UNIT 2 OPENER, pp. 106–107

This unit begins by discussing the activity within the cell nucleus that controls cell reproduction. Students then study how the cell cycle and cell division are controlled. The stages of sexual reproduction are examined, beginning with the making of the gamete in meiosis, followed by mating, fertilization, and embryonic development. Human reproduction systems are also examined. The unit ends with a study of genetic changes.

USING THE UNIT OPENER

The unit-opening photograph features a salmon alevin (early salmon fry stage) hatching from an egg. Without reading the caption, students may be unable to predict what organism is emerging from the egg. They may predict that it is a salamander, for example, or another water-dwelling animal. You may comment that many organisms look very similar at a very young stage. The salmon embryo develops into an alevin, which has a large yolk sac to provide nutrients as the baby salmon undergoes millions of cell divisions to develop into a fry and eventually into an adult salmon.

The idea of genetically engineered salmon is introduced in the textbook. In this unit, students will learn how growth and development is controlled by genes. In the case of salmon, research has allowed scientists to modify genes so that the fish grow to market size more quickly. Students may already have ideas about whether genetic modification is a good thing or not. Use this photograph as an opportunity to generate a discussion to learn what students already know about how genes work. For example, students may have learned that genes contain specific instructions to control the growth and development of every cell in a body, and that in some cases, they pass information from one generation to the next, and that a modification to a gene can cause the organism to develop differently than it would have otherwise. This discussion may also help students appreciate that genetics is a dynamic and relevant field of study as they begin this unit.

You may want to hand out BLM 2-1, Unit 2 Summary, and BLM 2-2, Unit 2 Key Terms, to help students record their understanding of the unit and important terms.

GETTING STARTED, pp. 108–109

USING THE TEXT

The beginning of this unit and the Find Out Activity on page 109 are designed to facilitate a discussion about genetic engineering, specifically the genetic engineering of animals and plants we eat as food and how they might affect our environment. After students have read the Getting Started section, you might begin a discussion about the benefits and risks of genetic engineering. Some possible issues are mentioned in the textbook. A very detailed understanding of genetics is required to carry out this discussion successfully. Also, it can take many years before the impact of a genetically engineered species on the wild population, and on the environment, is known. There is some concern that the gene pool of the entire species could be changed; or the genetically engineered population could out-compete the wild population for food, or spread disease among the wild population. On the other hand, it could be argued that genetic engineering has made more food, and higher-quality food, available for humans than would have been available without it. The point of any classroom discussion should not be to resolve the issue, but to help students appreciate the many points of view, and the importance of rigorous scientific research to support them.

USING THE ACTIVITY

Find Out Activity

Designing Your Supper, p. 109

Purpose

- Students will consider individual characteristics of organisms, and how those might be controlled by genes. They will also begin to consider the possible impacts of changing each characteristic on other organisms and on the environment.

Advance Preparation

- none required

Time Required

- 20 min

Science Background

There are many types of genetic engineering. For centuries, farmers have selected seed from the largest fruits to plant the next year, and they have bred the meatiest animals. Although they did not consider themselves genetic engineers, they were choosing the genes that the population would pass on. More recently, we have been able to use microscopic techniques to select individual plants or animals with particular genes, to create future generations with particular characteristics. In the past few years, scientists have begun to introduce genes from one species into another. Each of these techniques provides advantages in terms of the food available to us, and each carries environmental impacts and risks. In this

activity, students will examine some of the specific advantages and possible disadvantages of genetically engineered food.

Activity Notes

- Students can work individually, in pairs, or in small groups.
- Students could work on large paper, and display their chart for other groups to view.
- Discuss the What Did You Find Out? questions as a class, after groups have considered them, to help students consider as many points of view as possible.

Supporting Diverse Student Needs

- If possible, place interpersonal learners in each group to help the groups accept differing points of view and learn from them. It is not necessary for students to reach consensus, but they should respectfully consider others' points of view and respectfully offer their own. You could model this for the class by stating a point of view on another issue, and inviting a student with an opposing point of view to discuss it with you in front of the class. Tell the students that both of you will be working to express your point of view and also to understand and accept the other's point of view. Encourage groups to come as close as they can to a consensus, but recognize that sometimes that will not be possible.
- Some students may feel that genetic engineering is wrong in every case. Ensure that this point of view is accepted, and that all other points of view are accepted, as valid by other students. Point out that we do not all have to agree on the best answer. Different people place different value on different issues. This decision is an individual choice, and one that others should respect.

What Did You Find Out? Answers

1. If groups had trouble reaching consensus, it may be because different members of the group placed a higher value on different issues.
2. For example, students may feel that increasing the protein content of bananas was worth a drawback that they identified, but creating multicoloured bananas was not.

CHAPTER 4 OPENER, pp. 110–111

USING THE PHOTO AND TEXT

The nucleus controls the functions of a living cell. Have students list the life functions of a cell. Students may recall this information from Grade 8. Like all animal cells, nerve cells must be able to:

- obtain nutrients
- change these nutrients into energy
- grow
- repair themselves
- reproduce
- get rid of waste

The nucleus controls all of these functions. Have students predict how the nucleus controls these functions. Ask students what is contained within the nucleus.

USING THE WHAT YOU WILL LEARN/WHY IT IS IMPORTANT/SKILLS YOU WILL USE

Invite students to share any previous background knowledge that they may have about genes. You might ask the following questions:

- What are genes?
- Where do we find genes in our body?
- How do we inherit genes?
- How do the genes we inherit give us long or short fingers, or large or small noses?

Use the opportunity to begin to build a framework for the unit and to establish what previous knowledge and misconceptions students may have.

USING THE FOLDABLES™ FEATURE

See the Foldables section of this resource.

4.1 THE FUNCTION OF THE NUCLEUS WITHIN THE CELL

BACKGROUND INFORMATION

Students should have previous background knowledge about the structure and function of cell organelles from Grade 8. In Grade 8, students may have learned that the nucleus controls all the activities within a cell. This section describes how the nucleus accomplishes this function. The nucleus of every cell contains long strands of deoxyribonucleic acid (DNA). Sections of DNA, called genes, store the messages that tell cells to make particular proteins. Proteins have a variety of functions in the cell: they direct the activities within the cell and control the cell's growth, chemical reactions, the movement of organelles and molecules, and even cell death. When it comes time for a cell to divide, the strands of DNA in the nucleus shorten into chromosomes and separate (but remain joined at one point), and each is replicated exactly so that both new cells contain exactly the same genetic information as the original cell. Every organism has a characteristic number of chromosomes, for example, humans have 46, arranged in 23 pairs.

COMMON MISCONCEPTIONS

- Students may believe that human cells only reproduce sexually. Point out that if this belief were true, we would never grow larger than a single cell. Human cells divide as described in this section to help us grow, as well as to replace cells that have died.
- Students may assume that humans have more chromosomes than other organisms because we are more complex. This assumption is not true. Table 4.1, Comparison of Chromosome Number in Various Organisms, on page 117, shows that humans have 46 chromosomes, cows have 60, and butterflies can have 80.
- Students may think that the information stored in the DNA in our eye cells is different from the DNA stored in cells in our heart muscle since the cells perform very different functions. The DNA is identical in every cell in your body. What is different is that different DNA messages are read in different cells, so different proteins will be made.

ADVANCE PREPARATION

- Two weeks before teaching this section, gather small boxes and small household objects, and assemble the black boxes for Find Out Activity 4-1A, The Nucleus as a Black Box, on page 114.

Useful research materials for advance preparation can be found at www.discoveringscience.ca.

INTRODUCING THE SECTION, p. 112

Using the Text

The photographs on page 112 show examples of traits that two people do and do not share, and traits that three basset hounds do and do not share. Use these photographs to initiate a discussion of what causes our physical characteristics and what causes individuals to share certain physical characteristics. Students can probably also find characteristics that the people in Figure 4.1B share with the basset hounds in Figure 4.1A (for example, bilateral symmetry, hair, brown eyes.) Some genes are shared by many very different types of organisms.

Using the Key Terms and Section Summary

At the beginning of each section in the student textbook are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the Key Terms by scanning the text and using the Glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are important for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 2-2, Unit 2 Key Terms, which lists the important terms in the unit, can be used to assist students.

Using the Activity

Find Out Activity 4-1A

The Nucleus as a Black Box, p. 114

Purpose

- Students predict the contents of a sealed box, as a model of a cell's nucleus.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
2 weeks before for initial preparation Same day of instruction in subsequent years	Gather materials and boxes. Student volunteers could create the black boxes. Number the boxes and prepare a list of the contents before they are sealed.	For each group: – 1 assembled black box – 1 cotton ball – 1 drinking straw – clear adhesive tape – 1 wooden skewer

Time Required

- 20 min

Science Background

The purpose of the activity is to provide students with the opportunity to explore the unknown and make predictions based on knowledge gained through tools that they use. Students learn that not everything is known about the activities of a cell. They make predictions about the black box just as scientists make predictions about the nucleus. As more knowledge is gained, the scientist can learn to what extent his or her prediction is incorrect.

Activity Notes

- Students can work individually, in pairs, or in small groups.
- You may want to use a box like a shoebox or 2 L juice box.
- Place different objects inside each box. Use small household, non-perishable items like empty thread spools, paper cups, plastic spoons, milk lids, nuts,

bolts, balls of aluminum foil, small pieces of unbreakable lab equipment, and so on.
- Number the boxes and prepare a list of contents so that students can check their conclusions, and so that you can reuse the same boxes from year to year.
- You may want to seal the box with duct tape to protect the mystery of the contents.
- You may want to reveal the contents of the box to each individual group or wait until after all groups in all classes have participated.

Supporting Diverse Student Needs

- English language learners could be encouraged to draw a sketch of what they believe is inside the box.
- This activity is beneficial for body-kinesthetic and visual-spatial learners. Encourage these students to test systematically and use all of their observations to draw conclusions.
- For enrichment, students might research other advances in nanotechnology.

What Did You Find Out? Answers

1. Answers will vary but could include the following: There are several different objects in the box. Some objects are heavier than others.
2. Answers will vary but could include the following: You cannot be certain what is inside because you cannot reach the edges. You cannot gain as much information with the straw as with the skewer.
3. Accept all answers. Students might say that using the wooden skewer provided more information.
4. Answers will vary, but more information should be gained with the skewer.

TEACHING THE SECTION, pp. 113–119

Using Reading

Pre-reading—K-W-L (Know-Want to Know-Learned)

Ask students to read The Nucleus is Responsible for Heredity on page 113 and to look at Figure 4.2. Have students generate questions about what they want to know about the nucleus and heredity based on what they see on this page.

During Reading—Note Taking

Have students write a one-sentence summary for each paragraph on pages 114 to 119 on self-adhesive removable notes as they read. They may enjoy the novelty of using the self-adhesive removable notes, and the one-sentence summary will force students to find the main idea. (Alternatively, students can use strips of paper for their summaries.)

After Reading—Semantic Mapping

Students can construct a concept map using the self-adhesive removable notes to connect the ideas together.

Supporting Diverse Student Needs

- Interpersonal learners and students with difficulties interpreting text may benefit from writing their summaries and/or creating their concept maps with a partner. Pair those having difficulty with students who have stronger reading or summarizing skills.
- If students formulate questions that you anticipate will not be answered in this unit, encourage them to do some research to find the answers, and to present the results of their research to the class orally, or in a graphic display.

Reading Check Answers, p. 113

1. An example of a trait is eye colour or the size of your nose.
2. Heredity is the process through which patterns of traits are passed on from an individual to its offspring.
3. Heredity information is stored in the nucleus.

Reading Check Answers, p. 119

1. Most human cells have 46 chromosomes or 23 pairs of chromosomes.
2. (a) Genes are small pieces of DNA that store the information to make a particular protein.
   (b) The genes are located at specific places on the chromosome.
3. In retinal cells and muscle cells, only specific genes are "read" in each cell and so only specific proteins are made. Your retinal cells will read certain genes and make different proteins than your muscle cells, and different proteins make your cells function differently.

USING THE ACTIVITY

- Find Out Activity 4-1A, on page 114 of the student textbook, is best used as an introductory activity. Detailed information about this activity can be found in Introducing the Section.

USING THE FEATURE

www Science: Glowing Genes, p. 120

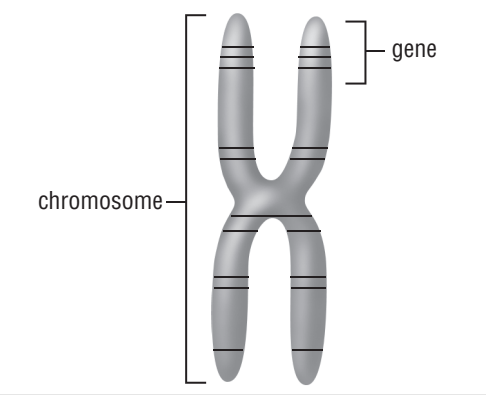
Ask students to read the feature independently, record what they think is important about glowing genes, and then pair up with another student to discuss and share their thoughts. An alternative is to have students write three things that they learned about glowing genes and write down one thing that

they still wonder about. Check for students' understanding on the future use of glowing genes and the advantages of using glowing genes over other tracing methods.

SECTION 4.1 ASSESSMENT, p. 121

Check Your Understanding Answers

Checking Concepts

1. The hereditary information would be stored in the nucleus.
2. The nucleus is sometimes called "the control centre of the cell" because it contains the master set of instructions that determines what each cell will become, how it will function, when it will grow and divide, and when it will die.
3. A gene is a section of DNA that contains the coded information to produce a particular trait. A chromosome is made up of many genes and contains coded information for many traits.
4. 

5. The function of genes is to store the information to make a specific protein.
6. The DNA molecule contains coded information for many traits in an organism. A full set of DNA determines what traits an organism will have and will pass on to its offspring through heredity.

Understanding Key Ideas

7. Family resemblance is determined by the hereditary traits that are stored in the nucleus, so family resemblance is related to the nucleus.
8. The nucleus contains the information on the genes to make different proteins. These different proteins help the cell to carry out life functions by functioning as enzymes and hormones or forming structures within the cell.
9. A skin cell is different than a nerve cell because different proteins are made within each type of cell. Different proteins are made because different genes are read on the DNA molecule.
10. Even though all cells in our body contain the genes that code for the protein hemoglobin, only signals received by red blood cells will cause these genes in the DNA to be read and copied.
11. If a protein was not made within a cell or the protein was not made correctly within that cell, there may be no effect on the individual. But if there were many of the same type of cells unable to make that protein, the individual might develop a disease since that protein is not functioning to do its job.
12. DNA is loosely coiled when a cell is growing so the DNA can aid in the manufacture of proteins. DNA is tightly folded into a chromosome when the cell is going to divide. This position keeps the DNA from getting tangled or broken.
13. If DNA is like a chemical alphabet, then genes are like sentences because they describe one trait, and chromosomes are like paragraphs because they describe many traits.

Pause and Reflect Answer

Answers will vary but should include the idea that DNA contains the information in the genes to make proteins. Proteins direct the activities of the cell and therefore direct the life of the cell and the life of the organism.

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment Blackline Masters.

4.2 MUTATION

BACKGROUND INFORMATION

Gene mutations occur in the base sequence of DNA. Three types of mutations may occur in the sequence: addition, loss, or substitution of a base. Substitution of a base has the least effect of the three. While some mutations are caused by human lifestyles or inventions, others have natural causes.

COMMON MISCONCEPTIONS

- Students may think that all mutations are a result of human activity. While human activities such as smoking and using chemicals that destroy the ozone layer can cause gene mutations, many mutations have natural causes. Radioactive elements occur in nature, and can cause mutations. Viruses can cause mutations. The Spirit Bear shown on page 122 likely underwent a mutation caused by a natural mutagen.

ADVANCE PREPARATION

Useful research materials for advance preparation can be found at www.discoveringscience.ca.

INTRODUCING THE SECTION, pp. 122–123

Using the Text

Begin this section by talking with students about bacteria and antibiotics. If we have a bacterial infection, such as strep throat, a doctor may prescribe antibiotics to kill the bacteria. If we take the medicine as we are told to, it will usually work, and we will get better. If we take some of the medicine, then stop taking it because we feel better, some of the bacteria may be resistant to the antibiotic and survive. Antibiotic-resistant bacteria are more dangerous, because the infections they cause are harder to stop. How do these bacteria become resistant to antibiotics? Some of them undergo a genetic mutation that causes them to react differently to the medicine than other bacteria do. They can then pass this mutation on to their offspring. A more visible example of a mutation is the Spirit Bear, on page 122. Have students read the text on page 122, and then discuss with them the similarities and differences between the two bears shown in Figure 4.12. Both bears are kermode bears with many similar genes, but one carries a gene that results in a white coat. Ask students if they know of any human characteristics that a child might have but that his or her parent might not have, even though the child still inherited that characteristic from his or her parent. (Eye colour and hair colour are two examples.)

This section opening provides an opportunity to talk about simple Mendelian genetics if you introduce that topic. While it was a gene mutation that first caused a kermode bear to have a white coat, that changed gene was passed on to the bear's offspring in the same way other genes are passed on. If both parents have the mutation, then the offspring may also be white. You can explain that the black kermode bear carries two genes for coat colour (BB or Bb). The gene represented as "b" is the result of a mutation. From the mating of one parent Bb and another parent Bb, there is a one-in-four chance that the offspring will be bb, which is the recessive white kermode trait. In order to protect the population of white kermode bears, or Spirit Bears, the black kermode bears must also be protected because they can carry the gene for the white kermode bears.

Using the Key Terms and Section Summary

At the beginning of each section in the student textbook are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the Key Terms by scanning the text and using the Glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are important for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 2-2, Unit 2 Key Terms, which lists the important terms in the unit, can be used to assist students.

Using the Did You Know, p. 122

Genetic research on ancient DNA has been under way since the mid-1980s, including research using ancient remains of mummies, plants, and fossils. Some of the early work focussed on determining food preferences of ancient populations and genetics of human populations.

Recently, Australian researchers used the latest biotechnology tools in an attempt to clone the Tasmanian tiger (*Thylacine*). Settlers hunted this doglike marsupial to extinction. In 1999, scientists successfully extracted DNA from a 150-year-old ethanol-preserved Tasmanian tiger pup sample. Two years later, scientists extracted more DNA from bone, teeth, and dried muscle from two other pups. They concluded that the preserved DNA was too damaged to clone an embryo. However, they did successfully duplicate individual Tasmanian tiger genes, which can be inserted into another animal to make a transgenic species. The project has now been abandoned, with the rationale that the huge amounts of money spent on it would be better spent protecting today's endangered species.

In the future, technology may overcome the current difficulties of cloning preserved DNA. However, there will still be obstacles. All of the individuals cloned from the preserved specimen would be genetically identical and would be the same sex. Also, there are no close marsupial relatives to be a surrogate womb or offer a pouch for the young pups. These obstacles still may also be overcome, and the dreams of reviving the Tasmanian tiger may become reality.

Using the Activity

Find Out Activity 4-2A

Identify the Mutation, p. 123

While this is not part of NL curriculum, students could complete it as an extension or enrichment if time permits.

Purpose

- Students learn how three types of gene mutations affect the protein made in a cell.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
Day of instruction	No advance preparation necessary.	None

Time Required

- 15 min

Science Background

The DNA code is interpreted in groups of three bases for each amino acid. If a letter is added, deleted, or substituted, it will change the gene message. A substitution of a base may change one amino acid, and there is a possibility that the same amino acid still will be created because of the nature of the code. Deletion and addition of bases will change the rest of the code after the mutation so the protein made will not function correctly.

Activity Note

- Make sure that students study the table before they attempt the activity.

Supporting Diverse Student Needs

- For English language learners, share the examples of sentence mutations before students proceed to complete the activity. You may want to pair an English language learner and a fluent English speaker together for the activity.
- This activity is beneficial for logical-mathematical learners. Pair them with students whose skills may be weak in these areas.
- For enrichment, students may want to refer to a codon chart and determine the actual amino acid sequence.

What to Do Answer

3. (a) substitution of C for G in the middle of the sequence
   (b) deletion of a T near the end
   (c) insertion of a G near the end

What Did You Find Out? Answers

1. The least damaging gene mutation is when one base is substituted for another since the message will make sense and the gene message may still make the correct protein.
2. The most damaging gene mutations are when a base is lost or added and the message no longer makes sense. An entirely different protein will be made that may not be useful for the cell.

TEACHING THE SECTION, pp. 124–129

Using Reading

Pre-reading—Predict-Read-Verify

Ask students to predict the meanings of the terms gene mutation and mutagen. If they write their predictions at the left side of a piece of paper, they can use the space beside each one to revise the definition after they have read the section.

During Reading—Inferring

Have students create a T-chart to take notes in. In the left column, they should record the mutations that they read about. In the right column they can infer whether the cause of each mutation was natural or caused by humans, if possible. For many mutations, the cause is still unknown.

After Reading—Reflect and Evaluate

Have students summarize the possible causes of mutations and classify them as natural and caused by humans.

Ask students to reflect on whether it is important to try to find the cause of mutations. Have them write a paragraph stating their opinion, and supporting it with evidence.

Supporting Diverse Student Needs

- Interpersonal learners and others may benefit from discussing and classifying possible causes of mutations with a classmate.
- As an extension, ask students to reflect on whether it is important to try to find the cause of mutations. Have them write a paragraph stating their opinion, and supporting it with evidence.
- The section Correcting Mutations can be used with students who show an interest in this area. Students may have differing points of view on the acceptability of recombinant gene technology and gene therapy. Model acceptance for all points of view, and emphasize an individual's right to hold his or her own point of view. As much as possible, focus on the scientific evidence supporting a point of view.

Reading Check Answers, p. 127

1. The Spirit Bear is white because of a gene mutation for coat colour. If a bear inherits this mutation from both of its parents, it will have a white coat.
2. A gene mutation is a change in the specific order of the bases that make up a gene.
3. Viruses cause mutations since viruses cause genes to be read or copied incorrectly.

4. Mutagens can occur in nature or they can be caused by human activity.
5. Three examples of environmental mutagens are cigarette smoke, radiation from X rays or UV rays, and pollutants. In addition, certain household chemicals may cause mutations.

USING THE ACTIVITY

- Find Out Activity 4-2A, on page 123 of the student textbook, is best used as an extension for those students who want to know more about how gene mutations work. Detailed information about this activity can be found in Introducing the Section.
- Activity 4-2B, on page 129 of the student textbook, is best used as an extension for students who enjoy debating ethical issues after students read Correcting Mutations on student textbook pages 127 to 129. Detailed notes on doing the activity follow.

Think About It Activity 4-2B

Considering Gene Therapy, p. 129

While this is not part of NL curriculum, students could complete it as enrichment or extension if time permits.

Purpose

- Students consider the pros and cons of gene therapy.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
Day of instruction	No advance preparation necessary.	None

Time Required

- 20 min

Science Background

Although gene therapy holds promise, it is still a highly experimental procedure as discussed in the textbook. You may want to check the Internet for news of recent breakthroughs in gene therapy to add to the discussion.

Activity Notes

- Students often enjoy being asked ethical questions. Asking and answering ethical questions can become a very engaging social activity where students who rarely answer science-related questions finally find their voice.
- Ask students to make decisions about each point and write down their reasons. Then, for visual effect, have students move to various corners of the room based on the 1–5 scale rating. Have students from each area voice their opinions.
- After students have discussed the issues, have students write a reflection on what they have learned about their own opinions and how their opinions may have changed during the activity.

Supporting Diverse Student Needs

- Pair English language learners with fluent English speakers to discuss the points before students make their decisions.
- This activity promotes intrapersonal and existential thinking. Encourage all students to respect one another's opinions.
- For enrichment, students can research the work of Canadian scientists who helped discover the cystic fibrosis gene and current information about cystic fibrosis.

What Did You Find Out? Answers

1. Answers will vary, but students should summarize what they learned about each point in What to Do step 1, parts (a) to (d).

USING THE FEATURES

While this is not part of NL curriculum, students could complete it as an extension or enrichment if time permits.

Science Watch: Banana Factories for Vaccines, p. 130

This feature is an excellent starting point to begin discussing biotechnology for those who are interested in this extension. Biotechnology means any technological application that uses biological systems, living organisms, or parts of a living organism to make or modify products or processes for specific use. Biotechnology can be used for medical purposes as illustrated in this feature. It can be also used for industrial purposes to design an organism to make a particular chemical product. Biotechnology is also used in agriculture to design plants that are resistant to insects or drought and cows that produce more milk.

This feature can also be used as a springboard for a discussion on helping developing nations by making them less dependent on other countries.

Science Watch Answers

1. 2 000 000 deaths/365 days in a year = 5479 deaths each day in the developing world due to lack of vaccinations for curable diseases.
2. The bananas would be engineered to produce the protein coat of the virus. If a person ate a bioengineered banana, the person's immune system would recognize the foreign protein invader and their white blood cells would produce antibodies against the foreign protein.

If the real virus with its protein coat came along, the immune system would recognize the virus and attack it with antibodies and white blood cells to destroy it before it could multiply.

3. There are several advantages to using bananas to produce vaccines. Bananas can be eaten raw, whereas other staple foods like rice and potatoes must be cooked first, which could destroy the protein. Bananas can be mashed for infants. It would cost only a few cents for each vaccine. These vaccines do not require refrigeration or medical doctors to administer them. Developing countries could grow their own bioengineered bananas and not have to rely on other countries.

SECTION 4.2 ASSESSMENT, p. 131

Check Your Understanding Answers

Checking Concepts

1. A gene mutation creates a change in an organism by changing the specific order of the bases that make up a particular gene.
2. In addition to protecting the Spirit Bear, the black kermode bear must also be protected because two copies of the mutated gene are required for the white kermode bear to be produced. The mating of two black bears that both carry the mutated gene could produce a Spirit Bear. The mating of two white kermode bears would produce all-white offspring, but only 10 percent of kermode bears are white.
3. A mutagen is a substance or factor that can cause mutations in DNA.
4. Developing skin cancer from being exposed to UV rays is an example of a mutation caused by a naturally occurring mutagen.
5. Developing lung cancer from smoking is an example of a mutation caused by a human activity.
6. When a mutated gene makes a protein that does not function properly, it can cause a disease. For example, in cystic fibrosis, the protein that normally functions to transport chloride ions into and out of the cell is not made correctly, causing a build-up of mucus in the lungs, which leads to respiratory problems.

Understanding Key ideas

7. Mutations are important to the survival of a species because, if conditions in the environment change, entire populations of individuals could be wiped out. For example, if a virus that spreads very quickly appears in a population of Canada geese, an entire population of Canada geese could be wiped out if no geese in the population were resistant to the virus. The individuals who were resistant would survive to mate and produce more offspring who were also resistant to the virus.
8. A mutation in a human skin cell that occurs after birth cannot be passed on to the next generation. Only the skin cells are mutated. No other cells in the body are affected. Only mutations carried in the egg and sperm cells can be passed on to the next generation.
9. (a) The genes in the three remaining plants might have contained a mutation that made them resistant to the disease, allowing them to survive.
   (b) If the farmer grows the new wheat crop from the seeds of the three plants, the new crop will also be resistant to the disease because it will have the same genetic make-up as the three plants.
10. It is important to be protected with a lead shield because X rays can cause mutations in your cells. It is especially important to protect your reproductive organs, where sperm and eggs are produced.
11. No. You can protect yourself from known mutagens such as ultraviolet rays, X rays, and cigarette smoke, but there are many unknown mutagens in your everyday environment. You can be careful with chemicals and other potential mutagens, but you cannot protect yourself from all of them.
12. You should always use proper precautions when handling chemicals because chemicals used in the workplace—and even some household chemicals—can cause mutations.
13. By suntanning, you are exposing your skin cells to ultraviolet light, which causes mutations and possibly skin cancer.
14. No. If a mutagen causes a mutation that is positive or neutral, then the mutagen is not harmful. An example is the Spirit Bear. An unknown mutagen caused the bear to be white, which does not affect the bear's survival.
15. It depends on who is being tested. If a patient is sick and the doctor cannot determine why, then the benefits of getting a correct diagnosis and medical treatment outweigh the risks of being exposed to electromagnetic radiation. However, if the medical tests are used to screen healthy patients, the risk from the electromagnetic radiation is too high and another safer screening method should be used.

Pause and Reflect Answer

Answers will vary. Accept all reasonable answers that demonstrate an understanding of the effects of mutagens. Students must support their opinions.

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment Blackline Masters.

CHAPTER 4 ASSESSMENT, pp. 132–133

PREPARE YOUR OWN SUMMARY

Students' summaries should incorporate the following main ideas:

1. The Nucleus: Control Centre of the Cell
   - The nucleus contains the master set of instructions that tell how a cell will function, when it will grow and divide, and when it will die.
   - The nucleus contains chromosomes, which are made of DNA and proteins.
2. Genes
   - Genes are small segments of DNA at specific places on the chromosome.
3. Mutations
   - A gene mutation is a change in the order of the bases in a gene.
   - Gene mutations can involve deletion, addition, or substitution of a base.
   - Mutations can be caused by natural mutagens or by human-created mutagens.

CHAPTER REVIEW ANSWERS

Checking Concepts

1. The nucleus is like a black box because there are still unknown processes occurring and we are not able to see all the activity that is happening inside the nucleus.
2. DNA is required in every cell because DNA contains the genes that code for the proteins that the cell requires to perform its functions.
3. Three examples of human traits are eye colour, hair colour, and the size and shape of your nose.
4. The information contained in the nucleus determines what traits you inherited from your parents and which traits you will pass on to your offspring.
5. A human skin cell contains 46 chromosomes.
6. Some functions of proteins in cells include enzymes speeding up chemical reactions and hormones acting as chemical messengers. In addition, there are structural proteins, such as the proteins in muscle, and signalling proteins, such as antibodies.
7. DNA is usually loosely coiled but can be tightly coiled. A chromosome is a strand of tightly coiled DNA, formed when the cell is ready to divide. Students' diagrams should look similar to Figure 4.7 on page 116.
8. The correct sequence of DNA bases is important because, if the base sequence is incorrect, then the correct protein will not be made or the protein that is made will not work correctly. The cell will be unable to do its job well if the proteins are not working correctly.
9. A genetic mutation seems to have caused some people to be immune to HIV (human immunodefficiency virus). In sickle cell anemia, a genetic mutation causes the protein hemoglobin to take on a different shape. This mutation is a negative mutation because the abnormally shaped hemoglobin molecules cannot carry oxygen efficiently, resulting in a variety of medical problems.
10. Gene mutations are caused by errors in the DNA. They can be caused by mutagens, such as viruses, cigarette smoke, radiation from X rays and ultraviolet light, and various kinds of chemicals in the environment. (In the next chapter, students will learn that mutations can also occur during mitosis and meiosis when the DNA is copied.)
11. We can protect ourselves from mutagens in our environment by avoiding or limiting our exposure to them. Some examples are using sunscreen or staying out of the Sun to reduce exposure to ultraviolet rays, being careful when handling household chemicals, and using a lead shield to block X rays at the dentist's office.
12. The cell was not taken from a human. There are only 22 pairs of chromosomes, and not 23 pairs as in human DNA.

Understanding Key Ideas

13. A gene is a section of DNA that contains the coded information to produce a particular trait.
14. A "unit of heredity" likely refers to a gene since it contains the coded information to produce one trait that is inherited. A DNA molecule, a chromosome, and a genome contain many genes and would more likely be described as "blueprints of heredity."
15. The amount of DNA in a skin cell and the amount of DNA is a muscle cell would be

the same because the DNA within each body cell is identical.

16. DNA directs a cell to have a particular function when messages are sent to the nucleus of a cell to read certain genes and make specific proteins. The proteins that are made and that function in that cell will determine if the cell is a muscle cell or a stomach cell.
17. The number of chromosomes in an animal cell or a plant cell does not reflect how advanced the organism is. Many plants have very large numbers of chromosomes. Some amoeba have 40 or more chromosomes. A butterfly has 80 chromosomes, while humans have 46. Chickens have 78 chromosomes. Scientists have found that some DNA is very repetitive in organisms.
18. The nucleus of a cell controls the functioning of the cell. If the nucleus of a cell did not perform its function, the cell would not be able to function and would die.
19. A gene mutation can have a positive or negative effect on a species. If the gene mutation makes the species more resistant to disease, for example, the species will have a better chance of surviving. If the gene mutation makes the species more susceptible to disease, then the species is less likely to survive.
20. Occupations that could pose greater risks of mutations include the following: (a) pilots because they are exposed to a lot of cosmic radiation; (b) construction workers because they are exposed to a lot of dust, chemicals, and sunlight; (c) firefighters because they are exposed to many toxic substances; (d) dry cleaners because they are exposed to chemicals used to clean garments; (e) X-ray technicians, because they work with X-rays; (f) farmers because they are exposed to pesticides, fertilizers, and ultraviolet light. Accept other possible answers, and discuss the importance of following proper safety precautions when working in certain occupations or using chemicals at home.
21. All of an organism's characteristics are not controlled by the cell's nucleus. An organism's size and height are partially due to the amount of food it has when it is young. Disease and accidents can also change an organism's characteristics.
22. (a) Sources of potential mutagens in the photograph are exhaust from the smokestacks, and pesticides and other chemicals used on the farmland. These mutagens are human-made. Since the sky is clear, there is also a risk of ultraviolet rays, which is a naturally occurring mutagen.
    (b) Sources of potential mutagens in the photograph are electomagnetic radiation from the medical machines, and possibly radioactive materials in the machines, given the radiation sign on the door. These mutagens are human-made.

Pause and Reflect Answer

Answers will vary, but students should make a connection that the nucleus controls the cell by turning off and on gene messages to make specific proteins, and these specific proteins direct the activities and functioning of the cell.