as an alternative. Students are provided with a lab report assessment rubric (see Appendix A2) and then submit a lab report on this investigation. The report could include an explanation of how a spectroscope and telescope are used to identify the chemical composition of stars and other distant luminous celestial objects.

Assessment/Evaluation

- The pocket guide to the universe may be assessed for knowledge and understanding, and communications using a process rubric (Appendix A1), and a product rubric (Appendix A3). (ES1.01, ES2.05, ES2.07)
- The bright line spectrum lab activity may be assessed for knowledge and understanding, inquiry, and making connections, by roving conference, using a process rubric (Appendix A1), and lab product rubric (Appendix A3). (ES1.07, ES2.02, ES2.03, ES2.05, ES2.06, ES2.09)
- A paper and pencil quiz could be used to evaluate knowledge and understanding, and communications of the components of this activity. (ES1.01, ES1.07, ES2.09)

Resources

Astronomy Adventures. McGraw-Hill.

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice Hall Science, 1994.

Wolfe, E., et al. *SCIENCEPOWER™ 9*. Toronto: McGraw-Hill Ryerson, 1999.

Variety of astronomy photo books and posters (see Unit Resources for references)

Gas discharge tubes, holders, and power supplies, hand-held spectroscopes, standard line spectrum charts (all available from various science supply companies)

Accommodations

1. See Accommodations in Activity 1 for a list of general accommodations.
2. Individuals with fine or gross motor impairment require table-top spectroscopes and may require modifications to other classroom and/or laboratory furniture and apparatus.
3. Individuals with visual impairments should participate in the spectrum lab activity with the assistance of a fellow student who orally describes the observations.
4. Possible ScienceWorld ideas:
   - Write an article in the school newspaper on the astronomy concepts and information learned in this activity.
   - Add an "Astro-News" or "Skywatch" page to your school's web site containing information, images, and links related to topics explored in this unit.

Activity 6: Universal Evolution

Time: 150 minutes (2 periods)

Description

Student observations of the night sky with the unaided eye reveal a universe composed of relatively stable objects that apparently move in predictable patterns. Students discover that the apparent stability is an illusion caused by the great distances that separate Earth from other celestial objects, and the enormous time-lines over which cosmic changes occur. Students learn that all objects in the universe have an origin, go through an evolutionary phase, and eventually reach an end-state or death. They also discover that the universe, as a whole, may evolve along the same lines.

Students gain familiarity with generally accepted scientific theories of the origin, evolution, and fate of stars, galaxies, and the universe as a whole. They are also given opportunities to reflect on biblical accounts of the origin and fate of the universe, as well as those of other cultures and traditions.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1d, h, i; 2a, b, c, d, e; 3b, c, d, e, f; 4a, b, c, d, e, f, g, h; 5a, b, c, d, e, f, g, h; 7a, b, d, e, f, g, h, i, j.

Strand(s): Earth and Space Science

Overall Expectations: ESV.01, ESV.02.

Specific Expectations: ES1.02❖, ES1.07❖.

Planning Notes

- Many of the concepts and theories concerning the origin and fate of stars and the universe are highly abstract. Students in this grade lack sufficient background in chemistry and physics to make sense of the details of cosmic evolution. They may appreciate the concept of gravity as a pulling force on Earth but have not yet dealt with universal gravitation, which is central to any understanding of cosmic or stellar evolution. Provide concrete analogies and simplifying diagrams wherever possible to illustrate new concepts. The use of computer software and video resources is indispensable in this section of the unit. Three-dimensional space-filling illustrations, vivid animations and simulations on video and/or computer enhance the teaching/learning experience.

- Encourage students to enter their questions into their logs and provide question/answer periods at suitable intervals.
- Provide Blastoff! teams with opportunities to meet and assimilate information from this activity into their component. A final Blastoff! steering committee meeting should be held during this activity in order to finalize and consolidate colonization plans that require consensus.

Prior Knowledge Required

- Grade 3 Science: Forces: push/pull, gravity, unbalanced forces cause movement
- Grade 4 Science: Light: straight line travel, reflection/refraction, colour, prisms.
- Grade 5 Science: Energy: conservation law, states of matter and changes.
- Grade 7 Science: Heat: heat vs temperature, particle theory, heat transmission
- Grade 8 Science: Optics: types of EM radiation, colour, wavelength.
  Fluids: mass, volume, density, liquids and gases, temp. change and density.

Teaching/Learning Strategies:

1. Students produce a poster illustrating the life-cycle of various types of stars (see "The Evolution of Stars" on pages 468-471 in McGraw-Hill's *SCIENCEPOWER™ 9*, or "The Life of a Star" on pages 468-471 in Nelson's *Science 9*). The poster should include labelled diagrams that illustrate the formation of stars from the dust and gases of nebulae, followed by various outcomes that largely depend on the star's original mass.
2. Students are introduced to the Doppler Effect as a phenomenon used to detect the expansion of the universe. See "The Expanding Universe" on pages 503-504 in McGraw-Hill's *SCIENCEPOWER™ 9* or "Evidence of an Expanding Universe" on pages 476-477 in Nelson's *Science 9*.
3. Students brainstorm questions drawn from discussions of the Big Bang Theory. Discuss these questions as a whole class with the teacher as moderator. Questions to anticipate include:
   What existed before the Big Bang?
   How small was the original singularity?
   Where is the place where the Big Bang began?
   Does the universe have a boundary? If so, what's on the other side of the boundary line? What's the universe expanding into?
   Will the universe expand forever?
   How does God figure into the Big Bang Theory?
   How do we interpret the creation story in Genesis?
   Although detailed answers to many of these questions are beyond the scope of the Grade 9 course, students should be provided with adequate guidance and resources to arrive at satisfactory explanations. Inviting expert guest speakers (physicists, cosmologists, theologians, etc.) or viewing suitable videotapes where experts speak out on these issues will help with these difficult questions. Teachers and students are encouraged, however, to familiarize themselves with the Church's teachings on the origin of the universe.

Assessment/Evaluation

- The star life-cycle poster may be assessed for knowledge and understanding, and communications using a product rubric (see Appendix A2). (ES1.02, ES1.07)
- Log entries and class discussion on the origin, evolution, and fate of the universe may be assessed for knowledge and understanding, communications, and making connections by means of a suitable check-list or rating scale, and a process rubric (see Appendix A1) (ES1.02, ES1.07)

Resources

Various videos (see Unit Resources for references).

University, college, Archdiocese, and/or local astronomical society individuals with expertise in the creation, evolution and fate of stars, and the creation and evolution of the universe as a whole.

Wolfe, E., et al. *SCIENCEPOWER™ 9*. Toronto: McGraw-Hill Ryerson, 1999.

Ritter, et al. *Science 9*. Toronto: ITP Nelson, 1999.

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice Hall Science, 1994.

Starry Night Deluxe CD-ROM

Accommodations

1. See Accommodations in Activity 1 for general accommodations.
2. Possible ScienceWorld ideas:
   - Create a computer simulation that illustrates the Big Bang Theory or the creation, evolution and fate of various stars.
   - Write a short research essay on the "3K background radiation", describing what it is; why it exists; who first detected it; when it was first detected; how it was first detected; and how it is used as evidence for the Big Bang Theory.
   - Create a collage depicting how five or six different cultures from around the world explain the origin and formation of the universe. Ensure that one of the cultures researched is a Canadian indigenous culture (i.e., Inuit, Huron, Iroquois, etc.).

Activity 7: Blast Off!

Time: 300 minutes (4 periods)

Description

In this activity students gather information from a variety of sources to evaluate the impact of space science on our knowledge of the solar system, specifically, and the advancement of science, in general. Students will also present the culminating Blastoff! activity.

Strand(s) and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: CGE 1a, d, h, i; 2a, b, c, d, e; 3b, c, d, e; f; 4a, b, c, d, e, f, g, h; 5a, b, c, d, e, f, g; 7a, b, d, e, f, g, h, i, j.

Strand(s): Earth and Space

Overall Expectations: ESV.03.

Specific Expectations: ES1.04❖, ES2.04❖, ES3.01❖, ES3.02❖, ES3.03❖, ES3.04.

Planning Notes

- Discuss the History of Space Travel Time Line assignment with the teacher librarian. If there is no library in the school, the teacher should assemble the required resources (vertical file, journals, magazines, videos, etc.) in the room before the activity starts.
- Posters and pictures of various space satellites should be collected for reference from the Canadian Space Resource Centre or from NASA.
- *Earth-Ocean-Atmosphere Explorer* CD-ROM contains information on satellite remote sensing technologies and applications.

- Ensure that Internet access is available and that students are reminded of the ethical use of the Internet and other information technology resources.
- Ensure that community links are made (e.g., tours, phone interviews, presentations, guest speakers).
- You may wish to conclude this unit with a Thanksgiving Para-Liturgy (see Appendix D10). Planning for this event should start near the beginning of the unit. Enlist the help of the school chaplain, religion teachers, or pastor in organizing this event.

Prior Knowledge Required

In Grade 6 Earth and Space Systems unit on Space, students studied:

- the tools and techniques that humans use in space exploration;
- how astronauts meet their basic needs in space;
- problems arising from space exploration;
- the ways in which materials and technology for space exploration have led to the use of new technologies and materials on Earth.

Teaching/Learning Strategies

1. The teacher presents and monitors the research assignment on the History of Space Travel. This activity can be done a jigsaw activity. The final product is a time line, where each student in the group studies a ten-year period from 1954 to the present. The time line could include the following information:
   a) manned flights;
   b) satellites (communication, weather, navigational, scientific) - Canadian contributions should be emphasized;
   c) interstellar probes;
   d) space stations;
   e) Canada's contributions to space technologies associated with international space programs (e.g., research into microgravity, the Canadarm, the International Space Station).

   Students work in groups of five to research, describe, and evaluate the impact that space explorations and accomplishments in space technologies have had on:
   a) our understanding of scientific theories and principles;
   b) our knowledge of the solar system;
   c) our appreciation of the fragility of the planet Earth and our responsibilities as Christian stewards;
   d) international cooperation in space;
   e) the improvement of life-style through space technology spin-offs.
2. The Blastoff! Relocation Sub-Committee Hearing takes place. The classroom should be set up into a suitable council chamber format. Teams present their brief and supporting audio-visual materials. The written brief will be submitted to the Minister of Relocation (teacher).
3. The Thanksgiving Para-Liturgy may take place at this time. See Appendix D10 for a possible format.

Assessment/Evaluation

- Students ability to research, work collaboratively with peers and teacher, focus and solve problems and recognize relevant information can be assessed for knowledge/understanding, inquiry, and communication using a process rubric (Appendix A1) and rating scale (Appendix A4). (ES1.04, ES2.04, ES3.01, ES3.02, ES3.03)
- Students collaborate to produce and present a time line which the teacher can assess for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3). (ES3.01, ES3.02, ES3.03)

- Students collaborate to produce and present their Blastoff! products which the teacher can assess for knowledge/understanding, communication, and making connections by adapting the process and product rubrics (see Appendices A1 and A3). (ES1.03, ES1.04, ES2.02, ES2.03, ES2.04, ES2.07, ES2.08)

Resources

Sky & Telescope Magazine photos and illustrations (available at most news-stands and public libraries)

Sky News Magazine (news-stands/libraries)

Astronomy Magazine (news-stands/libraries)

Maton, A., J. Hopkins, et al. *Exploring the Universe*. Prentice-Hall.

Bennet, B., C. Rolheiser-Bennet, L. Stevhan. *Cooperative Learning: When Heart Meets Mind*.

Fraknoi, Andrew. *The Universe at Your Fingertips*. Astronomical Society of the Pacific, 1995.

Wolfe, E., et al. *SCIENCEPOWER™ 9*. Toronto: McGraw-Hill Ryerson, 1999.

Ritter, et al. *Science 9*. Toronto: ITP Nelson, 1999.

Catechism of the Catholic Church, 1994.

See appropriate web sites in Unit Resources

Accommodations

1. See Accommodations in Activity 1.
2. Possible ScienceWorld ideas include:
   - Build a scale model of a Space Shuttle.
   - Research and share current space events with the entire school by announcing “Space News” once a week as part of the school’s announcements.
   - Read a science fiction novel and cite the facts vs. fiction in a 3 – 5-page essay.
   - Write an essay on the current attempts to communicate with extraterrestrial life-forms. The essay should identify some of the key scientists and organizations who are currently involved in this sort of research, describe the technology involved in the search, and any advances that have been made.
   - Design a Bristol board-sized poster outlining the historical development of the spacesuit, beginning with the protective wear used by high altitude airplane pilots of the past, to those worn by the Gemini and Apollo astronauts, and the suits now worn by the Space Shuttle crew
   - Build a model rocket and launch it from a school site under the supervision of your teacher and in the presence of classmates. The rocket may use pressurized air or water as its energy source, or it may be a commercial model that uses pre-assembled "engines". During the demonstration, explain the structure and function of your rocket. Caution: Ensure that all safety precautions outlined by the manufacturer are strictly followed.

Appendix C4: A Catholic Perspective on the Applications of Science: Guiding Principles (Teacher) Bioethics

The new reproductive technologies have ushered in an era of increasing ethical complexity. There are more than thirteen different technologies available in order to enhance, artificially, the probability of having a baby. Anyone attempting to unravel the ethical complexities, from a secular philosophy, is doomed to the uncertainty of relativism.

The Catholic church has a clear set of teachings in the area of human sexuality and the human person. These teachings, through their reflection on the mysteries of Creation, Incarnation, and Redemption, present us with criteria based on the Truth of what it means to be fully human. As such, they provide all Catholic teachers with a set of criteria from which to evaluate the new reproductive technologies.

There are essentially two criteria for moral judgment: The first is the life of the person who is called into existence. The second is the special nature of the transmission of life. For the purposes of this article one could consider the first criterion as being associated with the post-conception period and with issues around respect for human embryos. The second criterion is associated with the conditions leading up to conception and the meaning of the conjugal act.

Once a human person is called into existence (at the moment of conception) he/she has certain inviolable rights based on human dignity and unity. Every human person has an inalienable dignity because each is a reflection of the Creator. We were made in the image of God (Genesis 1:27) and as such are of inestimable value and worth. Every human person has certain rights. These rights include the right to be seen as an end and not a means to another end; the right to life; the right to be conceived and carried in utero; the right to family. Any violation of these rights constitutes a violation against the inherent dignity of the person and is morally unacceptable.

The calling of a human person into existence is an act that co-operates with the power of the Creator. Life is a gift from God and always finds its origin in God. The human person by his/her very nature should always seek to promote goodness, unity, and integrity. The conjugal act is not one that can be separated from the integrity of the person. Based on the two creation accounts in Genesis, the conjugal act finds its meaning in its procreative and unitive dimensions (Genesis 1:27-28, 2:24). Reproductive technologies that willfully remove the procreative dimension for the sole purpose of avoiding conception diminish the meaning of the conjugal act as an open expression of the life-giving love of the Creator. This is morally unacceptable. The unitive dimension of the conjugal act is expressed both physically and in its totality as the fruit of marriage. Any attempt to separate the corporal and spiritual components of the act from each other or from the indissoluble bond of marriage diminishes the dignity of both the act and the persons involved in the act. This, too, is morally unacceptable.

Ultimately all the new reproductive technologies can be analysed in terms of their procreative and unitive dimensions. Extra-utero fertilization, surrogacy, embryo transfer, intrauterine insemination, gamete intrafallopian transfer, zygote intrafallopian transfer, intracytoplasmic sperm injection, egg donation, embryo donation, cytoplasmic transfer, egg freezing and nuclear transfer are all violations of the unitive dimension of the conjugal act. A number of these technologies are also used in a manner that is a violation of the created person's right to family. In addition, all experimental procedures involving the fetus, other than those interventions that are therapeutic, are a moral violation of the dignity, integrity, and unity of the human person.

Appendix C5: A Catholic Perspective on the Applications of Science: Guiding Principle (Student Guide) Bioethics

The Catholic church has a long tradition of teaching within the sphere of human sexuality. These teachings have focussed on the dignity of the whole human person. All of these teachings guide us in the direction of the preservation of life. When we talk about the preservation of life we are referring to more than physical life, we are also speaking of the integrity (physical, spiritual, emotional, intellectual, and social dimensions of being human) of the life of the person. To be fully alive is to be alive in all the various dimensions of our humanity. If any of these dimensions are ignored then it brings a "partial death" to the whole person. Science and technology are the fruits of human intelligence and as such reflect the goodness of the Creator. However, because we have been given free will by our Creator, it is possible to use science and technology in ways that are sinful. Any use of science or technology that does not use a good means for a good end is considered unholy and morally wrong.

When we analyse the contributions of science and technology to the human race, we must ask some fundamental questions. Are these technologies life-giving to the whole person? Are these technologies life-giving to all human persons affected by the procedures? If the answer to either of these questions is no, then the technologies are unholy (lack life-giving benefit to the whole person or persons involved). Technologies or procedures that are unholy are not morally acceptable.

Not all technology is unholy. There are many technologies that are therapeutic (restore the health of the person) and as such are life-giving and morally acceptable. The key question that needs to be asked in the case of therapeutic technologies is: what is the risk to the life of the person involved? If the risk of death is greater than the chance of life then the procedure may not be justifiable. Often, in these cases, the proper religious and medical personnel need to be consulted before a decision is made.

For the purposes of this course we can evaluate the value of a particular action from two criteria.

The first is with respect to the purpose and goodness of sexual intercourse. The act of sexual intercourse has two fundamental purposes: the first is to create life (procreative dimension) and the second is to express the love between a man and a woman (unitive dimension). Any technology whose purpose is artificially to prevent procreation diminishes the value and goodness of the sexual act. In addition, any technology that separates conception from sexual intercourse also diminishes the value and goodness of the sexual act. These technologies are morally unacceptable.

The second criterion applies to human life from the moment of its conception. At the moment of conception a human person is formed. This person, who is made in the image and likeness (dignity) of God, has the right to be respected as a completely whole (holy) and indivisible person (unity and integrity). Each person has a soul (spirituality) and a body and as such is a good in him/herself. A person must never be used as a wrong means for another good (using aborted human fetuses for experimentation).

Appendix C6: The Creation Stories

As teachers of science from a Catholic perspective, we are often faced with the “either/or” type of question from our students - which is correct, the Bible or Science? Our students seem to view the "truths" of the Bible and Science as being mutually exclusive. To view the world in this way is to have a fundamental misunderstanding of the two types of truths and the methods by which these truths are conveyed. Science searches for its truth through empirical methods. Religion searches for its truth through revelation and reason. The convergence of both disciplines on a common phenomenon can create the “either/or” dilemma in the minds of our students. The Creation stories are a case in point.

When students recognize the truths of both religion and science within a common phenomenon, they add meaning to knowledge. The Biblical account of creation is a story told to explain the meaning of the universe. The scientific account of creation is a theory on the material origin of the universe.

There are two creation stories in the Bible. Each emphasizes a different meaning in creation. It is important to realize that these two accounts of creation are narratives and, as such, contain religious truths in allegorical form. The first creation story was written in the Priestly tradition in the sixth century B.C.E. Its emphasis was on a single God who created the universe. God created order and goodness. God also created man and woman in his own image. In this story humankind was given dominion over creation. As Science teachers, we can appreciate the close parallel between the order of creation in a story written 2600 years ago and our modern scientific understanding of the order of evolution. The Yahwist (who referred to God as Yahweh) wrote the second creation story in the ninth century B.C.E. This story represents God as being more personal and intimate with creation. The imagery used in the story is that of a gardener. It is from this story that we get the notion of “stewardship,” as man and woman are to cultivate and care for the garden (life). The human person is given a special status in this story. God forms "man" out of the soil of the earth (Adam - meaning 'of the earth'; Eve - meaning 'life') and breathes life into “him.”

Many people subscribe to the theories of the "Big Bang" and evolution. As teachers of Science from a Catholic perspective, we can teach both theory and meaning. Neither the "Big Bang" nor evolution provides an answer to the fundamental questions of human existence. In a secular culture, which trivializes all forms of religious beliefs and culture, students could fall victim to the malaise of our time, which is despair. Despair means without hope. When we teach Science from a Catholic perspective, we lead our students out of the despair of meaninglessness toward the hope of our salvation.

Appendix D5: Enrichment, Extensions, and/or ScienceWorld

Creating a dynamic classroom atmosphere would greatly enhance the achievement of the expectations in this strand. Such an atmosphere can be created by preparing exploration stations around the perimeter of the class. The stations would contain other examples of reproduction which the students could investigate, research or duplicate. The teacher could design each station as an open or guided experience. The students could use the results of their mini-activities for their ScienceWorld project, own enrichment (which could be used to assess achievement of Level 4 expectations), or extensions of an activity that they did in class. The students may even want to design their own inquiries or research projects based on the information that they received on the Internet while doing research for other activities.

Where space and equipment are limited, it is suggested that one classroom be set up in the above manner and that other classes be rotated into that classroom.

The teacher needs to provide a wide array of project topics for the students to choose from. Listed below are some possibilities:

- An aquarium could be set up with guppies and plants that reproduce asexually via runners. Guppies are relatively hardy fish that reproduce sexually through internal fertilization. The females have about a 30-day gestation period. The offspring are born alive and should provide lots of excitement to the novice breeder. Guppies also have a number of interesting adaptations that would serve as rich material for research.
- The underwater plants could form the basis of a study where students modify some of the environmental variables of the tank and note the effects on the reproductive cycle of the plant. Plants also have a number of methods for reproducing asexually and this would provide good material for research.
- The variety of ways in which plants reproduce asexually would also be a suitable research project.
- The Beta (Siamese fighting fish) is an interesting fish. The male builds a bubble nest and fertilizes the eggs externally as they are squeezed out of the female. The males are very aggressive toward each other and females. It is best to float the female in a container and watch the courtship displays of the male. Do not put two males in the same container. Students should research the behaviour of Siamese fighting fish before attempting to breed them.
- One station could contain paramecia that are undergoing conjugation. The teacher needs to assist students in setting this up.
- A terrarium could be set up with plants that have a gametophytic and sporophytic generation. Students could research the life cycles of these plants and compare them to higher plants.
- A station could also contain a number of flowering plants that students could use to study plant adaptations, evolution of sexual reproduction, or conditions affecting flowering.
- Stations could be set up with plants undergoing asexual reproduction through any of the following methods: bulbs, runners, leaf cuttings, stem cuttings, etc.
- Fruit flies provide an interesting study of the life of an insect. It could also provide an introduction to genetics as the students study the inheritance of a trait like eye colour. This activity would span at least two weeks, depending on how many generations were studied. The students could alter environmental conditions and see the effects on the length of the life cycle.
- Some stations could be information technology stations where students research topics approved by the teacher (i.e., the effects of male hormones on male patterns of baldness).

Each student pursuing an activity of interest to himself/herself should arrange a contract ahead of time so that both the teacher and student know what student work is expected and how the work is evaluated.

Appendix D6: Teacher's Guide for "The Can Do Redactor"

The introduction should include an overall description of the assignment. The students create a scientific magazine called "The Can Do Redactor." The significance of the title is its link with science, religion, and the publishing business. The title echoes that of the Candu Reactor a Canadian technology for the transformation of energy from its nuclear form to its thermal form. "Can Do" is an affirmation of the ability of the students to "do" science. Redactor is a term that means editor. In the terms of this project, the students act as magazine editors. In the religious sense, a redactor was the person who edited the various sources Biblical writings into a coherent form. The redactor had to be very knowledgeable about the religious and spiritual nature of the writings that he/she was transcribing. The students also become knowledgeable about the religious and spiritual dimensions of the work that they are producing and hopefully there will be a transformation in their own world views.

The students are free to be creative in the design of their magazine. They should have several sample magazines available from which to draw their overall layout. This activity should be done as a group activity, with each student being responsible for a specific part. Student groups should contain no less than four and no more than six people. It would be a good idea to ensure that at least one member of the group had the computer skills needed for the assignment. The students should decide their responsibilities before starting the assignment and hand in a written contract to the teacher. The teacher should conference with the students before they start their research. The students share their research with the rest of the group. The entire group is responsible for an oral defence of their magazine in front of the class.

Students should be encouraged to interview scientists/religious(priests, sisters and brothers) as a part of their research and to report on it as a column in their magazine.

This activity could be modified to accommodate the computer skills of the students and the availability of computers within the school. Students could use the computer to put together the entire package importing graphics and pictures from various sources including the Internet.

It is recommended that each of the expectations in the "Relating Science to Technology, Society, and the Environment" of the Ministry Policy Document be used as the basis for each article. It is also recommended that the expectation related to careers in reproductive technology be done as job advertisements throughout the magazine. Careers that would be morally illicit should be left out or have a warning attached to them (i.e., hazardous to your soul). In addition, each magazine must contain a column called "From the Pulpit" (Pulpit being a symbol of the integration of the natural world-Jack in the Pulpit- and the spiritual world-proclamation of our Faith), which would summarize the Catholic perspective on a reproductive technology or a career in a reproductive technology. It would be of value for them to analyse one of their own articles from a Catholic perspective.

The teacher could use the rubric (Appendix D7) to assess this activity. The teachers should also develop a self-assessment and group assessment rating scale for students to complete. Each magazine should contain five articles, three career postings, five pictures (theme related), and three advertisements (theme related).

Appendix D7 - Rubric for "The Can Do Redactor"

Category	Criterion	Level 1	Level 2	Level 3	Level 4
Knowledge, Comprehension, and Connections	Content	- limited understanding of the historical development of the microscope - incomplete outline of the contributions of the microscope - poor examples of impact of reproductive biology - incomplete description of Canadian research and technology - incomplete description of careers - limited application of an analysis using Church teaching	- some understanding of the historical development of the microscope - sketchy outline of the contributions of the microscope - examples cited were limited in impact - satisfactory description of Canadian research and technology - limited number/ sketchy description of careers - some application of an analysis using Church teaching	- good understanding of the historical development of the microscope - clear outline of the contributions of the microscope - examples cited demonstrated an impact - successful description of Canadian research and technology - careers cited were clear and related to topic - good application of an analysis using Church teaching	- thorough understanding of the historical development of the microscope - insightful outline of the contributions of the microscope - examples cited demonstrated a number of impacts - impressive description of Canadian research and technology- an interesting breadth and depth of career descriptions - excellent application of an analysis using Church teaching
Inquiry	Learning Process	- showed little ability to research topics independently	- needed some support in researching topics independently	- demonstrated good independent research skills	- highly effective and creative independent research skills

Category	Criterion	Level 1	Level 2	Level 3	Level 4
Communication	Form	- demonstrated little ability to use computer for layout purposes - layout lacked organization - magazine lacked aesthetic appeal	- demonstrated some ability to use computer for layout purposes - layout had some organization - parts of the magazine had aesthetic appeal	- demonstrated good ability to use the computer for layout purposes - layout was logically organized - whole magazine had aesthetic appeal	- used the computer in ways that exceeded the expectations for layout purposes - layout had a unique and effective organization - magazine had exemplary aesthetic appeal
Communication	Impact	- articles were not interesting to read - some articles were unclearly written - the articles were not persuasive	- only parts of the articles were interesting - some articles were clearly written - some of the articles were persuasive	- articles were interesting to read - most articles were clearly written - most of the articles were persuasive	- all articles captured the interest of the reader - all articles were clearly written - all of the articles were persuasive
Communication	Appearance	- magazine had little resemblance to a model magazine - materials used were inadequate quality	- magazine had some resemblance to a model magazine - materials used were substandard quality	- magazine contained many of the features of the model magazine - materials used were acceptable quality	- magazine was indistinguishable from a professional magazine - materials used were of professional quality
Communication	Oral	- spoke in an inexpressive manner - very little eye contact with audience - answers to questions lacked clarity	- sometimes spoke in an expressive manner - some eye contact with the audience - answers to some questions were clear	- spoke in an expressive manner - good eye contact with the audience - answers to most questions were clear	- spoke in a highly expressive manner - excellent eye contact with audience - answers to all questions had clarity

Appendix D8: Learning/Teaching Strategies and Assessment/Evaluation Overview for Biology Unit

Expectation BY:	Activity	Teaching/Learning Strategy	Assessment Strategy	Instrument
1.02; 2.05 1.02 2.02 2.02, .08 2.02, .08 2.04, .05 cge 2c,e.	1a) Introduction b) Microslides c) Pre-requisite skills d) Expt. design e) Investigation f) Analysis g) Reflection	a) Class Instruction b) Inquiry c) Demonstration d) Brainstorming e) Lab. Based f)Discussion group g) Individual	a) Performance b) Performance c) Observation d) Conferencing e) Observation f) Performance g) Reflection	a) Peer assessment b) Worksheet c) Checklist d) Lab. Proposal e) Checklist/Drawings f) Rubric g) Journal
1.04 2.09 1.04, 2.03 2.02 2.02 2.09 2.04, .05, .10 cge 2c,e.	2a) Introduction b) Prepared slides c) Research d) Pre-requisite skills e) Expt. Design f) Investigation g) Analysis h) Reflection	a) Class instruction b) Inquiry c) Information Technology d) Demonstration e) Brainstorming f) Lab. based g) Discussion group h) Individual	a) Performance b) Performance c) Performance d) Observation e) Conferencing f) Observation g) Performance h) Reflection	a) Worksheet b) Drawings c) Venn diagrams d) Peer assessment e) Lab. proposal f) Checklist/Drawings g) report h) Journal
1.05 1.07 1.06 cge 2c,e	3a) Introduction b) Research c) Comparison d) Reflection	a) Class Instruction b) Report c) Brainstorming d) Individual	a) Performance b) Performance c) Performance d) Reflection	a) Worksheet b) Venn diagrams c) Chart d) Journal
1.08 1.08;2.04 1.09 2.01 2.03 1.03,.10 1.01 cge 2c, e.	4a) Introduction b)Investigation c) Human Development d) Formulate Questions e) Research f) Microslides g) Cell Theory h) Reflection	a) Class Instruction b) Lab. based c) media d) Brainstorming e) Information Technology f) Inquiry g) Group discussion h) Individual	a) Performance b) Performance c) Performance d) Performance e) Presentation f) Performance g) Performance h) Reflection	a) Worksheet b) Worksheet c) Graphic organizer d) Graphic organizer e) Checklist f) Drawings g) Rating Scale h) Journal
2.06; 3.01; 3.02; 3.03; 3.04 cge 1i, 2e, 3c, d, e, f, g, 5e, 6b, c, 7a, d, e, j.	5a) The Can Do Redactor b) Oral presentation	a) Research b) Presentation	a) Performance b) Performance	a) Rubrics b) Rubric

Appendix D9: Achievement Categories and Assessment Strategies For Biology Unit

Categories	Ex.	Act.	Assess. Strategy	Tool
Knowledge/Comprehension				
understanding of concepts, principles, laws and theories	1.01 1.04 1.07 1.08 1.09 1.03 1.10	4g 2b, 2b 3 4a 4c 4f 4	performance performance performance performance performance performance performance	rating scale drawings Venn diagram worksheet/quiz graphic organizer drawings drawings
knowledge of facts	1.02 1.02 1.04 1.05 1.08	1a 1b 2a 3a 4b	performance performance performance performance performance	checklist worksheet/quiz worksheet/quiz worksheet/quiz worksheet
transfer of concepts to new contexts	1.04	2c	performance	Venn diagram
understanding of relationships between concepts	1.06	3c	performance	chart
Inquiry				
application of the skills and strategies of scientific inquiry	2.02 2.04 2.02 2.04 2.10 2.04 2.01	1c 1f 2e 2g 2g 4b 4d	conference performance performance performance performance performance performance	lab. proposal report conference report report worksheet graphic organizer
application of technical skills and procedures	2.08 2.09 2.02 2.02	1d 2b 2e 2f	conference performance performance performance	lab. proposal drawings conference report
use of tools, equipment, and materials	2.02 2.08 2.02 2.09	1c 1e 2d 2f	observation observation observation observation	checklist checklist checklist checklist

Categories	Ex.	Act.	Assess. Strategy	Tool
Communication				
communication of information and ideas	2.05 2.05 2.04 2.05	1a 1f 2g 2g	performance performance performance performance	checklist report report report
use of scientific terminology, symbols, conventions, and standard units (SI)	2.05 2.05	1f 2g	performance performance	report report
communication for different audiences and purposes				
use of various forms of communication				
use of information technology	2.03 2.03	2c 4e	performance performance	Venn diagram presentation
Making Connections				
understanding connections among science, technology, society and the environment	cge2c,e cge2c,e cge2c,e cge2c,e 3.01 3.03 3.04	1e 2h 3d 4h 5 5 5	reflection reflection reflection reflection performance performance performance	journal journal journal journal magazine magazine magazine
analysis of social and economic issues involving science and technology	3.02 cge 1i; 2e; 3c,d,e,f 4g; 5e; 6b,c; 7a,d,e,j	6e+06	performance performance performance performance performance performance performance	magazine magazine magazine magazine magazine magazine magazine
assessment of impacts of science and technology on the environment	3.02	5	performance	magazine
proposing courses of practical action in relation to science-and technology-based problems				

Appendix D10: Thanksgiving Para-Liturgy

Written by John LaBatte, St. Mary's Catholic High School, Hamilton-Wentworth Catholic District School Board. For the complete text of this Appendix see the Additional Resources section of the ICE web site, www.tcdsb.on.ca/ice/profile/html

Theme: In Thanksgiving and Admiration of God's Creation.

- **Welcome:**
- **Opening Prayer:** Psalm 33: 6-9, 13-15
- **Reading from Genesis** (1:1 - 2:4)
- **Reflections on Above** (found below)
- **Response (all):** I believe in God, the Father Almighty, Creator of heaven and Earth.
- **Guided reflection on creation narratives:**
- **3-5 Minutes of silence with background music:**
- **Reading from Psalm 148: 1-6 and/or Psalm 8: 1-10** (Other possible readings: Psalm 136: 1-9; Ps. 104: 1-35; Ps. 19: 1-7; Ps. 145: 1-5; or Matthew: 6: 24-34)
- **Closing Prayer:** (below)
- **Dismissal and Blessing:**

CREATING WITH GOD

Reading taken from Genesis 1: 1-5

Reflection: Out of chaos, God brings order; can we bring order and peace out of the chaos of our "busy" lives?

Response: I believe in God, the Father Almighty, Creator of heaven and Earth.

Reading taken from Genesis 1: 6-8

Reflection: Think of the child-like question, "Why is the sky blue?" Far from a simple question, it reminds us that much of life is still a mystery - it belongs to the realm of the divine.

Response: I believe in God, the Father Almighty, Creator of heaven and Earth.

Reading taken from Genesis 1: 9-13

Reflection: God sees only good in what He creates. Let us also look for the good in others and in life.

Response: I believe in God, the Father Almighty, Creator of heaven and Earth.

Appendix D10: Thanksgiving Para-Liturgy (Continued)

Reading taken from Genesis 1: 14-19

Reflection: We have all gazed breathlessly at the night sky or marvelled at a rainbow. Let us take more moments like these.

Response: I believe in God, the Father Almighty, Creator of heaven and Earth.

Reading taken from Genesis 1: 20-23

Reflection: Even with all our scientific advances and modern technology, we are just beginning to understand the complexities of life; let us make wise use of our knowledge.

Response: I believe in God, the Father Almighty, Creator of heaven and Earth.

Reading taken from Genesis 1: 24-31

Reflection: The creation of man and woman is the culmination of creation; we are made in God's image - each one of us. At the same time, we share in the creative process: we have the responsibility to preserve, protect and care for all creation.

Response: I believe in God, the Father Almighty, Creator of heaven and Earth.

Reading taken from Genesis 2:1-4

Reflection: It is God-like practice to rest; leisure is an integral part of the creative process.

Response: I believe in God, the Father Almighty, Creator of heaven and Earth.

Closing Prayer

O God, the Creator of all things, you have given all men and women the responsibility and the dignity to participate in creation as stewards of the Earth. Share your wisdom with us, that we may all find ways to foster the preservation, protection, and care for all creation. In doing so, we will work to attain the dignity and glory of your Kingdom. We ask this through Christ, our Lord, who lives and reigns with You and the Holy Spirit, forever and ever. Amen.