

Unit 4

Reproduction

Suggested Time: 18 Hours

Unit Overview

Introduction

Reproduction is an essential biological mechanism for the continuity and diversity of species. Students should be provided with opportunities to explore the fundamental processes of reproduction. As well, heredity and the transmission of traits from one living generation to the next will be examined. The ability of scientists and technologists to manipulate, alter and substitute genetic material in a variety of cells has increased greatly in recent years. Students will have the opportunity to investigate and debate the current developments and uses of gene manipulation and therapy. An STSE “Science - Technology - Society - Environment” approach to this unit should provide the framework around which an investigation into the every-expanding world of genetics and gene manipulation. At this level, only an introductory and elementary introduction to the science of genetics is expected.

Focus and Context

The focus of this unit is inquiry. The unit is subdivided into three sections: cellular processes, asexual and sexual reproduction, and genetic changes. In the first section, students will investigate and study the role of the nucleus in determining mitosis or meiosis. Students will have an introduction into these two processes of cell division. In the second section, students will explore the processes of asexual and sexual reproduction in representative organisms and compare the two processes. Finally, the current topics of cloning, gene therapy and genetic manipulation will be investigated in the context of genetic changes and the debates and discussions that accompany these topics and issues.

Science Curriculum Links

By the end of grade three, students will have explored the life cycles of several common animals and plants. At the end of **grade six**, students should be able to describe the role played by body systems in helping humans and other animals to grow and reproduce. In grade eight, students were introduced to the cell as a living system that exhibits all the characteristics of life. Students also investigated the structural and functional relationships between and among cells, tissues, organs and systems in the human body.

In the **high school**, students will have the opportunity to study a unit in biology called “Genetic Continuity”. Meiosis and mitosis will be explored in detail at this level. As well, students will have the opportunity to develop an understanding of Mendelian genetics, including the concepts of dominance, co-dominance, recessiveness, and independent assortment. Much of the foundation for that unit of study is found in this unit.

Curriculum Outcomes

STSE	Skills	Knowledge
<p><i>Students will be expected to</i></p> <p>Nature of Science and Technology</p> <p>109-14 Explain the importance of using precise language in science and technology</p> <p>110-3 Identify major shifts in scientific world views</p> <p>Relationships Between Science and Technology</p> <p>111-1 Provide examples of scientific knowledge that have resulted in the development of technologies</p> <p>Social and Environmental Contexts of Science and Technology</p> <p>112-12 Provide examples of Canadian contributions to science and technology</p> <p>113-10 Provide examples of problems that arise at home, in an industrial setting, or in the environment that cannot be solved using scientific and technological knowledge</p>	<p><i>Students will be expected to</i></p> <p>Performing and Recording</p> <p>209-3 use instruments effectively and accurately for collecting data</p> <p>209-4 organize data using a format that is appropriate to the task or experiment</p> <p>209-5 Select and integrate information from various print and electronic sources or from several parts of the same source</p> <p>209-6 Use tools and apparatus safely</p> <p>Analyzing and Interpreting</p> <p>210-2 Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots</p> <p>210-4 Predict the value of a variable by interpolating or extrapolating from graphical data</p> <p>210-6 interpret patterns and trends in data, and infer and explain relationships among the variables</p> <p>210-8 Apply given criteria for evaluating evidence and sources of information</p> <p>210-9 Calculate theoretical values of a variable</p> <p>Communication and Teamwork</p> <p>211-1 receive, understand, and act on the ideas of others</p> <p>211-2 Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means</p> <p>211-3 work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise</p>	<p><i>Students will be expected to</i></p> <p>304-11 Illustrate and describe the basic process of cell division, including what happens to the cell membrane and the contents of the nucleus.</p> <p>304-12 explain signs of pregnancy and describe the major stages of human development from conception to early infancy</p> <p>305-1 Recognize that the nucleus of a cell contains genetic information and determines cellular processes.</p> <p>305-2 Distinguish between sexual and asexual reproduction in representative organisms.</p> <p>305-3 Compare sexual and asexual reproduction in terms of their advantages and disadvantages</p> <p>305-4 compare the structure and function of the human reproductive systems</p> <p>305-5 Discuss factors that may lead to changes in a cell's genetic information</p>

Function of the Nucleus

Suggested Assessment Strategies

Performance

- Do a survey of the people in your family or class in order to collect data on the following:
 - smooth hair line versus widow's peak
 - can roll tongue versus cannot roll tongue
 - attached ear lobes versus detached ear lobes.Create a data display of your findings (210-2, 305-1)

Paper and Pencil

- Create an advertisement showcasing the role of the nucleus and its contents in determining traits and controlling cell division. (305-1)

Journal

- What role does the nucleus play in determining traits? (305-1)

Resources

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

ST pp. 112
BLM Activity 5 (Ch. 4 cards)

ST pp. 113-114

Genes and Chromosomes

Outcomes

Students will be expected to

- explain the importance of using the terms gene and chromosome properly (109-14)

- define gene
- define DNA
- define chromosome
- describe genes as being composed of DNA
- describe chromosomes as being composed of numerous genes

- provide examples of how the knowledge of cellular functions has resulted in the development of technologies (111-1)

Elaborations—Strategies for Learning and Teaching

The terms gene and chromosome should be carefully distinguished as they are often incorrectly used interchangeably in everyday language. The primary distinction is that a chromosome is not a gene, rather it contains genes.

To elaborate this point, teachers could use an analogy such as a train. The train would represent the chromosome while each individual car is representative of a gene.

Students could simulate a chromosome by forming a linked line. Along the line, 3 students bunch together to perform a task (e.g. colour the iris of an eye on a provided template). Then, another 4 together perform a different task (e.g. draw in a widow's peak), etc. down the line. The whole line represents a chromosome, while the smaller groups within represent a gene (each coding for a different trait). Alternatively each student could represent different genes.

Teachers should limit the discussion of this topic to the fact that a gene is a segment of DNA located on the chromosome that instructs the nucleus to produce a specific protein. The types of proteins produced determine traits that will be manifest in the individual person.

Students could add this information to their Mind Map.

Teacher Information: A gene is composed of a specific sequence of nucleotide bases along a chromosome. Each sequence of bases (gene) instructs the nucleus to produce a particular type of protein. Proteins may be structural or functional. Structural proteins will affect physical traits of an organism such as eye colour or skin pigmentation. Functional proteins determine body process traits like growth rate or aspects of sexual development. Nucleotide bases of the DNA (A,G,C and T) can be likened to letters. These letters are arranged to form words (genes). Words come together to form sentences (chromosomes). Sentences are arranged in pages of book. The book could be likened to the genome of a cell. The genome is a set of instructions that tells the nucleus what proteins to make (what traits to manifest). **Please note** that specific information related to nucleotide bases is NOT part of the outcomes of this course.

The Wild, Weird, Wonderful feature “Glowing Genes” provides an interesting example of such technological developments in the field of medicine.

Genes and Chromosomes

Suggested Assessment Strategies

Paper/Pencil

- Use a sketch or drawing to illustrate the difference between a gene and a chromosome (109-14, 305-1).
- Create a flow chart showing the levels of organization from the organism to the gene. Organism – organ systems – organs – tissues – cells – nucleus – chromosome – gene (109-14).
- Explain the difference between genes and chromosomes and why they cannot be used interchangeably. (109-14, 305-1)

Performance

- Compose and perform a song to the tune of “Rattlin’ Bog” showing the levels of organization from the organism to the gene (109-14).
- Using Lego or other building blocks construct a model of a chromosome using different colour blocks to represent genes (109-14, 305-1).

Presentation

- Create a 3-D model of a simplified nucleus containing chromosomes and explain why this term is used and not “genes” (109-14, 305-1).

Journal

- Use an analogy to explain the difference between a gene and a chromosome. (109-14, 305-1)

Resources

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

ST p. 115

ST pp. 118-119

ST p. 116

ST p. 118

ST p. 118

ST p. 120

Mutations

Outcomes

Students will be expected to

- discuss factors that may lead to changes in a cell's genetic information (305-5).
 - define gene mutation
 - define mutagen

- give examples of mutations caused by:
 - (i) nature
 - (ii) human activity

Elaborations—Strategies for Learning and Teaching

Students may be aware of some of the work being done by researchers around the world on genetic manipulation. Teachers could use this topic to address the general “nature of science” topic as this topic lends itself easily to the introduction and study of differing opinions in science and technology and how societal norms and expectations often shape the nature of scientific research.

Teachers could engage students in a discussion to ascertain how much they know about mutations and mutagens. Teachers could ask students whether mutations are a good or bad thing?

Teachers should limit the discussion of gene mutation as “a change in the order of chemicals that make up a portion of a gene”. Note that the different types of gene mutations (deletion, addition, and substitution), and their effects (positive, negative, and neutral mutations) **are not an outcome**.

Students could investigate the “environment versus genetics” debate with regards to genetic changes within populations. Natural (solar radiation and radioactive gases) and human-made factors (chemicals and nuclear radiation) should be investigated in order to understand the ways in which genetic information can be altered within an individual and between generations.

Teachers could encourage students to identify current questions being debated, in the popular media, with regards to this topic. Students could present their own questions.

Students could summarize the information to this point in their mind maps.

Mutations

Suggested Assessment Strategies

Performance

- Create a poem, song, or rap, that describes the factors that lead to changes in a cell's genetic information. Include as many of the following terms as possible: gene, chromosome, mutation, mutagen, nucleus, genetic material. (305-5)
- Create and perform a skit that demonstrates how both natural events and human activities can result in mutations. (305-5)

Journal

- Write a question about what you have learned about mutations. (305-5)
- Use the “What? So What? Now What?” format to write about mutations and mutagens. (305-5)

Paper and Pencil

- Write a letter to a friend explaining what mutations are and why some mutations are beneficial to a species while others are harmful (305-5)

Presentation

- Select a mutation from the bulletin board display “Nature versus Human Activity Causes of Mutations”. Create a poster or brochure showing the result of the mutation and whether it was an environmental cause or caused by human activity (305-5).

Resources

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

ST p. 122

ST p. 127

BLM 2-3

ST p. 127

The Cell Cycle and Mitosis

Outcomes

Students will be expected to

- illustrate and describe the basic processes of cell division, including what happens to the cell membrane and the contents of the nucleus (304-11)

- define cell cycle
- list the stages of the cell cycle
- define mitosis
- define cytokinesis

Elaborations—Strategies for Learning and Teaching

In Grade 8, students were involved in activities that led them to understand and explain that growth and reproduction occur through cell division. This will lead to the development of an understanding of cellular and asexual reproduction via mitosis and sexual reproduction via meiosis. Teachers could have students engage in a “marathon writing” activity in which they describe what they know about how cells are involved in growth and reproduction (see Appendix B).

Students should understand that mitosis is the process of cell division that results in growth and/or cell replacement of all cells of the body, with the exception of egg cells and sperm cells (or gametes) which are produced by meiosis. Teachers could note that some organisms use mitosis to regenerate lost body parts (e.g. a salamander can regrow its tail if lost).

The specific process of DNA replication is **NOT** part of the outcomes for this course. While teachers may want to refer to the diagram to briefly explain how the chromosomes duplicate, students are not expected to know this. At this grade level, the study of mitosis is intended to be a general examination of the process.

To illustrate the rate of cell division, students could complete the Find Out Activity 5-1A.

The Cell Cycle and Mitosis

Suggested Assessment Strategies

Performance

- Create a dramatic presentation (skit or interpretative dance) that describes the process of cell division. (304-11)
- Create pictures using computer software (e.g. Paint) to produce a slideshow that shows the movement of the chromosomes during the four phases of mitosis. (304-11)

Paper/Pencil

- Create a flipbook showing the four phases of mitosis. Include multiple pages for each phase to show the movement of the chromosomes. (304-11)
- Using a worksheet of blank cells for the stages of mitosis and video clips or still pictures from print resources or the Internet, draw the position of the chromosomes at each stage (304-11).
- Create a “moving” cartoon sketch to illustrate the process of mitosis. (304-11)

Resources

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

ST pp. 139, 142, 144

The Cell Cycle and Mitosis (continued)

Outcomes

Students will be expected to

- illustrate and describe the basic processes of cell division, including what happens to the cell membrane and the contents of the nucleus (304-11)

(continued)

- state and briefly describe the four phases of mitosis followed by cytokinesis.

Include:

- i) Prophase
- ii) Metaphase
- iii) Anaphase
- iv) Telophase

- list the checkpoints in the cell cycle

Elaborations—Strategies for Learning and Teaching

Emphasis should not be placed on the rote memorization of this process, but rather on understanding that this form of cell reproduction results in the production of two genetically identical daughter cells. Discussion of centrioles, centromeres, and the formation of spindle fibers are not required. Additionally, the distinction between early and late prophase is not necessary. Teachers should note that some sources consider interphase to be one of the phases of mitosis. At this level, students should know the phase names for mitosis and a brief description of each phase. For example:

- prophase: the double-stranded chromosomes shorten and thicken and the nuclear membrane begins to fade
- metaphase: chromosomes line up across the middle of the cell
- anaphase: chromosomes are pulled to opposite poles of the cell
- telophase: the set of chromosomes at each pole now form 2 nuclei and the cell is ready to divide into two.

Teachers may wish to address the topics of cell growth and cancer as enrichment if time permits.

Students could work in collaborative groups to develop a mnemonic device to remember the phases of mitosis. Teachers could have students engage in a Jig-saw activity (see Appendix B) to review and reinforce the phases of mitosis.

Students could model or act out the process of mitosis by pairing up and simulating the process. Students could use different colored pennies or labels that indicate the chromosome or chromosome pairs in the process. Alternately, students could model the process of mitosis using different coloured pipe-cleaners to indicate the chromosomes and wool to indicate the cell membranes. It is important to caution students to use no more than four chromosomes in this activity.

Students could update their mind maps with the information in this section.

Cell Cycle and Mitosis (continued)

Suggested Assessment Strategies

Performance

- To show the shortening and thickening of the genetic material into a chromosome prior to prophase, use an unwound ball of wool and wind it into a skein to represent a chromosome. (304-11)
- Students could perform a role play showing the movement of chromosomes during the phases of mitosis. (304-11)
- Create 3D models to show the four phases of mitosis. (304-11)

Resources

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

ST pp. 142-143
BLM 2-8, 2-9, 2-10, 2-11

ST pp. 145

Cell Cycle and Mitosis (continued)

Outcomes

Students will be expected to

- select and integrate information from various print and electronic sources to examine chromosomes (209-5).
 - observe, identify, and describe a cell nucleus undergoing division
 - observe, identify, and describe chromosomes in each stage of mitosis.
- determine and graph the theoretical population growth rate of cells and interpolate and extrapolate the cell population from the graph (210-2, 210-4, 210-9)

Elaborations—Strategies for Learning and Teaching

Teachers should point out that chromosomes are not normally visible under a light microscope unless the cell being observed is in the process of dividing. Students should observe prepared slides of cells undergoing division, such as onion roots tips, in order to view the chromosomes in the nucleus. Appropriate videos and computer software can supplement microscope investigations of cellular activities.

Teachers could use the flex camera to display the video/slides of mitosis on a television or with a computer data projector.

Teachers could have students perform activity 5-1C to address these and other outcomes.

Students should appreciate the theoretical exponential growth rate of cells due to mitosis. Teachers could ask students if they would prefer to have a million dollars or the total value of pennies on a checker board if one penny were placed on the first square and then doubled its value for every subsequent square. Students could do this exercise with a calculator.

Students should know that cells die and are replaced at about the same rate in most cases of cell division. Teachers could inform students that not all cells have the same rate of cell reproduction (e.g. skin cells are renewed every 15-30 days, in some diseased states such as psoriasis epidermal cells are renewed every 7-10 days).

Teachers could have students perform the Find Out Activity 5-1A as an example of the theoretical population growth rate of cells.

Cell Cycle and Mitosis (continued)

Suggested Assessment Strategies

Paper/Pencil

- From an onion root tip slide, sketch the contents of a cell undergoing division. Label the phases of mitosis. (209-5, 304-11)
- As enrichment students could research the rate of cell division in skin cells, brain cells, cells in stomach lining, and bone cells. Display your findings in a properly labeled line graph with a key. (304-11)

Presentation

- Create a poster showing a cell nucleus undergoing division. (304-11)

Resources

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

ST pp. 142-144

BLM 2-12

BLM Activity 5 (Ch. 5 cards)

BLM 2-5, 2-6

Asexual Reproduction

Outcomes

Students will be expected to

- distinguish between sexual and asexual reproduction in representative organisms (305-2)
 - define asexual reproduction
 - explain methods of asexual reproduction using an example. Include:
 - (i) binary fission
 - (ii) budding
 - (iii) fragmentation
 - (iv) vegetative reproduction
 - (v) spore formation

- use tools and apparatus safely and accurately to investigate the growth of yeast cells under positive and negative environmental conditions (209-3, 209-6)

- interpret trends in data, and infer and explain relationships among the variables (210-6)

- communicate the results of an investigation into yeast population growth (211-2)

Elaborations—Strategies for Learning and Teaching

Teachers should use a variety of examples and non-examples when addressing this topic to ensure students understand and recognize the distinctions.

Students should investigate the various processes of asexual reproduction. Students could observe slides, live samples, or videos in which the following types of asexual reproduction take place:

fission - algae and protozoa

spore production - molds

budding – yeast, spider plant, or hydra

vegetative reproduction including: tubers – potato

bulbs – tulips and daffodils

runners – strawberries, blackberries, and raspberries

cuttings – many common houseplants.

Students should be able to illustrate various types of asexual and sexual reproduction. Students should recognize that asexual reproduction results in much less variation within a species.

Students could update their mind maps.

Core Laboratory Activity: Determining the Best Conditions for Yeast Reproduction.

The laboratory outcomes 209-3, 209-6, 210-6, 211-2 and, in part 305-2 are addressed by completing CORE LAB 5-2B “Determining the Best Conditions for Yeast Reproduction”.

Asexual Reproduction

Suggested Assessment Strategies

Paper/Pencil

- Research and explain how new plants are produced from seedless fruit (e.g. grapes). (305-2)

Performance

- Take cuttings of various household plants and vegetatively reproduce them. Do some reproduce better than others through this method? (305-2)
- Use sculpting clay or putty to model each method of asexual reproduction: binary fission, fragmentation, budding, vegetative reproduction and spore formation. (305-2)

Presentation

- Create a display that illustrates the variety that can occur in a species that reproduces sexually. (305-3)

Resources

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

ST p. 152

ST pp. 152-160

Core Lab #7: Determining the Best Conditions for Yeast Reproduction”

ST pp. 162-164

ST pp. 488-491 (Science Skills)

TR 2.22-2.24

BLM 2-18

TR AC 7, 19

TR PS 3, 5, 7, 8, 10

TR AR 3, 4, 11

Meiosis

Outcomes

Students will be expected to

- illustrate and describe the basic processes of cell division, including what happens to the cell membrane and the content of the nucleus (304-11)
 - define sexual reproduction
 - define gamete, fertilization, zygote, embryo
 - describe the role of meiosis in sexual reproduction
 - state and briefly describe the eight phases of meiosis
 - define diploid
 - define haploid
 - describe interkinesis

Elaborations—Strategies for Learning and Teaching

Students should understand that meiosis results in the production of sex cells (eggs and sperm) of most plants and animals. Students should investigate the general stages of meiosis. Emphasis should not be placed on the rote memorization of this process, but rather on understanding that this form of cell reproduction results in the production of four daughter cells, each contains half the number of chromosomes (half the genetic material) of the parent cell.

When introducing the process of meiosis, teachers could replace the word “haploid” with the phrase “half the genetic content” and “diploid” with the phrase “genetic content equal to the parent”. Students should know the phase names for meiosis I and meiosis II and a brief description of what occurs at each phase. Discussion of centrioles, centromeres, and the formation of spindle fibers are not required. For example,

Meiosis I

- Prophase I: homologous chromosomes pair up
- Metaphase I: homologous chromosomes pair up at the equator
- Anaphase I: homologous chromosomes separate and are pulled to opposite poles
- Telophase I: homologous pairs have moved to opposite ends of the cell and cell begins to divide

Interkinesis: the cell grows and makes various proteins

Meiosis II

- Prophase II: nucleus contains only 1 chromosome from the homologous pair in each cell
- Metaphase II: chromosomes line up at the equator
- Anaphase II: half of the chromosomes are pulled to opposite poles
- Telophase II: a nuclear membrane forms around each set of chromosomes and the cell begins to divide to produce four haploid gametes

Students could model the processes of meiosis using colored pipe cleaners to represent the chromosomes. It is important to caution students to use no more than four chromosomes in this activity.

Students could add a “meiosis” branch to their mind map.

Meiosis

Suggested Assessment Strategies

Portfolio

- Develop a concept map to link terms that have been introduced in this unit (gene, chromosome, mitosis, meiosis, asexual reproduction, and sexual reproduction) (109-14, 304-11).

Paper and Pencil

- Create a cartoon strip showing the stages of Meiosis I and Meiosis II. (304-11)
- Create a flipbook showing the eight stages of meiosis. Include multiple pages for each stage to show the movement of the chromosomes. (304-11)
- Draw a sketch to show the difference between diploid and haploid. (109-14, 304-11)

Performance

- Perform a skit to show Meiosis I and Meiosis II. (304-11)

Resources

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

ST p. 170
BLM Activity 5 (Ch. 6 cards)
ST pp. 172
BLM 2-24

ST pp. 173-177
BLM Activity 7
BLM 2-20, 2-21, 2-26

Meiosis (continued)

Outcomes

Students will be expected to

- illustrate and describe the basic processes of cell division, including what happens to the cell membrane and the content of the nucleus (304-11)

(continued)

- compare and contrast mitosis and meiosis.

Include:

- types of cells
- number of daughter cells produced
- amount of genetic material in each daughter cell

- organize data using a format that is appropriate to the task or experiment (209-4)
- compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots (210-2)
- receive, understand, and act on the ideas of others (211-1)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (211-3)

Elaborations—Strategies for Learning and Teaching

To highlight the differences between mitosis and meiosis, it is useful for students to organize the material in a table or chart similar to the one below:

	Mitosis	Meiosis
Type of Cells	In body cells	In sex organs to produce sex cells
Number of Daughter Cells Produced	Two daughter cells	Four daughter cells
Genetic Material in each Cell	Same number of chromosomes as in parent cell	One half the number of chromosomes as parent cell

Teachers could use video clips of the process of meiosis or prepared whitefish blastula slides to demonstrate each of the stages of meiosis. Teachers could use the flex camera to display the video/slides on a TV screen or with a computer projector.

Students could play a game to review the difference between mitosis and meiosis. Using two templates of fruit flies, write the word “mitosis” on one and “meiosis” on the other. Attach these to a wall or white board. Divide the class into two teams and give each team a fly swatter. Pose questions about mitosis and meiosis. The first team member to “swat” the correct word receives a point.

Core Laboratory Activity: Comparing Mitosis and Meiosis.

The laboratory outcomes 209-4, 210-2, 211-1, 211-3 and, in part 304-11 are addressed by completing CORE LAB 6-1B “Comparing Mitosis and Meiosis”.

Meiosis (continued)

Suggested Assessment Strategies

Paper and Pencil

- Use diagrams to compare mitosis with the process of meiosis II. (304-11)
- Draw pictures to show the difference between meiosis and mitosis. (304-11)

Resources

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

ST p. 173-175, 142-143
BLM 2-22, 2-23, 2-25

Core Lab #8: Comparing Mitosis
and Meiosis
ST pp. 176-177
TR 2.30-2.31
TR AR 3

Sexual Reproduction

Outcomes

Students will be expected to

- distinguish between sexual and asexual reproduction in representative organisms (305-2)
 - explain how various organisms reproduce sexually. Include:
 - (i) moss
 - (ii) flowering plant
 - (iii) insect
 - a) incomplete metamorphosis
 - b) complete metamorphosis
 - compare and contrast complete and incomplete metamorphosis
 - compare and contrast external and internal fertilization

Elaborations—Strategies for Learning and Teaching

Sexual reproduction involves two parents in the majority of cases. Students often have the misconception that sexual reproduction and sexual intercourse are one and the same. It is important that teachers emphasize the difference between these two concepts. Students should understand that sexual intercourse is not required for sexual reproduction to occur. As it is used in the textbook, “mating” is a very general term that refers to “the process by which gametes arrive in the same place at the same time”. However, this may be misleading to some students as the general use of the term “mating” implies copulation. Teachers should clarify that although sexual reproduction occurs in many different plants and animals, intercourse occurs only in animals having internal fertilization. Teachers should also clarify that sexual reproduction involves the fusion of an egg cell (diploid) and a sperm cell (diploid) to produce a fertilized egg (haploid). Depending on the species, a fertilized egg will develop differently. For example, in an apple a fertilized egg will become a seed where as in the case of houseflies it will become a larva. Students should understand that sexual reproduction results in greater variation within the species.

When discussing moss: limit the discussion to (1) the need for water, (2) asexual is also possible by spores, (3) sexual reproduction has specific male and female parts in the moss plant. For flowering plants, limit discussion to (1) pollen is formed in the male part of the flower and the egg is formed in the female part of the flower, (2) the fertilized egg will become the seed, (3) pollination is transfer of pollen from male to female part of flower, (4) identify the male and female parts of the flower in general but not the specific sub-parts, (5) identify where pollination and fertilization occur.

Typical insect life cycles could include the grasshopper as an example of incomplete metamorphosis and the butterfly as an example of complete metamorphosis. Teachers could provide students with the opportunity to visually display the process of metamorphosis through the use of posters, web-page, collage, and/or comparison tables.

Limit discussion to depth of coverage provided in student text book. Students could update their mind maps with a new branch that will include this information.

Sexual Reproduction

Suggested Assessment Strategies

Presentation

- Prepare bulletin board displays or posters of organisms that reproduce asexually and their method of asexual reproduction .(305-2)
- Prepare bulletin board displays or posters of organisms that reproduce sexually and their method of sexual reproduction. (305-2)

Journal

- Why would the offspring of organisms that reproduce asexually closely resemble the parent organism? (305-2)
- What feature of the stigma makes it well-suited for receiving pollen grains? (211-2, 305-2)
- Bees gather a sweet fluid called nectar from flowers. In the process, they do something to help fertilize flowers. What do they inadvertently do when gathering nectar? (305-2)

Presentation

- Research and compile pictures of insects that undergo incomplete and complete metamorphosis to create before and after posters, web-page displays, or collages. (305-2)
- Write a skit for a reality TV show of an insect that wants a makeover and goes through the process of complete or incomplete metamorphosis. (305-2)

Resources

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

ST pp. 184, 185, 188, 189, 192, 193

ST pp. 192-193

ST pp. 183-187

Sexual Reproduction (continued)

Outcomes

Students will be expected to

- compare sexual and asexual reproduction in terms of their advantages and disadvantages (305-3)
 - compare and contrast asexual and sexual reproduction
 - compare and contrast asexual and sexual reproduction in terms of their role in meiosis and mitosis
 - compare the advantages and disadvantages of sexual and asexual reproduction. Include:
 - (i) amount of energy required
 - (ii) parental care
 - (iii) genetic variety in offspring

Elaborations—Strategies for Learning and Teaching

Students should be able to compare and contrast asexual and sexual reproduction. Students could use a table similar to the one that follows for this purpose.

	Asexual Reproduction	Sexual Reproduction
Number of parent cells	1	2
Gametes (eggs or sperm)	None (cell divides)	2 (cells unite to form a zygote)
Variation in offspring	Lesser	Greater
Amount of energy required	Lesser	Greater
Parental care	Lesser	Greater
Meiosis or Mitosis?	Mitosis	Meiosis

Students should evaluate each of the criteria to determine if it is an advantage or disadvantage in a given environment.

Organisms that reproduce asexually must generally rely on a mutation in order to have offspring that are significantly different than the parent. Organisms that reproduce sexually generally must have two parents in order to reproduce. Exceptions can be found in some organisms that have both male and female parts. For example, hermaphrodites and perfect flowers may self-fertilize. There are also some plants that reproduce sexually through the production of seeds, but can also reproduce asexually using a cutting. A greater variety of traits are possible in species that reproduce sexually. A class discussion that focuses on local organisms could highlight the variation that exists within and across species.

Teachers could have students add to their mind map.

Sexual Reproduction (continued)

Suggested Assessment Strategies

Journal

- Explore the conditions under which a sexually reproducing organism, such as strawberry plants, would reproduce asexually. (305-3)

Paper and Pencil

- Use a graphic organizer to compare and contrast sexual and asexual reproduction. (305-3)

Resources

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

ST pp. 161, 194

BLM Activity 4

Modern Genetics

Outcomes

Students will be expected to

- provide examples of genetic conditions that cannot be cured using scientific and technological knowledge at the present time. Include: (113-10)
 - (i) Down syndrome
 - (ii) Cystic Fibrosis
 - (iii) Allderdice Syndrome

- identify major shifts in scientific understanding of genetics. Include: (110-3)
 - (i) Mendel’s experiments
 - (ii) Watson and Crick’s double helix model of DNA
 - (iii) Human Genome Project
 - (iv) genetic engineering

Elaborations—Strategies for Learning and Teaching

Teachers could set the stage for this section by having a general discussion of some genetic conditions that are presently not curable. Students could investigate situations in which science and technology have yet to solve problems associated with reproduction, genes which cause certain types of cancer (e.g. Breast Cancer, Colon Cancer, Prostate Cancer), and certain conditions such as cystic fibrosis.

Allderdice Syndrome is a local example of a genetic condition identified by Dr. Penny Allderdice, of Memorial University’s Health Science Center. Initially, this condition was restricted to the geographically isolated community of Sandy Point on the west coast of the province, which was later resettled to St. George’s. Caused by an inverted insertion of a chromosome, it leads to such clinical features as low birth weight, hand and facial abnormalities, and psychomotor dysfunction. It is the female who is the carrier, with a 31 % likelihood of occurrence per pregnancy in that population.

Students could research other genetic conditions and have them present to the class using various formats.

This topic allows for a more direct “nature of science” discussion as the focus of this topic is not on the models/theories, but rather on how they have changed over time with advances in science and technology. Teachers should restrict discussion or descriptions of the models/theories to a very brief overview, using this to highlight the changes in scientific thinking over time. For example, Mendel’s experiments provided a scientific explanation for hereditary and suggested the involvement of “dominant” and “recessive” factors in the transmission of traits from one generation to the next. Watson and Crick’s model helped pave the way for an explanation of how and why mutations occur. The HGP has provided greater insights into how and why certain medical conditions occur and how to treat them; it has also led to concerns over the potential of genetically engineering people. Genetic Engineering has applications to many areas including the food we eat and issues related to health. This has led to many concerns and fears both inside and outside the scientific community. Teachers may wish to address this outcome while completing the core STSE for this unit.

Modern Genetics

Suggested Assessment Strategies

Performance

- Visit the Human Genome Project website and locate genes for a variety of traits, such as cataracts, breast cancer, and eye colour. (110-3)

Presentation

- Create a timeline of events in the development of modern genetics from Mendel's pea plants experiments to advances in genetic engineering. (110-3)
- Research a genetic condition and present the findings as slide shows, posters, or essays. (110-3)
- Create a simple model of Watson and Crick's double helix. (110-3)
- In small groups, brainstorm and discuss the positive and negative effects of mutations in the genetic code (i.e. curing/treating diseases; organisms developing resistance to control agents (mosquitoes developing resistance to pesticides, bacteria developing resistance to antibiotics); diseases becoming more virulent due to mutation (flu pandemics)). (113-10)

Journal

- Why do genetic researchers consider Newfoundland to be a good population on which to study genetic conditions? (113-10)

Resources

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

ST pp. 205-207

ST pp. 204-205

Modern Genetics (continued)

Outcomes

Students will be expected to

- provide examples of how the knowledge of cellular functions has resulted in the development of technologies (111-1)
- provide examples of Canadian contributions to science and technology related to heredity and genetic engineering (112-12)
- evaluate information and evidence gathered on the topic of genetics and genetic engineering (209-5, 210-8)

Elaborations—Strategies for Learning and Teaching

The **CORE STSE** component of this unit incorporates a broad range of Grade 9 outcomes. More specifically, it targets (in whole or in part) 110-3, 111-1, 112-12, 209-5, 210-8, and 305-5. The STSE component “Genetic Engineering” can be found in Appendix A.

In addition to the examples provided in the textbook and STSE module, teachers could include other examples such as the development of wheat and potato varieties, and an investigation of companies that work in genetic engineering such as Aqua Bounty Farms in Newfoundland and Labrador could provide contexts for these investigations. Breeding programs in the livestock industry as well as the development of the Macintosh apple could be a topic to be investigated.

The topic of gene manipulation and engineering lends itself well to the critical investigation of information and evidence of a particular process or technology. Teachers should provide opportunities to investigate and discuss the positions of various scientists, researchers, and organizations that work in or study the field of gene manipulation and/or gene technologies. Students should have the opportunity to critically examine and evaluate sources of information by keeping in mind such things as the date of the publication, the type of audience for which the material was intended, and the author’s intent.

Students could explore and investigate information about genetic engineering from the various special interest groups regarding topics such as cloning, gene manipulation/therapy in people, and genetically-modified foods. Students could role play or use debates to highlight the issues related to the use of genetic manipulation/therapy/engineering as it relates to the production of food or medical treatments. Teachers should ensure that debates or role plays show both sides of the issue. Students should be encouraged to make their own decisions on these issues based on the available facts and information.

Genetic research and technologies associated with foods and food quality could be used to help students appreciate the complex nature of the debate as well as the complexity of the nature of science.

Teachers could present students with case studies that address these issues and requires that they debate and discuss the topic and draw their own conclusions.

Modern Genetics (continued)

Suggested Assessment Strategies

Presentation

- Research various positions of scientists and others with regards to cloning of animals. Participate in a role play or debate on the subject. (210-8, 305-5)
- Conduct research on a local or Canadian company that is engaged in genetic engineering. What is their main product? What do they hope to (or what did they) achieve through this process? Present your findings to the class. (112-12)

Journal

- As a consumer, how do you feel about genetically modified foods and do you think they should be labeled? (209-5, 210-8)
- Use the “What?, So What?, Now What?” format to write a journal entry on genetic engineering using what you have learned from the STSE module as a starting point. (111-1, 209-5, 210-8)
- What are the genetic and societal implications of genetically engineering “designer babies”? (209-5, 210-8)

Paper and Pencil

- Write a letter to the editor of your local newspaper outlining how you feel about requiring labels on genetically modified foods. (111-1, 210-8)

Resources

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

Core STSE: “Genetic Engineering,” Appendix A
ST pp. 208-210

