6.3 Assisted Reproductive Technologies

There are many forms of reproductive technology. In assisted reproductive technology, various procedures help infertile couples have children. These procedures include artificial insemination, in vitro fertilization, gamete intrafallopian transfer, and intracytoplasmic sperm injection. Reproductive technologies have a range of impacts on people and society.

Words to Know

artificial insemination
in vitro fertilization

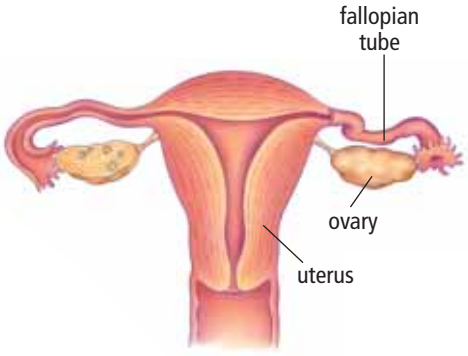


Figure 6.39 The structures of the female reproductive system

Infertility is the inability of a couple to have a baby. It is estimated that about 15 percent of couples in North America are infertile. Causes of infertility range from a man being unable to produce enough sperm to a woman being unable to produce enough hormones. In other situations, disease and the medical treatment used to cure the disease can cause infertility. For example, chemotherapy or radiation treatment to stop the spread of cancer can damage the egg cells of women or the sperm cells of men. As a result, women may decide to freeze embryos before undergoing cancer treatment, and men may decide to freeze sperm cells (Figure 6.38).

Figure 6.38 Before Stephen Mercer began cancer treatment, he had samples of his sperm cells frozen. Eleven years later, these sperm cells were used to fertilize his wife's egg cells, and his twin daughters were born.

In some cases, infertility can be corrected through medical treatment. For example, women can be given hormone injections to correct a hormone imbalance. However, in many situations couples must try one or more **assisted reproductive technologies**. Most assisted reproductive technologies include removing egg cells from a woman's body, fertilizing them, and returning the embryos to the uterus. The uterus is the organ in a female mammal such as a human in which an embryo (and, later, a fetus) develops and is nourished before birth. Figure 6.39 shows the female reproductive structures involved in reproductive technologies, such as artificial insemination, in vitro fertilization, gamete intrafallopian transfer, and intracytoplasmic sperm injection.

6-3A A Summary of Assisted Reproductive Technologies

Find Out ACTIVITY

You have been asked to prepare a summary of assisted reproductive technologies for a reproductive health clinic. The clinic plans to include the summary in a brochure.

What to Do

1. Read all the headings in this section. Identify the headings you think are associated with assisted reproductive technologies.
2. On a plain sheet of paper, write down each of these headings. Make sure the headings are evenly spaced over the page.
3. Under each heading, write down anything you know about the reproductive technology. You may work with a partner or in a small group to brainstorm ideas. If necessary, scan the section further for more information.
4. As you work through this section, add new information about each technology to your summary.

Artificial Insemination

Artificial insemination (AI) is a reproductive technology with a long history. Techniques for collecting sperm from a male and injecting it into a female were first developed for animals more than 200 years ago. Today, AI is used widely to breed farm animals, especially dairy cattle (Figure 6.40).

Figure 6.40 Artificial insemination techniques were first developed for the dairy cattle industry. Other animals that can be reproduced using artificial insemination include beef cattle, sheep, horses, and pigs.

Over the past 30 years, AI has also been used to help many infertile couples. In some cases, the sperm is provided by the woman's partner. In other cases, the sperm is provided by a donor who wishes to remain unknown. The use of donor sperm can help when there is something wrong with the partner's sperm cells. For example, sometimes a man's semen (the fluid that carries the sperm) contains too few sperm or the sperm are not active enough. In these cases, the man's sperm can be concentrated through a medical procedure or an anonymous donor can provide sperm that will allow the couple to produce a child.

In Vitro Fertilization

After Louise Brown, the world's first "test-tube baby," was born in England in 1978, researchers at the University of British Columbia began to use **in vitro fertilization** (IVF) technology to treat specific fertility problems. "In vitro" means in glass, so in vitro technology refers to the method of fertilizing an egg cell in a petri dish (see Figure 6.41). One common fertility problem occurs when a woman's fallopian tubes are blocked and the egg and sperm cannot meet. IVF attempts to solve this problem by taking egg cells from the woman and sperm cells from the man and combining them. Two to four days after fertilization, the embryos are placed in the female's uterus. The goal is to have one of the fertilized embryos become implanted in the uterus and begin developing. Since more than one embryo is placed in the uterus at the time of in vitro fertilization, the chance of multiple births increases.

To help ensure the success of IVF, a woman receives powerful hormone treatments to increase the number of eggs she produces. Some women find this part of the process unpleasant because it produces side effects such as dizziness, nausea, and headaches.

Figure 6.41 An embryologist injects sperm into a petri dish containing an egg cell.

Table 6.3 illustrates the success rate of in vitro fertilization. Notice that the success rate changes as the age of the woman increases.

Table 6.3 Success Rate of In Vitro Fertilization

Age of Woman	Success Rate
Up to 35	40 out of 100
Up to 39	20 out of 100
Up to 43	10 out of 100

Only about one in three couples succeeds in having a baby by in vitro fertilization.

One couple was especially happy in 1983 when their son was born. Robbie Reid was the first IVF baby to be born in British Columbia and Canada (Figure 6.42). Since Robbie's birth, many other families have been helped by IVF technology. In fact, more than 1500 IVF babies have been born in British Columbia over the past 20 years. Many of them, like Robbie, are now young adults.

Figure 6.42 Robbie Reid and his mother

Did You Know?

The first Canadian clinic for in vitro fertilization was started at the University of British Columbia by Dr. Victor Gomel in 1982. There are now more than 20 similar IVF clinics in Canada.

Gamete Intrafallopian Transfer

Gamete intrafallopian transfer (GIFT) is an assisted reproductive technology in which egg cells are removed from a woman's ovaries and combined with sperm cells to produce a "mixture" of eggs and sperm. The mixture is immediately injected into the woman's fallopian tubes, so that fertilization can take place inside her body. The process differs from in vitro fertilization because an embryo is not produced outside the woman's body.

Intracytoplasmic Sperm Injection

Intracytoplasmic sperm injection (ICSI) is a very specialized procedure in which a single sperm cell is injected into an egg cell (Figure 6.43). The resulting zygote is then inserted into the uterus of the woman. The ICSI procedure can be used when a man has severe fertility problems, such as very low sperm production, or if in vitro fertilization has been unsuccessful. About 25 percent of all ICSI procedures result in a birth.

Figure 6.43 An embryologist injects a sperm cell into an egg cell.

Reading Check

1. What is assisted reproductive technology?
2. What is artificial insemination?
3. What is in vitro fertilization?
4. How does the success rate of in vitro fertilization change as the age of the woman increases?
5. What is the difference between gamete intrafallopian transfer and in vitro fertilization?

The Impact of Reproductive Technologies on Society

Advances in reproductive technology, genetics, and biotechnology have already had a big impact on society and will continue to do so. Reproductive technologies have helped many infertile couples conceive a child. However, the reproductive technologies discussed here have also led to concerns and questions. For instance, there is some evidence that conception by IVF may cause a slightly higher number of birth defects. Should we continue to use a technology that carries an extra risk?

As well, there is the issue of what to do with embryos left over from the IVF process. Typically, more embryos are created than will be needed. With the use of cryopreservation, embryos can be frozen in liquid nitrogen (Figure 6.44). These extra embryos can be useful for stem cell and gene therapy research, but some people feel it is wrong to use embryos that could develop into a human being for such purposes. Some people also feel that it is wrong to discard extra embryos. Who owns these embryos, and what should be done with them?

Figure 6.44 An embryologist pulls straws containing frozen embryos from a liquid nitrogen tank.

Then there is the question of artificial insemination by an unknown donor. Most children conceived by AI will never know the identity of their fathers. Is it fair to a child to keep this information secret?

Another area of difficulty concerns surrogacy. This is an arrangement involving a surrogate mother who becomes pregnant and gives birth to a child for someone else to raise. Surrogacy can take different forms. Sometimes a man and woman ask the surrogate mother to carry an embryo created from the woman's egg and the man's sperm. Sometimes the surrogate mother is asked to provide the egg. Disputes have arisen when the people involved change their minds about whether the couple or the surrogate mother should raise the child. How do we decide what to do in these complicated situations?

As scientists continue to develop ways to help infertile couples, our society will have to consider these and other questions.

Explore More

In 2004, the *Assisted Human Reproduction Act* became law in Canada. Find out which assisted reproductive technologies are allowed under this law and which ones are not. Start your search at **www.bcscience9.ca.**

Science Watch

Embryo Screening

As a result of embryo screening, this couple's baby will not develop Huntington disease.

Baby Roger started life in a laboratory dish, where eggs taken from his mother were fertilized by sperm from his father. Three days after fertilization, at the eight-cell stage, doctors removed a single cell from each of the fertilized eggs to conduct genetic tests. Roger's parents were concerned that Roger might carry the gene for Huntington disease, a fatal non-curable disease that appears in youth or middle age and affects the nervous system. One of Roger's parents carries the gene, and a grandparent and a great-grandparent had died because of the disease. Roger's parents were determined that the disease not be passed to future generations, so they chose to keep only the embryo without the gene for Huntington disease.

Embryo screening is currently used to identify genetic conditions such as cystic fibrosis, Tay-Sachs disease, Down syndrome, some inherited cancers such as forms of colon and breast cancer, and Huntington disease. In some countries, it is legal to screen embryos for the presence of these diseases, then implant only healthy embryos. Some couples use embryo screening purely for sex selection—for example, to test for the presence of the Y chromosome, which indicates that the embryo is a male.

Genetic screening is also used to tissue type embryos. If a sibling has a serious genetic condition that requires a perfect tissue match and no donor can be found, the umbilical cord or bone marrow from the selected baby can be used as a source of stem cells to treat the ill brother or sister. Controversy has arisen as couples with disorders such as gene-related deafness and dwarfism request selection for embryos carrying the defective genes in order to have children like themselves.

Embryo screening does not appear to harm the developing embryo, but the process is difficult and expensive. A slight possibility of making an error in screening still exists. Selection for particular traits such as eye colour is not currently occurring, but countries must continue to develop guidelines for genetic screening to guard against unethical choices.

Questions

1. List three reasons for embryo screening.
2. What are some ethical concerns about embryo screening?
3. Amniocentesis is a procedure in which fluid containing cells from the developing embryo is removed from the pregnant woman in the second trimester. The fluid is then examined for genetic abnormalities. What is the advantage of genetic screening over amniocentesis?

Check Your Understanding

Checking Concepts

1. Describe two possible reasons for infertility.
2. What is the function of the uterus?
3. Outline the steps for in vitro fertilization.
4. What are some potential side effects of in vitro fertilization for a woman?
5. Approximately how many births result from every 100 intracytoplasmic sperm injection procedures?
6. Where in British Columbia did the first in vitro fertilization occur?
7. How can embryos be preserved for an extended period of time?
8. Describe two different types of surrogacy.

Understanding Key Ideas

9. Consider all the types of reproductive technology described in this chapter. What are some advantages of reproductive technology?
10. What are some disadvantages of reproductive technologies?
11. Compare the process of gamete intrafallopian transfer to intracytoplasmic sperm injection.
12. Use the table on page 227 to create a bar graph illustrating how the success rate of in vitro fertilization changes as the mother's age increases.

Pause and Reflect

Some reproductive technologies have the potential to allow people to determine the genetic make-up of their children before an embryo is implanted. Do you agree or disagree with giving people this option?

Prepare Your Own Summary

In this chapter, you investigated meiosis as the basis of sexual reproduction. Create your own summary of the key ideas from this chapter. You may include graphic organizers or illustrations with your notes. (See Science Skill 12 for help with using graphic organizers.) Use the following headings to organize your notes.

1. Meiosis
2. Genetic Variation
3. Methods of Fertilization in Sexual Reproduction
4. Early Embryonic and Fetal Development
5. Types of Assisted Reproductive Technologies

Checking Concepts

1. Why is meiosis necessary for multicellular organisms?
2. Compare meiosis II to mitosis.
3. How do cells at the beginning of meiosis compare to the cells at the end of meiosis?
4. Describe two events that produce genetic variation in organisms.
5. How is crossing over like shuffling a deck of cards?
6. With your knowledge of meiosis, explain why you do not look identical to your parents or to your brothers, sisters, or cousins.
7. How can a karyotype be useful to geneticists?
8. Identify the syndrome associated with an extra copy of the 21st chromosome.
9. Create a concept map using the following terms: diploid, embryo, fertilization, gamete, haploid, and zygote.
10. State whether each of the following sentences is related to internal fertilization or to external fertilization.
    (a) Energy is required to find a mate.
    (b) Embryos are unprotected.
    (c) Large numbers of embryos are produced.
    (d) Embryos are not genetically identical to parents.
11. The following table provides information about the growth of the human embryo and fetus during the three trimesters. Create a line graph to show the growth rate during this time.
    (a) Identify where the growth rate of the embryo or the fetus is the fastest.
    (b) Identify where the growth rate of the embryo or the fetus is the slowest.
    (c) How did you know which were the fastest and slowest periods of growth?

Growth of an Embryo and a Fetus

Trimester	Time after Fertilization	Size
First trimester	3 weeks	3 mm
	4 weeks	4 mm
	6 weeks	12 mm
	7 weeks	2 cm
	8 weeks	4 cm
	9 weeks	5 cm
	3 months	9 cm
Second trimester	4 months	15 cm
	5 months	25 cm
	6 months	35 cm
Third trimester	7 months	35 cm
	8 months	40 cm
	9 months	50 cm

Understanding Key Ideas

12. What is the purpose of fertilization?

13. How is external fertilization suited to aquatic environments?

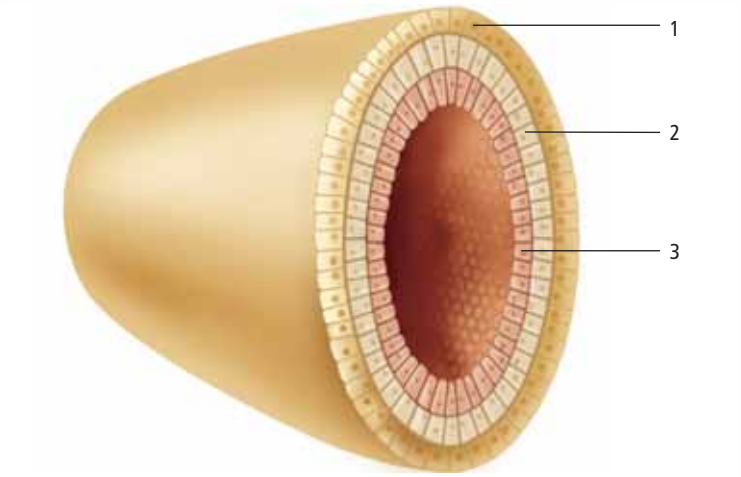
14. Explain how a single fertilized egg grows into a multicellular embryo.

15. Collecting pollen from a crime scene can provide evidence as valuable as fingerprints, DNA, hair, or clothing fibres. From your understanding of meiosis and sexual reproduction, explain how pollen can be used to solve crimes.

16. Study the illustration below.

(a) Identify the three tissue layers shown.

(b) State one type of organ that will develop from each layer.



17. Why do biotechnologists prefer to use embryonic stem cells for research instead of adult stem cells?

18. Study the picture below. Describe what type of analysis the researcher is conducting.

19. Summarize how reproductive technology impacts society.

Pause and Reflect

Asexual reproduction produces little diversity in a population. Sexual reproduction results in a lot of diversity due to the shuffling of genes in meiosis and the random meeting of an egg cell and a sperm cell. When, overtime, sea urchin becomes less and less like other sea urchins in a population, it may no longer be able to mate with sea urchins of that population. if other sea urchins change in the same way that this first sea urchin did, and if these changed sea urchins are able to mate and have fertile offspring, they may be considered a new species. Predict whether a new species of sea urchin is more likely to appear in a large population of sea urchins or in a small population. Draw a diagram to explain your prediction.

Unit Summary

4 The nucleus controls the functions of life.

- Chromosomes found within the nucleus contain the genes that store the information to make proteins. (4.1)
- Proteins control the activities of cells. (4.1)
- RNA carries the message out of the nucleus to the ribosomes, which function to make proteins. (4.1)
- A gene mutation is a change in the order of the A, G, C, and T bases. (4.2)
- Gene mutations can have a positive, negative, or neutral effect on the individual. (4.2)
- Mutations can occur when DNA is being replicated, or they can be caused by mutagens. (4.2)
- Gene therapy attempts to correct gene mutations. (4.2)

5 Mitosis is the basis of asexual reproduction.

- There are three stages to the cell cycle: interphase, mitosis, and cytokinesis. (5.1)
- There are four phases to mitosis: prophase, metaphase, anaphase, and telophase. (5.1)
- Checkpoint proteins instruct the nucleus whether or not to proceed through the cell cycle. (5.1)
- An error in a checkpoint protein can cause diseases such as cancer, which is uncontrolled cell division. (5.1)
- Asexual reproduction requires only one parent, and the resulting offspring are genetically identical to the parent. (5.2)
- Types of asexual reproduction include binary fission, budding, fragmentation, vegetative reproduction, and spore formation. (5.2)
- Human-assisted plant and animal cloning methods can be used to save the genetic information of endangered species or to produce an organism with a desired trait. (5.2)

6 Meiosis is the basis of sexual reproduction.

- Meiosis produces gametes with half the number of chromosomes as body cells. (6.1)
- In meiosis I, homologous chromosome pairs line up at the equator, separate, and then move to opposite poles of the cell. (6.1)
- In meiosis II, chromosomes move to the equator and sister chromatids move to opposite poles of the cell. (6.1)
- The process of meiosis creates variation in organisms because genetic information is shuffled during meiosis I. (6.1)
- Chromosome mutations can occur during meiosis and can cause genetic disorders. (6.1)
- The three stages of sexual reproduction are mating, fertilization, and development. (6.2)
- For sexually reproducing plants and animals, there are two ways for a sperm cell and an egg cell to meet—through either internal or external fertilization. (6.2)
- The early development of an organism takes place during a stage called embryonic development. (6.2)
- Assisted reproductive technologies enable infertile couples to have children and have an impact on society. (6.3)

Key Terms

- chromosome
- DNA (deoxyribonucleic acid)
- gene
- gene mutation
- protein
- ribosome

Key Terms

- asexual reproduction
- binary fission
- budding
- cancer
- cell cycle
- fragmentation
- mitosis
- stem cell
- vegetative reproduction

Key Terms

- embryonic development
- fertilization
- gametes
- sexual reproduction
- zygote

Making a Decision for Genetown

You have been asked to attend a town council meeting in Genetown, British Columbia. Genetown is a small community just outside of a mid-sized B.C. city. The nearby city has a rapidly expanding university with a well-respected biomedicine department. A biotechnology company called Stem Cells Now wants to build a $150 million research facility on the edge of town. The company is based overseas. The federal government has recently approved the company's proposal, but the location is still to be determined. Stem Cells Now wants to conduct research on human embryos in hopes of curing diseases and treating injuries.

Problem

Genetown's town council is holding a public meeting to decide whether Stem Cells Now is welcome in this community. You have an interest in the building of this facility in Genetown, and you have been invited to voice your opinion on whether Stem Cells Now should be allowed to proceed. Genetown's council members are depending on your knowledge and input to help them make their decision.

Criteria

- You will be given three minutes to state your point of view and convince the town council that your position is valid.
- Your position and perspective on the decision should be clear to the audience.
- You should present at least three strong arguments for your opinion.
- Your argument should be well researched.
- You should appear serious in your intent.

Procedure

1. Choose your role randomly from an envelope. Your teacher will give you a list of all the roles and may give you the opportunity to swap roles.
2. Record your name and the number of your role on the list of speakers to confirm your attendance at the meeting.
3. Research your role and issue. Begin your search at **www.bcscience9.ca**. When researching on the Internet, use key words such as "stem cells" and "diabetes" to help narrow your search.
4. Prepare your three-minute presentation. Use Science Skill 4: Societal Decision Making to help you make a decision about what information to include in your presentation.
5. Think about how you should dress for the role you are playing on the day of the presentation. Small props may be used to make your presentation more effective.
6. Practise your presentation. Try not to read from a script. Practise looking directly at your audience because eye contact is important.

Report Out

1. The mayor of Genetown will conduct the council meeting and call on the speakers to present their arguments. Following all of the presentations, town council members will meet with the mayor to make a decision about whether or not Stem Cells Now can build its facility. With the announcement of the decision, each council member will present arguments for the final decision of the council.

Just Because We Can, Does It Mean We Should?

As our understanding of the activity inside the nucleus grows, researchers are learning more about how and when cells divide. Geneticists are finding ways to change information in genes and move these messages to new locations. These advances in reproductive technology have an impact not only on the individual but also on society. In this research investigation, you will use print and electronic sources to research a reproductive technology issue.

Background

The Canadian government has made laws on reproductive technologies to ensure that research conducted in Canada represents the interests of Canadian citizens. The government recognizes that there are benefits and consequences related to the use of these technologies. The future of scientific research in Canada and around the world will depend on decisions by government lawmakers. As future voters, it is important that you become familiar with issues about reproductive technologies, as you have the power to shape the 21st century.

Find Out More

Choose a topic from the following list. You will need to become an expert on this topic to prepare for a debate or multimedia presentation of your research. Begin your research at **www.bcscience9.ca**, and use print sources such as magazines and newspapers. You may wish to contact your local member of Parliament for further information.

1. Should we donate frozen embryos left over from in vitro fertilization to science?
2. Should we patent genetic material?
3. Should we have the right to know the results of genetic testing?
4. Should we be able to select the traits to make a perfect baby?
5. Should we clone extinct species?
6. Should we be able to select against embryos carrying genetic diseases?
7. Should medical researchers be allowed to combine the genomes of two different species?
8. Should we clone humans?
9. Should individuals be allowed to buy or sell embryos, sperm, and eggs?
10. Should sperm donors be paid?

Report Out

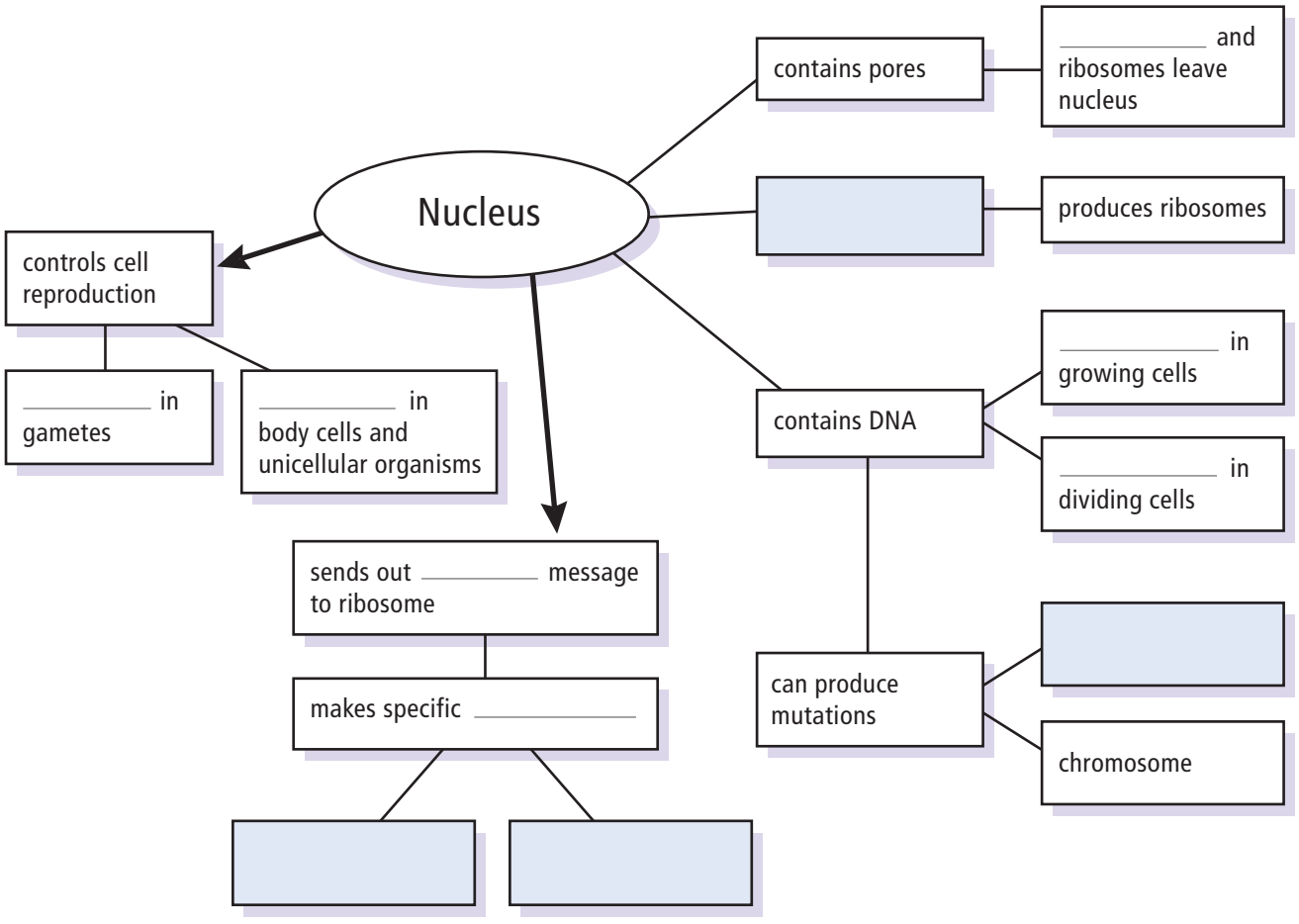
After you have thoroughly researched your topic, present either positive or negative arguments for the issue in a debate or multimedia presentation. Your presentation should be interesting and well rehearsed to make your argument convincing. Record all the source information for any graphics, facts, and quotations you have used.

Visualizing Key Ideas

1. Copy the following concept map into your notebook. Fill in as many terms as you can without looking in your textbook. After you have completed the map, go back through the unit to check your work. Fill in any missing terms using a different colour of pen.

Using Key Terms

2. For each of the lists of terms below, create a meaningful sentence that shows your understanding of the terms and uses all three terms.
   (a) DNA, genes, protein
   (b) gene therapy, mutagen, negative mutation
   (c) binary fission, budding, mitosis
   (d) cancer, cell cycle, DNA replication
   (e) embryonic development, fertilization, gamete
   (f) differentiation, stem cell, therapeutic cloning



Checking Concepts

4

3. DNA is often described as a twisted ladder. What materials make up the sides and steps of the ladder?
4. What is the relationship between chromatin and DNA?
5. What is a chromosome?
6. What is the function of the nuclear membrane?
7. Why are genes important to the functioning of a cell?
8. Each of the following terms is associated with making a protein. Write a sentence for each of the terms to describe how the term is involved in making proteins.
   (a) DNA
   (b) RNA
   (c) Golgi body
   (d) vesicle
   (e) nuclear pore
   (f) ribosome
   (g) endoplasmic reticulum
   (h) cell membrane
9. List three factors that could change the cell's genetic information.
10. What are the three different effects of mutations?

5

11. Why must body cells be able to reproduce?
12. Explain why each of the following is important for cell reproduction.
    (a) interphase
    (b) mitosis
    (c) cytokinesis
13. How is cell reproduction controlled?
14. In which stage of the cell cycle is the nucleolus always visible?
15. In what phase of mitosis do the sister chromatids move to opposite poles of the cell?
16. Explain how the following events of the cell cycle differ in plants and animals:
    (a) mitosis
    (b) cytokinesis
17. What are two ways in which humans assist plant reproduction?
18. What are the benefits of plant grafting?
19. What are some current uses of reproductive cloning?

6

20. What is the purpose of meiosis?
21. State the main differences between:
    (a) mitosis and meiosis
    (b) meiosis I and meiosis II
22. How can two chromosomes be identified as a pair of homologous chromosomes?
23. During which stage of meiosis do homologous chromosomes separate?
24. Summarize the differences between:
    (a) the formation of sperm and eggs
    (b) the physical appearance of sperm and eggs
25. How does a gene mutation differ from a chromosome mutation?
26. Name a disease that is caused by a chromosome mutation.
27. Explain how animals aid plant reproduction through:
    (a) pollen transport
    (b) seed transport

Understanding Key Ideas

28. Would a cell be able to function without a nucleolus? Explain why or why not.
29. Why would a protein be made on ribosomes in the cytoplasm instead of on ribosomes on the endoplasmic reticulum?
30. Explain how the production of particular proteins determines what a body cell will become and how it will function.
31. If a protein is to be transported out of the cell, how does it leave the cell?

32. How can you tell that a human or animal cell is from a male and not a female when examining chromosomes under the microscope?

33. Explain why the addition of an extra base in a DNA sequence would change the message carried by a DNA molecule.

34. How does a mutation change the activities occurring in a cell?

35. Explain why it is important that:
(a) DNA uncoils during DNA replication
(b) the correct sequence of bases is constructed in the newly forming DNA

36. Construct a chart to compare what is happening to the chromosomes, nucleus, and cell membrane during each phase of mitosis.

37. Explain why it is important that the cell not divide when:
(a) there are not enough nutrients
(b) DNA has not been replicated
(c) DNA is damaged

38. Classify each of the following descriptions as being an event in:
(i) mitosis (iii) both mitosis and meiosis
(ii) meiosis (iv) neither mitosis nor meiosis
(a) the method that produces genetically different cells
(b) the method that doubles the number of chromosomes
(c) the method necessary for growth in more complex organisms
(d) the method in which the number of chromosomes in daughter cells remains the same
(e) the method in which chromosomes replicate only once
(f) the method that produces genetically identical cells
(g) the method that produces gametes
(h) the method that produces haploid cells
(i) the method in which cells divide two times

39. Explain how a fish embryo and human embryo look:
(a) identical in the early stages of embryonic development
(b) very different in later stages of development

40. What happens when cell reproduction is no longer controlled?

41. Genetic diversity results from meiosis I. Explain.

42. Why are some mutations not necessarily bad for the individual?

43. Give two differences between reproductive cloning and therapeutic cloning.

44. Horses have 64 chromosomes. How many chromosomes will be in a daughter cell following meiosis II?

45. Create a graphic organizer that describes embryo development and includes the terms blastula, ectoderm, endoderm, gastrula, mesoderm, morula, and zygote.

46. Summarize the main events in fetal development in:
(a) the first trimester
(b) the second trimester
(c) the third trimester

47. Compare and contrast artificial insemination and in vitro fertilization.

Thinking Critically

48. The nucleus is still considered a black box. What methods are scientists using to gain further knowledge about the ways in which the nucleus controls the functions of life?

49. Why is it important for eukaryotic cells that DNA be contained within the nucleus?

50. Explain why mitosis does not produce genetic variation.

51. A cell with four homologous chromosomes is undergoing meiosis. Compare the events in metaphase I to those in metaphase II by drawing the cell at metaphase I and at metaphase II.

52. By examining a karyotype, could you identify a gene mutation? Explain.
53. Would a mutation in a cell in your skin be inherited by your children? Explain.
54. A cell has a mutation in the protein that ensures DNA has replicated before cell division.
    (a) What might occur in the daughter cells as a result of this mutation?
    (b) Will the daughter cells be able to function normally? Explain why or why not.
55. A patient has been diagnosed with lung cancer and is to undergo radiation therapy. Radiation will damage the DNA. How might this affect the growth of the tumour?
56. Treatment for bladder cancer often involves chemotherapy. Explain how each of the following methods of chemotherapy will interfere with the rapidly growing cancer cells. Remember what you have learned about the checkpoints in the cell cycle.
    (a) a chemical that blocks the replication of DNA
    (b) a chemical the prevents the formation of spindle fibres
57. Should scientists change plant genes to resist insects and infection? Explain why or why not.
58. Defend this statement: Mutations are necessary for the survival of a species.
59. Explain why some scientists believe that gene therapy will cure diseases in the future.
60. In this unit, you were presented with the variety of methods by which multicellular organisms are able to reproduce sexually and asexually. It is now the year 2250. You are a biological engineer given the task of designing the first animal-like organism that will colonize a planet called Sedohr, 100 light years away. The planet appears to have a small amount of water and frequently experiences strong winds. The temperature on the planet ranges from –20°C to 50°C. There is some small plant life on the planet at present. Consider the methods of reproduction you have learned about, and decide which method or methods of reproduction would be most suited for this animal. Write a brief report to your supervisor to explain and convince him that you have made the correct decision.

Developing Skills

61. To demonstrate your understanding of how genetic diversity occurs as a result of meiosis, do the following.
    (a) Draw a cell that has two homologous chromosomes.
    (b) Draw a cell in prophase I after crossing over has occurred.
    (c) Draw how the chromosomes will sort independently.
62. A bacterium avoids your body's defence mechanisms and begins to replicate. This bacterium replicates itself every 30 minutes. Develop a graph to show how many bacteria will invade your body after 48 hours.
63. Create a graphic organizer that demonstrates your knowledge of how an egg cell and sperm cell unite and eventually become a fetus.

Pause and Reflect

Some scientists say that when a species that once reproduced both asexually and sexually begins to reproduce only through asexual reproduction, that species is heading toward extinction. Based on your knowledge of asexual and sexual reproduction, write a paragraph to explain whether you agree or disagree with this statement.