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UNIT 6

Reproduction and Development

Teaching Unit 6: Reproduction and Development

(20% percent of the course time; approximately 25 hours)

Student Textbook pages 472-543

General Outcomes

- explain how survival of the human species is ensured through reproduction
- explain how human reproduction is regulated by chemical control systems
- explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine, and environmental factors
- explain classical genetics at the molecular level

Curriculum Fit (See the Curriculum Correlation for Full Listing)

Background: This unit builds on concepts from *Science 8*, Unit B: Cells and Systems; Science 9, Unit A: Biological Diversity; *Science 10*, Unit C: Flow of Matter in Living Systems; and *Biology 20*, Unit D: Human Systems.

Contents

- Chapter 14: The Continuance of Human Life
- Chapter 15: Human Development

The theme of this unit, Change and Systems, builds from the theme of the previous unit, Equilibrium and Systems.

Content Summary

All species must reproduce in order to survive. The majority of plants and animals reproduce sexually: gametes of the opposite sex combine to form genetically diverse offspring. Unit 6 deals exclusively with human reproduction and embryonic and fetal development.

In this unit, you will be presenting potentially controversial subject matter in more detail and more graphically than those of some cultures or belief systems may be accustomed to. It may be necessary to work to find a balance between the need to teach the science in this unit and respect for cultural or faith-based sensitivities. Consult with experienced colleagues or respected members of the communities in question as appropriate in order to find that balance.

If you choose to have students do work in groups, same-sex groups or same-sex, culturally homogeneous groups may work best in the classroom.

Chapter 14 focusses on human reproductive biology and health and social issues related to male and female reproductive systems.

Section 14.1 compares and contrasts the structures and functions of the male and female reproductive systems, including primary and secondary sex characteristics and gamete production. There are detailed diagrams and summary tables to assist reinforcement of the information. Investigation 14.A asks students to compare slides of ovarian and testicular tissues under a microscope and identify ovarian and testicular structures. Pathways of the sperm ejaculation and the glandular secretions are described, as is the process of ovulation to the point of fertilization. (Fertilization is covered in more detail in Chapter 15.)

Section 14.2 describes the more common sexually transmitted infections (STIs)—both bacterial and viral—including transmission, symptoms, effects on the human reproductive system and general health, and currently available treatments. In the accompanying thought lab, students are asked to research the effects of STIs and design a project to educate young Canadians about their findings.

Section 14.3 outlines the hormones that are involved both in the development of human reproductive systems and the regulation of the systems throughout life. The development of both primary and secondary sexual characteristics in males and females are presented, as well as the role these hormones play in preparing the body for the events that form and maintain a new life, which is the focus of Chapter 15. There are a number of activities in this section, allowing students to look at testosterone and male development (Thought Lab 14.2) and development of the corpus luteum (Thought Lab 14.3). In Investigation 14.B: The Menstrual Cycle, students analyze blood hormone data, while Thought Lab 14.4 asks them to research and assess the medical use of reproductive hormones and their effect, specifically as they are used to treat the symptoms of menopause. The Connections feature ends the chapter with a look at common household chemicals that interfere with the normal function of hormones, asking students to consider endocrine disruptors in their environment.

In Chapter 15, students examine human development from conception through birth.
The chapter looks at basic human developmental biology, the advancement of reproductive technologies, and the related moral and ethical issues. The topics are integrated to pair information about current technologies and issues with the related biology.

In Section 15.1, students will learn of key events and developments that take place from fertilization through the first eight weeks of pregnancy (the embryonic period). Key events include fertilization, cleavage, and implantation, the development of the blastocyst, gastrulation, tissue formation, morphogenesis, differentiation, neurulation, and organ formation. Students will compare embryonic structures in humans and another animal in Investigation 15.A.

Section 15.2 outlines the key events and processes that occur after the first eight weeks, during fetal development, the birth process, and lactation, and the related hormonal regulatory mechanisms for these events. There is a subsection describing the negative effects of teratogens and other environmental factors on the body systems of the developing fetus. In contrast, in Thought Lab 15.1, students study the effects of folic acid in promoting fetal development and consider the responsibility of the public and government in safeguarding fetal development. The Connections feature asks students to consider the sometimes controversial issue of the use of stem cells to treat diseases and the related ethical concerns.

Section 15.3 considers technologies that enhance reproductive potential, as well as those that reduce it. Examples of enhancement technologies include *in vitro* fertilization, artificial insemination, intrafallopian transfer, surrogate mothers, and superovulation. Abstinence, surgical sterilization, hormone treatments, and other methods of birth control, such as chemical and physical barriers, are presented as examples of contraceptive technologies. Thought Lab 15.2: Evaluating Reproductive Technologies: Safety and Effectiveness gives students a chance to research and describe various reproductive technologies available for both males and females who are considered infertile. Related social and ethical considerations covered in this section include the rights of the developing child, parents' rights, and the use of government funding for both population growth and control.

Activities and Related Target Skills

Activity	Target Skills
Chapter 14: The Continuance of Human Life	
Launch Lab: Inside Story, p. 477	■ Comparing reproductive strategies of salmon and humans
Investigation 14.A: Examining Gonads and Gametes, p. 483	■ Using a microscope to observe prepared slides of ovarian and testicular tissues ■ Distinguishing and identifying ovarian and testicular structures
Thought Lab 14.1: STIs: What To Know and How To Know It, p. 491	■ Planning a strategy to effectively communicate information about sexually transmitted infections to a teenage audience ■ Working cooperatively to research and communicate findings about damage to the reproductive systems caused by STIs
Thought Lab 14.2: Testosterone and Male Development, p. 494	■ Analyzing blood hormone data and physiological events for a human male ■ Inferring the roles of male sex hormones ■ Selecting and using an appropriate mode of representation to communicate ideas and information about sex hormone levels
Thought Lab 14.3: Development of the Corpus Luteum, p. 497	■ Identifying structures within the ovary from a diagram
Thought Lab 14.4: Therapy Options for Menopause, p. 499	■ Identifying physiological and ethical concerns about the medical use of reproductive hormones ■ Researching and assessing the medical use of reproductive hormones and their effects
Investigation 14.B: The Menstrual Cycle, p. 500	■ Graphing changes in blood hormone levels through a single menstrual cycle ■ Analyzing blood hormone data and physiological events for a single menstrual cycle ■ Inferring the roles of female sex hormones ■ Selecting and using an appropriate mode of representation to communicate ideas and information about sex hormone levels
Chapter 15: Human Development	
Launch Lab: Visualizing Early Human Development, p. 507	■ Analyzing data on the growth of a human embryo during the first 56 days ■ Predicting changes in an embryo for the remaining 7 months ■ Predicting the effect of substances consumed by the mother during gestation

Activities and Related Target Skills

Activity	Target Skills
Investigation 15.A: Comparing Embryonic Structures, p. 519	■ Observing changes during embryo development ■ Comparing extra-embryonic membranes of human and chicken embryos
Thought Lab 15.1: Folic Acid and Neural Tube Defects, p. 524	■ Investigating the effects of folic acid on embryonic and fetal development ■ Discussing the societal impact of folic acid consumption on fetal development
Thought Lab 15.2: Evaluating Reproductive Technologies: Safety and Effectiveness, p. 533	■ Evaluating, from published data, the effectiveness and safety of various reproductive technologies ■ Justifying, through the use of clear and logical arguments, a decision about the effectiveness and safety of reproductive technologies

Conceptual Challenges

- Students may consider this unit to be "the one on sex education." You may wish to point out that while the unit covers the mechanics and biology of human sexual reproduction, it does not cover the emotional and social aspects that must also be taken into consideration.

Chapter 14

- The menstrual cycle and negative feedback loops can be challenging for students. Figures 14.13 and 14.15 illustrate the hormonal control of the male (14.13) and female (14.15) reproductive systems. Both of these illustrations have been converted into overheads for classroom teaching (BLMs 14.3.1A and 14.3.3A); versions with the labels removed have also been provided for use as a reinforcement tool (BLMs 14.3.1 and 14.3.3). Investigation 14.B looks at the effect of hormones on the menstrual cycle.

Chapter 15

- Students need to understand that the development of organs happens very, very early in the first trimester. The Launch Lab is designed to highlight this information, and it is the subject of Section 15.1: Fertilization and Embryonic Development.
- The effect of teratogens is introduced in Section 15.2. Students need to make the connection between this information and their knowledge of events in the first eight weeks after conception when the mother may not be aware of the pregnancy.
- Students' decision-making skills need to be applied in this unit. Thought Lab 15.1: Folic Acid and Neural Tube Defects (p. 524), the Connections feature on Stem Cells (p. 527), and Thought Lab 15.2: Evaluating Reproductive Technologies: Safety and Effectiveness (p. 533) provide opportunities for students to evaluate points of view and form an opinion.
- Figure 15.14 (p. 523) provides an opportunity to review positive feedback loop, this time in connection with the birthing process. Again, the illustration has been provided both as an overhead (BLM 15.2.3A) and as a reinforcement tool for labelling and writing up a description of the process (BLM 15.2.3).

Using the Unit 6 Opener and Unit 6 Preparation Feature

Student Textbook pages 472-475

This unit deals with more than the biological details of reproduction. Students will also be considering the impact of environmental factors on human reproduction, as well as the social and ethical considerations surrounding technological intervention in human reproduction.

- Have the students read the Unit Opener and consider the Focussing Questions. Question 1 will briefly focus attention on the fact that the human body is constantly changing; question 2 will draw attention to one of the key topics in the unit, and students can use their knowledge from the previous unit to begin to answer it. Question 3 could be used to explore some of the cultural issues that students think are important.
- The advent of the birth control pill is now a historical example of the impact of reproductive technologies—students likely take the ability to delay, plan for, or avoid conception for granted. The impact of this change on the role of women in Western society could be the brief focus of a discussion of the impact of reproductive technology.
- The Unit Preparation feature includes a brief review of the endocrine system. **BLM 14.0.1 Principal Endocrine Hormones** can be used as an overhead or a handout to remind students of the system as a whole and highlight the hormones specifically involved in reproduction. Encourage students to take the Unit Prequiz (found at **www.albertabiology.ca,** Online Learning Centre, Student Edition) to gauge their recall, noting that if they are familiar with the background science, their experience with this unit will be much easier.

UNIT 6: COURSE MATERIALS

Chapter, Section	Item Description	Suggested Quantity	Text Activity
Chapter 14, Section 14.1	blank paper prepared slides of testicular tissue prepared slides of ovarian tissue microscope pencil	1 piece per student 1 per student 1 per student 1 per student 1 per student	Investigation 14.A: Examining Gonads and Gametes, p. 483
Chapter 15, Section 15.1	prepared slides showing stages of development of an animal from zygote to embryo (e.g., sea star or sea urchin) microscope or microviewer	40 slides 1 per student	Investigation 15.A: Comparing Embryonic Structures, p. 519

CHAPTER 14 THE CONTINUANCE OF HUMAN LIFE

Curriculum Correlation

General Outcome 1: Students will explain how survival of the human species is ensured through reproduction.

	Student Textbook	Assessment Options
Outcomes for Knowledge		
30–B1.1k identify the structures in the female reproductive system and describe their functions, i.e., ovaries, Fallopian tubes, uterus, cervix, vagina, endometrium, fimbriae	**Launch Lab: Inside Story, p. 477** **Section 14.1: Structures and Functions of the Female Reproductive System, p. 481** *The Ovaries, p. 482* **The Uterus and Vagina, p. 482**	**Launch Lab, Analysis, p. 477** **Questions for Comprehension: 7–10, p. 484** **Section 14.1 Review: 1, 2, 4, 6, p. 485** **Chapter 14 Review: 1, 2 (b, d–f), 3, 8, p. 504** **Chapter 14 Test** Unit 6 Review: 1, 2, 7, 8, p. 540
30–B1.2k identify the structures in the male reproductive system and describe their functions, i.e., testes, seminiferous tubules, interstitial cells, Sertoli cells, epididymides, vasa (ductus) deferentia, Cowper's glands, seminal vesicles, prostate gland, ejaculatory duct, urethra, penis	**Launch Lab: Inside Story, p. 477** **Section 14.1: Structures and Functions of the Male Reproductive System, p. 478** **The Testes, p. 479** **The Penis, p. 480** **Seminal Fluid, p. 481**	**Launch Lab, Analysis, p. 477** **Questions for Comprehension: 2–6, p. 481** **Section 14.1 Review: 1–3, 5, 8, p. 485** **Chapter 14 Review: 1, 2 (a, c), 3, 4, p. 504** **Chapter 14 Test** Unit 6 Review: 1, 2, 6–9, p. 540
30–B1.3k distinguish egg and sperm from their supporting structures, i.e., seminiferous tubules, interstitial cells, Sertoli cells, follicle, corpus luteum	**Section 14.1: Differences between Sperm Cells and Egg Cells, p. 484**	**Questions for Comprehension: 2–4, 6, p. 481** **Section 14.1 Review: 7, 485** **Chapter 14 Review: 3, 4, 11, 18, pp. 504–505** **Chapter 14 Test** Unit 6 Review: 3, 6–8, 16–18, 26, 34, pp. 540–541
30–B1.4k describe the chromosomal factors and hormonal influence in the formation of the gonads and reproductive organs in the female and male embryo and fetus, i.e., Y chromosome and role of testosterone	**Section 14.3: Hormonal Regulation of the Reproductive System (Section Opener), p. 492**	**Questions for Comprehension: 18, p. 492** **Chapter 14 Test** Unit 6 Review: 3, 25, 30, pp. 540–541
30–B1.5k explain how sexually transmitted diseases can interfere with fertility and reproduction, e.g., *chlamydia, gonorrhea, human papilloma virus*	**Throughout Section 14.2, pp. 486–490** **Thought Lab 14.1: STIs: What To Know and How To Know It, p. 491**	**Questions for Comprehension:** **11–13, p. 487** **14–16, p. 488** **17, p. 490** **Thought Lab 14.1** **Analysis, Extension, p. 491** **Section 14.2 Review: 1–6, p. 491** **Chapter 14 Review: 5–6, 17, 19, pp. 504–505** **Chapter 14 Test** Unit 6 Review: 19, p. 541

	Student Textbook	Assessment Options
Outcomes for Science, Technology, and Society (Emphasis on social and environmental contexts)		
30–B1.1sts explain that decisions regarding the use of scientific and technological developments involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations by ■ *evaluating the implications of reproductive technology for human biology* ■ discussing society's expectations of the scientific community with respect to reproductive technology	**e.g., Thought Lab 14.4: Therapy Options for Menopause, p. 499** **Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538** **e.g., Thought Lab 14.1: STIs: What To Know and How To Know It, p. 491** **Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538**	**e.g., Thought Lab, p. 499** **Career Focus, 1–3, p. 538** **e.g., Thought Lab 14.1: STIs: What To Know and How To Know It, p. 491** **Section 14.2 Review: 6, p. 491** **Career Focus, 1–3, p. 538** Unit 6 Review: 44, p. 542
■ *discussing the impact of sexually transmitted diseases on an individual, considering the physiological damage they cause*	**Section 14.2: Controlling the Spread of STIs in Canada, p. 490** **Thought Lab 14.1: STIs: What To Know and How To Know It, p. 491** Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538	**Thought Lab 14.1: Analysis, Extension, p. 491** **Section 14.2 Review: 1–6, p. 491** Career Focus, 2, p. 538
Skill Outcomes (Focus on decision making)		
Initiating and Planning		
30–B1.1s ask questions about observed relationships and plan investigations of questions, ideas, problems and issues by ■ *identifying ethical concerns about, e.g.,* ■ *reproductive technologies* ■ *infertility* ■ *spread of STDs.*	**Thought Lab 14.1: STIs: What To Know and How To Know It, p. 491**	**Thought Lab 14.1: Analysis, Extension, p. 491**
Performing and Recording		
30–B1.2s conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information by ■ observing the principal features of the human reproductive system using models or computer simulations, and identifying the major structures from drawings	**Throughout Section 14.1, pp. 478–485** **Investigation 14.A: Examining Gonads and Gametes, p. 483**	**Investigation 14.A: Analysis, Conclusion, p. 483** **Section 14.1 Review: 6, p. 485** Unit 6 Review: 7, p. 540
■ using a microscope to observe prepared slides of ovaries and testes so as to distinguish eggs and sperm from their supporting structures, i.e., follicle, corpus luteum, seminiferous tubules, interstitial cells, Sertoli cells	**Investigation 14.A: Examining Gonads and Gametes, p. 483**	**Investigation 14.A: Analysis, Conclusion, p. 483**

	Student Textbook	Assessment Options
Analyzing and Interpreting		
30–B1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions by ■ evaluating practical solutions to decreased fertility, i.e., low sperm count, difficulty in egg production, hormonal imbalance by ■ *evaluating information collected from library and electronic sources on the implications of reproductive technologies, e.g., surrogate mothers, sperm banks, cloning*	**Investigation 14.B: The Menstrual Cycle, p. 500** **Connections—Endocrine Disruptors in the Environment, p. 501**	**Investigation 14.B: The Menstrual Cycle, Analysis, p. 500** **Section 14.1 Review: 8, p. 485** **Chapter 14 Review: 16, p. 504** Unit 6 Review: 39, p. 542
Communication and Teamwork		
30–B1.4s work as members of a team in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results by ■ working cooperatively as a team to research the physiological and physical damage to reproductive organs caused by exposure to sexually transmitted disease organisms and, using appropriate multimedia, present the findings to the class	**Thought Lab 14.1: STIs: What To Know and How To Know It, p. 491**	**Thought Lab 14.1: Analysis, Extension, p. 491**

General Outcome 2: Students will explain how human reproduction is regulated by chemical control systems

NOTE: The curriculum correlation for this outcome covers two chapters. The references for Chapter 14 are in boldface.

	Student Textbook	Assessment Options
Outcomes for Knowledge		
30–B2.1k describe the role of hormones (gonadotropic-releasing hormone (GnRH), FSH, LH, estrogen, progesterone, testosterone, inhibin) in the regulation of primary and secondary sex characteristics in females and males	**Section 14.1: The Male and Female Reproductive Systems (Section Opener), p. 478** **Section 14.3: Hormonal Regulation of the Reproductive System (Section Opener), p. 492**	**Questions for Comprehension: 1, p. 478** **Section 14.3 Review: 1, p. 502** **Chapter 14 Test** Unit 6 Review: 10, p. 540
30–B2.2k identify the principal reproductive hormones in the female and explain their interactions in the maintenance of the menstrual cycle, i.e., estrogen, progesterone, luteinizing hormone (LH), follicle-stimulating hormone (FSH)	**Section 14.3: Sex Hormones and the Female Reproductive System, p. 495** **Hormonal Regulation of the Female Reproductive System, p. 495** **The Ovarian Cycle, p. 496** **The Uterine Cycle, p. 498** **Aging and the Menstrual Cycle, p. 498** **Thought Lab 14.3: Development of the Corpus Luteum, p. 497** **Investigation 14.B: The Menstrual Cycle, p. 500** **Connections: Social and Environmental Contexts: Endocrine Disruptors in the Environment, p. 501**	**Questions for Comprehension: 20, p. 495 21–24, p. 498** **Thought Lab 14.3: Analysis, Extension, p. 497** **Investigation 14.B: Analysis, Conclusion, p. 500** **Connections, p. 501** **Section 14.3 Review: 3, 4, 6, p. 502** **Chapter 14 Review: 7–10, 12, 13, 15, 16, 20, pp. 504–505** **Chapter 14 Test** Unit 6 Review: 5, 11, 21, 23, 24, 28, 43, pp. 540–542

	Student Textbook	Assessment Options
30–B2.3k identify the principal reproductive hormones in the male and explain their interactions in the maintenance and functioning of the male reproductive system, i.e., testosterone, luteinizing hormone (LH), follicle-stimulating hormone (FSH)	**Section 14.3: Sex Hormones and the Male Reproductive System, p. 492** **Maturation of the Male Reproductive System, p. 493** **Hormonal Regulation of the Male Reproductive System, p. 493** **Aging and the Male Reproductive System, p. 495** **Thought Lab 14.2: Testosterone and Male Development, p. 494** **Connections: Social and Environmental Contexts: Endocrine Disruptors in the Environment, p. 501**	**Questions for Comprehension: 19, p. 495** **Thought Lab 14.2: Testosterone and Male Development, Analysis, p. 494** **Connections, p. 501** **Section 14.3 Review: 2, 3, 5, 8, p. 502** **Chapter 14 Review: 12, 14, 21, pp. 504–505** **Chapter 14 Test** Unit 6 Review: 12, 37, 43, pp. 540–542
Outcomes for Science, Technology, and Society (Emphasis on social and environmental contexts)		
30–B2.1sts explain how science and technology are influenced and supported by society and have influenced, and been influenced by, historical development and societal needs by ■ *researching and assessing the effects of the medical use of reproductive hormones on humans*	Section 15.3 Hormone Treatments, p. 531 e.g., Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538	Section 15.3 Review: 2, p. 534 e.g., Career Focus, 1–3, p. 539 Chapter 15 Review: 22, p. 536 Unit 6 Review: 22, 49, 50 p. 541–543
■ *researching and assessing the implications for humans of producing and using reproductive hormones in domestic animals, e.g., cattle and horses*	**e.g., Thought Lab 14.2: Testosterone and Male Development, p. 494** **e.g., Thought Lab 14.4: Therapy Options for Menopause, p. 499** e.g., Connections (Social and Environmental Contexts): Stem Cells, p. 527	**e.g., Thought Lab 14.2, Analysis, p. 494** **e.g., Thought Lab 14.4, Analysis, p. 499** e.g., Connections, Questions, p. 527
30–B2.2sts explain why decisions regarding the use of scientific and technological developments involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations by ■ *explaining how reproductive hormone homeostasis is disrupted by the natural aging process and whether available technologies should be used to restore balance; e.g., hormone treatment for menopause and andropause*	**Section 14.3: Aging and the Menstrual Cycle, p. 498** **Thought Lab 14.4: Therapy Options for Menopause, p. 499** Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538	**Thought Lab 14.4: Analysis, p. 499** Career Focus, 1–3, p. 538
Skill Outcomes (Focus on decision making)		
Initiating and Planning		
30–B2.1s ask questions about observed relationships and plan investigations of questions, ideas, problems and issues, e.g., by ■ *designing an investigation to determine at which point during the menstrual cycle a female is most fertile*	**Investigation 14.B: The Menstrual Cycle, p. 500**	**Investigation 14.B: Analysis, Conclusion, p. 500**

	Student Textbook	Assessment Options
Performing and Recording		
30–B2.2s conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information by ■ graphing the changes in estrogen, progesterone, LH and FSH levels in the blood of a female through a single menstrual cycle	**Investigation 14.B: The Menstrual Cycle, p. 500**	**Investigation 14.B: Analysis, Conclusion, p. 500** **Section 14.3 Review: 4, p. 502** **Chapter 14 Review: 10, p. 504**
■ using models, diagrams or computer simulations, identifying the follicle and corpus luteum within the ovary	**Thought Lab 14.3: Development of the Corpus Luteum, p. 497** **Investigation 14.B: The Menstrual Cycle, p. 500**	**Thought Lab 14.3: Analysis, Extension p. 497** **Investigation 14.B: Analysis, Conclusion, p. 500**
Analyzing and Interpreting		
30–B2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions by ■ analyzing blood hormone data and physiological events for a single menstrual cycle, inferring the roles of female sex hormones	**Investigation 14.B: The Menstrual Cycle, p. 500**	**Investigation 14.B: Analysis, Conclusion, p. 500** **Section 14.3 Review: 4, p. 502** **Chapter 14 Review: 10, p. 504**
■ analyzing blood hormone data and physiological events, inferring the roles of male sex hormones	**Thought Lab 14.2: Testosterone and Male Development, p. 494**	**Thought Lab 14.2: Analysis, p. 494** **Section 14.3 Review: 5, p. 502**
■ *researching and assessing the effects of the medical use of reproductive hormones, e.g., menopause, andropause, infertility*	**Aging and the Menstrual Cycle, p. 498** **Thought Lab 14.4: Therapy Options for Menopause, p. 499** Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533	**Thought Lab 14.4: Analysis, p. 499** Thought Lab 15.2, p. 533 Section 15.3 Review: 2, p. 534
Communication and Teamwork		
30–B2.4s work as members of a team in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results by ■ selecting and using appropriate numerical and graphical modes of representation to communicate information on changing reproductive hormone levels in the blood	**Thought Lab 14.2: Testosterone and Male Development, p. 494** **Investigation 14.B: The Menstrual Cycle, p. 500**	**Thought Lab 14.2: Analysis, p. 494** **Investigation 14.B: Analysis, Conclusion, p. 500** **Section 14.3 Review: 4, 7, p. 502** **Chapter 14 Review: 10, 16, p. 504** Unit 6 Review: 46–51, p. 543
■ *working cooperatively with team members to investigate the value of producing and using reproductive hormones in domestic animals and, using the appropriate multimedia, present the information to the class*	**e.g., Thought Lab 14.2: Testosterone and Male Development, p. 494** **e.g., Thought Lab 14.4: Therapy Options for Menopause, p. 499** e.g., Connections (Social and Environmental Contexts): Stem Cells, Section 15.2, p. 527	**e.g., Thought Lab 14.2, Analysis, p. 494** **e.g., Thought Lab 14.4, Analysis, p. 499** e.g., Connections, Questions, p. 527

General Outcome 3 [selected correlation]: *Students will* explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors.

	Student Textbook	Assessment Options
Skill Outcomes		
Analyzing and Interpreting		
30–B3.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions by ■ observing the changes during embryo development, using preserved material such as chicken embryos, prepared slides, models or computer simulations, and extrapolating these events to the development of a human	Investigation 15.A: Comparing Embryonic Structures, p. 519	Investigation 15.A: Analysis, p. 519
■ evaluating, from published data, the effectiveness and safety of various reproductive technologies	Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533	Thought Lab 15.2, p. 533
■ interpreting hormonal data from published investigations, e.g., *pregnancy testing*	Section 14.3: The Ovarian Cycle, p. 496 The Uterine Cycle, p. 498 *Aging and the Menstrual Cycle, p. 498* Thought Lab 14.2: Testosterone and Male Development, p. 494 Thought Lab 14.4: Therapy Options for Menopause, p. 495 *Investigation 14.B: The Menstrual Cycle, p. 500*	Thought Lab 14.2, p. 494 Thought Lab 14.4, p. 495 *Investigation 14.B: Analysis, Conclusion, p. 500* Chapter 14 Review: 10, 16, p. 504 Unit 6 Review: 46–51, p. 543
■ *analyzing the stages of embryo development*	Chapter 15 Launch Lab: Visualizing Early Human Development, p. 507 Investigation 15.A: Comparing Embryonic Structures, p. 519	Chapter 15 Launch Lab: Analysis, p. 507 Investigation 15.A: Analysis, p. 519

Chapter 14

The Continuance of Human Life

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Chapter Concepts

14.1 The Male and Female Reproductive Systems

- The male and female reproductive systems have features in common as well as features that distinguish one from the other.
- The reproductive cells (gametes) in males are sperm and in females are eggs (ova).

14.2 The Effect of Sexually Transmitted Infections on the Reproductive Systems

- Sexually transmitted infections may be caused by a variety of organisms, including bacteria and viruses.
- Sexually transmitted infections can harm the health of individuals as well as interfere with the proper functioning of egg and sperm cells.

14.3 Hormonal Regulation of the Reproductive Systems

- Hormonal as well as genetic (chromosomal) factors affect the formation of the gonads and reproductive organs during prenatal (pre-birth) development.
- Sex hormones help in the maintenance and function of male and female reproductive systems.

Common Misconceptions

- Many students do not realize how much fertility depends on the age and health of the partners. Fertility refers to the percentage of eggs produced that can develop into living young. While it is true that females are only fertile at certain times during a given year, younger females and males consistently produce a very high percentage of viable eggs and sperm and are therefore more likely to conceive a child than older partners are.
- While the ovum is only viable for up to 24 hours, sperm can live for a much longer period of time (3 days or more), increasing the likelihood of conception.
- Most students do not consider themselves to be vulnerable to an STI. They may believe that some STIs, such as gonorrhea, have been eradicated or are easily cured. They may not realize how many STIs are transmitted through means other than intercourse. They may also not understand that since most of the reproductive organs are inside the body, the symptoms are not often immediately apparent and serious damage can be done before an infection is detected.
- Some may believe that the AIDS epidemic has peaked and new cases are decreasing. This is untrue. New HIV infections and the number of AIDS cases are still on the rise.
- Students may be surprised to hear that the adrenal glands in females produce a type of testosterone, which is converted into estrogen after menopause, courtesy of an enzyme from the liver. Female bodies require healthy levels of testosterone throughout life to help maintain muscle and bone mass, among other things. Males, on the other hand, produce some estrogen, and their level of this hormone tends to increase as they age.
- Students almost always believe sexual reproduction involves mating; they do not understand there are other methods of sexual reproduction other than the mammalian. For example, plants can provide a very different approach to sexual reproduction, as do fish via external fertilization, which students will see in the Launch Lab.

Helpful Resources

Books and Journal Articles

- *From Conception to Birth: A Life Unfolds*, Alexander Tsiaras, (Doubleday, 2002).
- *Senior Biology Teacher Resource,* (Biozone International, Hamilton, New Zealand, CD-ROM, ISBN 1-877329-50-9, August 2005.)
- "Spermatogenesis," *Biological Sciences Review*, 15(4), April 2003, pp. 10-14, University of Manchester, School of Biological Sciences.

Web Sites

- Web links related to this chapter can be found at **www.albertabiology.ca**. Go to the Online Learning Centre, and log on to the Instructor Edition. Choose Teacher Web Links.
- Cable channels, such as TLC, CLT, Discovery Health, PBS, and Life, produce many excellent series and specials on human reproduction.

List of BLMs

Blackline masters (BLMs) have been prepared to support the material in this chapter. The BLMs are either for assessment (AST); use as overheads (OH); use as handouts (HAND), in particular to support activities; or to supply answers (ANS) for assessment or handouts. The BLMs are in digital form, stored on the CD that accompanies this Teacher's Resource or on the web site at **www.albertabiology.ca**, Online Learning Centre, Instructor Edition, BLMs.

Number (Type)

14.0.1 (OH/HAND) Principal Endocrine Hormones
14.0.2 (HAND) Launch Lab: Inside Story
14.0.2A (ANS) Launch Lab: Inside Story Answer Key
14.1.1 (HAND) Structure of the Male Reproductive System
14.1.1A (ANS/OH) Structure of the Male Reproductive System Answer Key
14.1.2 (HAND) Human Testis and Sperm

14.1.2A (ANS/OH) Human Testis and Sperm Answer Key
14.1.3 (HAND) Structures of the Female Reproductive System
14.1.3A (ANS/OH) Structures of the Female Reproductive System Answer Key
14.1.4 (HAND) Investigation 14.A: Examining Gonads and Gametes
14.1.4A (ANS) Investigation 14.A: Examining Gonads and Gametes Answer Key
14.1.5 (HAND) Comparing Sperm Cells and Egg Cells
14.1.5A (ANS) Comparing Sperm Cells and Egg Cells Answer Key

14.2.1 (HAND) Rates of STI Infection in Alberta
14.2.1A (ANS) Rates of STI Infection in Alberta Answer Key
14.2.2 (HAND) Thought Lab 14.1: STIs: What to Know and How to Know It
14.2.2A (ANS) Thought Lab 14.1: STIs: What to Know and How to Know It Answer Key

14.3.1 (HAND) Hormonal Control of Male Reproductive System
14.3.1A (ANS/OH) Hormonal Control of Male Reproductive System Answer Key
14.3.2 (HAND) Thought Lab 14.2: Testosterone and Male Development
14.3.2A (ANS) Thought Lab 14.2: Testosterone and Male Development Answer Key
14.3.3 (HAND) Hormonal Control of the Ovarian Cycle
14.3.3A (ANS/OH) Hormonal Control of the Ovarian Cycle Answer Key
14.3.4 (HAND/OH) Key Reproductive Hormones and Their Functions
14.3.5 (HAND) The Ovarian Cycle
14.3.5A (ANS/OH) The Ovarian Cycle Answer Key
14.3.6 (HAND) Thought Lab 14.3: Development of the Corpus Luteum
14.3.6A (ANS) Thought Lab 14.3: Development of the Corpus Luteum Answer Key
14.3.7 (HAND) Thought Lab 14.4: Therapy Options for Menopause
14.3.7A (ANS) Thought Lab 14.4: Therapy Options for Menopause Answer Key
14.3.8 (HAND) Investigation 14.B: The Menstrual Cycle
14.3.8A (ANS) Investigation 14.B: The Menstrual Cycle Answer Key
14.3.9 (OH) Hormone Levels Through the Menstrual Cycle

14.4.1 (AST) Chapter 14 Test
14.4.1A (ANS) Chapter 14 Test Answer Key

Using the Chapter 14 Opener

Student Textbook pages 476-477

- With a diameter of around 100 micrometres, the human egg is one of the largest cells in the body. It is barely visible to the human eye. In comparison, a chicken egg is 300 times larger.

Teaching Strategies

- Different reproductive strategies, e.g., the ability to reproduce at any time of the year vs. the ability to reproduce many offspring at only one time of the year, give each species a different biological advantage in the quest for survival. This paragraph and the Launch Lab should direct thinking to the consideration of reproduction and survival, a theme begun in the Unit opener.
- The inset photo and caption could be used to explore the idea that many cultural and social taboos around the subject of human sexuality and reproduction can be traced to the desire to ensure the survival of certain population groups.

Launch Lab: Inside Story

Student Textbook page 477

Purpose

Students will begin thinking about reproductive strategies and how human reproductive strategies compare with other methods used in the animal kingdom, for example, the salmon.

Outcomes

- B1.1s

Advance Preparation

When to Begin	What to Do
1 day before	■ Photocopy **BLM 14.0.2 Launch Lab: Inside Story**

Time Required

20 minutes

Helpful Tips

- Discuss various reproductive and mating strategies of different species. For example: Male seahorses (a fish) incubate the fertilized embryos. The female deposits the eggs into the male's pouch on the abdomen; the male releases sperm into its pouch, and the embryos develop in the male's pouch. The male gives birth to the tiny seahorses. For more examples, visit **www.albertabiology.ca**, Online Learning Centre, Instructor Edition.
- Use **BLM 14.0.2 Launch Lab: Inside Story** to support this activity. Modify as necessary.

Answers to Procedure Questions

1. Table comparing salmon and human reproductive strategies.

Salmon Reproductive Strategies	Human Reproductive Strategies
■ reproduce in the fall ■ female lays eggs ■ 500-2500 eggs released at once ■ fertilization outside of the body ■ eggs develop over the winter, in water; gestation period is 3 months	■ can reproduce any time of the year ■ female egg remains in the body ■ 1 egg released at a time ■ fertilization and gestation inside the female reproductive system ■ gestation period is 9 months

2. Answers can include the following points: both species require organs to produce gametes and hormones to control the release of these gametes. The differences can reflect the fact that salmon do not nurture their young and humans do. Female salmon will not require a uterus because they are simply releasing eggs; human females require a uterus because they are nurturing the egg as well. Human males require a penis to deliver the sperm inside the female reproductive system; male salmon need only to release the sperm close to the eggs. Encourage students to think about the structure and the function of the organs and their associated systems.

Answers to Analysis Questions

1. An advantage of fetal development taking place inside the body is that the fetus is (typically) nourished by the parent; there is less of a risk of being preyed upon than if the embryo is outside the body. Disadvantages of this strategy include: increased stress on the female, risk of injury or death during the birthing process, and a limitation of the number of offspring.

2. It would not be expected for male salmon to have an external penis because the salmon does not deliver its sperm into the female; sperm is simply released, through an opening in front of the anal fin, over hundreds of eggs in the stream bed for external fertilization.

3. A female salmon would not be expected to have a uterus because the fertilized eggs develop and hatch outside of the female's body.

4. Human sperm are not only much smaller than the egg, they have a tail-like structure, so students should be reminded that they move. Based on their familiarity with hen eggs, students might infer that an egg is larger because it might have to store nutrients for the life that develops inside it. Note: The female egg is the largest cell in the human body. One adaptive advantage of motile sperm and immobile eggs is that the sperm are better able to find and penetrate the egg.

Assessment Options

- Collect and assess students' graphic organizers, tables, and answers to Analysis questions to gauge students' understanding and recall of basic reproductive processes.

14.1 The Male and Female Reproductive Systems

Student Textbook pages 478-485

Section Outcomes

Students will:

- examine the principal features of the human reproductive system
- identify male and female reproductive structures and describe their functions
- observe prepared slides of ovaries and testes, and distinguish gametes from their supporting structures in each of these organs

Key Terms

gonads
sex hormones
primary sex characteristics
secondary sex characteristics
sperm cells
testes
scrotum
seminiferous tubules
Sertoli cells
epididymis
ductus deferens
ejaculatory duct
penis
seminal vesicles
prostate gland
Cowper's gland
semen
urethra
ejaculation
ovaries
ova
follicle
ovulation
fimbriae
oviduct
uterus
endometrium
cervix
vagina
menstruation
vulva

Biology Background

- Sexual reproduction is necessary in order for a species to create and maintain genetic variability. Asexual reproduction simply results in more identical individuals, while sexual reproduction generates an entirely new combination of genes in every new individual (other than identical twins).
- Male and female reproductive organs produce gametes in the form of sperm and eggs and provide an ideal environment for the fusion of the two and the development of the embryo and fetus.
- The male reproductive system is designed to produce millions of sperm on a daily basis. Spermatogenesis (introduced briefly in this chapter and covered in detail in Chapter 16) is controlled by hormonal and environmental factors. In females, the hormones promote oogenesis (Meiosis II) within the ovaries to release a mature ovum.
- Sex chromosomes direct the development of primary sex characteristics in males and females. The male developing embryo has the XY chromosome arrangement that begins the creation of the male reproductive tract along the genital ridge during development. The female embryo has the XX chromosome arrangement that will develop the female reproductive tract on the genital ridge during development.

Teaching Strategies

- Students will know, think they know, or want everyone to believe they know all about human reproduction. Rather than highlighting anyone's state of ignorance, simply acknowledge that they know the basic mechanics of reproduction and note that they are about to study the biology behind the mechanics.
- Refer students to page 75 (Unit 2 Preparation) for a simple overview of the differences between mitosis and meiosis. Ensure that the students understand that meiosis creates haploid gametes within humans. **BLM 3.0.1 Meiosis and Mitosis: A Comparison** could be revisited, as an overhead or a handout.
- Use the Questions for Comprehension to help students review the information about the functions of the reproductive systems.
- Have the students create their own charts for the male and female reproductive systems, naming each structure and then describing its function in the second column.
- A number of overhead masters and reinforcement activities have been prepared for this section. In particular, art illustrating the various structures and processes are available in BLM format for use in labelling structures and tracing and/or describing processes. You will find them with the Chapter 14 BLMs on the CD that accompanies this Teacher's Resource or at **www.albertabiology.ca**, Online Learning Centre, Instructor Edition, BLMs.

  Number (Type)
  14.1.1 (HAND) Structure of the Male Reproductive System
  14.1.1A (ANS/OH) Structure of the Male Reproductive System Answer Key
  14.1.2 (HAND) Human Testis and Sperm
  14.1.2A (ANS/OH) Human Testis and Sperm Answer Key
  14.1.3 (HAND) Structures of the Female Reproductive System
  14.1.3A (ANS/OH) Structures of the Female Reproductive System Answer Key
  14.1.4 (HAND) Investigation 14.A: Examining Gonads and Gametes
  14.1.4A (ANS) Investigation 14.A: Examining Gonads and Gametes Answer Key
  14.1.5 (HAND) Comparing Sperm Cells and Egg Cells
  14.1.5A (ANS) Comparing Sperm Cells and Egg Cells Answer Key

SUPPORTING DIVERSE STUDENT NEEDS

- All Students: Consider pairing or grouping students based on their particular needs, whether they be strengthening language skills or consolidating conceptual understanding. Pairs or groups should be same-sex, and if you have students with particular cultural or faith-based sensitivities, they should be together in same-sex groups.
- Allow use of computers for written assignments and graphic organizers.
- Provide students with notes ahead of time so that they can follow them while you teach the chapter.

Answers to Questions for Comprehension

Student Textbook page 478

Q1. Primary sex characteristics are structures that have a direct role in reproduction, and these include the gonads (ovaries and testes), the penis, and the vagina. Secondary sex characteristics such as facial hair, muscle development in men and prominent breasts in women are structures that are not directly related to reproductive function.

Student Textbook page 481

Q2. The paragraph, graphic organizer (e.g. flow chart), or diagram should indicate the following: the *scrotum* contains the *testes,* which contain the *seminiferous tubules* (long coiled tubes) where the sperm is produced and nurtured by the Sertoli cells. Sperm are transported to the *epididymis*, where they mature and become motile. Sperm then move to the storage duct known as the *ductus deferens* (or vas deferens) awaiting transport to the penis.

Q3. The interstitial cells are hormone-secreting cells that lie between the seminiferous tubules. Sertoli cells are inside the seminiferous tubules, where they nourish the sperm cells.

Q4. Seminiferous tubules → epididymis → ductus deferens → urethra.

Q5. The acrosome is a cap-like structure that covers the head of the sperm and contains the enzymes needed to penetrate the protective membrane surrounding the ovum. Without these enzymes, the sperm would not be able to penetrate and fertilize the egg.

Q6. *seminal vesicles*: contribute mucus-like fluid containing fructose; *prostate gland*: contributes alkaline and mucus-like fluids; *Cowper's gland*: contributes alkaline and mucus-like fluids

Investigation 14.A: Examining Gonads and Gametes

Student Textbook page 483

Purpose

Students will observe, compare, and distinguish between testicular and ovarian tissue and structures.

Outcomes

- B1.2s

Advance Preparation

When to Begin	What to Do
1 day before	■ Locate prepared slides of ovarian and testicular tissue ■ Photocopy **BLM 14.5: Investigation 14.A: Examining Gonads and Gametes**

Materials
■ blank paper ■ prepared slides (ovarian and testicular tissue) ■ microscopes ■ pencils

Time Required

- 45 minutes (25 minutes for observations and scientific drawings and 20 minutes for Analysis questions)

Helpful Tips

- Use **BLM 14.1.4 Investigation 14.A: Examining Gonads and Gametes** to support this activity. Modify it as necessary to meet the needs of your students. The answers can be found on **BLM 14.1.4A**.
- Refer students to Appendix D to review criteria for scientific drawings and scale drawings.
- Refer students to Appendix C to review safe handling and proper microscope technique.
- Show images of testicular and ovarian tissue and structures from an electron microscope. Links to examples of images can be found at **www.albertabiology.ca**, Online Learning Centre, Instructor Edition, Teacher Web Links.

Safety Precautions

Handle microscope slides with care and dispose of broken slides according to departmental procedure.

Answers to Analysis Questions

1. The number of sperm cells observed will be far greater than the number of ova that are visible in the tissue specimens.

2. The sperm cell is much smaller than any visible ova. Have students calculate the size of the cells they observed based on field of view and magnification used.

Answer to Conclusion Question

3. The large quantity and tiny size of the sperm cells enable a large number of them to attempt to penetrate the protective membrane around the ovum at any one time. This increases the chances of the motile sperm fertilizing an ovum.

Assessment Options

- Collect and assess students' drawings and answers to Analysis and Conclusion questions.

Answers to Questions for Comprehension

Student Textbook page 484

Q7. Fertilization takes place in the oviduct.

Q8. Both a fertilized ovum and an unfertilized ovum travel down the oviduct. A fertilized ovum will leave the oviduct and implant itself into the endometrium (lining in the uterus). An unfertilized ovum does not implant itself in the endometrium and will pass through the cervix and vagina.

Q9. The endometrium is the lining of the uterus. It is richly supplied with blood vessels that provide nutrients to support the implanted zygote as it develops from an embryo into a fetus.

Q10. Menstruation is the monthly shedding of the endometrium, including tissues and blood flow, if a fertilized egg has not implanted itself.

Section 14.1: Review Answers

Student Textbook page 485

1. The two main purposes of the gonads are to produce gametes and to secrete sex hormones.

2. (a) *fimbriae*: found in the female reproductive system; it is responsible for helping to move the ovum (released during ovulation) into the oviduct. It sweeps over the ovary and moves the ovum into the cilia-lined oviduct.

(b) *ductus deferens*: found in the male reproductive system; it is a storage duct responsible for storing and eventual transport of sperm to the urethra during ejaculation.

(c) *endometrium*: found in the female reproductive system; it is the uterine lining that will support an implanted embryo.

(d) *epididymis*: found in the male reproductive system, it stores the sperm during maturation and as they become motile. Once matured, the sperm move to the ductus deferens.

3. Sperm move out of the epididymis into the ductus deferens where they are mixed with various fluids to make semen. The seminal vesicles provide a mucus-like fluid containing fructose for energy; the prostate gland and Cowper's gland provide alkaline and mucus-like fluids that can neutralize the acids in the female reproductive tract. The combination of sperm and the fluids make up semen.

4. The ovum is moved from the ovary into the oviduct with the aid of the fimbriae, which are thread-like projections. As the egg moves down the oviduct it is aided by the beating of the cilia. This creates a current that moves the ovum towards the uterus.

5. The diagram needs to trace the sperm cells from the seminiferous tubules inside the testes to the epididymis, then on to the ductus deferens and urethra in the penis.

6. (a) an oocyte; **(b)** a follicle; **(c)** ovarian tissue.

7. The sperm is composed of three parts; a head, a mid-section, and a tail. The tail provides the motility required to move the sperm through the female reproductive tract; the tail is powered by a middle section that has mitochondria that can use the fructose provided by the seminal vesicles to make energy. The head section carries both the chromosomal material and the acrosome (a cap-like structure that contains the enzymes needed to penetrate the jelly-like layer surrounding the egg). The much larger, round ovum is covered by a specialized layer that only allows sperm with acrosome enzymes to penetrate. The egg has no structures to support motility, making it a more accessible target for the sperm, and its larger size makes it easier for the tiny sperm to attempt to fertilize it. The egg also contains cytoplasm and organelles to support the zygote as it makes its way into the uterus to implant itself in the endometrium.

8. By wearing looser pants, his scrotum will be further away from his body and at a temperature more conducive to the production of viable sperm—35 °C as opposed to the usual 37 °C. High temperatures can cause deformed sperm to mature, as well as decrease the number of sperm produced.

14.2 The Effect of Sexually Transmitted Infections on the Reproductive Systems

Student Textbook pages 486-491

Section Outcomes

Students will:

- identify the risks that sexually transmitted infections present to individuals and to human reproduction
- explain how sexually transmitted infections can interfere with the passage of eggs and sperm
- research the effects of sexually transmitted infections
- design and collaborate on a plan to communicate information about these infections, including their prevention and control, to young adults

Key Terms

sexually transmitted infection (STI)
AIDS
HIV
hepatitis
genital herpes
human papilloma virus (HPV)
chlamydia
pelvic inflammatory disease (PID)
gonorrhea
syphilis

Biology Background

- Diseases known as sexually transmitted infections (STIs) are transmitted through sexual contact. STIs can be caused by either viral or bacterial pathogens. The incidence of many of these diseases is on the rise. The age group of 15- to 25-year-olds tends to be at the highest risk for contracting STIs.
- Many STIs can permanently affect the reproductive tracts of males and females and may cause sterility. It is also possible for STIs to be transmitted to a fetus. The STI hepatitis B can cross the placenta and affect the developing child (as can other forms of hepatitis), whereas STIs such as genital herpes can be passed on during delivery through the birth canal. These STIs can cause permanent damage to organs such as the liver and affect the nervous system of the child, and in some cases, even cause death.

- Some types of STIs can be passed on through not only sexual intercourse but through oral sex. Herpes and gonnorhea are passed on through oral sex.

Teaching Strategies

- At the beginning of the unit, use a class discussion period to make a list on the board of the STIs that students have heard of. Add any covered in this section that they have missed. Ask the students which one they think is the most dangerous and which one they think is the most benign. Why do they believe that? Revisit the class's conclusions at the end of the unit to find out if they have changed their perceptions.
- Use **BLM 14.2.1 Rates of STI Infection in Alberta** to help students rate the chances of contracting an STI. Discuss whether the consequences of any of these infections make taking the risk of getting any of them (no matter how small) worth it. Have the class make a list of behaviours that increase the risk and those that decrease the risk of contracting an STI. (Table 14.5 Preventing Transmission of STIs on page 490 summarizes the strategies.)
- Ask students what they would advise if someone they know suspected they had contracted an STI. If possible, encourage a discussion about the best places to go for diagnosis and treatment. Who would they trust for treatment? What aspects of the treatment would be important to them?
- Before beginning Thought Lab 14.1: STIs: What to Know and How to Know It, ask students if they have seen any information about STIs in the local media. What form has the information been in? (news stories, information brochures, lectures, etc.) Ask students to rate the effectiveness of the information in terms of educating them about the diseases (type, transmission, symptoms, treatment etc.).
- Contact the local public health office and invite a guest speaker to lead an information session or discussion about the issues raised in the class discussion about STIs. Make a list of the questions and concerns that students have raised to present to the speaker.

SUPPORTING DIVERSE STUDENT NEEDS

- All Students: Consider pairing or grouping students based on their particular needs, whether they be for strengthening language skills or consolidating conceptual understanding. Pairs or groups should be same-sex, and if you have students with particular cultural or faith-based sensitivities, they should be together in same-sex groups.
- Gifted Students: Make arrangements for students who are finished Thought Lab 14.1 early to research the biochemical pathways of disease transmission for the STIs discussed in class.

Answers to Questions for Comprehension

Student Textbook page 487

Q11. HIV (human immunodeficiency virus) attacks the white blood cells known as helper T cells, which are the cells in the human immune system that signal the other immune cells to fight infections. (Refer to Section 8.3 of *Inquiry into Biology 20*, p. 292) With the immune system weakened in this way, the body of the infected person becomes vulnerable to a host of infections that it would have otherwise been able to overcome. When the helper T cell count drops to a certain level, the condition is classed as AIDS (acquired immunodeficiency syndrome), and the body is incapable of defending itself from opportunistic infections such as pneumonia or tuberculosis, which will eventually kill the infected person.

Q12. HIV is transmitted through the exchange bodily fluids. Methods of transmission include sexual contact and the sharing of needles. Mothers with HIV can pass the virus to their child during pregnancy, birth, or by breastfeeding.

Q13. Methods of Transmission of Hepatitis A, B, and C

Hepatitis A	Hepatitis B	Hepatitis C
■ drinking water that is contaminated with fecal matter ■ oral or anal sexual contact with an infected person	■ sexual contact with an infected person ■ contact with infected bodily fluids or blood	■ contact with infected needles or syringes ■ transfusions of infected blood

Student Textbook page 488

Q14. The most common symptoms of genital herpes infections are: discomfort caused by tingling or itching followed by blisters. Most common areas of infection are the genitals, buttocks, and thighs.

Q15. It is recommended that mothers with genital herpes give birth by Caesarian section to reduce the risk of infecting the baby as it passes through the birth canal. If the baby is infected, blindness, neurological disorders, or death can result.

Q16. People who are infected with HPV (human papilloma virus or genital warts) do not always display symptoms. This is particularly dangerous because the untreated infected individual may develop more serious disorders such as cervical cancer or other tumours. In addition, the infected person may unknowingly pass the virus to someone else who could develop complications or pass it further.

Student Textbook page 490

Q17. Causes and treatments for chlamydia, gonorrhea, and syphilis

Disease	Cause	Treatment
chlamydia	bacterium *Chlamydia trachomatis*	antibiotics
gonorrhea	bacterium *Neisseria gonorrhoeae*	antibiotics
syphilis	bacterium *Treponema pallidum*	antibiotics

Thought Lab 14.1: STIs: What to Know and How to Know It

Student Textbook page 491

Purpose

Students will improve their understanding of the risks and dangers of STIs by gathering information through print and electronic resources. They will then plan an effective method to communicate their findings about sexually transmitted infections to a teenage audience.

Outcomes

- B1.1s
- B1.4s
- B1.1sts

Advance Preparation

When to Begin	What to Do
1 month before	■ Ask students to begin collecting articles they see in the media about STIs ■ Collect health and teen magazines that include discussions of STIs
1 week before	■ Book the library and/or computer lab ■ Photocopy **BLM 14.2.2: Thought Lab 14.1: STIs: What to Know and How to Know It**

Materials
■ computers or library ■ print sources (magazines, newspapers, pamphlets from health centre) ■ poster paper or other appropriate media

Time Required

- 1-2 periods for research
- 1 period for presentations

Helpful Tips

- Use **BLM 14.2.2** to support this activity. Modify as necessary.
- If possible, work with 7 groups, and have each group draw the STI to be researched out of a hat.
- Use Assessment Checklist 4 Performance Task Group Assessment and Assessment Checklist 7 Independent Research Skills to work with the students to develop criteria for judging the presentation.
- Prepare a web page or handout with useful medical links or starting points for research.
- Coach students on how to properly reference sources of information, including the importance of not plagiarizing.

Safety Precautions

If using the Internet for research, caution students about using clear, specific search strings in their query of the search engines to avoid inappropriate search results. Revisit page xvi to review concerns about online safety.

Answers to Analysis Questions

1. STIs that will disrupt the reproductive system are: HPV, which is linked to cervical cancer; and Chlamydia, which can lead to PID (which may damage oviducts and cause infertility).
2. STIs that will permanently damage the reproductive system are: HPV and Chlamydia in later stages.
3. Answers will depend on what groups did with their presentations and the assessment instrument that the class created for evaluating the presentations. Effective presentations will be easy to follow, interesting, interactive, and engaging. They will leave the audience with a clear message about the topic and knowledge of what to do.
4. Challenges for health practitioners are to connect with the age group they are presenting the information to, and overcome resistance to a message that the audience will be reluctant to hear. Look for suggestions concerning the best types of media, the kinds of presenters students will respect, and ways to shape the message so that the listeners will pay attention and take action.

Answer to Extension Question

5. Topics for debate could include teaching abstinence vs. educating teens about STIs, the availability of protection such as condoms, the confidentiality of STI test results, or whether personal privacy rights should prevail over the need to protect public health when it comes to STIs. (You could use recent high-profile media stories concerning these issues to get the debate going.) In evaluating the points for the debate, look for convincing arguments on

both sides of the issue and points that are backed with facts that were researched and logically presented.

Assessment Options

- Collect and assess students' written reports, presentations, projects, and answers to the Analysis questions.
- Use Assessment Checklist 8 Oral Presentations to assess the presentations. Have the students complete assessments of their peers' presentations.
- If you use the Extension question, have the students in the audience submit a simple evaluation of each side of the debate(s) and state why they think the debater was effective (or not).

Section 14.2: Review Answers

Student Textbook page 491

1. Examples of Viral and Bacterial STIs

Viral STIs	Bacterial STIs
HIV/AIDS hepatitis (A, B, and C) genital herpes HPV	chlamydia gonorrhea syphilis

2. PID (pelvic inflammatory disease) is a disease that occurs in women; it is caused by undetected Chlamydia that has spread to the cervix and oviducts. PID is painful and can lead to the build-up of scar tissue in the oviducts and open sores on the cervix. This may lead to infertility (oviduct damage) and/or an increased risk of acquiring HIV. Chlamydia and PID also pose risks to babies who come into contact with the disease during birth, including potential respiratory infections and eye infections. PID can also arise if gonorrhea goes untreated.

3. A woman who is infected with an STI can present numerous risks to her baby. Diseases can be passed to the baby through the placenta (e.g., HIV, hepatitis B), during birth (e.g., HIV, genital herpes, Chlamydia, gonorrhea), through breast milk (e.g., HIV).

4. (a) A person who is infected with an STI but does not present any symptoms will not visit a doctor for treatment. While they wait, the infection may become more serious, progressing to PID, infections, cancer of the cervix (women), tumors on the vulva, vagina, anus or penis, or infertility.

(b) The public health risk of the asymptomatic individual infected with an STI is that they may unknowingly infect other people if they engage in unsafe sex practices or, in the case of pregnant women, pass the STI to their babies.

5. Look for the following key points: Both viral and bacterial STIs have health consequences, the severity of which increases as the infection progresses untreated and depending on the type of infection. It is true that the viral infections cannot be cured, only managed, and there is a high likelihood that death will result with some viral infections (HIV and hepatitis) or that cancer may develop (HPV). Bacterial infections, while curable, are more likely to go undetected, increasing the possibility that they will be spread unknowingly, as well as the possibility that they won't be detected until they have progressed to the more damaging PID, which can cause scarring and infertility in women, or infect a baby during birth. In addition, many bacterial diseases are becoming resistant to current antibiotics. The consequences of either form of STI make it preferable to avoid both.

6. (a) Points supporting the teaching of abstinence: abstinence (from oral, anal, and vaginal sex, and the sharing of needles) is the only way to guarantee the prevention of transmission of STIs. Points supporting the teaching of safe sex practices: students may argue that individuals will engage in sexual practices, so it is better to be educated about safe sex practices to avoid transmission of STIs (as well as unwanted pregnancies). Students can evaluate the arguments from an individual point of view, a societal point of view, or even a government viewpoint. It is in the best interest of society and government to teach people about the effects and transmission of STIs so that healthcare does not have to deal with large volumes of transmissions.

(b) Health practitioners can design education campaigns that respect the views of those advocating abstinence and safe sex practices by presenting the facts of each and allowing the recipients of the information to make their own decision. This can be done by avoiding nuanced language or judgmental, subjective conclusions.

14.3 Hormonal Regulation of the Reproductive System

Student Textbook pages 492-502

Section Outcomes

Students will:

- identify the main reproductive hormones and describe how they interact
- explain the role of sex hormones in the development and regulation of primary and secondary sex characteristics
- analyze blood hormone data and associated physiological events
- research and assess the medical use of reproductive hormones in humans

Key Terms

chromosomal sex
puberty
gonadotropin releasing hormone (GnRH)

follicle-stimulating hormone (FSH)
luteinizing hormone (LH)
testosterone
inhibin
andropause
estrogen
progesterone
menstrual cycle
corpus luteum
follicular stage
luteal stage
menopause
hormone replacement therapy (HRT)

Biology Background

- Sex hormones regulate the functions of the sex organs.
- Hormone therapies and surgeries can alter a person's appearance, but the person's chromosomal sex will never change. Each cell of a person's body will tell the gender that was determined when the egg united with the sperm.
- The reproductive hormones of both males and females are controlled by negative feedback mechanisms. Some reproductive technologies utilize the understanding of these feedback mechanisms to prevent pregnancy.
- The menstrual cycle in humans and some other primates is regulated by hormonal fluctuations throughout the month. This is to ensure that a human female will be fertile at various times of the year. The female is fertile for a short period after ovulation and then, if the egg is not fertilized, menstruation will occur and the process of maturing a new ovum and preparing a new endometrium begins again. In an estrous cycle, fertility is influenced by seasonal changes and is more physically obvious. For many species, the females only ovulate and thus become fertile once a year. This is an evolutionary strategy that ensures both fertilization and the successful development and delivery of the offspring.

Teaching Strategies

- Students will be familiar with the intricacies involved in maintaining homeostasis in other body systems; reproductive processes follow many of the same principles.
- Have the students complete the Biology Files "Try This" on pages 495 and 496 to illustrate the hormone feedback loops for both males and females. Students who have difficulty copying the outline can use **BLMs 14.3.1 Hormonal Control of the Male Reproductive System** and **14.3.3 Hormonal Control of the Ovarian Cycle** to fill in the feedback loops of the male and female reproductive systems.
- Book a computer lab to research the pros and cons of hormone replacement therapy as a treatment alternative for menopause for Thought Lab 14.4. Students may also research andropause.
- Have the students summarize the information about the male and female reproductive hormone cycles in a flow chart or columnar chart to help them visualize the cycles.
- A number of overhead masters and support activities have been prepared for this section. You will find them with the Chapter 14 BLMs on the CD that accompanies this Teacher's Resource or at **www.albertabiology.ca**, Online Learning Centre, Instructor Edition, BLMs.

Number (Type)
14.3.1 (HAND) Hormonal Control of Male Reproductive System
14.3.1A (ANS/OH) Hormonal Control of Male Reproductive System Answer Key
14.3.3 (HAND) Hormonal Control of the Ovarian Cycle
14.3.3A (ANS/OH) Hormonal Control of the Ovarian Cycle Answer Key
14.3.4 (HAND/OH) Key Reproductive Hormones and Their Functions
14.3.5 (HAND) The Ovarian Cycle
14.3.5A (ANS/OH) The Ovarian Cycle Answer Key
14.3.9 (OH) Hormone Levels Through the Menstrual Cycle

- ESL Students: Pair ESL students with same-sex peer tutors and provide class time for pair interactions with regard to the information presented in this section of the text. This will help both groups to better comprehend the material. In addition to respecting cultural sensitivities in this subject area and matching same-sex ESL students and tutors, there are some cautions to consider, most notably that the most gifted students do not always make the best tutors, and that the needs of all students involved in the tutoring process must be considered.

Answer to Question for Comprehension

Student Textbook page 492

Q18. (a) The XY chromosome combination will produce a genetically male offspring.

(b) The XX chromosome combination will produce a genetically female offspring.

Thought Lab 14.2: Testosterone and Male Development

Student Textbook page 494

Purpose

Students will analyze the levels of testosterone in males from ages 1-29 and infer the onset of puberty.

Outcomes

- B2.3s
- B2.4s

Advance Preparation

When to Begin	What to Do
1 week prior to activity	■ Book the computer lab or library for access to spreadsheet program and the Internet ■ Photocopy **BLM 14.3.2 Thought Lab 14.2: Testosterone and Male Development**

Materials
■ graph paper or print paper

Time Required

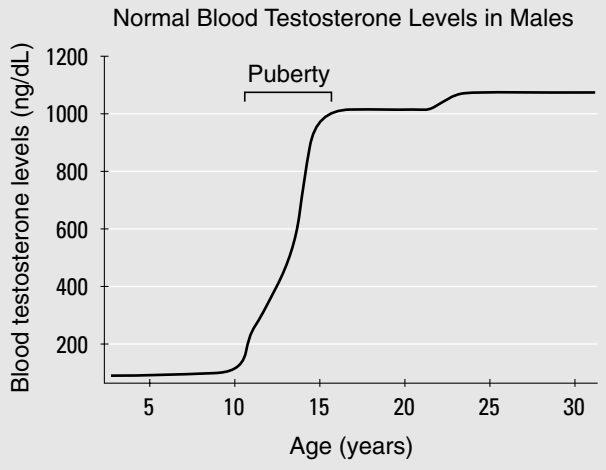
- 15 minutes for the graph
- 15 – 20 minutes for Internet research (Procedure #3)
- 15 minutes for Analysis questions

Helpful Tips

- Go to the Online Learning Centre, Instructor Edition, Teacher Web Links, for 2 or 3 web sites for starting points for students research.
- Use **BLM 14.3.2: Thought Lab 14.2** to support this activity. Modify as necessary.

Answers to Procedure Questions

1. & 2.



2. It can be seen from the graph (by looking at the jump in testosterone levels), that puberty begins at age 11 in average males.

3. The development of secondary sex characteristics in males is dependent upon changing levels of testosterone. These changes include: muscle development, formation of facial and body hair, deepened voice, broadened shoulders, and more aggressive behaviour. Testosterone is responsible for the development and normal functioning of the male reproductive organs. Testosterone is also required for spermatogenesis in the mature male.

Answers to Analysis Questions

1. Yes. Puberty ends when testosterone levels become stabilized. In this particular data set, it appears to be around 18 years, where testosterone levels remain constant in the blood.

2. (a) It can be argued that a certain level of testosterone (androgens) is required for the growth of facial hair, since facial hair does not begin to grow until testosterone levels in the blood rise. It is not accurate for students to say that the presence of testosterone alone causes facial hair to grow, as testosterone is present in low levels in the blood in males from 1-8 years, and there is minimal production of facial hair during these years.

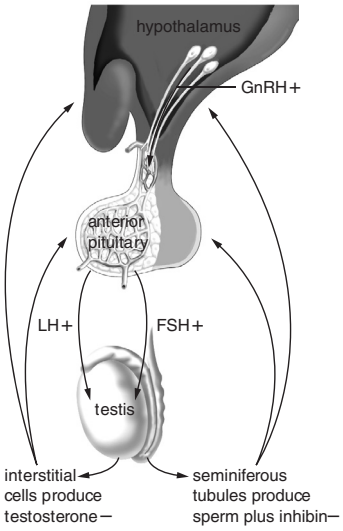
(b) An experiment to test the hypothesis that testosterone causes facial hair growth in males is to compare blood testosterone levels with the amount of facial hair (number of hairs per given area) in a large sample of males of a variety of ages. An alternate method would be to monitor the development of certain males through puberty and measure testosterone levels, and correlate it with their corresponding facial hair growth.

Assessment Options

- Collect and assess students' graphs, Internet research, and answers to Procedure and Analysis questions.

Biology File: Try This

Student Textbook page 495



Answers to Questions for Comprehension

Student Textbook page 495

Q19. Male sex hormones and their significance

Male Sex Hormone	Significance
GnRH (gonadotropin-releasing hormone)	an increase in the production of this hormone initiates puberty; stimulates release of FSH and LH
FSH (follicle-stimulating hormone)	stimulates the development of the sex organs and production of testosterone, and inhibin
LH (luteinizing hormone)	stimulates the production of testosterone
testosterone	stimulates the development of the male reproductive tract (sex organs) and secondary sex characteristics; inhibits the release of LH
inhibin	acts on the anterior pituitary to inhibit FSH production

Q20. The roles of GnRH, FSH, and LH in the development of the female reproductive system:

Female Sex Hormone	Significance
GnRH (gonadotropin-releasing hormone)	initiates puberty; stimulates release of FSH and LH from the anterior pituitary
FSH (follicle-stimulating hormone)	stimulates the follicle to produce estrogen
LH (luteinizing hormone)	stimulates the corpus luteum to produce progesterone

Biology File: Web Link page 495

Doctors may prescribe synthetic testosterone treatments if they are treating a male with low testosterone levels (hypogonadism). Low testosterone levels can cause a drop in sex drive, poor erections, low sperm count, and enlarged breasts. Over time, low testosterone may cause a man to lose body hair, muscle bulk and strength, accumulate body fat, have weaker bones, mood changes, less energy, and small testis.

Testosterone replacement therapy can improve sexual interest, erectile function, mood and energy, body hair growth, bone density, and muscle mass. Treatment methods include injections, patches, gel, and tablets. The risks associated with testosterone treatment include a high red blood cell count, sleep apnea, an increase in prostrate gland enlargement or prostate cancer growth, breast enlargement, and acne.

Anabolic steroids are drugs that are forms of the male hormone testosterone and are know for their effects on muscle tissue. They also have effects like growth of facial hair and deepening of the voice. These drugs are used illegally by some athletes to improve performance, and by others to get a more muscular appearance.

Anabolic steroids have dangerous physical and psychological side effects. These may be more dangerous in young adults because the use of steroids can stop growth, and in females they can cause permanent changes in the voice and genitals.

Side effects of anabolic steroid use for females include:

- facial hair
- deep voice
- increased body hair
- irregular menstrual periods
- increased appetite

For boys

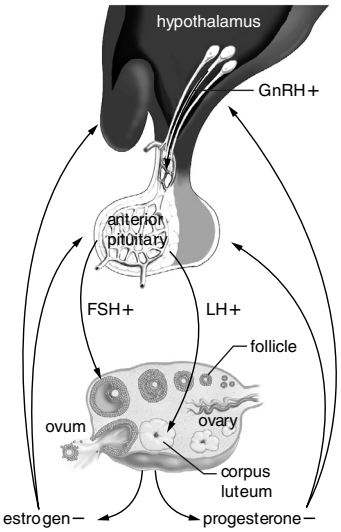
- increased breast size
- shrunken testicles

For both genders

- severe acne
- baldness
- liver abnormalities and tumours
- angry outbursts ("roid rage") or aggressive behaviour
- paranoia
- hallucinations
- psychosis
- blood clots

Biology File: Try This

Student Textbook page 496



Thought Lab 14.3: Development of the Corpus Luteum

Student Textbook page 497

Purpose

Students will use a diagram to identify ovarian structures that develop and change during the menstrual cycle.

Outcomes

- B2.2s

Advance Preparation

When to Begin	What to Do
1 week before	■ Select online animation of development of corpus luteum (optional)
1 day before	■ Obtain slides of ovarian tissue and set up in microscope (optional) ■ Photocopy **BLM 14.3.6**

Materials
■ sketch paper, pencil crayons

Time Required

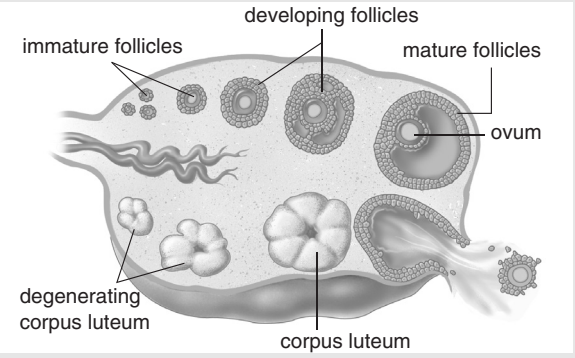
- 25 minutes for drawings
- 15 minutes for Analysis questions

Helpful Tips

- Use **BLM 14.3.6: Thought Lab 14.3** to support this activity. Modify as necessry.
- Show online animation of the development of the corpus luteum to the class
  For example:
  http://www.howstuffworks.com/menstruation.htm
- Have prepared microscope slides of ovarian tissue available for students to view.

Answers to Procedure Question

1. and **2.**



3. Student diagrams should indicate that this woman is in the follicular phase of her menstrual period. The follicular phase spans the length of time between the first day of menstruation and the moment of ovulation. Prompted by the hypothalamus, the pituitary gland releases follicle-stimulating hormone (FSH). This hormone stimulates the ovary to produce around five to 20 follicles, which bead on the surface. Each follicle houses an immature egg. Typically, only one follicle will mature into an egg, while the others die away.

Answers to Analysis Questions

1. To locate the corpus luteum in a tissue sample, one would look near the outer edge for it as it develops from the follicle that has just burst and released the ovum outside of the ovary.

2. An adaptive advantage of having a gland that develops and then disappears within a few weeks is that menstrual cycles are monthly, and this allows for reproduction at any time of the year.

Answer to Extension Question

3. Students will create an animation or series of slides in a slide show to show the development and disintegration of the corpus luteum within the ovary. Because the corpus luteum is a continuation of follicle development, students should show the process beginning with the immature follicle.

Assessment Options

- Assess and evaluate the diagram for correctly labelled ovarian structures.
- Assess answers to Analysis questions.
- Assess animation or slide show for clarity and completeness.

Answers to Questions for Comprehension

Student Textbook page 498

Q21. The menstrual cycle ensures that an ovum is released at the same time that the uterus is most receptive to a fertilized egg.

Q22. Two stages of the ovarian cycle:

(a) The follicular stage – FSH levels (released by the pituitary gland) increase, stimulating one follicle to mature. The maturing follicle releases estrogen and some progesterone. The increased estrogen inhibits the release of FSH and stimulates the release of GnRH. This leads to an increase in LH, causing the follicle to burst and the ovum to be released.

(b) The luteal stage – after the ovum is released, LH causes the follicle to develop into a corpus luteum. The corpus luteum releases progesterone and some estrogen. Increased levels of these hormones inhibit

FSH and LH production. As the corpus luteum degenerates, progesterone and estrogen levels drop, resulting in the secretion of FSH and the cycle beginning again.

Q23. The corpus luteum secretes progesterone and some estrogen, which inhibit FSH and LH production. When the corpus luteum degenerates, the level of those hormones drops, stimulating an increase in FSH and LH production as a new follicle begins to mature. If the ovum is fertilized, the corpus luteum does not degenerate and instead keeps the levels of progesterone high enough to support the endometrium and the embryo/developing fetus.

Q24. The ovarian cycle begins the same day as the uterine cycle—the first day of menstruation. The ovarian cycle refers to events occurring in the ovary, beginning with the degeneration of the corpus luteum and a drop in the levels of estrogen and progesterone; the uterine cycle relates to events occurring simultaneously in the uterus, beginning with the shedding of the endometrium. A new follicle begins to mature in the ovary and levels of estrogen go up; around the 6th day, due to high blood estrogen levels, the endometrium begins to thicken. Around day 14 (ovulation), the endometrium thickens rapidly, and if fertilization does not occur, the corpus luteum degenerates, progesterone and estrogen levels drop again, the endometrium breaks down, and menstruation begins again.

Thought Lab 14.4: Therapy Options for Menopause

Student Textbook page 499

Purpose

Students will identify physiological and ethical concerns about the medical use of reproductive hormones.

Outcomes

- B1.1s
- B2.3s

Advance Preparation

When to Begin	What to Do
1 week before	■ Book the computer lab for research.
1 day before	■ Photocopy **BLM 14.3.7: Therapy Options for Menopause** to assist students with their research of alternatives to HRT

Materials
■ print resources on menopause and therapies

Time Required

50 – 60 minutes

Helpful Tips

- Use **BLM 14.3.7** to support this activity. Modify as necessary.
- Students should do the research outside of class time.
- Ensure that students include the most commonly used HRT program, a combination of estrogen and progesterone.

Answers to Procedure Questions

1. The most common therapies are: combined HRT; non-pharmaceutical supplements in various combinations; yoga; changes in diet (e.g. excluding alcohol; adding soy-based products); naturopathy; exercise
2. Use **BLM 14.3.7** to help students gather and organize their researched information.
3. Students' reports should include a statement of what treatment therapies were being investigated, clear headings and sub-headings, indicating the organization of the information, and detailed source documentation.

Answers to Analysis Questions

1. Ensure that students justify any claims that one therapy is "better" than the others with information uncovered during their research. Likely answers will include the fact that the effectiveness of therapy varies from one woman to the next, in terms of relief from symptoms and possible side effects, and so does their personal choice for therapy. Most (pharmaceutical) medications have side effects and benefits that require a careful assessment of possible risks.
2. Look for students to discuss the importance of experimental and clinical trials before practitioners and pharmaceutical companies release drug therapies to the public to ensure that the risks and short- or long-term side effects are better known.

Assessment Options

- Collect and assess students' reports or presentations and answers to Analysis questions and completed **BLM 14.3.7: Therapy Options for Menopause**, including a list of the resources chosen.
- Use Assessment Checklist 7 Independent Research Skills

Investigation 14.B: The Menstrual Cycle

Student Textbook page 500

Purpose

Students will analyze changes in blood hormone levels during the menstrual cycle.

Outcomes

- B2.2s
- B2.3s
- B2.4s

Advance Preparation

- Photocopy **BLM 14.3.8: Investigation 14.B: The Menstrual Cycle**

Time Required

20-30 minutes

Helpful Tips

- Use **BLM 14.3.8: Investigation 14.B** to support this activity. Modify it as necessary.
- Have students work in small groups to discuss the analysis of the graph.

Answers to Analysis Questions

1. FSH increases during the follicular stage of the ovarian cycle (between day one and day six). During the rise in FSH, a follicle is maturing in preparation for the release of a mature ovum.
2. LH reaches its highest concentration on day 13. This causes the follicle to burst, releasing the ovum, and the follicle begins to develop into a corpus luteum.
3. LH begins to decline in the blood once the corpus luteum begins to secrete progesterone and some estrogen.
4. The greatest rise in estrogen levels happens as the follicle matures. This increase acts on the anterior pituitary to inhibit the release of FSH and trigger the release of GnRH from the hypothalamus. (This leads to an increase in LH levels.) The endometrium begins to thicken.
5. The most significant rise in progesterone levels is after ovulation (around day 14). During this time the endometrium thickens rapidly.
6. Estrogen and progesterone are at their lowest levels during the first two or three days of the cycle. During these early days of the cycle, the endometrium is sloughed off. This is menstruation.

Answers to Conclusion Questions

7. Increased levels of estrogen and progesterone suppress the release of FSH.
8. Yes, the names of FSH and LH correspond to their function in females. FSH — follicle-stimulating hormone — was named for its function, which is to stimulate follicles to grow and mature. LH — luteinizing hormone — was named for its function, which is to stimulate the development of the corpus luteum.
9. The students' representation should show that estrogen stimulates the initial growth of the endometrium, while progesterone stimulates vascularization and maintenance of the endometrium.
10. A woman is most fertile on day 14, after the follicle has burst and the ovum has been released.

Assessment Options

- Collect and assess students' answers to Analysis and Conclusions questions.

Connections – Endocrine Disruptors in the Environment

Student Textbook page 501

Teaching Strategies

- A class discussion or formal debate on one or both of the two questions can help raise students' awareness of the issue of disposal of chemicals and their effect on the environment.
- The small point about synthetic estrogen from birth control pills, along with other medications that are secreted in urine and present in treated sewage, may be another avenue of exploration for students.

Answers to Questions

1. Students' answers should weigh the impact on the environment, human health-related quality of life issues, and societal concerns, as well as the impact on the economy (benefits in terms of products and productivity; costs in terms of dealing with waste clean-up and storage or health care costs).
2. Students might suggest that they would want to know if other populations of the same species in similar and in different ecosystems are experiencing the same or similar effects. Students might also want to know if other substances that occur naturally in the environment of the affected population have the same effects as those associated with the endocrine disruptors. Accept all well-reasoned and reasonable answers.

Section 14.3: Review Answers

Student Textbook page 502

1. Chromosomal sex, also known as genetic sex, is determined genetically through the chromosome combination XX or XY. Reproductive sex refers to the physical expression of male or

female anatomical structures based on the presence or absence of specific hormones that are secreted after the seventh week of prenatal development.

2. Students should reproduce the negative feedback loop shown in Figure 14.13 on page 494 and label it.

3. (a) *male puberty*: the production of GnRH increases in the hypothalamus; GnRH acts on the anterior pituitary gland, causing it to release LH and FSH. These hormones stimulate the testes to begin producing sperm and releasing testosterone. Testosterone fuels the complete development of the sex organs and the secondary sexual characteristics.

(b) *female puberty*: the production of GnRH increases in the hypothalamus; GnRH acts on the anterior pituitary gland, causing it to release LH and FSH. These hormones stimulate the ovaries to produce estrogen and progesterone, which fuel the development of the secondary sexual characteristics and the onset of the monthly reproductive cycle.

(c) *the ovarian cycle*: This cycle begins when the pituitary gland increases the level of FSH, which stimulates one follicle to mature. The maturing follicle releases estrogen and some progesterone. The rising level of estrogen inhibits the release of FSH and triggers release of GnRH, which leads to an increase in LH—the hormone that stimulates the burst of the follicle, the release of the ovum, and the development of the corpus luteum. The corpus luteum secretes progesterone and some estrogen, which inhibit FSH and LH production; the corpus luteum then degenerates, decreasing the levels of progesterone and estrogen, which causes FSH to increase and begin the ovarian cycle again. (Fertilization can interrupt this process.)

(d) *the uterine cycle*: begins when the levels of progesterone and estrogen are low (the corpus luteum has degenerated). Levels of estrogen gradually increase as a new follicle matures and the endometrium begins to thicken. Once the ovum has been released and the corpus luteum is producing even more progesterone and estrogen, the endometrium thickens rapidly. Once the corpus luteum degenerates, the endometrium is shed and the cycle begins again. (Fertilization can interrupt this process.)

4. (a) A – follicle stimulating hormone (FSH)

B – estrogen

C – luteinizing hormone (LH)

D – progesterone

(b) Region E on this graph represents the follicular phase of the cycle. The follicular phase spans the length of time between the first day of menstruation and the moment of ovulation. Prompted by the hypothalamus, the pituitary gland releases follicle-stimulating hormone (FSH). This hormone stimulates the ovary to produce around five to 20 follicles, which bead on the surface. Each follicle houses an immature egg. Typically, only one follicle will mature into an egg, while the others die away.

(c) Region F represents ovulation. Ovulation means the release of a mature egg from the ovary surface. This occurs roughly at mid-cycle, around two weeks or so before the onset of menstruation. During the follicular phase, the ripening follicle causes a rise in the level of the sex hormone estrogen. The hypothalamus in the brain recognizes these rising levels and releases a chemical called gonadotropin-releasing hormone (GnRH). This hormone prompts the nearby pituitary gland to produce boosted levels of luteinizing hormone (LH) and FSH. Within two days, ovulation is triggered by the high levels of luteinizing hormone.

(d) Region G represents the luteal phase of the cycle. During ovulation, the egg bursts from its follicle. However, the ruptured follicle remains on the surface of the ovary. For the next two weeks or so, the follicle transforms into a structure known as the corpus luteum. This structure starts releasing the sex hormone progesterone, along with small amounts of estrogen. This hormonal combination maintains the thickened uterine lining, awaiting implantation of the fertilized egg.

(e) Area H caption: Blood levels of pituitary *and* ovarian hormones.

Area I caption: Endometrial Changes

(f) A possible caption for this entire diagram could be:

The menstrual cycle is complex. It is controlled by a variety of glands and their associated hormones. The hypothalamus influences the nearby pituitary gland to secrete FSH and LH, which prompt the ovaries to secrete their sex hormones, principally estrogen and progesterone. The menstrual cycle is a negative feedback system, which means all of the structures and glands are influenced by the activity of the others.

5. Both testosterone and estrogen are responsible for stimulating the development of the secondary sexual characteristics. While testosterone levels may decrease over time, they never cease and the functions they fuel never cease. Estrogen production in the ovaries ceases in females sometime during mid-life.

6. The human menstrual cycle combines events in the female's ovary and the uterus to create the most favourable conditions for a zygote to implant successfully and be nourished into a fetus.

7. In an adolescent male whose anterior pituitary produces FSH we would expect spermatogenesis to occur. It would occur at a reduced level, because spermatogenesis is also influenced by testosterone. And as this male does not produce LH, his testosterone levels will be lower than normal, and thus so will his spermatogenesis. Also with a low LH level, and thus a low testosterone level, we would see a reduction in the secondary sex characteristics, such

as the enlargement of the penis and testicles; there would be a reduction in muscle mass development; as well as a reduction in hair production on areas such as the face and chest. Students' flow charts or diagrams should show an interruption in the negative feedback loop.

8. A large injection of testosterone would result in high levels of testosterone in the blood. The hypothalamus would respond by reducing the amount of GnRH, which would result in a reduction in the amount of LH released into the blood. At the same time, the anterior pituitary would also recognize high levels of testosterone in the blood. In response, less LH would be released from the anterior pituitary into the bloodstream. Low levels of LH result in the interstitial cells of the testis producing less testosterone.

This negative feedback loop keeps testosterone levels relatively constant in the body.

Chapter 14: Review Answers

Student Textbook pages 504-505

Understanding Concepts

1. *seminiferous tubules*: long, coiled tubules in which sperm begin to develop

Sertoli cells: found inside the seminiferous tubules; they nourish the sperm

interstitial cells: surround seminiferous tubules and produce testosterone

sperm: tadpole-shaped structure containing 23 chromosomes; penetrates and fertilizes the egg

2. (a) testosterone is produced in the testes, by the interstitial cells

(b) progesterone is produced in the ovary

(c) sperm is produced in the testes, in the seminiferous tubules

(d) luteinizing hormone is produced in the anterior pituitary

(e) follicle-stimulating hormone is produced in the anterior pituitary gland

(f) ovum is produced in a follicle in one of the ovaries

3. Sperm to ovum flow chart: seminiferous tubules (m) → epididymis (m) → ductus deferens (m) → urethra (m) → vaginal orifice (f) → vagina (f) → uterus (f) → oviduct (f)

Student diagrams should reflect the same information.

4. The components of semen are:

- sperm cells (contribute the gamete containing 23 chromosomes)
- mucus from the seminal vesicles, which contains fructose and provides energy
- mucus-like fluid plus an alkaline fluid from the prostate gland to neutralize the acids in the female reproductive tract
- fluid from the Cowper's gland plus an alkaline fluid to neutralize the acids in the female reproductive tract

5.

STI	Source	Transmission	Effects	Treatment
(a) HIV/AIDS	human immunodeficiency virus (HIV)	sexual contact with infected person; intravenous drug use; mother to child during birth or breast milk	HIV attacks helper T cells; person more vulnerable to infections; can be fatal	no cure; treatments alleviate symptoms of specific diseases and can extend life-expectancy
(b) hepatitis B	hepatitis B virus	sexual contact or through contact with infected body fluids or blood; mother to child before child birth (across the placenta)	initially flu-like symptoms (headache, fever, nausea, loss of appetite); skin may turn yellowish (jaundice); later stages can cause liver failure, liver cancer, or death.	vaccines are available
(c) genital herpes	herpes simplex 1 or herpes simplex 2 viruses	HSV 2 transmitted by genital contact HSV 1 commonly causes infections of the mouth (cold sores)	tingling or itching followed by blisters on genitals, buttocks, thighs	no cure; individual always carries the virus; antiviral medication can help to control outbreaks
(d) human papilloma virus	HPV virus	skin to skin contact	develop flat, raised warts around genital area; linked to serious disorders such as cervical cancer	no cure

STI	Source	Transmission	Effects	Treatment
(e) chlamydia	bacterium (C*hlamydia trachomatis*)	sexual contact	discharge from the penis or vagina, a burning pain while urinating, or a fever; in women can lead to pelvic inflammatory disease which can block oviducts (sterility); infections in cervix lead to sores that can be the sight of HIV	antibiotics
(f) gonorrhea	bacterium (*Neisseria gonorrhoeae*)	sexual contact	infection or urethra, cervix, rectum, and throat; pain when urinating and a thick greenish-yellow discharge from the urethra; can lead to PID and may spread to joints, heart, or brain	antibiotics
(g) syphilis	bacterium (*Treponema pallidum*)	sexual contact	first stage:- forms ulcerated sores (chancres) at infection site; second stage – rash on palms and soles of feet; third stage – affects cardiovascular and nervous systems (mental illness, lameness, blindness)	antibiotics (if treated early)

6. (a) The following chart summarizes transmission of specific STIs to newborn and

(b) the effects of these STIs on infants:

STI	(a) Transmission	(b) Effects on Infants
genital herpes	mother to child during childbirth	infection may cause blindness, neurological disorders, even death
chlamydia	mother to child during childbirth	eye and respiratory tract infections
gonorrhea	mother to child during childbirth	serious eye infections
syphilis	can infect developing embryo at any stage	causes birth defects or stillbirth

7. Genital herpes is a health risk to the individual due to the associated symptoms, as well as to the public, since the virus is easily transmitted, especially if the infected person is asymptomatic. There is also a risk of an infected mother transmitting the virus to her baby during birth. There is no cure for genital herpes; however, antiviral medication can help to control the severity of outbreaks. Syphilis is a bacterial infection that has progressive stages, and if left untreated can result in death. If diagnosed early, the disease can be treated with antibiotics.

8. At the beginning of an ovarian cycle, slightly raised levels of FSH will stimulate a follicle to grow. A follicle matures by growing layers of follicular cells and a central, fluid-filled vessicle. By the midpoint of the cycle, a spike of LH stimulates the follicle to rupture and release an ovum. LH then stimulates the empty follicle to develop into a corpus luteum and secrete progesterone. If the ovum is not fertilized, the corpus luteum degenerates.

9. At the beginning of the ovarian cycle, the endometrium (in the uterus) is very thin. As a follicle matures in the ovary, it secretes estrogen. By the sixth day of the cycle, the increased levels of estrogen stimulate the thickening of the endometrium. After ovulation and the release of progesterone, the thickening of the endometrium increases dramatically. Between days 15 and 23, the thickness will double or triple. If fertilization does not occur, the degenerating corpus luteum causes the endometrium to break down, and menstruation begins.

10. After the onset of puberty, the levels of sex hormones in the blood of a female increase dramatically and stimulate the final development of the reproductive system. GnRH is secreted by the hypothalamus, and stimulates the release of LH and FSH. These two hormones act on the ovaries to produce estrogen and progesterone, which stimulate the development of the secondary sexual characteristics and launch the menstrual cycle.

11. (a) luteinizing hormone = red line

(b) progesterone = yellow line

(c) progesterone

Applying Concepts

12. Syphilis is caused by a bacterial infection and antibiotics can be used to treat bacterial infections. AIDS is caused

by the HIV virus. Antibiotics do not have any effect on viral infections.

13. The acrosome contains enzymes that help the sperm penetrate the jelly-like layer protecting the egg during fertilization. Without the acrosome, this penetration is not possible, and fertilization would not take place. The male would be sterile.

14. The names of the hormones reflect their functions in the female reproductive system. FSH (follicle-stimulating hormone) stimulates the follicles in the female reproductive system to mature and release increased quantities of estrogen into the bloodstream. In males, it stimulates the production of sperm. LH (luteinizing hormone) stimulates the development of the corpus luteum after the ovum has been released. In males, LH causes the testes to release testosterone.

15. Delayed puberty would be reflected in the blood by lower levels of sex hormones such as estrogen. In addition, secretions of hypothalamus and pituitary hormones (GnRH, LH, and FSH) would be reduced.

16. Castrated farm animals produce no sperm or testosterone and tend to be a smaller size. These animals also tend to have higher fat and less muscle development, which yields meat with richer fat content—for more tender cuts for the market. Farmers also benefit because castrated animals are less aggressive and easier to work with.

17. (a) Students can hypothesize that the most likely reasons are an interruption in the negative feedback loop or not enough of one of the hormones that plays a key role in the cycle.

(b) A simple investigation could be to investigate hormonal levels through urinalysis or blood tests. If levels of estrogen and progesterone were irregular, then the endometrium would not thicken regularly either.

18. (a) The release of the egg corresponds with hormone A (LH) because of the peak in concentration on day 13, the day of ovulation. The build-up of the uterine lining corresponds with hormone B (progesterone) because of the high concentrations from day 17-28 and the reduced concentration on day 1.

(b) If hormone A remained constant, it is likely that the follicle was not releasing the ovum. Since the follicle was not releasing the ovum, the corpus luteum in turn was not developing, so hormone B remained constant (no rise in the progesterone level) and therefore the uterine lining would not be developing. (FSH levels appear normal). Without the release of the ovum and development of the uterine lining, pregnancy would not be possible.

19. Students' responses should focus on the best ways to protect public health. They should acknowledge that the key conflict is between prevention and finding a cure. Which is more important? Accept all well-reasoned answers.

Making Connections

20. (a) The individual would have ovaries. The Y chromosome contains the gene necessary for testicular formation.

(b) No, this person cannot respond to estrogen. An estrogen receptor is a protein molecule found inside those cells that are targets for estrogen action. Estrogen receptors contain a specific site to which only estrogen (or closely related molecules) can bind. Without these receptors, cells will not respond to estrogen. In breast tissue, for example, estrogen triggers the proliferation of cells lining the milk glands, thereby preparing the breast to produce milk if the woman should become pregnant. Without estrogen receptors, breast tissue would not develop. Estrogen also promotes proliferation of the cells that form the inner lining, or endometrium, of the uterus, thereby preparing the uterus for possible implantation of an embryo. Without estrogen, the lining of the endometrium would not thicken and vascularize.

(c) It is unlikely that this individual would develop male secondary sexual characteristics. It is unlikely that the adrenal cortex would produce enough testosterone.

(d) This individual would not likely be fertile since estrogen is required for the development of the endometrium, preparing the uterus for possible implantation of the embryo. As well, without high levels of estrogen, the hypothalamus will not release GnRH. Without GnRH, LH will not be released and ovulation will not occur.

21. The high mortality rate for sperm is acceptable because hundreds of millions of sperm are formed and only one is needed for fertilization, millions of sperm can be eliminated without compromising the species' survival. In contrast, only one egg is released each month, and if it dies, the opportunity for reproduction is lost.

22. Three reasons why there are so many new cases of chlamydia reported each year:

- 75% of infected people are asymptomatic and are unknowingly passing the infection on to other people.
- the age group it is affecting is more likely to be sexually active with less knowledge of STIs and taking fewer precautions, such as a using condom.
- because the infection rate is double in women, they may unknowingly pass it on to their child during birth

23. (a) When a woman becomes pregnant, menstruation stops for the duration of the pregnancy because the corpus luteum remains and continues to secrete high levels of estrogen and progesterone. These hormones keep the endometrium growing and supporting the fetus, instead of disintegrating and sloughing off.

(b) After pregnancy, estrogen and progesterone levels are low. Their low levels allow GnRH to stimulate the release of LH and FSH from the anterior pituitary. With the release of these hormones, the cycle begins again: a new ovum matures and is released; the endometrium thickens; and if the ovum is not fertilized and implanted, the endometrium will be shed.

24. High testosterone levels generated by anabolic steroids will inhibit the release of GnRH, which subsequently stops the release of LH and FSH from the anterior pituitary gland. Sperm production will decrease and natural production of testosterone will also decrease. If steroid use continues, the testicles and secretory cells will shrink. Since production of testosterone declines, secondary sex characteristics such as facial hair will decrease. Students may also copy or sketch the feedback loop showing testosterone (Figure 14.13) to explain their answer.

CHAPTER 15 HUMAN DEVELOPMENT

Curriculum Correlation

General Outcome 2: *Students will* explain how human reproduction is regulated by chemical control systems.

NOTE: The curriculum correlation for this outcome covers two chapters. The references for Chapter 15 are in boldface.

	Student Textbook	Assessment Options
Outcomes for Knowledge		
30–B2.1k describe the role of hormones in the regulation of primary and secondary sex characteristics in females and males	Section 14.1: The Male and Female Reproductive Systems (Section Opener), p. 478 Section 14.3: Hormonal Regulation of the Reproductive System (Section Opener), p. 492	Questions for Comprehension: 1, p. 478 Section 14.3 Review: 1, p. 502 Chapter 14 Test Unit 6 Review: 10, p. 540
30–B2.2k identify the principal reproductive hormones in the female and explain their interactions in the maintenance of the menstrual cycle, i.e., estrogen, progesterone, luteinizing hormone (LH), follicle-stimulating hormone (FSH)	Section 14.3: Sex Hormones and the Female Reproductive System, p. 495 Hormonal Regulation of the Female Reproductive System, p. 495 The Ovarian Cycle, p. 496 The Uterine Cycle, p. 498 Aging and the Menstrual Cycle, p. 498 Thought Lab 14.3: Development of the Corpus Luteum, p. 497 Investigation 14.B: The Menstrual Cycle, p. 500 Connections: Social and Environmental Contexts: Endocrine Disruptors in the Environment, Section 14.3, p. 501	Questions for Comprehension: 20, p. 495 21–24, p. 498 Thought Lab 14.3: Analysis, Extension, p. 497 Investigation 14.B: Analysis, Conclusion, p. 500 Connections, p. 501 Section 14.3 Review: 3, 4, 6, p. 502 Chapter 14 Review: 7–10, 12, 13, 15, 16, 20, p. 504–505 Chapter 14 Test Unit 6 Review: 5, 11, 21, 23, 24, 28, 43, p. 540–542

	Student Textbook	Assessment Options
30–B2.3k identify the principal reproductive hormones in the male and explain their interactions in the maintenance and functioning of the male reproductive system, i.e., testosterone, luteinizing hormone (LH), follicle-stimulating hormone (FSH)	Section 14.3: Sex Hormones and the Male Reproductive System, p. 492 Maturation of the Male Reproductive System, p. 493 Hormonal Regulation of the Male Reproductive System, p. 493 Aging and the Male Reproductive System, p. 495 Thought Lab 14.2: Testosterone and Male Development, p. 494 Connections: Social and Environmental Contexts: Endocrine Disruptors in the Environment, Section 14.3, p. 501	Questions for Comprehension: 19, p. 495 Thought Lab 14.2: Testosterone and Male Development, Analysis, p. 494 Connections, Section 14.3, p. 501 Section 14.3 Review: 2, 3, 5, 8, p. 502 Chapter 14 Review: 12, 14, 21, pp. 504–505 Chapter 14 Test Unit 6 Review: 12, 37, 43, pp. 540–542
Outcomes for Science, Technology, and Society (Emphasis on social and environmental contexts)		
30–B2.1sts explain how science and technology are influenced and supported by society and have influenced, and been influenced by, historical development and societal needs by ■ *researching and assessing the effects of the medical use of reproductive hormones on humans*	**Section 15.3 Hormone Treatments, p. 531** **e.g., Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538**	**Section 15.3 Review: 2, p. 534** **e.g., Career Focus, 1–3, p. 539** **Chapter 15 Review: 22, p. 536** Unit 6 Review: 22, 49, 50 pp. 541–543
■ *researching and assessing the implications for humans of producing and using reproductive hormones in domestic animals, e.g., cattle and horses*	e.g., Thought Lab 14.2: Testosterone and Male Development, p. 494 e.g., Thought Lab 14.4: Therapy Options for Menopause, p. 499 **e.g., Connections (Social and Environmental Contexts): Stem Cells, Section 15.2, p. 527**	e.g., Thought Lab 14.2, Analysis, p. 494 e.g., Thought Lab 14.4, Analysis, p. 499 **e.g., Connections, Questions, Section 15.2, p. 527**
30–B2.2sts explain why decisions regarding the use of scientific and technological developments involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations by ■ *explaining how reproductive hormone homeostasis is disrupted by the natural aging process and whether available technologies should be used to restore balance; e.g., hormone treatment for menopause and andropause*	Section 14.3: Aging and the Menstrual Cycle, p. 498 Thought Lab 14.4: Therapy Options for Menopause, p. 499 Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538	Thought Lab 14.4: Analysis, p. 499 Career Focus, 1–3, p. 538
Skill Outcomes (Focus on decision making)		
Initiating and Planning		
30–B2.1s ask questions about observed relationships and plan investigations of questions, ideas, problems and issues, e.g., by ■ designing an investigation to determine at which point during the menstrual cycle a female is most fertile	Investigation 14.B: The Menstrual Cycle, p. 500	Investigation 14.B: Analysis, Conclusion, p. 500

	Student Textbook	Assessment Options
Performing and Recording		
30–B2.2s conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information by ■ graphing the changes in estrogen, progesterone, LH and FSH levels in the blood of a female through a single menstrual cycle	Investigation 14.B: The Menstrual Cycle, p. 500	Investigation 14.B: Analysis, Conclusion, p. 500 Section 14.3 Review: 4, p. 502 Chapter 14 Review: 10, p. 504
■ using models, diagrams or computer simulations, identifying the follicle and corpus luteum within the ovary	Thought Lab 14.3: Development of the Corpus Luteum, p. 497 Investigation 14.B: The Menstrual Cycle, p. 500	Thought Lab 14.3: Analysis, Extension p. 497 Investigation 14.B: Analysis, Conclusion, p. 500
Analyzing and Interpreting		
30–B2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions by ■ analyzing blood hormone data and physiological events for a single menstrual cycle, inferring the roles of female sex hormones	Investigation 14.B: The Menstrual Cycle, p. 500	Investigation 14.B: Analysis, Conclusion, p. 500 Section 14.3 Review: 4, p. 502 Chapter 14 Review: 10, p. 504
■ analyzing blood hormone data and physiological events, inferring the roles of male sex hormones	Thought Lab 14.2: Testosterone and Male Development, p. 494	Thought Lab 14.2: Analysis, p. 494 Section 14.3 Review: 5, p. 502
■ *researching and assessing the effects of the medical use of reproductive hormones, e.g., menopause, andropause, infertility*	Aging and the Menstrual Cycle, p. 498 Thought Lab 14.4: Therapy Options for Menopause, p. 499 **Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533**	Thought Lab 14.4: Analysis, p. 499 **Thought Lab 15.2, p. 533** **Section 15.3 Review: 2, p. 534**
Communication and Teamwork		
30–B2.4s work as members of a team in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results by ■ selecting and using appropriate numerical and graphical modes of representation to communicate information on changing reproductive hormone levels in the blood	Thought Lab 14.2: Testosterone and Male Development, p. 494 Investigation 14.B: The Menstrual Cycle, p. 500	Thought Lab 14.2: Analysis, p. 494 Investigation 14.B: Analysis, Conclusion, p. 500 Section 14.3 Review: 4, 7, p. 502 Chapter 14 Review: 10, 16, p. 504 Unit 6 Review: 46–51, p. 543
■ *working cooperatively with team members to investigate the value of producing and using reproductive hormones in domestic animals and, using the appropriate multimedia, present the information to the class*	e.g., Thought Lab 14.2: Testosterone and Male Development, p. 494 e.g., Thought Lab 14.4: Therapy Options for Menopause, p. 499 e.g., Connections (Social and Environmental Contexts): Stem Cells, Section 15.2, p. 527	e.g., Thought Lab 14.2, Analysis, p. 494 e.g., Thought Lab 14.4, Analysis, p. 499 e.g., Connections, Questions, p. 527

General Outcome 3: S*tudents will* explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors.

	Student Textbook	Assessment Options
Outcomes for Knowledge		
30–B3.1k trace the processes of fertilization, implantation, and extra-embryonic membrane formation; i.e., amnion, chorion, allantois followed by embryo development, placental and fetal development, parturition and lactation, and the control mechanisms of the above events, i.e., progesterone, LH, human chorionic gonadotropin (hCG), oxytocin, prolactin, prostaglandins	**Chapter 15, Launch Lab: Visualizing Early Human Development, p. 507** **Throughout Section 15.1, pp. 508–519** **Throughout Section 15.2, pp. 520–528** **Investigation 15.A: Comparing Embryonic Structures, p. 519**	**Chapter 15, Launch Lab: Analysis, p. 507** **Questions for Comprehension:** **1–4, p. 509** **5–9, p. 511** **10–14, p. 512** **15–19, p. 515** **20–23, p. 517** **24–26, p. 520** **27, 28, p. 523** **29–32, p. 526** **Investigation 15.A, Analysis, p. 519** **Section 15.1 Review: 1–10, p. 518** **Section 15.2 Review: 1–7, p. 528** **Chapter 15 Review: 1–14, 17–22, 24, p. 536** **Chapter 15 Test** Unit 6 Review: 4, 13–15, 20, 22, 27, 29, 48–51, pp. 540–543
30–B3.2k describe development from fertilization to parturition in the context of the main physiological events that occur in the development of organ systems during each major stage (trimester), i.e., zygote, blastocyst, gastrulation, general morphogenesis	**Chapter 15, Launch Lab: Visualizing Early Human Development, p. 507** **Section 15.1: Fertilization, p. 508** **Cleavage and Implantations, p. 509** **Gastrulation and Start of Tissue Formation, p. 511** **Neurulation and Organ Formation, p. 512** **Investigation 15.A: Comparing Embryonic Structures, p. 519** **Section 15.2: Fetal Development and Birth, p. 520** **Parturition: Delivery of the Baby, p. 523**	**Chapter 15, Launch Lab: Analysis, p. 507** **Questions for Comprehension:** **1–4, p. 509** **5–9, p. 511** **10–14, p. 512** **15–19, p. 515** **Section 15.1 Review: 4, 8, 10, p. 518** **Investigation 15.A: Analysis, p. 519** **Section 15.2 Review: 1, 2, p. 528** **Chapter 15 Review: 3, 4, 7, 12, 13, 17–19, 21, 24, 26, pp. 536–537** **Chapter 15 Test** Unit 6 Review: 4, 13, 20, 27, 29, pp. 540–541
30–B3.3k identify major tissues and organs that arise from morphological development of the ectoderm, mesoderm and endoderm in the embryo, i.e., * ectoderm: nervous system, epidermis * mesoderm: skeleton, muscles, reproductive structures * endoderm: lining of the digestive and respiratory systems, endocrine glands	**Section 15.1: Gastrulation and the Start of Tissue Formation, p. 511** **Neurulation and Organ Formation, p. 512**	**Questions for Comprehension: 14, p. 512** **15–19, p. 515** **Section 15.1 Review: 5, 10, p. 518** **Chapter 15 Review: 6, 7, 14, p. 536** **Chapter 15 Test** Unit 6 Review: 4, 14, p. 540

	Student Textbook	Assessment Options
30–B3.4k describe the influence of environmental factors on embryonic and fetal development of body structures or systems, e.g., maternal lifestyle, teratogens such as alcohol, drugs, viral infections	**Section 15.3: The Effects of Teratogens on Development, p. 521** **Thought Lab 15.1: Folic Acid and Neural Tube Defects, p. 524**	**Questions for Comprehension: 27–28, p. 523** **Thought Lab 15.1: Analysis, p. 524** **Section 15.2 Review: 3, p. 528** **Chapter 15 Review: 15–16, p. 536** **Chapter 15 Test** Unit 6 Review: 44, p. 542
30–B3.5k describe the physiological or mechanical basis of different reproductive technology methods, i.e., conception control, *in vitro* fertilization, infertility reversal.	**Throughout Section 15.3, pp. 529–534** **Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533**	**Questions for Comprehension: 33-34, p. 530** **35-36, p. 532** **Thought Lab 15.2, Analysis, p. 533** **Section 15.3 Review: 1–5, p. 534** **Chapter 15 Review: 25, p. 537** **Chapter 15 Test** Unit 6 Review: 35, 39, pp. 541–542
Outcomes for Science, Technology, and Society (Emphasis on social and environmental contexts)		
30–B3.1sts explain that science and technology are developed to meet societal needs and expand human capability by * *analyzing the use of technology to solve problems of immunological incompatibility between fetus and mother and possible solutions to such problems*	**e.g., Connections (Social and Environmental Contexts), Stem Cells, Section 15.2, p. 527**	**e.g., Connections, Section 15.2, p. 527**
30–B3.2sts explain why decisions regarding the application of scientific and technological development involve a variety of perspectives including social, cultural, environmental, ethical and economic considerations by * *assessing the effects of conception control technology on population demographics in developed and underdeveloped countries*	**Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533** Career Focus: Ask a Sexual and Reproductive Health Coordinator, p. 538	**Thought Lab 15.2, Extension, p. 533** Career Focus, 1–3, p. 539
* a*ssessing the use of imaging technologies in monitoring fetal development, e.g., ultrasound, CVS, amniocentesis, fetal heart rate monitor*	**Section 15.3: In Vitro Fertilization, p. 530**	
* *discussing how knowledge of embryonic/fetal development has influenced the value that society places on human life*	**Section 15.3: Social and Ethical Questions, p. 532**	
* *discussing the societal impact of chemicals on fetal development, e.g., environmental contaminants such as polychlorinated biphenyls (PCBs), heavy metals, dioxins and furans.*	**Thought Lab 15.1: Folic Acid and Neural Tube Defects, p. 524**	**Thought Lab 15.1: Analysis, p. 524**

	Student Textbook	Assessment Options
Skill Outcomes		
Initiating and Planning		
30–B3.1s ask questions about observed relationships, and plan investigations of questions, ideas, problems and issues by * *designing an experiment to investigate hormonal changes during pregnancy*	**e.g., Thought Lab 15.1: Folic Acid and Neural Tube Defects, p. 524**	**e.g., Thought Lab 15.1: Analysis, p. 524** **e.g., Section 15.2 Review: 8, p. 528** **e.g., Section 15.3: 5, p. 534**
Performing and Recording		
30–B3.2s conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information by * investigating, using library and electronic sources, the effects of environmental factors on human embryonic and fetal development, e.g., *alcohol, cocaine, cigarette smoke, diet and prescription drugs*	**Thought Lab 15.1: Folic Acid and Neural Tube Defects, p. 524**	**Thought Lab 15.1: Analysis, p. 524**
* *investigating, using library and electronic sources, how embryonic cells communicate during development*	**e.g., Connections (Social and Environmental Contexts) Stem Cells, Section 15.2, p. 527**	**e.g., Connections, Section 15.2, p. 527**
* *researching the societal impact of technology, e.g., ultrasound, amniocentesis,* in vitro *fertilization, chorionic villi sampling.*	**Section 15.3 Social and Ethical Questions, p. 532** **Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533**	**Thought Lab 15.2, Analysis, p. 533**
Analyzing and Interpreting		
30–B3.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions by * observing the changes during embryo development, using preserved material such as chicken embryos, prepared slides, models or computer simulations, and extrapolating these events to the development of a human	**Investigation 15.A: Comparing Embryonic Structures, p. 519**	**Investigation 15.A: Analysis, p. 519**
* evaluating, from published data, the effectiveness and safety of various reproductive technologies	**Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533**	**Thought Lab 15.2, Analysis, p. 533**

	Student Textbook	Assessment Options
* interpreting hormonal data from published investigations, e.g., *pregnancy testing*	Section 14.3: The Ovarian Cycle, p. 496 The Uterine Cycle, p. 498 Aging and the Menstrual Cycle, p. 498 Thought Lab 14.2: Testosterone and Male Development, p. 494 Thought Lab 14.4: Therapy Options for Menopause, p. 495 Investigation 14.B: The Menstrual Cycle, p. 500	Thought Lab 14.2, p. 494 Thought Lab 14.4, p. 495 Investigation 14.B: Analysis, Conclusion, p. 500 Chapter 14 Review: 10, 16, p. 504 Unit 6 Review: 46–51, p. 543
* *analyzing the stages of embryo and fetal development*	**Chapter 15 Launch Lab: Visualizing Early Human Development, p. 507** **Investigation 15.A: Comparing Embryonic Structures, p. 519**	**Chapter 15 Launch Lab: Analysis, p. 507** **Investigation 15.A: Analysis, p. 519**
Communication and Teamwork		
30–B3.4s work as members of a team in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results by * developing clear and logical arguments, based on published data, to defend a given decision on the effectiveness and safety of available reproductive technologies	**Thought Lab 15.2: Evaluating Reproductive Technologies, p. 533**	**Thought Lab 15.2, p. Analysis, 533**

Chapter 15

Human Development

Student Textbook pages 506–543

Chapter Concepts

15.1 Fertilization and Embryonic Development

- Fertilization results in a zygote, which goes through several stages of development before implantation.
- An implanted embryo undergoes significant stages of development and differentiation in the first eight weeks after fertilization.
- Extra-embryonic membranes, some of which develop into the placenta and umbilical cord, provide support, protection, and nourishment for the developing life.

15.2 Fetal Development and Birth

- Fetal development occurs over about the last 30 weeks of pregnancy.
- Parturition is the process leading up to and including birth.
- Hormones play an important role during pregnancy, birth, and lactation following birth.
- Environmental factors, including teratogens, have an effect on embryonic and fetal development.

15.3 Development, Technology, and Society

- Reproductive technologies include technologies to enhance reproductive potential and technologies to restrict reproductive potential.
- The use of reproductive technologies leads to ethical, moral, legal, and personal issues.

Common Misconceptions

- Students may believe that stem cell research is performed on embryos that have undergone many divisions and differentiated. Stem cell lines for research are generated from embryos that are only a few cells large (i.e., just hours after fertilization).
- Students may believe that human embryological development is truly unique. They may not understand that in the early stages of development vertebrate embryos are strikingly similar.
- Students may not realize that reproductive technologies such as IVF are expensive techniques that are not covered in Canada by our healthcare plan. This becomes a personal expense to the parents using it.
- Students may believe that as soon as the zygote is formed, the organism is beginning to develop and grow. This is not initially true; the initial cleavage divisions are producing smaller cells within the zygote, which remains the same size.
- Students need to understand that an individual can become pregnant once she has begun her menstrual cycle. There is no support to the thought that someone cannot get pregnant the first time they have intercourse.
- Pregnancy can happen during the flow period of the menstrual cycle. The sperm can live up to 5 days within the body; as well, many women ovulate more than once within a month, making the rhythm method a challenge to manage.
- Infertility is a couple's problem. Based on statistics, 40% of the time it is the man and his sperm, 40% of the time it is problems within the female reproductive system, and 20% of the time, it is the unique situation created by this particular couple.

Helpful Resources

Books and Journal Articles

- Advanced biology texts such as *Inquiry into Life*, by Sylvia S. Mader, 10th edition, McGraw-Hill, 2003, or *Biology, 7th* Edition, by Raven, Johnson, Losos, and Singer, McGraw-Hill, 2005, provide more detailed information on human reproduction.

Web Sites

- Web links related to human development can be found at **www.albertabiology.ca**. Go to the Online Learning Centre. Log on to the Instructor Edition, and choose Teacher Web Links.
- Cable channels, such as TLC, CLT, Discovery Health, PBS, and Life, produce many excellent series and specials on human reproduction.
- Invite a guest speaker in from the community – contact your public health nurse (call 311 in Calgary for a contact).
- *Maclean's*, "Canada is in the Vanguard of Stem Cell Research," May 30, 2005. Also available online at the *Canadian Encyclopedia* web site.

List of BLMs

Blackline masters (BLMs) have been prepared to support the material in this chapter. The BLMs are either for assessment (AST); use as overheads (OH); use as handouts (HAND), in particular to support activities; or to supply answers (ANS) for assessment or handouts. The BLMs are in digital form, stored on the CD that accompanies this Teacher's Resource or on the web site at **www.albertabiology.ca**, Online Learning Centre, Instructor Edition, BLMs.

Number (Type)

15.0.1 (HAND) Launch Lab: Visualizing Early Human Development
15.0.1A (ANS) Launch Lab: Visualizing Early Human Development Answer Key

15.1.1 (HAND) Fertilization
15.1.1A (ANS/OH) Fertilization Answer Key
15.1.2 (HAND) From Ovulation to Implantation
15.1.2A (ANS/OH) From Ovulation to Implantation Answer Key

15.1.3 (OH) Hormone Levels During Pregnancy
15.1.4 (OH) Gastrulation
15.1.5 (OH) Organ Formation from the Primary Germ Layers
15.1.6 (OH) Neurulation
15.1.7 (OH) Carnegie Stages
15.1.8 (HAND) Extra-embryonic Membranes
15.1.8A (ANS/OH) Extra-embryonic Membranes Answer Key
15.1.9 (OH) Nourishing the Embryo
15.1.10 (HAND) Investigation 15.A: Comparing Embryonic Structures
15.1.10A (ANS) Investigation 15.A: Comparing Embryonic Structures Answer Key

15.2.1 (OH) Major Events in Prenatal Development, by Month
15.2.2 (OH) Critical Phases of Prenatal Development
15.2.3 (HAND) Positive Feedback Mechanisms Controlling Parturition
15.2.3A (ANS/OH) Positive Feedback Mechanisms Controlling Parturition Answer Key
15.2.4 (HAND) Thought Lab 15.1: Folic Acid and Neural Tube Defects
15.2.4A (ANS/OH) Thought Lab 15.1: Folic Acid and Neural Tube Defects Answer Key
15.2.5 (OH) The Three Stages of Parturition
15.2.6 (HAND) Milk Production and Secretion
15.2.6A (ANS/OH) Milk Production and Secretion Answer Key

15.3.1 (HAND) Thought Lab 15.2: Evaluating Reproductive Technologies: Safety and Effectiveness
15.3.1A (ANS/OH) Thought Lab 15.2: Evaluating Reproductive Technologies: Safety and Effectiveness Answer Key
15.3.2 (HAND) Human Development Graphic Organizer
15.3.2A (ANS/OH) Human Development Graphic Organizer Answer Key

15.4.1 (AST) Chapter 15 Test
15.4.1A (ANS) Chapter 15 Test Answer Key

Using the Chapter 15 Opener

Student Textbook pages 506-507

Teaching Strategies

- Use the photograph of the sperm penetrating an egg, on pages 476-477, to contrast with the photograph of the complex organism that results about 266 days later, as shown on pages 506-507, to spark consideration of the process of development and lead into the Launch Lab on page 507.

Launch Lab: Visualizing Early Human Development

Student Textbook page 507

Purpose

The purpose of this activity is to determine some student preconceptions, e.g., what an embryo looks like at four weeks; and what's going on during the first three weeks, since there's virtually no gain in mass. Students will speculate on what other changes might be occurring during this time.

Outcomes

- B3.3s, 4th bullet

Advance Preparation

When to Begin	What to Do
1 week before	■ Book the computer lab for spreadsheet program
1 day before	■ Photocopy **BLM 15.0.1: Launch Lab: Visualizing Early Human Development**

Time Required

- 10 minutes – graphing activity
- 20 minutes – Analysis questions

Helpful Tips

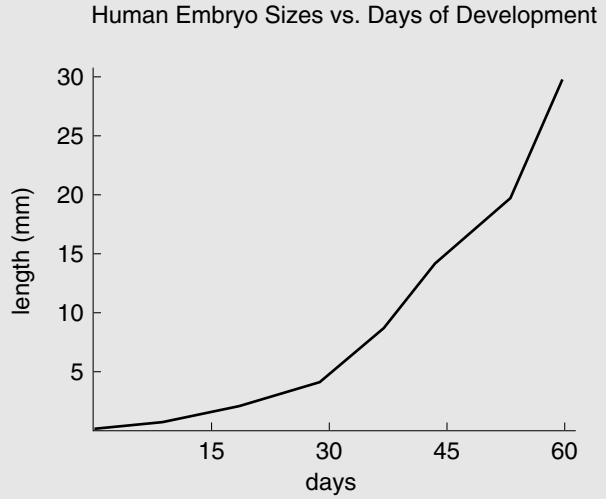
- Use **BLM 15.0.1: Launch Lab** to support this activity. Modify as necessary.
- The first 56 days (two months) are the most crucial period of human development. Among the many changes that occur during this time is a rapid increase in size, and it is hoped that this will lead to a "wow" moment of astonishment regarding changes that occur during this time of development. The change in size from day 1 to day 56 is truly amazing compared even to the change in size from day 57 to day 266. Encourage students to find points of reference such as the period at the end of a sentence, a finger tip, or a small chicken egg to help them visualize the sizes under consideration.
- Have students use a spreadsheet program to create their graphs. They may also use the computer program to create images on the page that are the same size as those listed.
- You may ask more advanced students to calculate and graph the percentage of change in size through the days to further emphasize the rate of change underway.

SUPPORTING DIVERSE STUDENT NEEDS

- Advanced students may be challenged to calculate and graph the rate of change during the first eight weeks of a pregnancy.

Answer to Procedure Question

1.



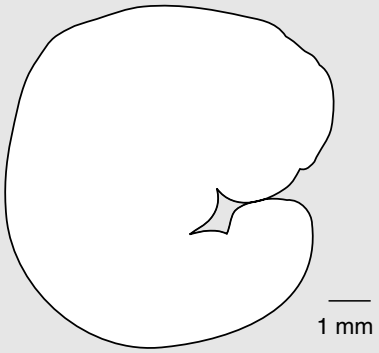
Answers to Analysis Questions

1. The least amount of change in size is occurring from days 1-7 (none).

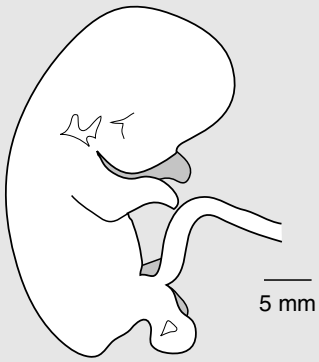
2. Change in length during the first four weeks is significantly less than the second four weeks. The first four weeks shows an increase in length by 3 mm; the second four weeks shows an increase in length of 27 mm.

3. Students' sketches should show a progression with more human features emerging in the second sketch.

Sketch of embryo at 4 weeks



Sketch of embryo at 8 weeks



Changes that are occurring during the first four weeks are: rapid cell division (mitosis), implantation, cell differentiation begins. Changes that occur during the second four weeks are: tissues form, organs begin to form, head and limbs form.

4. Students need to list any five of the following changes:

Month	Significant developmental events	
3	• Eyes are well developed, but eyelids are still fused. • Nose develops bridge. • Fetus swallows amniotic fluid and produces urine. • Sexes can be distinguished visually.	• Limbs are well-formed, with nails on fingers and toes. • External ears are present. • Fetus moves but too weakly for mother to feel it.
4	• Face looks more distinctly human. • Body is larger in proportion to head. • Skin is bright pink. • Scalp has hair.	• Joints are forming. • Lips exhibit sucking movements. • Heartbeat can be heard with a stethoscope.
5	• Body covered with fine hair (lanugo). • Skin has oily secretion to protect it from amniotic fluid. • Fetus is now bent forward into "fetal position" because it is beginning to outgrow the amniotic sac.	• Mother can feel fetal movements. • Skin is bright pink.
6	• Eyes are open. • Eyelashes form.	• Skin is wrinkled, pink, and translucent.
7	• Skin is wrinkled and red. • Fetus turns to an upside-down position. • Bone marrow is now the only site for red blood cell formation.	• Testes descend into scrotum. • Fetus can usually survive if born prematurely.
8	• Fatty tissue deposition gives fetus a more plump, "babyish" appearance, with lighter, less wrinkled skin. • Twins are usually born now.	
9	• More fat deposition occurs. • Lanugo is shed.	• Nails extend to or beyond fingertips. • Birth is imminent.

5 (a) Substances that are harmful to the developing baby include alcohol, cigarette smoke, some antibiotics, drugs, and environmental toxins.

(b) The developing fetus will be most sensitive to harmful substances during the first eight weeks of pregnancy because that is when all the organs, along with the central nervous system and blood cells and major blood vessels, begin to form.

SUPPORTING DIVERSE STUDENT NEEDS

- Advanced students may be challenged to calculate and graph the rate of change during the first eight weeks of a pregnancy.

Assessment Options

- Collect and assess students' graphs and sketches, as well as answers to questions 4 and 5 to gauge their level of prior knowledge and their understanding of the process of human development and the threats to it.

15.1 Fertilization and Embryonic Development

Student Textbook pages 508-519

Section Outcomes

Students will:

- trace the processes and key events that occur during embryonic development (the first eight weeks of life)
- describe the significance of the primary germ layers and identify the tissues and organs that arise from them
- compare embryonic changes and extraembryonic structures in humans and other animals

Key Terms

fertilization
zygote
cleavage
blastocyst
inner cell mass
implantation
human chorionic gonadotropin (hCG)
gastrulation
primary germ layers
morphogenesis
differentiation
neurulation
extra-embryonic membranes
allantois
amnion
chorion
yolk sac
placenta
umbilical cord

Biology Background

- Embryologists have a series of terms that they use to describe the various stages of the transformation of the zygote into an embryo (zygote → morula → blastocyst → gastrula → embryo); they also divide the development into two distinct phases: the embryonic (first 8 weeks) and fetal periods (week 9 to birth).
- The cellular processes involved in the very early stages include mitosis (the continuous division of cells throughout development), cleavage (division without growth of cell size), implantation (blastocyst nestles into the endometrium), gastrulation (formation of the primary germ layers), morphogenesis (formation of the distinct structures of the embryo through differentiation), neurulation (formation of the neural tube (leading to development of the brain and spinal cord), and the formation of organs). These processes take place over the first 8 weeks of the pregnancy, and at the end of them, the embryo is considered to be a fetus.
- The embryo (and later the fetus) is supported by a number of structures: the placenta is a layered, disk-shaped organ that is composed of both tissue from the mother and the developing embryo. The extra-embryonic membranes (the allantois, amnion, chorion, and yolk sac) contribute the embryological part of the placenta formation. The umbilical cord also supports the developing embryo. Support functions include: nutrition, excretion, respiration, and protection.
- The hormones progesterone and estrogen are secreted in varying amounts and from varying structures throughout the developmental process.
- Not all scientists consider fertilization to be the beginning of development; some consider the term "development" to be only correctly used to describe the embryo after implantation has taken place.

Teaching Strategies

- Prior to starting the chapter, ask students to bring in their ultrasound photos, if their parents still have them. This will help to generate student interest, as many of the ultrasounds will have been taken at different times in the pregnancy and preliminary comparisons of development and size can be made prior to starting the chapter. If none are available, try to obtain some from an outside source.
- At the start of the chapter, ask each student to find a picture or photo of a developing embryo from a magazine or newspaper. Ask them to note the stage in development on the back and to ensure that that information does not appear on the front of the picture. As a review activity, set up the collected photos on a board or bench, and have students arrange them chronologically. At the end of the exercise, turn the pictures over to find out how accurate the students' sense of the chronology is.
- Use the Questions for Comprehension to help students review the material in this section.
- There are many new terms in this section. Students learn the meaning of new terms by hearing them in context many times. Therefore, use such terms as zygote, morula, blastocyst, gastrula, neurula, amnion, and chorion often and in context.
- A number of overhead masters and reinforcement tools have been prepared for this section. Many are adapted from illustrations in the student text and can be used to practice or test recall. You will find them with the Chapter 15 BLMs on the CD that accompanies this Teacher's Resource or at **www.albertabiology.ca**, Online Learning Centre, Instructor Edition, BLMs.

Number (Type)
15.1.1 (HAND) Fertilization
15.1.1A (ANS/OH) Fertilization Answer Key

15.1.2 (HAND) From Ovulation to Implantation
15.1.2A (ANS/OH) From Ovulation to Implantation Answer Key
15.1.3 (OH) Hormone Levels During Pregnancy
15.1.4 (OH) Gastrulation
15.1.5 (OH) Organ Formation from the Primary Germ Layers
15.1.6 (OH) Neurulation
15.1.7 (OH) Carnegie Stages
15.1.8 (HAND) Extra-embryonic Membranes
15.1.8A (ANS/OH) Extra-embryonic Membranes Answer Key
15.1.9 (OH) Nourishing the Embryo

- All Students: Consider pairing or grouping students based on their particular needs, whether they are for strengthening language skills or consolidating conceptual understanding.
- When working on large concepts, break larger topics into chunks for students. Allow use of computer for written assignments and graphic organizers.
- Suggest that students with language difficulties begin (or continue) to build a glossary that explains the terms in their own words.
- Provide students with notes ahead of time throughout the chapter so that they can listen while you teach

Answers to Questions for Comprehension

Student Textbook page 509

Q1. There are 46 chromosomes that make up the zygote (fertilized egg): 23 from the sperm and 23 from the egg.

Q2. The egg must be fertilized within 12 to 24 hours of release because it loses its capacity to develop further after 24 hours.

Q3. The sperm must survive the acidic environment of the female reproductive tract. In addition, only one oviduct contains an egg each month; many of the sperm may enter the "wrong" oviduct.

Q4. It takes the actions of several sperm and their acrosome enzymes to break through the protective jelly-like layer of the egg, so a sperm that arrives after the first few have breached the barrier is able to utilize its own acrosome enzymes to enter successfully.

Student Textbook page 511

Q5. Cleavage is cell division without growth. This is the initial stage of mitotic divisions after the formation of the zygote in the oviduct. The cleavage divisions do not increase the size of the zygote. They only increase the number of cells within it.

Q6. The morula reaches the uterus within 3-5 days of fertilization, and upon arrival it begins to fill with fluid that diffuses from the uterus. Within the fluid-filled space inside the morula, two different groups of cells develop and these two different groups of cells characterize the blastocyst: ones that nourish the embryo and ones that become the embryo.

Q7. It is the inner cell mass that develops into the embryo.

Q8. Implantation occurs when the blastocyst nestles in the endometrium (lining of the uterus). This happens between about the 10th and 14th day after fertilization. The blastocyst attaches to the endometrium by secreting enzymes from the trophoblast cells within to digest some of the tissues and blood vessels.

Q9. hCG is human chorionic gonadotropin hormone, which is secreted to maintain the corpus luteum once implantation has taken place. It is secreted at a high level for the first two months, declining to a low level by the end of four months, when there is a fully functional placenta to take over the production of estrogen and progesterone from the corpus luteum. At this point, the hormone production of the corpus luteum is no longer important, although it continues to exist throughout the pregnancy.

Student Textbook page 512

Q10. The amniotic cavity is a space that forms between the inner cell mass and the trophoblast. This space fills with fluid, and this is where the embryo will develop, within the sac known as the amnion.

Q11. The embryonic disk is composed of three layers: the ectoderm, mesoderm, and endoderm.

Q12. The creation of the primary germ layers is called gastrulation. The developing embryo at this point is called the gastrula.

Q13. Morphogenesis, which begins with gastrulation, is a series of events that form the distinct structures of the developing embryo. It depends on the ability of embryonic cells to change into different types of cells.

Q14. The development of the primary germ layers creates three distinct layers of cells: the endoderm, mesoderm, or the ectoderm. The cells in the primary germ layers are the source of all of the organs and tissues of the body. The process of the development of these cells into particular shapes and able to perform particular functions is called differentiation.

Student Textbook page 515

Q15. Neurulation is the development of the neural tube (found just above the notochord), which develops into the brain and the spinal cord. Cells along the surface of the notochord begin to thicken. As the cells thicken, folds develop along each side of a groove along this surface. As the folds fuse, they become the neural tube.

Q16. During the third week, a thickened band of mesoderm cells (a primary germ layer) develops along the back of the embryonic disk. These cells lie along what will become the baby's back and come together to form the notochord (the basic framework of the skeleton). In addition, a small reddish bulge that contains the heart forms; the heart begins to beat on the 18th day.

Q17. During the fourth week, the blood cells are forming and beginning to fill the developing blood vessels; the lungs and kidneys are taking shape; small buds which will become limbs form; a distinct head, with early evidence of eyes, ears, and a nose, is visible.

Q18. Students will list any four of the following: In the fifth week, the lidless eyes are open, and the cells of the brain are differentiating very quickly. At the sixth week, the brain is continuing to develop; the limbs are lengthening and can flex; the gonads produce hormones to influence the development of the external genitalia. In the seventh and eighth weeks, the organs are fully formed; the nervous system is coordinating the body activity; a skeleton of cartilage has formed; eyes are well developed, but not open; nostrils are developed but are plugged with mucus; external genitalia are developing, but are undifferentiated at this point. Upon completion of the eighth week, approximately 90 percent of the organs and structures are established, and continue to enlarge and mature.

Q19. The embryo is identified as a fetus ("offspring") after the eighth week of pregnancy, when the organs and structures are established.

Student Textbook page 517

Q20. The extra-embryonic membranes are: the allantois, the amnion, the chorion, and the yolk sac.

Q21. One portion of the placenta develops from the chorion. The allantois is the foundation of the umbilical cord.

Q22. The placenta has nutritional, excretory, respiratory, endocrine, and immune functions.

Nutritional: transports nutrients such as glucose, amino acids, and fatty acids; it also stores nutrients (protein, fats, carbohydrates, minerals) to be released later in the pregnancy.

Excretory: transports wastes such as urea, ammonia, and creatinine from the fetal blood to the mother's blood.

Respiratory: transports oxygen from mother to fetus, and carbon dioxide from fetus to mother.

Endocrine: secretes hormones such as estrogen, progesterone, and human chorionic gonadotropin; allows these hormones to diffuse from mother to fetus and fetus to mother.

Immune: provides passive immunity by transporting antibodies from the mother to the fetus's blood.

Q23. The umbilical cord contains one vein and two arteries; the arteries transport oxygen-depleted blood from the fetus to the placenta. The vein transports oxygen-rich blood to the fetus. (Students can diagram the pathway to summarize the role.)

Biology File: Web Link

Student Textbook page 517

Selected complications involving the umbilical cord include:

- *false knots*: no clinical significance
- *absence of one (of the two) umbilical artery* (< 1% of births); 20-50% of these cases will have fetal anomalies including cleft lip, cardiovascular deficiencies, or spina bifida.
- *velamentous insertion* (<1% of births): the umbilical cord inserts into the chorion away from the placental edge; this can result in hemorrhage and low birth weight.
- *vasa previa* (1 per 2000-3000 births): occurs when the umbilical cord inserts into the placenta abnormally. This can result in unprotected vessels; if they cross the cervix and are ruptured, this can result in death. More than half of these babies will be stillborn.
- *true cord knots* (1% of pregnancies): likely to occur early during pregnancy;
- *Nuchal cord* (1 loop – 20% of pregnancies; more than one loop in fewer than 2 per 1000 cases): when the cord becomes coiled around parts of the body (i.e., the neck); rarely causes harm to the fetus. If the cord is compressed during labour, the heart rate may decline.
- *cord stricture* (1 per 250 deliveries): the constriction or internal blocking of the cord. Most cases will result in stillbirth.
- *cord prolapse* (1 in 300 births): the cord slips into the vagina before birth; if cord is compressed, it can result in stillbirth if the baby is not delivered (by Caesarian section) immediately.

Section 15.1: Review Answers

Student Textbook page 518

1. Students should include three of the following:

- release of an egg from an ovary
- release of sperm into the female reproductive tract
- a quantity of sperm must survive the acidic environment of the female reproductive tract
- a quantity of sperm must be in the same oviduct as the egg
- sperm must encounter the egg within 12-24 hours of its release
- acrosome enzymes from the sperm must dissolve some of the jelly-like coating on the egg to allow a sperm to penetrate the egg
- a sperm must enter the egg

2. A fertilized egg has 23 pairs of chromosomes (46) rather than the 23 that the sperm and egg carry. The fertilized egg has a much longer life span than the limited life of the sperm (measured in days) or the egg (measured in hours). The fertilized egg, now known as a zygote, can undergo mitotic divisions (cleavage) and grow and develop into a new organism.

3. During implantation, the blastocyst (a hollow structure with two types of cells inside) attaches to the endometrium by secreting enzymes from the trophoblast cells (outer layer) to digest some of the tissues and blood vessels. This allows for the nestling of the blastocyst within the endometrium.

4. zygote → morula → blastocyst → gastrula

The *zygote* is formed by the union of the sperm and egg within the oviduct. As cleavage occurs, more cells are formed. The *morula* is the resulting mass of 16 cells that enters the uterus. As it absorbs fluid from the uterus, two different groups of cells form and the structure becomes known as the *blastocyst*. After implantation, the cells in the blastocyst continue to develop and differentiate into three layers in a process knows as gastrulation, and the result is known as the *gastrula*.

5. The three primary germ layers are:

- *ectoderm*: the outer layer; develops into structures such as the outer skin (epidermis), hair, nails, sweat glands, and mammary glands, as well as nerve tissue, pituitary gland, adrenal medulla, and tooth enamel.
- *mesoderm*: the middle layer; develops into the dermis of the skin, cellular lining of the blood vessels, lymphatic vessels, body cavities, muscle, connective tissue (bone, cartilage, blood), adrenal cortex, heart, kidneys and ureters, spleen, and internal reproductive organs.
- *endoderm*: the inner layer; develops into the cellular lining of the respiratory and digestive tracts, as well as the lining for the urinary bladder and urethra. It also develops most of the liver, gall bladder, pancreas, thymus, tonsils (partial), and the parathyroid and thyroid glands.

6. (a) hCG maintains the corpus luteum within the ovary so that the production of estrogen and progesterone will continue. This maintains the endometrium (to nourish the embryo/fetus) and prevents menstruation.

(b) hCG uses the circulatory system to travel; this would allow for detection within the blood. Excess hormones are filtered by the kidneys and excreted through the urine.

7. The table, concept map, or labelled diagram should show the following: the extra-embryonic membranes (amnion, yolk sac, allantois, chorion), the placenta, and the umbilical cord. (Students could use **BLM 15.5** to complete the diagram and their notes.)

- *amnion*: the sac that becomes fluid-filled to protect the embryo/fetus.
- *yolk sac*: contributes to the formation of the digestive tract and the first blood cells.
- *allantois*: develops to become the foundation of the umbilical cord and the bladder.
- *chorion*: this membrane encloses all the other extra-embryonic membranes and embryo. It will form the fetal portion of the placenta.
- *placenta*: a structure that allows nutrients and gases to diffuse from the mother's blood system to that of the embryo/fetus because they are so close together. It has nutritional, excretory, respiratory, endocrine, and immune functions.
- *umbilical cord*: two arteries transport wastes and oxygen-depleted blood from the fetus to the placenta and one vein brings oxygen-rich blood to the fetus.

8. (a) Trophoblastic nutrition reaches its peak at 3 weeks and ends at 12 weeks.

(b) Placental nutrition begins at 4 weeks.

(c) The shape indicates the gradual and continual increase in the nutrition provided to the developing fetus throughout the pregnancy.

(d) Trophoblastic and placental nutrition are about equal at 8 weeks.

9. Developing human embryos do not have a significant amount of yolk as part of their supporting tissues because they stay inside the mother's body and obtain their nutrition from her body via the placenta as the pregnancy progresses. Chick embryos must have their nutrition with them inside the egg because they develop outside the mother's body.

10.

Time Period	Place of Occurrence	Major Events
12 - 24 hours after ovulation oviduct	oviduct	■ fertilization (the formation of the zygote); sperm and egg nuclei fuse to form 23 pairs of chromosomes
within 30 hours after fertilization	oviduct	■ mitotic division (cleavage) begins
3-5 days after fertilization	uterus	■ morula enters the uterus; begins to fill with uterine fluid; blastocyst develops as two different groups of cells form
5th to 7th day	uterus	■ blastocyst attaches itself to the endometrium

Time Period	Place of Occurrence	Major Events
10th to 14th day	endometrium (in the uterus)	■ implantation proceeds as blastocyst sinks into the uterine wall; trophoblast begins to secrete hCG
second week	endometrium	■ implantation completed; amniotic cavity forms and fills with fluid and the embryonic disks form (two layers)
	endometrium	■ gastrulation (formation of three primary germ layers: endoderm, mesoderm, ectoderm); blastocyst now known as a gastrula ■ morphogenesis begins, forming distinct structures of the developing organism
third week	uterus / endometrium	■ neurulation occurs, marking the start of organ formation ■ notochord forms; nervous system begins to develop; heart begins beating around day 18
fourth week	uterus	■ rapid growth and differentiation; blood cells and vessels are forming; buds for appendages appear; head is visible with hints of eyes, ears, nose
fifth week	uterus	■ eyes open; brain cells are differentiating
sixth week	uterus	■ brain development continues; limbs lengthen and flex; gonads begin to produce hormones to influence development of external genitalia
seventh and eighth weeks	uterus	■ organs are formed; nervous system is coordinating body activities; skeleton is formed of cartilage; eyelids developed and cover eyes to protect them; external genitalia forming
end of eight weeks	uterus	■ embryo now considered to be a fetus, with 90 percent of its organs and structures developed; organism looks recognizably human

Investigation 15.A: Comparing Embryonic Structures

Student Textbook pages 519

Purpose

Students will observe changes that occur during embryonic development in a variety of animals, including human; in Part 2, students compare human and chicken embryos. Students will observe the various stages under the microscope as well as compare structures in photographs.

Outcomes

- B3.3s
- B3.3s

Advance Preparation

When to Begin	What to Do
1 day before	■ Locate materials ■ Photocopy **BLM 15.1.10: Investigation 15.A**

Materials
■ microscopes ■ prepared slides showing development of an animal from zygote to embryo (e.g. sea star, sea urchin)

Time Required

- 20 minutes: observations and diagrams
- 20 minutes: Analysis questions

Helpful Tips

- Use **BLM 15.1.10 Investigation 15.A** to support this activity. Modify as necessary.
- Review proper use of the microscope and expectations for scientific diagrams.
- Review key terms and definitions in context prior to beginning activity (cleavage, blastocyst, trophoblast, gastrula, germ layers, morphogenesis, gastrulation, and the extra-embryonic membranes).

Answers to Analysis Questions

1. Slides with evidence that cleavage has occurred will be the ones where students can see distinct cells that are approximately the same size.

2. Students should note the presence of two different groups of cells if a blastocyst has formed. The blastocyst is a hollow structure, with the trophoblast on the outside and the inner cell mass on the inside.

3. Students should note the presence of three layers (the primary germ layers—ectoderm, mesoderm, endoderm) if a gastrula has formed.

4. Students should be identifying any structures using the correct terminology.

5. Birds and humans have similar primary membranes that support the developing embryo.

- Allantois works with the chorion on gas exchange in birds, and stores wastes from and absorbs calcium for the developing bird; in humans, it becomes the umbilical cord and the urinary bladder.
- Amnion provides protection and allows for movement for the developing embryo in both birds and humans.
- Chorion is the outermost membrane, allowing for gas exchange in both birds and humans (is the fetal portion of the placenta in humans).
- Yolk sac and yolk store nutrients for the developing embryo in the chick (and other vertebrates); however, the yolk sac serves no nutritive function in humans (it does not include a yolk); in humans, it produces the first blood cells and helps with the formation of the digestive tract.

6. (a) Animals that develop in eggs that are laid and incubated outside the mother's body (such as frogs, turtles, pike, sea stars, and crows) do not develop in a placenta because the embryo does not attach to the mother to exchange gases.

(b) The placenta develops from the chorion and extends into the uterine lining. In humans, the placenta (originating from the chorion) allows for the exchange of oxygen and metabolic wastes. In birds, the chorion serves a similar function in that it is also involved in gas exchange; however it combines with the allantois (an extra-embryonic membrane) rather than with the mother's tissues.

Assessment Options

- Collect and assess students' diagrams for key details and labels from Part 1.
- Collect and assess student's answers to Analysis questions.

15.2 Fetal Development and Birth

Student Textbook pages 520-528

Section Outcomes

Students will:

- trace the processes and key events that occur during fetal development (the last thirty weeks of prenatal life)
- describe and investigate the effect of teratogens and other environmental factors on the development of prenatal body structures and systems
- trace the processes of parturition and lactation, and outline their control mechanisms

Key Terms

teratogen
fetal alcohol spectrum disorder (FASD)
parturition
lactation

Biology Background

- While pregnancy is traditionally divided into three 12-week sections, development at the end of the first trimester and during the other two—the fetal period—is the subject of Section 15.2.
- Teratogens interfere with the normal development of the embryo and fetus. They may result in the end of the pregnancy or a birth defect. Teratogens include medications, chemicals, and infectious diseases as well as environmental agents that can affect fetal development. Thalidomide is an example of a medication that affected the development of fetuses. It was prescribed originally as an anti-nausea drug for morning sickness, and as a result large numbers of children in Germany and Japan were born with physical defects.
- Heavy, sustained drinking during pregnancy can cause a range of developmental problems collectively known as Fetal Alcohol Spectrum Disorder (FASD).
- The hormones oxytocin and prostaglandins help stimulate the uterine contractions that assist the movement of the fetus during birth.
- Suckling triggers the secretion of oxytocin by the posterior pituitary, which stimulates the contraction of the milk glands and ducts for lactation.

Teaching Strategies

- Before starting to study this section, ask a number of questions such as, "How big is a fetus when 90 percent of its organs and structures are established?" (the size of a paperclip); "When does the fetal heart begin to beat?" (18

days after fertilization); "At what stage can a fetus begin to move its arms and legs?" (fourth month); "Does a fetus suck its thumb?" (yes); and "Does a fetus urinate?" (yes, beginning in the third month). When students learn the answers, they may be surprised at how soon body functions develop.

- Have students create a time line or flow chart illustrating stages of fetal development (week 9 to birth) with corresponding day, month, and trimester included. This assignment can be used by students for quick reference throughout the section. Distribute **BLM 15.2.1 Major Events in Prenatal Development, by Month** to help students organize their work.
- Have students complete the Biology File (Try This) on page 520 to summarize and reinforce the key events of development during the embryonic and fetal periods of pregnancy.
- Introduce and discuss specific examples and effects of a teratogen such as alcohol.
- Refer students to list of known teratogens; have them choose one and research what it is, how the mother can come into contact with it, its effects on the fetus, and ways to prevent contact. Use **BLM 15.2.2 Critical Phases of Prenatal Development** to help students organize their work.
- Have students work in groups and create an advertising campaign (poster, brochure, computer slide show, presentation, or commercial) outlining a particular teratogen, its risks to the developing fetus, and advice for a target audience on how to avoid coming into contact with the teratogen.
- Have students design and create a tip sheet for pregnant mothers on ways to ensure the development of a healthy fetus.
- Show a video of human development.
- Ask students to complete **BLM 15.2.3 Positive Feedback Mechanisms Controlling Parturition** to help them review the process and the hormones involved.
- The overhead masters and reinforcement tools that have been prepared for this section are listed below. You will find them with the Chapter 15 BLMs on the CD that accompanies this Teacher's Resource or at **www.albertabiology.ca**, Online Learning Centre, Instructor Edition, BLMs.

Number (Type)
15.2.1 (OH) Major Events in Prenatal Development, by Month
15.2.2 (OH) Critical Phases of Prenatal Development
15.2.3 (HAND) Positive Feedback Mechanisms Controlling Parturition
15.2.3A (ANS/OH) Positive Feedback Mechanisms Controlling Parturition Answer Key
15.2.5 (OH) The Three Stages of Parturition
15.2.6 (HAND) Milk Production and Secretion
15.2.6A (ANS/OH) Milk Production and Secretion Answer Key

SUPPORTING DIVERSE STUDENT NEEDS

- For strengthening language skills, have students continue to build their own glossary and encourage use of the correct terminology at all times.
- Allow use of computer for written assignments and graphic organizers.
- Provide students with notes ahead of time throughout the chapter so that they can listen while you teach.

Biology File: Try This

Student Textbook page 520

Tips for student projects:

- Projects should include significant events and changes in the embryo/fetus from fertilization through to birth. It may be a good idea to do this project at the end of Section 15.2 after the details of fetal development and birth have been discussed. Have students create a flow chart or time line to begin to organize their thoughts. They may continue the chart they began for section 15.1 Review, question 10. They could also refer to Table 15.2 on page 521 to summarize the details before they begin.
- Information can be gathered from the text. Images can be downloaded from the Internet, sketched by hand or sketched in a drawing program. Direct students to the following web sites for graphics and video links:
http://health.discovery.com/convergence/ultpregnancy/video.html
http://health.discovery.com/convergence/ultpregnancy/labor/labor.html

Answers to Questions for Comprehension

Student Textbook page 520

Q24. The main difference between the embryonic and fetal development periods relates to the type of development of the organism. The embryonic period is a time of morphogenesis when the organs are formed. During the fetal period the organs continue to develop.

Q25. Students can list any three of the following events during the second trimester:

- heartbeat can be heard with a stethoscope
- the bones of the skeleton and joints begin to form
- face begins to look distinctly human,
- the brain grows rapidly
- the nervous system begins to function
- the mother can feel fetal movements as the limbs grow and develop
- fetus becomes covered with fine soft hair and an oily substance
- skin becomes more pink as capillaries extend into it
- body becomes larger in relation to the head
- the scalp develops hair

- eyes open
- eyelashes form
- fetus assumes "fetal position"

Q26. Students can list any three of the following events during the third trimester:

- brain cells form rapidly
- testes descend in males
- fat develops beneath the skin
- fetus shifts to head-first position
- bone marrow takes over production of red blood cells
- the digestive and respiratory systems mature
- lanugo is shed

Student Textbook page 523

Q27. Teratogens are agents that cause structural abnormalities due to exposure during pregnancy.

Q28. Examples of dangers that teratogens pose include:

- structural abnormalities, such as deformed limbs (prescription medication, e.g., Thalidomide)
- constriction of blood vessels, restricting oxygen supply and increasing risk of underweight babies, premature birth, stillbirth, and miscarriage (cigarette smoke)
- damage to the brain, central nervous system, and physical development, leading to decreased weight, height, head size, capacity to learn, memory problems, and personality disorders (alcohol)
- excess amounts of vitamin C consumed by the mother can result in the baby being prone to scurvy, easy bruising, and infections
- increased danger of miscarriage, low birth-weight babies, difficulty fighting infection and disease, developmental delay (exposure to environmental contaminants)

Thought Lab 15.1: Folic Acid and Neural Tube Defects

Student Textbook page 524

Purpose

Students will investigate the effects of folic acid on embryonic and fetal development and discuss the social implications of such effects.

Outcomes

- B3.2s
- B3.1sts

Advance Preparation

When to Begin	What to Do
1 week before	■ Book the computer lab or library for further research on folic acid and neural tube defects.
1 day before	■ Photocopy **BLM 15.2.4: Thought Lab 15.1: Folic Acid and Neural Tube Defects**

Materials
■ Additional resources/readings on teratogens for further research

Time Required

50-60 min

Helpful Tips

- Use **BLM 15.2.4: Thought Lab 15.1: Folic Acid and Neural Tube Defects** for students to summarize their research answers on neural tube defects to the procedure questions
- Post related links (for challenged students) and further readings (for gifted students) on your class web site.
  http://www.medicalnewstoday.com/medicalnews.php?newsid=14077
  http://www.biomedcentral.com/1471-2393/4/20
  http://www.motherisk.org/updates/index.php?id=107
  http://www.stayinginshape.com/3chsbuffalo/libv/k36.shtml

Answers to Analysis Questions

1. The recommended daily amount of folic acid for women who could become pregnant is 0.4 mg daily prior to conception.
2. It is recommended that women should have an adequate intake of folic acid 1 month prior to conception and 3 months after conception.
3. Dietary intake of folic acid is inadequate to prevent NTDs because it is unlikely that women will reach the recommended intake of folic acid without a vitamin supplement.
4. Risk factors related to incidences of NTD such as spina bifida include: hydrocephalus, paralysis, abnormalities of the hips, and bowel and bladder problems. In addition to these problems, other problems such as tendonitis, learning disabilities, and social disorders are also common as the child develops.
5. In November 1998, the Canadian government mandated fortification of foods with folic acid based on the evidence

that showed a relationship between low folic acid intake and increasing prevalence of NTDs. Health organizations had been recommending that women increase their daily intake of folic acid to 400 micrograms since 1992.

Students' comments may include:

- the need for further testing to ensure that there were no negative consequences (side effects) of increased folic acid for the expectant mothers or the general population
- assessment of whether women would be able to increase their intake of folic acid (supplement it) on their own

Assessment Options

- Collect and assess **BLM 15.2.4: Thought Lab 15.1: Folic Acid and Neural Tube Defects.**
- Collect and assess answers to Analysis questions.
- Assess any extension activities or further research on teratogens.

Biology File: Web Link

Student Textbook page 525

A midwife is a specialist in normal pregnancy and birth. She works with other caregivers to provide the best possible care to women and their babies during the childbearing year. Midwifery promotes normal childbirth and the prevention of health problems. Midwives can provide care in both the hospital and home setting.

Their roles and responsibilities include providing primary care to women and their newborns through pregnancy, birth, and 6 weeks after birth.

A midwife is a primary caregiver, which means that she can provide all the care necessary for a healthy woman and her baby throughout pregnancy, birth, and for six weeks afterward. Midwives refer women and babies to family doctors or specialist doctors like obstetricians and pediatricians if the care becomes complicated. Even if care is transferred to a doctor at the birth, midwives will remain involved in the care as a support to the mother and baby. As primary caregivers, midwives do the following:

- care for healthy, pregnant women and their babies;
- see women for all prenatal visits and give prenatal education;
- order laboratory and ultrasound testing if needed;
- arrange for consultations with or transfers to doctors if needed;
- give some medications during pregnancy, labour, birth, and the period after birth if needed;
- take responsibility for primary care during labour, birth, and after birth, including delivering the baby;
- examine the newborn and care for mothers and babies for six weeks after the birth.

Canada's regulation of midwifery falls under provincial jurisdiction (as do other matters related to healthcare). Ontario, British Columbia, Alberta, Manitoba, and Quebec have registration procedures and some of these provinces have begun to integrate regulated midwifery into their health care systems. As of 2006, Saskatchewan and Nova Scotia had expressed an intention to do the same.

In Alberta, midwives have been registered since 1998, based on the submission of detailed portfolios and the results of written and practical exams. Currently, registration is issued under the authority of the Midwifery Health Disciplines Committee of Alberta Health and Wellness. Midwives must meet the requirements for registration annually. As of 2006, funding for midwifery in Alberta is considered a responsibility of the local health region and provision of funding varies. (In Ontario, midwifery is funded province-wide.)

Answers to Questions for Comprehension

Student Textbook page 526

Q29. During parturition (birth), estrogen and progesterone levels drop and prostaglandins cause the release of oxytocin (these two hormones result in uterine contractions).

Q30. A Caesarian section is a surgical procedure where the mother's abdomen and uterus are opened so that the baby can be delivered when a natural birth is unsafe. (A Caesarian section may be required if the mother has an STI, or if the mother has a small pelvis, or if the baby is in breech position or has the umbilical cord wrapped more than once around its neck.)

Q31. Lactation is the formation and secretion of breast milk in the mother.

Q32. Oxytocin causes contractions in the mammary lobules, enabling the mother's milk to flow to the milk ducts.

Biology File: Web Link

Student Textbook page 526

Some people choose to collect and save (bank) the blood that remains in the umbilical cord after birth. In Alberta, the Alberta Cord Blood Bank is operated to collect and preserve the umbilical cord blood stem cells for public use after the baby is born. These cells are used for a variety of treatments, including transplantation for cancer patients, lethal congenital anemia, and other blood disorders. In the future it is also possible that these cells will be used for gene therapy.
Links: http://www.acbb.ca and
http://www.acbb.ca/ACBBmain.htm

Connections (Social and Environmental Contexts) Stem Cells

Student Textbook page 527

Teaching Strategies

- Have an opening discussion to find out what students know about stem cell research and what they want to learn. This will help bring up misconceptions.
- Review the difference between specialized and unspecialized cells.
- Have students read page 527 of the student text and review with the class the difference between adult and embryonic stem cells and the source of these cells.
- Have students look up the latest stem cell research results and present their findings.
- Hold a class debate arguing for and against public funding of stem cell research.

Answers to Connections Questions

1. Leukemia is a cancer of white blood cells, or leukocytes, which results in white blood cells growing and functioning abnormally. The cells are unable to fight infection.

Treatment for leukemia involves removing or destroying all abnormal cells in the patient and allowing healthy ones to grow. Traditional methods involve chemotherapy (drug therapy that kills the target cells). Other methods involve bone marrow transplants. This allows patients to have their bone marrow stem cells replaced with those of a matching donor.

Links for teachers and students

http://gslc.genetics.utah.edu/units/stemcells/sctoday/

www.leukemia-lymphoma.org/all_mat_toc.adp?item_id=2443

For Dr. Weiss, see http://www.cbc.ca/stories/2003/01/03/prolactin030103

2.
- *Totipotent cells*: In mammals, totipotent cells can become any type of cell in the adult body or any cell of the extra-embryonic membranes. The only totipotent cells are the fertilized egg and the first cells produced after the fertilized egg undergoes cleavage, i.e., embryonic cells.
- *Pluripotent stem cells*: These are true stem cells in the sense that they can divide to make any differentiated cell in the body, with the exception of extra-embryonic membranes. Three types of pluripotent stem cells have been found so far, including embryonic stem cells (which can be isolated from the inner cell mass), embryonic germ cells (which can be harvested from the pre-gonads in aborted fetuses), and embryonic carcinoma cells (which are isolated from (teratocarcinomas), tumors that occur in the gonad of a fetus). To date, these three types of pluripotent stem cells can only be isolated from embryonic or fetal tissue.
- *Multipotent stem cells*: These are also true stem cells, however they can only differentiate into a limited number of types of cells. Multipotent stem cells can be found in adult animals in places such as the bone marrow, brain, and liver. Multipotent stem cells in the bone marrow give rise to all of the cells of the blood but not to other types of cells in different tissues. These may also be the cells that produce cancer cells.

Related links and readings for students and teachers:

http://stemcells.nih.gov/info/scireport

http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/S/Stem_Cells.html

http://www.thescientificworld.com/SCIENTIFICWORLDJOURNAL/toc/TSWJ_ArticleLanding.asp?ArticleId=1409

3. Harvesting embryonic stem cells from excess human embryos produced during *in vitro* fertilization is controversial because it destroys the embryo, which could have been implanted to produce another baby. The other side of this argument is that the excess embryos would have been discarded anyway.

Bill C-6 in regards to assisted human reproduction and related research became law on March 27, 2004. This law addresses concerns such as commercialization of sperm and eggs, preconception arrangements, and a lack of information on outcomes. It provides public accountability for stem cell research.

Focussing questions to guide a class discussion include: Are there inherent risks? What are the potential benefits? Who will the technology help? Will it hurt anyone? What are limits of current research?

Links for teacher and students:

http://www.cwhn.ca/resources/cwhn/billc6.html

http://www.cmaj.ca/cgi/content/full/166/8/1077

http://www.cihr-irsc.gc.ca/e/28216.html

http://stemcells.nih.gov/info/

http://gslc.genetics.utah.edu/units/stemcells/

http://www.abpischools.org.uk/resources/poster-series/stemcell/embstcl.asp

http://www.cihr-irsc.gc.ca/e/8000.html (This web page of the Canadian Institutes of Health Research discusses Canada's ethical guidelines for funding stem cell research.)

Opposing views on Canada's guidelines:

http://www.uofaweb.ualberta.ca/expressnews_template/article.cfm?id=1620 (wishes the laws were more liberal)

http://www.physiciansforlife.ca/stemcells.html (is against human stem cell research)

Excellent article on Canadian stem cell research (source of much of last section):

Maclean's "Canada is in the Vanguard of Stem Cell Research," May 30, 2005. Also available online at the Canadian Encyclopedia web site.

Section 15.2: Review Answers

Student Textbook page 528

1. The embryonic period (first eight weeks of pregnancy) is a time of morphogenesis, when the organs are forming. During the fetal period, the existing structures are refined and grow. The fetus looks human, structures such as the arms and legs develop further, and the organs are present and continue to develop.

2. Events and corresponding trimester:

(a) heart starts beating: 1

(b) the body is larger in proportion to the head: 2

(c) fatty tissues are deposited beneath the skin: 3

(d) brain cells are connecting to form more intricate networks: 3

(e) external reproductive organs are distinguishable as male or female: 1

(f) eyelashes form: 2

(g) contractions felt by the mother signal the onset of labour: 3

(h) skin appears wrinkled: 3

(i) nervous system starts to function: 2

(j) external reproductive organs are present but not distinguishable as male or female: 1

(k) the fetus produces urine: 1

(l) the fetus adopts the "fetal position": 2

(m) blood cells and major blood vessels start to form: 1

(n) the head is larger in proportion to the body: 1

3. (a) Folic acid is not a teratogen. (Students may also suggest that HIV is not a teratogen because it does not lead to structural abnormalities.)

(b) Folic acid is not a teratogen because it does not cause a structural abnormality; in fact it protects the embryo/fetus by ensuring that the neural tube closes.

4. Parturition is the process of giving birth.

5. (a) There are three stages of parturition: dilation, expulsion, and the placental stages.

(b)
- *Dilation* stage begins with uterine contractions. The hormone oxytocin causes the cervix to dilate. The amnion breaks, and the amniotic fluid is released through the vagina. This stage usually lasts from 2 to 20 hours.
- The *expulsion* stage occurs when forceful contractions begin to push the baby through the cervix to the birth canal and the head will rotate to make it easier to pass through the birth canal. This stage lasts from 0.5 to 2 hours.
- The *placental stage* occurs about 10 to 15 minutes after the baby is born. During this stage the placenta and umbilical cord are expelled from the uterus. The expelled placenta is called the afterbirth.

6. As parturition begins, estrogen and progesterone levels drop dramatically. Prostaglandins cause the release of oxytocin, and these two hormones cause the uterus to contract.

7. Lactation is the formation and secretion of breast milk in the mother. Prolactin is required for milk production, and it is not secreted until the birth has occurred. Once estrogen and progesterone levels decline, the anterior pituitary begins to produce prolactin, which stimulates milk production. The suckling action of the baby allows milk production to continue. The suckling results in a nerve impulse in the hypothalamus, which stimulates the posterior pituitary to release oxytocin, causing contractions in the mammary lobules. These contractions cause milk to be produced in the mammary lobules and milk to flow to the ducts where the infant can draw it out by suckling. Increased suckling by the infant results in increased milk production, while decreased suckling results in decreased milk production.

8. Inferences will include: the consumption of higher levels of fresh protein sources and fat will likely result in increased bodily reserves for the mother during breastfeeding. The fats consumed are high in Omega-3 fatty acids, the "good fats." The diet may also ensure that needed amino acids are available for the developing child. It is possible that aged food is avoided because of the bacterial counts causing stillbirth. It is also possible that these food choices are based upon the cultural belief that these foods are beneficial to both the mother and fetus during pregnancy.

15.3 Reproduction, Technology, and Society

Student Textbook pages 529-534

Section Outcomes

Students will:
- describe different reproductive technologies
- evaluate various reproductive technologies based on their effectiveness and safety, and justify their evaluation

Key Terms

reproductive technologies
in vitro fertilization (IVF)
sterile
infertile
artificial insemination
surrogate mother
superovulation

abstinence
tubal ligation
vasectomy
contraceptive technologies

Biology Background

- Medical research has provided technologies to both prevent conception and to enhance conception.
- A couple that has been unsuccessful after trying to have a child for a year or more is usually defined as infertile.
- Alcohol is a common cause of sexual impotence and infertility. Heavy, sustained drinking can damage testicular cells, as well as reduce sex drive in both sexes. In females, it can permanently damage the ovaries, as well as affect the menstrual cycle.
- Another name for surrogacy is a gestational carrier.
- The ability to affect conception (enhancing it or preventing it) raises social and ethical issues concerning the value of human life.

Teaching Strategies

- Contact the local public health office to find out if it is possible to have a presenter from a local fertility clinic come in to talk about fertility treatments and options.
- Have the students create a multimedia presentation or interactive web page that shows the different reproductive technologies for conception control, as well as for couples suffering from infertility.
- Collect brochures from the fertility clinic on fertility technologies, as well as brochures from the health region on conception control. Have them available for students to use in Thought Lab 15.2: Evaluating Reproductive Technologies: Safety and Effectiveness.
- Consider having an in-class discussion that puts the debate about family size in a family context. What is the average family size in Canada? (3.1 in the mid-1990s) What are the social and economic implications of having a big family? (Consider the impact on the individual family, the extended family, and the community at large (social planning). Students could look at the population bulge that happened after World War II, which had an impact on everything from home building to demand for education and health care and mortuary services.) What are the social and economic implications of having only one child (or none)? (Students can look at what is happening in modern China, with its rigid family planning policies and severe shortage of females.)
- **BLM 15.3.2 Human Development Graphic Organizer** can be used to help students summarize the content of the chapter.

SUPPORTING DIVERSE STUDENT NEEDS

- Continue to encourage students to build their own glossaries to strengthen their language skills as they consolidate conceptual understanding.
- Allow use of computer for written assignments and graphic organizers.
- Provide students with notes ahead of time throughout the chapter so that they can listen while you teach.

Biology File: Web Link

Student Textbook page 530

Sperm in microgravity conditions originally were believed to have greater motility, and this was thought to possibly have positive effects on fertility. This conclusion was based on samples of bull sperm that were studied in space.

It now appears that the complex nature of the sperm and its enzymes involved with movement as well as fertilization are designed to function optimally in our gravitational environment. The sperm may move more quickly in space, but some enzymes are affected also. If the enzymes affected are involved with the fertilization process, a microgravity environment could make fertilization more difficult. Further research needs to be done to understand the true effects of micro-gravity on sperm movement and fertilization.
http://weboflife.nasa.gov/currentResearch/currentResearchBiologyGravity/floatingFertility.htm
http://spaceresearch.nasa.gov/general_info/OBPR-01-196.html

Answers to Questions for Comprehension

Student Textbook page 530

Q33. Students should cite any two of the following reasons for male infertility: obstructions in the ductus deferens or epididymis; low sperm count; high proportion of abnormal or non-viable sperm; inability to achieve an erection or ejaculation; smoking; alcohol use, overheated testicles. Treatments can include: healthier lifestyle (cutting back on smoking, alcohol, wearing looser clothing); artificial insemination; *in vitro* fertilization; use of a sperm bank.

Q34. Students should cite any two of the following reasons for female infertility: blocked oviducts; failure to ovulate; endometriosis; damaged eggs. Treatments can include artificial insemination; *in vitro* fertilization; surrogate mothers; superovulation.

Student Textbook page 532

Q35. The most effective method to avoid conceiving a child is to practice abstinence. It not only prevents pregnancy, it also helps to minimize the risk of STIs.

Q36. The technology that does the best job of preventing conception and protecting against the transmission of STIs is a combination of condoms (a physical barrier) and chemical barriers (spermicides in the form of jellies, foams, or creams).

Thought Lab 15.2: Evaluating Reproductive Technologies: Safety and Effectiveness

Student Textbook page 533

Purpose

Students will evaluate the effectiveness and safety of various reproductive technologies and justify the use of such technologies based on safety and effectiveness.

Outcomes

- B3.3s
- B3.4s

Advance Preparation

When to Begin	What to Do
1 month before	■ Collect information on various reproductive technologies
1 week before	■ Book computer lab for research
1 day before	■ Adapt Assessment Checklist 7 Independent Research Skills to assist in evaluating students' work ■ Photocopy **BLM 15.3.1**

Materials

- Print materials concerning reproductive technologies; specifically including AI, assisted hatching, GIFT, IVF, ICSI, surrogacy, TET, ZIFT, condoms, fertility awareness, IUD, LAM, oral contraceptives, spermacides, tubal ligation, vasectomy
- Assemble materials for preparation of master chart (flip chart, computer etc.)

Time Required

- 90-120 minutes for research, in-class discussion and preparation of master chart
- 30 minutes for Analysis questions

Helpful Tips

- Use **BLM 15.3.1: Thought Lab 15.2** to support this activity. Modify as necessary.
- Make sure that every technique appears on the list of at least two groups to get a range of opinions.
- Encourage students to consider information from other parts of the world when they are researching their definitions of "safety" and "effectiveness" and considering acceptable risk.

Answers to Analysis Questions

1. Students may list factors such as mother's health, health and survival of the fetus, father's health, long-term effects, optimum conditions required, or failure/success rates. Assessment of risk may include long-term health of mother or likelihood of fetus surviving or being disabled in some way.

2. Arguments should reflect the relevant definitions that have been chosen and consider the priorities chosen or agreed upon.

Extension

3. Other factors could include: accessibility, ease of use, cost, social attitudes, cultural or religious taboos, partner's preferences, permanence of method.

Assessment Options

- Collect and assess students' answers to Analysis questions.
- Use a modified version of Assessment Checklist 7: Independent Research Skills from Appendix A.

Section 15.3: Review Answers

Student Textbook page 534

1. (a) Artificial Insemination: the sperm is collected from the male, concentrated, and then placed within the woman's vagina. Since she is reproductively healthy, this should work from this point.

(b) Super ovulation to ensure she produces and releases a viable ovum; hormone treatments will be necessary and may be used with other technologies.

(c) *In-vitro* fertilization, in which fertilization takes place within laboratory glassware. After successful fertilization, the developing embryo is placed in the uterus, avoiding the blocked oviducts.

(d) Sperm bank: the man could donate his sperm to be preserved within the sperm bank. If he does find a partner in the future, they could use his stored sperm.

(e) The woman could access a sperm bank. She could choose her donor sperm, and then, through techniques such as artificial insemination or *in-vitro* fertilization, she could conceive and carry a child.

2. Students' charts on enhancing fertility should show any three of the following:

Name and Description	How it works	Who would use it
Lifestyle changes: adopting a healthier lifestyle (quit smoking, avoid alcohol, improve nutrition)	Improves the chances of producing healthy sperm and ova	Couples who are having initial difficulties conceiving
Artificial insemination: sperm is collected, concentrated, and then injected into the woman's vagina	A quantity of viable sperm are injected into the vagina at ovulation to improve the chances of healthy sperm being able to penetrate the ovum	An infertile couple (if the man has a low sperm count); a woman who does not have a male partner and wants a child
In vitro fertilization: eggs and sperm are combined in a lab	Fertilized egg is implanted in the uterus	Woman who has damaged or blocked oviducts
Superovulation (multiple eggs are produced)	FSH injections stimulate the maturation of multiple follicles; hCG stimulates ovulation; insemination may or may not be used as well	Woman who rarely ovulates or has endometriosis
Surrogate motherhood (zygote is carried to term by a third party)	Zygote is placed in uterus of surrogate mother; or artificial insemination may be used, with sperm from the male of the infertile couple	Woman is unable to bring a child to term or who is carrying a disease such as MS that would be activated by the stress of pregnancy; infertile couple who have had no success with other treatments

3. Students' charts on methods of contraception should show any three of the following:

Name and Description	Effectiveness	How it works	Risks
Abstinence: couple refrains from sexual intercourse	100%	Egg and sperm do not meet	None
Vasectomy: sperm ducts are cut and tied	Close to 100%	No sperm in the ejaculate	Not easily reversed
Birth control pill: daily hormone medication, taken orally	Close to 100% (if used correctly)	FSH and LH are not released	Blood clots, especially in smokers, plus hormonal side effects
Tubal ligation: oviducts are cut and tied	Close to 100%	Eggs do not reach the oviduct	Not easily reversed
Needle (Depo-Provera): a hormone injection every three months	99%	FSH and LH are not released	Hormonal side effects
Contraceptive implant (e.g. Norplant): hormones are implanted in the skin	Over 90%	FSH and LH not released	Hormonal side effects
IUD: plastic coil or armature is inserted into the uterus; lasts up to 5 years	Over 90%	Prevents implantation	Pelvic inflammatory disorders
Diaphragm: large latex cup that fits over the cervix	About 90%	Prevents sperm from entering cervix; usually used with spermicide	Reaction to latex

Name and Description	Effectiveness	How it works	Risks
Cervical cap (must be used with spermicide): latex cup attached to cervix by suction	Almost 85%	Sperm is blocked and killed by spermicide	Reaction to latex
Male condom: latex sheath fits over erect penis	About 85%	Traps sperm	Reaction to latex
Female condom: polyurethane pouch inserted into the vagina	About 85%	Traps sperm and prevents it from entering the vagina	None known
Spermicidal jelly and foam: inserted into vagina before intercourse	About 75%; most effective when used with condoms	Kills a large percentage of sperm	Reaction to spermicide
Rhythm method: ovulation tracked and intercourse is avoided during fertile periods	About 70%	Egg and sperm do not meet	None

4. *In-vitro* fertilization is a technique in which both the male and female gametes are united in the glassware of a laboratory. Cells in the resultant zygote begin to divide; the zygote is inserted directly into the uterus for implantation. *Artificial insemination* is the collection and concentrating of a man's sperm. Once the sperm has been concentrated and enough collected, it is then deposited directly into the female's vagina at times during her menstrual cycle when she is most fertile.

5. Students should cite any three of the following:

- Do zygotes have rights? i.e., Once they have been created, do they have the right to continue to exist or can they be destroyed at will? Some people view the creation and destruction of zygotes as immoral.
- Should human reproduction be commercialized? Should we allow the buying and selling of human gametes? Should surrogate mothers be allowed to make a profit? (How much?)
- Do gamete donors and surrogate mothers have rights? If yes, what would they cover? The right to anonymity? The right to see their child? The right to intervene if the child is in jeopardy?
- Does everyone have the right to be a parent? Should there be criteria and an application process for people wishing to have a child? Should this process apply to everyone, rather than just to infertile people? Is it discrimination to require the qualification process only for those who are infertile? Is it discrimination if only those who are infertile and able to afford treatment are allowed access to the treatments? Is it poor social planning to make infertility treatments available to those who can't afford to raise the child?
- Does a society have the right to enforce contraception on those it perceives are unable to care for the children (financially or otherwise)?

Chapter 15: Review Answers

Student Textbook pages 536-537

Answers to Understanding Concepts Questions

1. Growth and differentiation are both forms of development. Differentiation refers to cellular development that forms a multitude of cells that have specialized functions (i.e., can become different structures and organs). This process only happens in embryos. Growth refers to established cells, structures, and organs increasing in size and maturing. This process relates to fetal development.

2. The egg and a quantity of sperm meet in an oviduct; the heads of the sperm bind to the outer covering of the egg and the enzymes in the acrosome begin to digest a path through the protective layer. Sperm use their tails to progress through the coating, with one sperm breaking through to enter the egg. Once breached, the membrane reseals itself to prevent any more sperm from binding to the egg. Within approximately 12 hours of successful penetration, the membranes of the sperm nucleus and the egg nucleus disappear and the 23 chromosomes found in each gamete create 23 pairs of chromosomes in the zygote.

3. A morula is a solid ball of 16 undifferentiated cells derived by cleavage. The blastocyst is a hollow structure containing differentiated cells.

4. (a) The inner cell mass, also known as the embryoblast, is the group of cells that will develop into the embryo.

(b) The inner cell mass and the trophoblast contain two different types of cells. The trophoblast will develop

into the extra-embryonic membrane that will nourish the embryo.

5. hCG is a hormone that is released by the trophoblast. It has the same effect as LH (luteinizing hormone) and maintains the corpus luteum. This ensures that the hormones estrogen and progesterone will continue to be secreted and menstruation does not occur.

6. The embryonic disk is the structure that develops into the primary germ layers.

7. **(a)** *Ectoderm:* outer skin, hair, nails, sweat glands, mammary glands, nervous tissue and sense organs, pituitary gland, tooth enamel, eye lens, and adrenal medulla

   (b) *Endoderm:* cellular lining of the respiratory tract, digestive tract, urinary bladder, urethra; most of the liver; gall bladder; pancreas; thymus; part of the tonsils; parathyroid gland; thyroid gland

   (c) *Mesoderm:* dermis of skin; cellular lining of blood vessels, lymphatic vessels, body cavities; muscle tissue; connective tissue, including bone, cartilage, and blood; adrenal cortex; heart; kidneys and ureters; internal reproductive organs; spleen

8. The placenta is formed from both maternal and embryonic tissue. The embryo contribution comes from the extra-embryonic membrane called the chorion. At the end of the second week after fertilization, the chorionic villi (finger-like projections) establish the beginnings of the placenta in the endometrium. The blood pools of the mother are found in the placenta, and this is where the exchange of nutrients and waste occurs. The placenta is an organ rich in blood vessels through which metabolic exchange occurs. The placenta has five main functions: nutritional (transporting and storing nutrients), excretory (transporting wastes from fetus to mother), respiratory (transporting oxygen from mother to fetus), endocrine (estrogen, progesterone, and human chorionic gonadotropin), and immune (transporting antibodies from mother to fetus).

9. The chorion and amnion are both extra-embryonic membranes. The chorion is the outermost layer; it encloses all of the extra-embryonic membranes and also forms the fetal portion of the placenta. The amnion is a transparent sac developed from cells of the embryonic disc.

10. The amniotic fluid fills the amnion and protects and cushions the developing fetus, as well as preventing temperature fluctuations. The fluid also allows the freedom of movement and prevents the limbs from sticking to the body.

11. The yolk sac and the allantois in humans are both extra embryonic membranes that assist in nourishing the embryo. In addition, both structures contribute to organ development. The yolk sac contributes to the formation of the digestive tract and produces the first blood cells and future egg or sperm cells. The allantois is the foundation of the umbilical cord, with some of the structure becoming part of the urinary bladder.

12. Students' answers concerning the embryonic period should include any five of: cleavage; formation of the morula; differentiation of cells to form the blastocyst; implantation; secretion of hCG; formation of the embryonic disk; gastrulation (3 layers in the disk or primary germ layers); morphogenesis (differentiation into a number of different types of cells); neurulation; formation of separate organs; brain cells are differentiating; limbs are lengthening and flexing; nervous system is starting to coordinate activity; skeleton of cartilage forms; embryonic support structures are also developing (allantois, chorion, amnion, yolk sac, placenta, umbilical cord).

    Students' answers concerning the fetal period should include any five of: organs maturing; fetus growing in size; cartilage in skeleton replaced by bone; reproductive organs mature and become visible; heartbeat becomes audible; lanugo develops to protect baby's skin; capillaries begin to extend into skin; layer of fat develops beneath skin; digestive and respiratory systems mature.

13. Morphogenesis refers to the process of forming distinct structures.

14. **(a)** Progesterone and estrogen levels drop. Prostaglandins and oxytocin levels then rise. Prostaglandins and oxytocin cause the uterus to contract, beginning labour.

    (b) The contractions cause the cervix to dilate; at some point, the amnion breaks and the amniotic fluid is released. Forceful contractions move the fetus through the cervix to the birth canal and the fetus is expelled. Once the baby is delivered and breathing normally, the umbilical cord is clamped, cut, and tied. The placenta is then normally delivered in a short time period after the delivery of the child.

15. The fetal and maternal blood vessels are close together in the placenta to allow materials within the maternal circulatory system to diffuse across to the fetus. If chemical teratogens are in the mother's blood stream, they will also diffuse across the placenta into the fetal bloodstream.

16. *Beneficial health habits* include: supplementing folic acid (helps to avoid neural tube defects); ensuring sufficient rest (so the body has the resources to support the pregnancy); ensuring adequate nutrition (so the body has the resources to support the pregnancy); protecting against STDs (which can be passed on to the baby); staying away from second-hand smoke (which can harm fetal development); avoiding x-rays, pollutants and known environmental carcinogens wherever possible (can cause congenital structural defects).

    Detrimental health habits include: consumption of alcohol (can damage the brain of the developing embryo and

fetus; cause low birth weight, height and head size; affect learning and memory (FASD)); smoking (increases risk of low birth weight, premature births, still births, miscarriages, behavioural problems, reduced intellectual ability); overdosing on vitamin C (causes scurvy).

17.

Hormone	Function/Relationship with other hormones
hCG	maintains corpus luteum to keep estrogen and progesterone levels high and block menstruation
estrogen	works with progesterone to maintain endometrium and nourish embryo/fetus; high levels suppress production of prolactin
progesterone	works with estrogen to maintain endometrium and nourish embryo/fetus; high levels suppress production of prolactin
prostaglandins	cause release of oxytocin; work with oxytocin to cause uterus to contract
oxytocin	works with prostaglandins to cause uterus to contract throughout labour; also causes contractions within the mammary lobules
prolactin	stimulates milk production within a few days of birth

Answers to Applying Concepts Questions

18. "Morphogenesis" refers to the formation or generation of the distinct structures of the developing organism. (Morphogenesis means "shape creator", or "producer of forms.") It could be inferred that organogenesis refers to the generation or formation of organs. Morphogenesis is a more comprehensive term that recognizes the cellular differentiation that includes the formation of organs as well as all of the other structures of the organism.

19. The students' responses should include the fact that they are looking at data reflecting the development of embryonic and fetal structures and the organism's sensitivities to teratogens during the entire prenatal period. (They should include a brief definition of teratogens and why they matter.) The information at the top of the graph shows when development of the various organs takes place during the pregnancy. The line graph shows the level of relative sensitivity to teratogens during pregnancy. Together, the information shows the vulnerability of organs to the effects of teratogens. The students should note that the heart, brain, skeleton, and mouth are being developed when the sensitivity to teratogens is at its peak. The genitals are formed at a less vulnerable time, and the brain and skeleton, which continue to develop throughout the pregnancy, remain under threat, although at decreasing rates of sensitivity.

20. The endometrium thickens during the menstrual cycle to prepare for the implantation of the zygote (fertilized egg) when it reaches blastocycst form. Fertilization, however, takes place in the oviduct, not the uterus.

21. An embryo is unlikely to survive an ectopic pregnancy because, as the sites on the diagram indicate, even if the zygote implants, the endometrium (in the uterus) is needed to nourish the embryo and develop support structures such as the placenta. In addition, the uterus is designed to expand to accommodate the fetus. In an ectopic pregnancy, the embryo would be growing in an area that is not designed to accommodate a growing organism, and ruptures and other damage are likely to occur, endangering the mother's life.

22. The drug may inhibit the production of prolactin. With the decrease in prolactin levels, the mammary glands will quit producing milk. Or the drug may inhibit the production of oxytocin, which will stop the contractions of the mammary lobules, causing the milk to stop flowing.

23. In addition to being viable, sperm must overcome some very high odds to reach the egg (e.g., being in the oviduct that has an egg; surviving the acidic environment of the female reproductive tract; and dissolving a path through the jelly-like protective membrane of the egg) so very large quantities of viable sperm are required in order to succeed. When the initial quantity of sperm is less than 10 million, it is unlikely that fertilization will occur.

Answers to Making Connections Questions

24. Ovulation takes place on day 14 of a cycle, so she is approximately 30 days into her pregnancy. Gastrulation is complete; neurulation has begun (to form the spinal cord and brain), as has organ formation. Limb buds are present; development of the placenta and the umbilical cord are underway, and the developing embryo will have a heart beat (day 18).

25. Inadequate secretion of GnRH would result in inadequate production of FSH and LH, which stimulate gamete production and ovulation respectively. Treatment to mimic the action of GnRH is part of the infertility treatment called superovulation. Due to the increased release of FSH and LH, more follicles will mature within the ovary, each releasing an ovum. As a result, when she ovulates, more than one egg is released.

26. This is a higher order question that will require some inferences on the student's part. Students' diagrams should show only one zygote was formed. Monozygotic twins are identical because they are derived from the same zygote (thus monozygotic). The fact that there is only one chorion means there is only one placenta and should indicate that rather than there being an unexpected cleavage at some point, the key to unravelling the mystery

of identical twins lies in the blastocyst. Two inner cell masses in the blastocyst will lead to identical twins, unlike fraternal twins, which are the result of two eggs being fertilized.

Career Focus: Ask a Sexual and Reproductive Health Coordinator

Student Textbook pages 538–539

Teaching Strategies

- Invite a sexual and reproductive health coordinator in to speak to the class about his or her work.

Answers to Go Further… Questions

1. Students' answers could reflect some of the following and can be extended to look at how these factors will be reflected in their own lives. Sexual health can be influenced by the following:
   - *income and access to services*: more affluent people tend to have access to more resources related to sexual health, such as general health care and more reliable forms of birth control as well as fertility treatments. This is most evident when looking at population groups in developing countries in contrast to those in developed countries where the incidence of STIs, in particular HIV-AIDS, tends to be much lower.
   - *social environment*: in populations where men and women are more equal, the standards of reproductive health tend to be higher because women in particular have more control over their bodies and reproduction.
   - *education levels*: populations with a higher general level of education tend to have smaller families, lower levels of STIs, and a better standard of living. The United Nations Population Fund has suggested that the education of girls and women in particular is a key way to improve the reproductive and general health of a population group and has made education part of their strategy for improving societies.
2. Student's answers could include segments such as teenagers and newcomers to Canada and others who may be socially isolated for some reason. The challenges and issues are varied but could broadly cover language and cultural barriers. Overcoming these barriers will require consideration of multi-lingual services, the location of the information, the way it's delivered, the age and gender of the person delivering the information, and any religious taboos concerning the subject.
3. Students should consider taking an objective look at what images and sexual behaviours are being portrayed in the media. Students should recognize that they need to evaluate the messages from the media in a broader context, both the media "make believe" context and the context of their own lives and what will work in reality. Examples can include:
   - The media often uses portrayals of sexual behaviour to sell everything from cars to vacuum cleaners. Students should realize that many situations are being presented in order to generate a purchase rather than to reflect reality or model behaviour.
   - Sex in movies and TV programs rarely goes beyond the moment to portray the longer-term emotional context of a relationship, nor do the participants seem to take much care to practice safe sex or suffer the consequences of not doing so. Students might discuss this disconnect from reality as they see it in their favourite shows or magazines.
   - Students could consider how popular music influences their attitudes and behaviour when it comes to sex. They could discuss, in class or in small groups, occasions when they have been aware of this, how they feel about being influenced this way, and whether they will be more aware of it in the future.

Unit 6: Review Answers

Student Textbook pages 540-543

Answers to Understanding Concepts Questions

1. The human reproduction system is unique because its organs and chemical pathways are not all contained within the body of one individual—the interaction of two individuals is required for it to complete its function. In addition, it's the only body system that functions to support the continuation of the species, rather than to support the well-being of the individual.
2. Similarities between the male and female reproductive system should include any three of: a pair of gonads that produce sex hormones; both produce gametes with 23 chromosomes; both the male and female have internal and external sex organs; ducts and glands that control the formation and transport of gametes as well as secondary sex characteristics; sex hormones are regulated by negative feedback loops.

   Differences between the male and female reproductive systems should include any three of: male gametes are motile, female gametes are not; males produce 100 million sperm a day, while females have a fixed number of gametes; male gametes are ejaculated daily, while one female gamete is released (typically) once per month; males deposit gametes in the females for fertilization; the female reproductive system has a finite span, the male reproductive system can function until death.
3. The male sex cell, the sperm, is a much smaller cell than the egg, being only about 0.06 mm long. The sperm has three parts: an oval head, a cylindrical middle piece, and an extended tail. The oval head contains the nuclear material, containing 23 chromosomes, and the acrosome,

which contains enzymes needed to penetrate the protective layer around the egg. The mid-piece contains many mitochondria that power the sperm's motility. The egg is a much larger gamete (approximately 0.1 mm), is not motile, and also contains 23 chromosomes. The mature egg contains a large quantity of cytoplasm to provide nourishment for the first few days after fertilization. It is also encased in a protective jelly-like layer that the acrosome of the sperm must penetrate for fertilization.

4. The primary germ layers are the endoderm, mesoderm and the ectoderm. They first appear in the gastrula.

5. The hormonal fluctuations during the month prepare a mature ovum and endometrium of the uterus each 28-day cycle. If fertilization does not occur, the ovum, tissues, and blood of the endometrium are shed through the vagina in the menstrual flow.

6. Seminiferous tubules are long coiled tubes in the testes, and they are where sperm is produced. Sertoli cells are found within the tubules; they support, regulate and nourish the developing sperm. Interstitial cells surround the seminiferous tubules, and they secrete male sex hormones. Sketch should be pased on Figure 14.3 on page 480 of the student textbook.

7. (a) The components of semen include: sperm, nutrients, alkaline and mucoid fluids

(b) testes (sperm); epididymis (supports maturing sperm); ductus deferentia (stores sperm); seminal vesicles (nutrients and fluid); prostrate gland (alkaline and mucoid fluids); Cowper's gland (alkaline and mucoid fluids). (Students' answers may begin with ductus deferentia.)

(c) Semen is mainly alkaline to neutralize the acidic environment of the female reproductive tract and help the sperm survive.

8. A. Ductus deferens
B. Urethra
C. Penis
D. Epididymis
E. Testis
F. Scrotum
G. Seminal vesicle
H. Prostate gland
I. Fimbriae
J. Ovary
K. Uterus
L. Cervix
M. Vagina

9.

Structure	Function
ductus deferens	conducts and stores sperm
urethra	conducts semen through the penis
penis	carries semen into the female reproductive tract
epididymis	supports developing sperm; stores mature sperm
testes	produce sperm and sex hormones
scrotum	pouch of skin that holds the testes
seminal vesicle	produces a mucoid fluid that contains energy in the form of fructose
prostate gland	contributes alkaline and mucoid fluids to semen
fimbriae	sweeps the ovum into the oviduct after it has been released
ovary	produces eggs in the female
uterus	houses and nourishes an embryo after implantation
cervix	connects the uterus to the vagina
vagina	entrance for penis to deposit sperm; exist for fetus during birth

10.

Hormone	Function in Males	Function in Females
GnRH	stimulates release of FSH and LH from the anterior pituitary	stimulates release of FSH and LH from the anterior pituitary
FSH	stimulates the development of the sex organs and gamete production	stimulates the development of the sex organs and gamete production
LH	stimulates the production of testosterone	triggers ovulation and (with FSH) stimulates the production of estrogen

Hormone	Function in Males	Function in Females
Estrogen	minor	stimulates the development of the female reproductive tract and secondary sex characteristics
Progesterone	minor	causes uterine thickening
Testosterone	stimulates the development of the male reproductive tract and secondary sex characteristics	minor

11. **(a)** *secreted by follicular cells*: estrogen and some progesterone

(b) *stimulates maturing of female sex organs:* GnRH, to trigger LH and FSH to trigger estrogen and progesterone

(c) *maintains the uterine lining during pregnancy:* progesterone

(d) *secreted by the corpus luteum:* progesterone (and some estrogen)

(e) *stimulates the development and function of the corpus luteum:* LH

(f) *promotes thickening of the endometrium:* estrogen

(g) *stimulates development of ovarian follicles:* FSH

(h) *high concentrations inhibit GnRH secretion:* FSH and LH

12. The male reproductive hormone testosterone is regulated by an internal feedback mechanism that keeps the level of testosterone relatively constant. GnRH is released from the hypothalamus; this triggers the release of FSH and LH from the anterior pituitary. FSH causes the interstitial cells to secrete testosterone and the seminiferous tubules to release inhibin. Inhibin acts on the anterior pituitary to inhibit production of FSH until the level drops enough to signal to the testes to release less inhibin so the anterior pituitary will release more FSH.

LH is also regulated by an internal feedback mechanism: LH causes testosterone to be released to maintain the secondary sex characteristics. Testosterone acts on the anterior pituitary to inhibit the release of LH until more testosterone is needed.

13. The inner cell mass and the trophoblast are both part of the blastocyst. The trophoblast is the outer layer, and this develops into the chorion, to ultimately become part of the placenta that nourishes the embryo. The inner cell mass develops into the actual embryo.

14. *Endoderm*: any two of: cellular lining of respiratory tract, digestive tract, urinary bladder, urethra; liver (most); tonsils (partial); gall bladder; parathyroid glands; pancreas; thyroid glands; thymus

Mesoderm: any two of: dermis of the skin; cellular lining of blood vessels, lymphatic vessels, body cavities; muscle tissue; connective tissue (including bone, cartilage, blood); adrenal cortex; kidneys and ureters; heart; spleen; internal reproductive organs

Ectoderm: any two of: outer skin (dermis) and associated structures (hair, nails, sweat glands, mammary glands); nervous tissue and sense organs; pituitary gland; tooth enamel; adrenal medulla; eye lens

15. *Chorion*: encloses all the other membranes and the embryo; forms the fetal portion of the placenta.

Amnion: develops from the embryonic disk and grows to enclose the embryo. It becomes filled with amniotic fluid to protect the embryo and is penetrated only by the umbilical cord.

Allantois: becomes the foundation for the umbilical cord and also part of the urinary bladder

Yolk Sac: contributes to the formation of the digestive tract and produces the first red blood cells, as well as the future egg or sperm cells

16. Seminiferous tubules are long, coiled tubes inside the testes. The function of the seminiferous tubules is to produce sperm.

17. **(a)** male

(b) The acrosome is a cap on the head of the sperm that contains enzymes that can digest a path through the coating that protects the egg and allow the sperm to penetrate and fuse with the egg.

18. The jelly-like coating and membrane of the egg are chemically stimulated to close up after penetration by a sperm, which prevents the egg from being fertilized by more than one sperm.

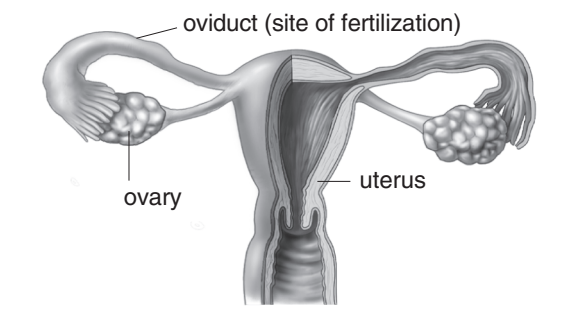
19. Answers could include: abstinence, and male and female condoms. The students may also answer that condoms coupled with other forms of birth control, such as the pill, are even more effective at preventing pregnancy than just condoms alone.

20. The morula is the 16-celled structure that leaves the oviduct (it was formed through cleavage after fertilization); it is the same size as the zygote. The blastocyst is the structure that forms after the morula fills with fluid that diffuses from the uterus. It has two different groups of cells (trophoblast and inner cell mass) and is the structure that implants in the endometrium.

21. No. Women cannot become pregnant because their hormone levels have changed after menopause. They no longer produce a mature ovum because of low FSH levels, nor do they ovulate due to lower levels of LH. In addition, menopausal women do not produce a thickened endometrium because of lower levels of estrogen and progesterone.

22. Prolactin (from the anterior pituitary) allows for milk production, and oxytocin (from the posterior pituitary) allows for the letdown of the milk so that it will flow.

23. The student diagram should show a reasonable facsimile of the female reproductive system.



24.

Hormone	Produced by	Target organ(s)	Effect(s)
testosterone	testes (interstitial cells)	entire body for secondary sex characteristics	■ development of secondary sex characteristics; helps to promote sperm production
GnRH	hypothalamus	anterior pituitary	■ stimulates release of FSH and LH
estrogen	ovaries (follicle cells prior to day 14, corpus luteum after day 14)	ovaries, uterus	■ inhibits ovulation ■ stimulates thickening of endometrium

Hormone	Produced by	Target organ(s)	Effect(s)
FSH	anterior pituitary	ovaries in females; testes in males	■ stimulates development of sex organs ■ stimulates gamete production

25. Chromosomal sex, or the genetic sex, is determined at fertilization by the union of the male and female gametes. The female gamete contributes an X chromosome; the sperm can either contribute an X or a Y chromosome. The resulting females are XX, and males are XY due to chromosomal factors. At the seventh week of development, hormonal influences will develop the male and female anatomy. GnRH will stimulate the release of LH to stimulate the production of testosterone in males (LH), and this promotes the development of the male reproductive tract. In puberty, testosterone will also stimulate the development of the secondary sex characteristics. In females, GnRH stimulates the production of FSH and LH, which stimulates the follicles to produce estrogen, which stimulates the development of the female reproductive tract, and, in puberty, the secondary sex characteristics.

26. Male gametes are produced in the testes, and they mature and are stored within the epididymis. They travel through the ductus deferens where they mix with glandular secretions to create semen. The sympathetic nervous system causes ejaculation through the urethra into the female vagina. The sperm motility is provided by the tail of the sperm. Sperm propel themselves up the vagina through the cervix and the uterus and into the oviducts where fertilization occurs.

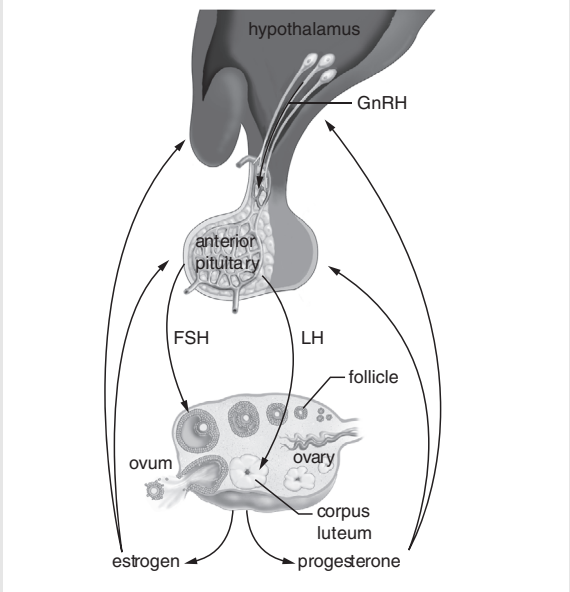
Female gametes (ova) are produced within the ovaries. When an ovum is released, it is swept by fimbriae from the ovary to the uterus via the oviduct. The beating of cilia creates a current that moves the ovum toward the uterus. Fertilization typically occurs in the oviduct where the ovum is relatively inert and accessible to the swarming sperm.

27. (a) *Fertilization:* LH - promotes ovulation; FSH stimulates the maturing of the follicle in females and testosterone production in males

(b) *Development of the placenta:* hCG - this hormone promotes the continuance of high levels of progesterone and estrogen as the placenta is formed, as its role is to maintain the corpus luteum.

(c) *Parturition:* Prostaglandins cause the release of oxytocin; both prostaglandins and oxytocin cause the uterus to contract throughout labour.

28.



Answers to Applying Concepts Questions

29. Students' responses should include eight of the following key events:

- fertilization (formation of the zygote in the oviduct)
- cleavage (eventually forming the morula)
- morula's arrival in the uterus
- continued mitotic divisions to form the blastocyst (second week)
- implanting of blastocyst in the endometrium
- trophoblast becomes the chorion (ultimately the fetal part of the placenta)
- development of the inner cell mass
- formation of the amniotic cavity
- formation of the embryonic disk
- gastrulation (differentiation of embryonic disk into the three primary germ layers: the endoderm, mesoderm, and ectoderm)
- morphogenesis (formation of distinct structures of the organism)
- neurulation (formation of the neural tube, the basis of the brain and spinal cord)
- heart begins beating
- rapid growth and differentiation as blood cells form, lungs and kidneys take shape, and arm and leg buds appear
- appearance of distinct head with evidence of eyes, ears, and nose
- cells in the brain differentiate
- arms and legs lengthen and begin to flex
- gonads begin to produce hormones
- organs form and nervous system begins to coordinate body activity
- skeleton of cartilage forms

30. Both the sperm and the ovum contain a nucleus with 23 chromosomes. Structurally they are quite different because they have very different roles in the reproduction process. One egg is produced monthly, and while it has a protective coating that can only be penetrated by human sperm, it is not structured to be elusive and has no structures to propel itself. The ovum is passed through the oviduct and contains enough nourishment to keep a zygote alive in the crucial early days after fertilization. Sperm, on the other hand, must navigate the acidic environment of the female reproductive tract, making their way through a number of structures (vagina, cervix, uterus) before coming upon the ovum in the oviduct. The comparatively tiny sperm have tails to propel themselves through the female reproductive tract, mitochondria to provide energy for the job, and an enzyme in their oval heads that can dissolve some of the protective coating on the egg. They are also numerous enough and small enough to be able to swarm the egg for maximum chance at penetration.

31. The testes need to descend into the scrotum so that they can be in the cooler environment they require for spermatogenesis to occur. The scrotum is normally 3-4 degrees cooler than body temperature. If the testes remained within the body, the male would be unable to produce viable sperm.

32. Since the developing embryo of a reptile is outside of the parent, within a hard shell, it must have a large amount of yolk available to nourish its entire development but will not require a placenta and an umbilical cord. Instead, the extra-embryonic structures will perform slightly different functions, as noted in Investigation 15.A: the amnion will provide protection and allow for movement for the developing embryo; the chorion (outermost) and the allantois work together to allow for gas exchange, waste storage, and the absorption of calcium; and the large yolk sac and yolk to store nutrients for the developing embryo.

33. Gametes have 23 chromosomes instead of 23 pairs because this half is the complement of chromosomes for the human species. Each parent provides 23 chromosomes to the zygote, which will have the necessary 23 pairs or chromosomes.

34. In the aftermath of ovulation, the follicle that released the ovum becomes the corpus luteum. The corpus luteum produces mostly progesterone, which inhibits the production of FSH and LH.

(a) If the egg is fertilized and the resulting blastocyst implants in the endometrium, the trophoblast releases human chorionic gonadotropin (hCG), which prevents the corpus luteum from disintegrating. For the next three months, the corpus luteum continues to produce progesterone to maintain the endometrium and prevent menstruation (until the placenta can secrete enough estrogen and progesterone to maintain the endometrium).

(b) If the egg is not fertilized, the corpus luteum begins to degenerate after about 10 days. Progesterone and estrogen levels decline and the endometrium, blood, tissues, and ovum are shed. The menstrual cycle begins again when the levels of progesterone and estrogen drop low enough to trigger the release of more FSH and LH.

35. If both the male and female of the couple were infertile or sterile, this couple could use donor eggs and sperm from two other individuals. Using a reproductive technology such as IVF, the zygote would be formed in a lab and this dividing cell mass would then be implanted in a surrogate mother to be carried to term. Thus the child would have "5 parents": the two who will raise him/her, as well as the two who contributed their gametes, and the surrogate mother who carried the child.

36. An indication that ovulation is soon to occur is the marked rise in blood levels of LH released from the

anterior pituitary. This rise in LH triggers the release of an ovum from one of the developing follicles.

37. The hormone testosterone is produced in the interstitial cells of the testicles. Without the testicles, testosterone would not be produced.

38. The graph shows the period of embryonic/fetal development that is most sensitive to the effects of teratogens. During the first eight weeks of pregnancy, specifically between weeks 3 and 8, the embryo is the most vulnerable to damage by teratogens. Whatever the mother ingests or inhales is circulated throughout the blood and can cross over to the embryo's bloodstream in the placenta. Some of these substances can result in structural abnormalities in the embryo/fetus.

Answers to Making Connections Questions

39. (a) The woman's age and her high level of physical activity will have an impact on the couple's ability to conceive. At the age of 35, her chances of successfully reproducing are reduced, and high levels of physical activity may be affecting her menstrual cycle.

(b) Less physical activity will reduce the physiological stress on her body, and the hormonal levels of her body may return to a level that can sustain a pregnancy. The couple can also begin to track her ovulation periods by using kits from the pharmacy, as well as consulting with their physician to monitor blood hormone levels and determine her ovulatory cycle so they may try for conception at the optimum time.

(c) IVF, superovulation, or surrogate motherhood may help the couple.

40. Students will show any three of the following likely effects of the expanding uterus on the mother: back ache, hip pain, pressure on the bladder resulting in frequent urination, abdominal cramps, higher blood pressure, shortness of breath, swelling (particularly of the feet and legs), development of varicose veins, and unsteady or altered balance.

41. A woman with only one ovary can still become pregnant. Typically, alternate ovaries produce the mature ovum each month. If she was missing an ovary, she may ovulate less often, but she would still have the ability to produce and nurture a mature ovum, as well as produce the hormones to sustain a pregnancy.

42. If a male has a vasectomy, he is still able to produce sperm because the operation only cuts and ties the sperm ducts (which transport the sperm). The sperm die, and the nutrients from them are reabsorbed into the bloodstream. After a vasectomy, the semen does not contain any sperm.

43.

Role of FSH in males	Role of FSH in females
■ GnRH released from the hypothalamus triggers release of FSH from the anterior pituitary gland	■ GnRH released from the hypothalamus triggers release of FSH from the anterior pituitary
■ at puberty, FSH works with LH to cause the testes to produce and release testosterone	■ at puberty, FSH acts on the ovaries to stimulate the production of estrogen to help stimulate development of secondary sex characteristics and launch the reproductive cycle
■ after puberty, FSH causes the interstitial cells in the testes to produce and release testosterone ■ at the same time, FSH causes the cells of the seminiferous tubules to release inhibin, which acts upon the anterior pituitary to stop FSH production in a negative feedback loop that keeps testosterone production relatively constant over time	■ after puberty, FSH stimulates one follicle to mature each month ■ rising levels of estrogen inhibit the release of FSH until the level drops low enough to cause the pituitary gland to produce FSH to begin the cycle again

44. Create a rubric before students begin the project to show how it will be marked; you may want to consult students on how to analyze the outlines. In addition to assessing the projects for accuracy, creativity, neatness, and completeness, the students should include the following:

- information concerning the stages of embryonic/fetal development, including the risks and vulnerabilities at various stages
- information concerning how teratogens can affect the embryo/fetus
- information on key teratogens and environmental risks, particularly in the immediate area
- tips for protecting against the effect of teratogens
- detailed description of the visuals, including full source information

45. Until about the seventh week of development, male and female embryos are anatomically identical. After the seventh week, the development of the primary sex characteristics begins. Between approximately 18-22 weeks, the gonads should be large enough for an ultrasound technician to be able to correctly assess the gender of the child.

46. Students could select any three of the following:

- *Primary amenorrhea*

  Primary amenorrhea affects approximately 1 in 1,000 adolescent girls in the United States. The most common causes of primary amenorrhea include:

  - *Chromosomal abnormalities.* Certain chromosomal abnormalities can cause a premature depletion of the eggs and follicles involved in ovulation and menstruation.
  - *Problems with the hypothalamus.* Functional hypothalamic amenorrhea is a disorder of the hypothalamus—an area at the base of the brain that acts as a control center for the body and regulates the menstrual cycle. Excessive exercise, eating disorders such as anorexia, and physical or psychological stress can all contribute to a disruption in the normal function of the hypothalamus. Less commonly, a tumour may prevent the hypothalamus from functioning normally.
  - *Pituitary disease.* The pituitary is another gland in the brain that's involved in regulating the menstrual cycle. A tumour or other invasive growth may disrupt the pituitary gland's ability to perform this function.
  - *Lack of reproductive organs.* Sometimes problems arise during fetal development that lead to a baby girl being born without some major part of the reproductive system, such as uterus, cervix, or vagina. Because her reproductive system didn't develop normally, she won't have menstrual cycles.
  - *Structural abnormality of the vagina.* An obstruction of the vagina may prevent menstrual periods from occurring. A membrane or wall may be present in the vagina that blocks the outflow of blood from the uterus and cervix.

- *Secondary amenorrhea*

  Secondary amenorrhea is much more common than primary amenorrhea. Many possible causes of secondary amenorrhea exist:

  - *Pregnancy.* In women of reproductive age, pregnancy is the most common cause of amenorrhea. When a fertilized egg is implanted in the lining of the uterus, the lining remains to nourish the fetus and isn't shed by menstruation.
  - *Contraceptives.* Some women who take birth control pills may not have periods. When oral contraceptives are stopped, it may take three to six months to resume regular ovulation and menstruation. Contraceptives that are injected or implanted, such as Depo-Provera, also may cause amenorrhea, as can progesterone-containing intrauterine devices, such as Mirena.
  - *Breast-feeding.* Mothers who breast-feed often experience amenorrhea. Although ovulation may occur, menstruation may not. Pregnancy can occur despite the lack of menstruation.
  - *Stress.* Mental stress can temporarily alter the functioning of the hypothalamus—an area of the brain that controls the hormones that regulate the menstrual cycle. Ovulation and menstruation may stop as a result. Regular menstrual periods usually resume after stress decreases.
  - *Medication.* Certain medications can cause menstrual periods to stop. For example, antidepressants, antipsychotics, some chemotherapy drugs, and oral corticosteroids can cause amenorrhea.
  - *Illness.* Chronic illness may postpone menstrual periods. As the patient recovers, menstruation typically resumes.
  - *Hormonal imbalance.* A common cause of amenorrhea or irregular periods is polycystic ovary syndrome (PCOS). This condition causes relatively high and sustained levels of estrogen and androgen, a male hormone, rather than the fluctuating condition seen in the normal menstrual cycle. This results in a decrease in the pituitary hormones that lead to ovulation and menstruation. PCOS is associated with obesity; amenorrhea or abnormal, often heavy uterine bleeding; acne; and sometimes excess facial hair.
  - *Low body weight.* Excessively low body weight interrupts many hormonal functions in the body, potentially halting ovulation. Women who have an eating disorder, such as anorexia or bulimia, often stop having periods because of these abnormal hormonal changes.
  - *Excessive exercise.* Women who participate in sports that require rigorous training, such as ballet, long-distance running or gymnastics, may find their menstrual cycle interrupted. Several factors combine to contribute to the loss of periods in athletes, including low body fat, stress, and high energy expenditure.
  - *Thyroid malfunction.* An under-active thyroid gland (hypothyroidism) commonly causes menstrual irregularities, including amenorrhea. Thyroid disorders can also cause an increase or decrease in the production of prolactin—a reproductive hormone generated by the pituitary gland. An altered prolactin level can affect the hypothalamus and disrupt the menstrual cycle.
  - *Pituitary tumor.* A noncancerous (benign) tumour in the pituitary gland (adenoma or prolactinoma) can cause an overproduction of prolactin. Excess prolactin can interfere with the regulation of menstruation. This type of tumour is treatable with medication, but it sometimes requires surgery.

- *Uterine scarring.* Asherman's syndrome, a condition in which scar tissue builds up in the lining of the uterus, can sometimes occur after uterine procedures, such as a dilation and curettage (D and C), Caesarean section or treatment for uterine fibroids. Uterine scarring prevents the normal buildup and shedding of the uterine lining, which can result in very light menstrual bleeding or no periods at all.
- *Premature menopause.* Menopause occurs at an average age of 51. If menopause is experienced before age 40, it's considered premature. The lack of ovarian function associated with menopause decreases the amount of circulating estrogen in the body, which in turn thins the uterine lining (endometrium) and brings an end to the menstrual periods. Premature menopause may result from genetic factors or autoimmune disease, but often no cause can be found.

47. At 10 weeks the woman is in her first trimester. The ovaries, specifically the corpus luteum, are still needed to produce the estrogen and progesterone necessary to maintain the pregnancy. At 16 weeks, the time when the ovaries were removed, the placenta was well enough developed that it could produce sufficient amounts of estrogen and progesterone to maintain the pregnancy. The ovaries were not needed.

48. Doctors did not measure luteinizing hormone (LH) in these women. Luteinizing hormone is released near the middle of the average menstrual cycle in response to high blood estrogen levels. It stimulates ovulation to occur. If fertilization and then implantation occur, the high estrogen and progesterone levels inhibit further release of LH. If a woman is pregnant, it is known that LH will not be present.

An alternative answer could be: Doctors did not measure human chorionic gonadotropin (hCG) because they already knew from the examination at eight weeks gestation that the woman was pregnant. hCG is present in the urine of women who are pregnant and is what pregnancy tests detect.

49. (a) In the oophorectomized woman, FSH concentration was low at 37 weeks gestation and remained low in the samples taken 8 h and 4 days after delivery but increased considerably at 5 weeks postpartum, reaching its highest level 2 months postpartum.

In the control women, FSH level was not measured at 37 weeks gestation nor at 8 h or 4 days postpartum. At five weeks the FSH level was approximately five times less than in the patient and about eight and a half times less at two months.

(b) Suckling (breast-feeding) normally inhibits release of FSH and LH for a period of time after birth. This study shows that the ovaries may be required to fully exert this gonadotropin (FSH and LH) - suppressing effect

50. Without ovaries the woman is in an artificial menopause and therefore lacking estrogen and progesterone. She may start to experience menopausal symptoms, so by giving her HRT, a treatment used for women experiencing real menopause, these symptoms can be alleviated.

51. Most of the estrogen produced in this late stage of pregnancy is produced by the placenta, not the ovaries, so the levels are similar in the patient and control group.

52. Delivery of the baby is due to oxytocin from the posterior pituitary gland stimulating the uterine muscles to contract. Breast-feeding is also possible because prolactin, the hormone that stimulates production of milk, comes from the anterior pituitary gland. Release or let-down of the milk is controlled by oxytocin. The ovaries are not involved in either of these functions.