Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section 38.1
Human Reproductive Systems
National Science Education Standards UCP1-3, UCP5; C.1, C.5; E.1 (2 sessions, 1 1/2 blocks)

1. Identify the parts of the male and female reproductive systems.
2. Summarize the negative feedback control of reproductive hormones.
3. Sequence the stages of the menstrual cycle.

Inside Story: Sex Cell Production, p. 1033
Problem-Solving Lab 38-1, p. 1035

Section 38.2
Development Before Birth
National Science Education Standards UCP1-3, UCP5; A.1, A.2, C.1, C.5, C.6, E.1, E.2; F.1, E6; G.1 (2 sessions, 1 block)

4. Summarize the events during each trimester of pregnancy.

MiniLab 38-1: Examining Sperm and Egg Attraction, p. 1038
MiniLab 38-2: Making a Graph of Fetal Size, p. 1042
Problem-Solving Lab 38-2, p. 1043
Investigative BioLab: What hormone is produced by an embryo? p. 1048
BioTechnology: Frozen Embryos, p. 1050

Section 38.3
Birth, Growth, and Aging
National Science Education Standards UCP1, UCP3, UCP5; A.1, A.2, C.6; E.1, E.2; F.1, E6; G.1-3 (2 sessions, 1 1/2 block)

5. Describe the three stages of birth.
6. Summarize the developmental stages of humans after they are born.

Careers in Biology: Midwife, p. 1046

MATERIALS LIST
BioLab p. 1048 scissors, heavy paper, tracing paper
MiniLabs p. 1038 microscope, microscope slide, droppers (2), live sea urchin eggs, live sea urchin sperm
p. 1042 graph paper, pencil

Alternative Lab p. 1030 graph paper, colored pencils (4 colors), data sheet
Quick Demos p. 1029 microprojector, prepared slide of testis cross section
p. 1039 microprojector, prepared slides of sea star embryos
p. 1049 overhead projector, photos of infants and elderly persons

Key to Teaching Strategies
L1 Level 1 activities should be appropriate for students with learning difficulties.
L2 Level 2 activities should be within the ability range of all students.
L3 Level 3 activities are designed for average students.
ELL ELL activities should be within the ability range of English-Language Learners.
COOP LEARN Cooperative Learning activities are designed for small group work.

Assessment Resources
Chapter Assessment, pp. 223-228
Mindjogger Videowizaries
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom

Additional Resources
Spanish Resources ELL
English/Spanish Audiocassettes ELL
Cooperative Learning in the Science Classroom
Lesson Plans/Block Scheduling

GLENCOE TECHNOLOGY
The following multimedia resources are available from Glencoe.
Biology: The Dynamics of Life CD-ROM
Video: Fetal Development
Videodisc Program Human Fertilization
Fetal Development
The Secret of Life Series
Tests
Cross Section of Ovary

Teacher’s Corner
Teacher Classroom Resources

Section
Reproductive Masters
Transparencies

Section 38.1
Human Reproductive Systems
Reinforcement and Study Guide, pp. 167-168 L2
Concept Mapping, p. 38 L2 ELL
Critical Thinking/Problem Solving, p. 38 ELL
Content Mastery, pp. 185-186, 168 L1

Section 38.2
Development Before Birth
Reinforcement and Study Guide, p. 169 L2
BioLab and MiniLab Worksheets, pp. 169-170 L2
Laboratory Manual, pp. 277-284 L2
Content Mastery, pp. 185, 167-168 L1

Section 38.3
Birth, Growth, and Aging
Reinforcement and Study Guide, p. 170 L2
BioLab and MiniLab Worksheets, pp. 171-172 L2
Tech Prep Applications, pp. 53-54 L2

Chapter 38 Organizer

Section
Objectives
Activities/Features

Section 38.1
Human Reproductive Systems
National Science Education Standards UCP1-3, UCP5; C.1, C.5; E.1 (2 sessions, 1 1/2 blocks)
**Theme Development**

The themes of homeostasis and systems and interactions are evident in the study of the hormone regulation of the male and female reproductive systems and in the examination of embryonic membranes, fetal development, growth, and aging.

**Getting Started Demo**

Visual-Spatial Have students examine a photomicrograph of a sperm. Ask them to identify the cellular structures visible: head, midpiece, flagellum (tail), cell membrane; possibly also nucleus and mitochondria.

**Getting Started**

**What You'll Learn**

- You will compare and contrast the anatomy, control, and function of the male and female reproductive systems.
- You will distinguish the stages of development before birth.
- You will summarize the processes of birth, growth, and aging.

**Why It's Important**

As you grow and develop, your reproductive system is maturing. The human reproductive system prepares sex cells—sperm or eggs—which, when combined, ensure the continuation of our species.

**Looking at Sperm Cells**

Examine a prepared microscope slide of sperm cells. What features of these cells suggest they might be capable of rapid motion?

**Internet**

To find out more about reproduction and development, visit the Glencoe Science Web Site:

www.glencoe.com/sec/science

Like a NASA astronaut in a space suit, a human fetus is protected inside a controlled environment.

**Multiple Learning Styles**

- **Kinesthetic Project**, p. 1040
- **Visual-Spatial Meeting**
  - Individual Needs, pp. 1028, 1032, 1044
  - Quick Demo, pp. 1029, 1039, 1045
- **Intrapersonal Meeting**
  - Individual Needs, p. 1028
  - Biological Journal, pp. 1029, 1037
  - Portfolio, pp. 1041, 1045
- **Linguistic Meeting**
  - Individual Needs, p. 1028
  - Biological Journal, pp. 1029, 1037
- **Logical-Mathematical**
  - Check for Understanding, p. 1041
- **Spatial**
  - Understanding, p. 1041
  - Retract, pp. 1036, 1041
- **Mathematical**
  - Check for Understanding, p. 1041

**Chapter 38 Reproduction and Development**

**Section 38.1 Human Reproductive Systems**

As the small sperm approach the large egg, their size difference becomes very apparent. Yet, a sperm and an egg each carry half of the chromosomes needed for the growth and development of a complete individual. As a sperm merges with an egg, a new life is launched.

**Human Male Anatomy**

The ultimate goal of the reproductive process is the formation and union of egg and sperm, development of the fetus, and birth of the infant. The organs, glands, and hormones of the male reproductive system are instrumental in meeting this goal. Their main functions are the production of sperm—the male sex cells—and their delivery to the female.

**Where sperm form**

Sperm production takes place in the testes, which are located in the scrotum. Because sperm can develop only in an environment with a temperature about 1°C lower than normal body temperature, the scrotum is positioned outside the abdomen. Muscles in the walls of the scrotum help maintain the proper temperature. The muscles contract in response to cold temperatures, pulling the scrotum closer to the body for warmth. The muscles relax in response to warm temperatures, lowering the scrotum to allow air to circulate and cool both testes and sperm.

**Figure 38.1** shows the organs and glands of the male reproductive system.

**Before birth**, the testes form in the embryo's abdomen and then descend into the scrotum. Because sperm can develop only in an environment with a temperature about 1°C lower than normal body temperature, the scrotum is positioned outside the abdomen. Muscles in the walls of the scrotum help maintain the proper temperature. The muscles contract in response to cold temperatures, pulling the scrotum closer to the body for warmth. The muscles relax in response to warm temperatures, lowering the scrotum to allow air to circulate and cool both testes and sperm.

**Figure 38.1** shows the organs and glands of the male reproductive system.

**Porcupine**

- **Portfolio Assessment**
- **Portfolio, TWE, pp. 1032, 1034, 1039, 1045**
- **Performance Assessment**
- **Assessment, TWE, pp. 1036, 1038, 1042**
- **Alternative Lab, TWE pp. 1030-1031**
- **BioLab, TWE, pp. 1048-1049**
- **BioLab, SE, pp. 1048-1049**

**Assessment Planner**

- **Assessment, TWE, pp. 1041, 1047**
- **Section Assessment, SE, pp. 1036, 1043, 1047**
- **Chapter Assessment, SE, pp. 1051-1053**

**Knowledge Assessment**

- **Assessment, TWE, pp. 1028, 1034, 1035, 1039, 1045**
- **Problem-Solving Lab, TWE, p. 1035**
- **Problem-Solving Lab, SE, pp. 1035, 1043**

**Resource Manager**

- **Section Focus Transparency 93** on the overhead projector and have students answer the accompanying questions.

**Bellringer**

Before presenting the lesson, display Section Focus Transparency 93 on the overhead projector and have students answer the accompanying questions.

**Tech Prep**

- **Portfolio Assessment**, p. 1028
- **Portfolio, TWE, pp. 1028, 1034, 1035, 1039, 1045**
- **Alternative Lab, TWE pp. 1030-1031**
- **BioLab, TWE, pp. 1048-1049**
- **BioLab, SE, pp. 1048-1049**
- **MiniLab, TWE, pp. 1038, 1042**
- **MiniLab, SE, pp. 1028, 1042**
- **Problem-Solving Lab, TWE, p. 1034**
- **Assessment, TWE, pp. 1036, 1038, 1042**
- **Chapter Assessment, SE, pp. 1051-1053**
- **Skill Assessment, TWE, pp. 1028, 1034, 1035, 1039, 1045**
- **Problem-Solving Lab, TWE, p. 1035**
- **Problem-Solving Lab, SE, pp. 1035, 1043**

**Portfolio Assessment**

- **Portfolio, TWE, pp. 1032, 1034, 1039, 1045**

**Performance Assessment**

- **Assessment, TWE, pp. 1036, 1038, 1042**
- **Alternative Lab, TWE pp. 1030-1031**
- **BioLab, TWE, pp. 1048-1049**
- **BioLab, SE, pp. 1048-1049**

**Assessment Planner**

- **Assessment, TWE, pp. 1041, 1047**
- **Section Assessment, SE, pp. 1036, 1043, 1047**
- **Chapter Assessment, SE, pp. 1051-1053**

**Knowledge Assessment**

- **Assessment, TWE, pp. 1028, 1034, 1035, 1039, 1045**
- **Problem-Solving Lab, TWE, p. 1035**
- **Problem-Solving Lab, SE, pp. 1035, 1043**
In the first column, have students make a table with the following headings: Organ, Reproductive Function.

- **Organ**: Testis, epididymis, vas deferens, urethra.
- **Function**: Reproduction.

Within each testis is a fine network of highly coiled tubes. Sperm are produced by meiosis of the cells that line these tubes. As sperm mature, they produce haploid cells. When a single cell in the testis divides by meiosis, it produces four haploid cells. All four of these cells develop into mature sperm over a period of about 74 days. A sexually mature human male can produce about 100 million mature sperm per day, each day of his life.

As you can see in Figure 38.2, a sperm is highly adapted for reaching and entering the female egg. The head portion of a sperm contains the nucleus and is covered by a cap containing enzymes that help penetrate the egg. A number of mitochondria are found in the midpiece of the sperm; they provide energy for locomotion. The tail is a typical flagellum that propels the sperm along its way. Sperm can live for about 48 hours inside the female reproductive tract.

**How sperm leave the testes**

Before the sperm mature, they move out of the testes through a series of coiled ducts that empty into a single tube called the epididymis. The epididymis (ep uh dih MIH muhs) is a coiled tube within the scrotum in which the sperm complete their maturation. When sperm are released from the epididymis, they enter the vas deferens, where they are stored until they are released from the body. The vas deferens (vas DEF uh rens) is a duct that transports sperm from the epididymis toward the ejaculatory ducts and the urethra. Peristaltic contractions of the vas deferens force the sperm along. The urethra is a tube in the penis that transports sperm out of the male's body. Notice in Figure 38.1 that the urethra also transports urine from the urinary bladder. A muscle located at the base of the bladder prevents urine and sperm from mixing.

**Fluids that help transport sperm**

As sperm travel from the testes, they mix with fluids that are secreted by several different glands. The seminal vesicles are a pair of glands located at the base of the urinary bladder. They secrete a mucouslike fluid into the vas deferens. The fluid is rich in the sugar fructose, which provides energy for the sperm cells.

The prostate gland is a single, doughnut-shaped structure that lies below the urinary bladder and surrounds the top portion of the urethra. The prostate secretes a thinner, alkaline fluid that helps sperm move and survive. Two tiny bulbourethral glands (bul boh yoo REE thrul) glands are located beneath the prostate. These glands secrete a clear, sticky, alkaline fluid that protects sperm by neutralizing the acidic environment of the vagina. The combination of sperm and all of these fluids is called semen.

**Hormonal Control**

In an earlier chapter, you learned that the glands of the endocrine system release hormones, which play a key role in the regulation of body functions, metabolism, and homeostasis. Hormones also control the development and activity of the male reproductive system.

**Hormones and male puberty**

It’s obvious from the physical appearance of young children that they are not sexually mature. In the early teen years, as shown in Figure 38.3, changes begin to occur. Puberty begins. Puberty refers to the time when secondary sex characteristics begin to develop so that sexual maturity—the potential for sexual reproduction—occurs. The changes associated with puberty are controlled by sex hormones secreted by the endocrine system.

**Concept Development**

Discuss some causes of infertility in men and women. In males, a low sperm count decreases the chances of a sperm reaching the egg. In females, the inability to release eggs, as a result of blocked oviducts or low levels of sex hormones, can result in infertility.
Hormones and the male reproductive system

In males, the onset of puberty causes the hypothalamus to produce several kinds of hormones that interact with the pituitary gland, which influences many physiological processes of the body. As shown in Figure 38.4, the hypothalamus secretes a hormone that causes the pituitary to release two other hormones: follicle-stimulating hormone (FSH) and luteinizing hormone (LH). When released into the bloodstream, FSH and LH are transported to the testes. In the testes, FSH causes the production of sperm cells. LH causes endocrine cells in the testes to produce the male hormone, testosterone (testes § tubule §), which is then converted to estrogen and androgens, including testosterone.

Human Female Anatomy

The main functions of the female reproductive system are to produce eggs, which are the female sex cells, and to provide an environment in which a fertilized egg can develop. Egg production takes place in the two ovaries, located on each side of the uterus. Each ovary is about the size and shape of an almond. One egg is located on each side of the lower part of the abdomen.

As you can see in Figure 38.6, the open end of an oviduct is located close to each ovary. The oviduct is a tube that transports eggs from the ovary to the uterus. Peristaltic contractions of the muscles in the wall of the oviduct combine with beating cilia to move the egg through the tube.

You learned earlier that female mammals have a uterus in which the fetus develops during pregnancy. The human uterus is a muscular organ between the urinary bladder and the rectum and is shaped like an inverted pear. The uterine wall is composed of three layers: an outer layer of connective tissue; a thick, muscular middle layer; and a thin, inner lining called the endometrium (en doe mee tree un). The lower end of the uterus, called the cervix, is a narrow opening into the vagina, which is a passageway to the outside of the female’s body.

Puberty in Females

As in males, puberty in females begins when the hypothalamic signals the pituitary to produce and release the hormones FSH and LH. These are the same hormones that are produced in males; however, in females, FSH stimulates the development of follicles in the ovary. A follicle is a group of epithelial cells that surround a developing egg cell. FSH also causes the release of the hormone estrogen from the ovary. Estrogen is the female hormone responsible for the secondary sex characteristics of females. These characteristics include the growth and maintenance of female sex organs: ovaries, fallopian tubes, uterus, vagina, and breasts.

Alternative Lab

Tracking Hormone Levels

Purpose

Students will graph and analyze patterns of change that take place in female hormones during the menstrual cycle.

Materials

- graph paper
- colored pencils (red, yellow, blue, green)
- data sheet

Preparation

Provide data sheets for students that include the information they will need.

Procedures

1. Give students the following directions.

   1. Using the data provided, make a graph showing changes in the amounts of LH and FSH throughout the menstrual cycle. Use a yellow pencil for LH and a blue pencil for FSH.

2. Make another graph showing the levels of estrogen (in red) and progesterone (in green).

3. Describe the pattern of each hormone. LH peaks around day 14, estrogen peaks around day 12, and progesterone around day 21. FSH levels rise on days 2 through 8 and then drop off until spiking around day 14.

   2. Indicate with a dashed green line how the progesterone level would look if it were absent. Check students’ graphs for maintenance of high level.

   Analysis

   1. Describe the pattern of each hormone. LH peaks around day 14, estrogen peaks around day 12, and progesterone around day 21. FSH levels rise on days 2 through 8 and then drop off until spiking around day 14.

   2. Indicate with a dashed green line how the progesterone level would look if it were absent. Check students’ graphs for maintenance of high level.

   Assessment

   Performance Ask students to include a summary of the lab, their graphs, and answers to Analysis questions in their journals. Use the Performance Task Assessment List for Lab Report in PASC, p. 47.
**Sex Cell Production**

As with many other animals, human sex cells are produced by meiosis. A mature male produces millions of swimming sperm cells each day. A mature female usually releases only one mature egg each month.

**Critical Thinking**

Compare the number of sex cells produced by each meiotic division in the testes and the ovaries.

1. **Egg production**
   - In the fetal ovary, cells undergo a partial meiotic division to become primary oocytes. These cells are held at prophase I. To find out, read the Inside Story.

2. **How eggs are released**
   - About once a month, beginning at puberty, the process of meiosis starts up again in several of the primary oocytes. How does the production of sperm differ from the production of egg cells? To find out, read the Inside Story.

3. **Egg released**
   - Usually, only one secondary oocyte is released from the ovary at ovulation. That oocyte will complete meiosis I only if fertilization takes place. Meiosis II produces another polar body.

**Critical Thinking**

For every cell starting meiosis in the male, there are four sperm cells produced; in the female, only one egg is produced. The other three cells in the female are polar bodies, which disintegrate.
The Menstrual Cycle

The sequence of changes in the female reproductive systems that includes producing an egg and preparing the uterus for receiving it is known as the menstrual cycle. The entire menstrual cycle repeats about once a month. Once an egg has been released during ovulation, the part of the follicle that remains in the ovary develops into a structure called the corpus luteum. The corpus luteum secretes the hormones estrogen and progesterone. Progesterone causes changes to occur in the lining of the uterus that prepare it for receiving a fertilized egg. The menstrual cycle begins during puberty and continues for 30 to 40 years, until menopause. At menopause, the female stops releasing eggs and the secretion of female hormones decreases. The length of each menstrual cycle varies from female to female, but the average is 28 days. If the egg released at ovulation is not fertilized, the lining of the uterus is shed, causing some bleeding for a few days. The entire menstrual cycle can be divided into three phases: the flow phase, the follicular phase, and the luteal phase, illustrated in Figure 38.8. The timing of each phase of the menstrual cycle correlates with hormone output from the pituitary gland, changes in the ovary, and changes in the uterus. Figure 38.9 shows how the cycle is altered when fertilization occurs.

Carry out the Problem-Solving Lab to find out how the phases of the menstrual cycle can vary in length.

Flow phase

Day 1 of the menstrual cycle is the day menstrual flow begins. Menstrual flow is the shedding of blood, tissue fluid, mucus, and epithelial cells that line the uterus. This flow passes from the uterus through the cervix and the vagina to the outside of the body. The series of changes in the female's body temperature increases leading up to ovulation, ovulation occurs, and menstruation begins. Figure 38.8.

Critical Thinking/Problem Solving

Study the graph and then answer the questions that follow.

1. Why does the menstrual cycle vary in length, regardless of the total time for a cycle? Which hormones are associated with phase length?

2. How are the phases of a 26-day cycle different from those of a 28-day cycle?

3. How would these events differ for the cycle during which a female becomes pregnant?

Thinking Critically

Thinking and Planning

1. What are the events that occur during the menstrual cycle?

2. Which phase does not vary in length, regardless of the total time for a cycle? Which hormones are associated with phase length?

3. How are the phases of a 26-day cycle different from those of a 28-day cycle?

4. How would these events differ for the cycle during which a female becomes pregnant?

Analysis

The graph compares menstrual cycles of different lengths. Study the graph and then answer the questions that follow.

Thinking Critically

Thinking and Planning

1. What are the events that occur during the menstrual cycle?

2. Which phase does not vary in length, regardless of the total time for a cycle? Which hormones are associated with phase length?

3. How are the phases of a 26-day cycle different from those of a 28-day cycle?

4. How would these events differ for the cycle during which a female becomes pregnant?
Fertilization and Implantation

After an egg ruptures from a follicle, it is able to stay alive for about 24 hours. For fertilization to occur, sperm must be present in the oviduct at some point during those first hours after ovulation. Sperm enter the oviduct of the female’s reproductive system when strong, muscular contractions eject semen from the male’s penis into the female’s vagina. As hormone levels drop, the thin lining of the uterus begins to thin. If fertilization occurs, as shown in Figure 38.10, the endometrium begins to secrete a fluid rich in nutrients for the zygote.

One sperm plus one egg

How is it possible that, of the millions of sperm released into the vagina during ejaculation, only one fertilizes the mature egg? One reason is that the fluids secreted by the vagina are acidic and destroy most of the delicate sperm. Yet, some sperm survive because of the buffering effect of semen. The surviving sperm swim up into the uterus. Of the sperm that reach the uterus, only a few hundred pass into the two ovaries. The egg is present in one of them. To examine the attraction between sperm and egg, carry out the MiniLab on the next page.

Recall that the head of the sperm contains enzymes that help the sperm penetrate the egg. As the sperm

Biology Journal

Life Before Birth

Linguistic: Ask students to write an imaginary story about what they think it is like to be an embryo or fetus in the uterus. The article “Sensing in the Womb,” by Jacqueline S. Palmer, The American Biology Teacher, vol. 49, no. 7 (October 1987), may be a helpful resource for students.

Glencoe Technology

Video: Human Fertilization

38.2 Development Before Birth

What do you have in common with a period at the end of a sentence? You were once about the same size. You started out life as a single, microscopic fertilized egg. That one cell went through numerous mitotic divisions to produce the trillions of cells that make up your body today. It all began when an egg from your mother was fertilized by a sperm from your father.

Fertilization and Implantation

After an egg ruptures from a follicle, it is able to stay alive for about 24 hours. For fertilization to occur, sperm must be present in the oviduct at some point during those first hours after ovulation. Sperm enter the oviduct of the female’s reproductive system when strong, muscular contractions eject semen from the male’s penis into the female’s vagina. As hormone levels drop, the thin lining of the uterus begins to thin. If fertilization occurs, as shown in Figure 38.10, the endometrium begins to secrete a fluid rich in nutrients for the zygote.

One sperm plus one egg

How is it possible that, of the millions of sperm released into the vagina during ejaculation, only one fertilizes the mature egg? One reason is that the fluids secreted by the vagina are acidic and destroy most of the delicate sperm. Yet, some sperm survive because of the buffering effect of semen. The surviving sperm swim up into the uterus. Of the sperm that reach the uterus, only a few hundred pass into the two ovaries. The egg is present in one of them. To examine the attraction between sperm and egg, carry out the MiniLab on the next page.

Recall that the head of the sperm contains enzymes that help the sperm penetrate the egg. As the sperm
Implantation

Examine the fertilized egg under the microscope. The fertilized egg develops into a structure that attaches to the inner lining of the uterus. This process is called implantation.

**Performance Task Assessment**

1. Place a dropperful of sea urchin eggs on a microscope slide. CAUTION: Use care when working with a microscope and microscope slides.
2. While observing the eggs under the microscope, add a drop of sea urchin sperm to the eggs.
3. Are the sperm attracted to the eggs? How do you know?
4. Cross the cell membrane of the egg, it loses its midpiece and tail. Once one sperm has entered the egg, the electrical charge of the egg’s membrane changes, thus preventing other sperm from entering. The sperm’s nucleus then combines with the egg’s nucleus to form a zygote. The fertilized egg travels to the uterus.

**Analysis**

1. Describe the motion of the sperm.
2. What cell structures are involved in providing energy for the sperm motion?
3. Could fertilization be occurring at the same time as the first cleavage?

**Embryonic Membranes and the Placenta**

You have already learned about the importance of the amniotic egg to the evolutionary advancement of animals. Membranes that are similar to those of the amniotic egg form around the human embryo, protecting it from the outside environment. About 30-40 days after fertilization, the otic placenta is formed. These vital substances are then removed by the mother’s excretory system.

**Exchange between embryo and mother**

The umbilical cord, called chorionic villi, begins to form into the uterine wall, as shown in Figure 38.12. Chorionic villi combine with part of the uterine lining to form the placenta.

**Performance**

Students will determine whether fertilization live in water and release their sperm and eggs into the water. The blastocyst is the term used when discussing human embryonic development. Recall that the term blastula is used for the embryonic development of other animals.

**Safety Precautions**

Caution students to be careful with microscopes and microscope slides. Have students wear a lab apron and safety goggles, and wash their hands at the end of the lab.

**Teaching Strategies**

Fertilize some of the eggs a few hours before class so students can observe various stages of cleavage. If the eggs are kept at room temperature, the first cleavage takes about 50-60 minutes; second cleavage, 1 1/2 hours; third cleavage, 1 3/4 hours. The blastula forms after about 6 hours.

**Expected Results**

Sperm will collect around the egg, indicating that they are attracted to the egg.

**Analysis**

1. The sperm swim like tadpoles with tails whipping back and forth.
2. mitochondria
3. Yes, they swim toward and gather around the egg.

**Assessment**

Performance: Have students write a summary of the MiniLab and place it in their journals along with their answers to the Analysis questions. Use the Performance Task Assessment List for Lab Report in PASC, p. 47.

**Portfolio**

**MiniLab 38-1**

**Purpose**

Students will determine whether fertilization occurs.

**CAUTION:** Have students wear a lab apron and safety goggles, and wash their hands at the end of the lab.

**MiniLab 38-1**

**Examine the fertilized egg.**

1. Describe the motion of the sperm.
2. What cell structures are involved in providing energy for the sperm motion?
3. Could fertilization be occurring at the same time as the first cleavage?

**Procedure**

1. Place a dropperful of sea urchin eggs on a microscope slide. CAUTION: Use care when working with a microscope and microscope slides.
2. While observing the eggs under the microscope, add a drop of sea urchin sperm to the eggs.
3. Are the sperm attracted to the eggs? How do you know?
Bioethics

Embryo Ownership Questions have arisen regarding ownership of fertilized human embryos. A couple who underwent in vitro fertilization had embryos frozen and stored. Later, they were divorced. During the divorce proceedings, the question was raised as to whom, if anyone, the embryos should belong. Initiate a class debate on this issue. Ask students what should happen to embryos when a couple divorces. If the embryos are implanted and a baby results, should one parent be permitted to sue the other for child support?

Hormonal maintenance of pregnancy

Remember that estrogen, and especially progesterone, cause the uterine lining to thicken in preparation for implantation. Once the blastocyst implants, the chorion membrane of the embryo starts to secrete the hormone human chorionic gonadotropin (HCG). This hormone keeps the corpus luteum alive so that it continues to secrete progesterone. Learn how this hormone is an indicator of pregnancy in the BioLab at the end of this chapter. By the third month, the placenta takes over for the corpus luteum, secreting enough estrogen and progesterone to maintain the pregnancy.

Fetal Development

When you think of an embryo growing within the mother’s body, you may not realize that its development involves three different processes: growth, development, and cellular differentiation. Growth refers to the actual increase in the number of cells. As the cells develop, they move within the embryo’s body and arrange themselves into specific organs. In addition, each cell becomes specialized to perform specific tasks and functions. All three processes begin with fertilization.

Pregnancy in humans usually lasts about 280 days, calculated from the first day of the mother’s last menstrual period. The baby actually develops for about 266 days, calculated from the time of fertilization to birth. This time span is divided into three trimesters, each about three months in length. Each trimester brings significant advancement in the development of the embryo and fetus.

First trimester:

Organ systems form

During the first trimester, all the organ systems of the embryo begin to form. A five-week embryo is shown in Figure 38.13A. At the beginning of the first trimester, the fetus weighs about 28 g and is about 7.5 cm long from the top of its head to its buttocks. The sex of the fetus can be determined by the appearance of the external sex organs when viewed by ultrasound.

Second trimester:

A time of growth

For the most part, fetal development during the next three months is limited to body growth. Growth is rapid during the fourth month, but then slows by the beginning of the fifth month. At this point, it is possible for the fetus to survive outside the uterus, but it would require a great amount of medical assistance, and the mortality rate is high. The fetus’s metabolism cannot yet maintain a constant body temperature, and its lungs have not matured enough to provide a regular respiratory rate. The end of the first trimester, the fetus weighs about 650 g and is about 34 cm long.

Third trimester:

Continued growth

During the last trimester, the mass of the fetus more than triples. By the beginning of the seventh month, the fetus kicks, stretches, and moves freely within the amniotic cavity, somewhat like the astronaut in the
**Expected Results**

The embryo grows fastest during the 6th and 7th weeks of development.

**Purpose**

Students will graph and evaluate the growth of a human embryo.

**Process Skills**

- make and use graphs, interpret data, analyze

**Teaching Strategies**

- Be sure students recognize the importance of the 6th and 7th weeks of development.

**Analysis**

- **1.** The embryo doubles in size to form a hollow ball. During the final weeks of pregnancy, the fetus grows large enough to fill the space within the embryonic membrane. During the ninth month, the head rotates so that its head is the heaviest part of the body. By the end of the third trimester, the fetus is about 39 cm long and about 5 kg in weight.

**Problem-Solving Lab 38-2**

**Thinking Critically**

1. List two situations where genetic counseling could be used. Include an example of each.

2. Why is genetic counseling important?

**Thinking Critically**

1. What are the advantages and disadvantages of genetic counseling?

**Performance Assessment**

Students will learn that folic acid and another nutrient can reduce the incidence of neural-tube defects.

**Process Skills**

- analyze information, compare and contrast, draw a conclusion, think critically

**Teaching Strategies**

- Explain that, during the third week of development, a groove forms on the embryo. Cells grow across the groove opening to form the neural tube, which will become the spine. Tube formation begins at the middle of the embryo and moves up toward the head. Incomplete closure results in neural-tube birth defects.

**Assessment**

- Students will learn that folic acid can reduce the incidence of certain neural-tube defects.

---

**Genetic Counseling**

- Most expectant parents desperately want to have healthy, normal babies. With our increasing knowledge of human heredity and advancing technology, determining that a newborn will be healthy and normal is much more possible today than it was in the past.

**Genetic disorders can be predicted**

- Generally, people in the industrialized nations are aware of the possible genetic disorders that can affect a child. For many, this awareness has made them eager to know whether a child will be affected.

**Problem-Solving Lab 38-2**

**Reading Comprehension**

- How can pregnant women reduce certain birth defects? Ten of every 10,000 American babies are born with neural-tube defects. One of the defects included in this group is spina bifida. This condition occurs during early embryonic development, the bones of the spine fail to form properly. As a result, the spinal column protrudes outside the spinal column rather than inside it. How can pregnant women decrease the occurrence of neural-tube defects?

**Analysis**

- Research findings about how neural-tube defects can be almost completely eliminated are provided in Table 38.2.

---

**Growth of a Fetus**

<table>
<thead>
<tr>
<th>Source of sample</th>
<th>First trimester</th>
<th>Second trimester</th>
<th>Third trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time after fertilization</td>
<td>1 week</td>
<td>16 weeks</td>
<td>31 weeks</td>
</tr>
<tr>
<td>Size</td>
<td>1 mm</td>
<td>6 mm</td>
<td>18 cm</td>
</tr>
</tbody>
</table>

**Procedure**

- Plot the data shown in Table 38.1 on your graph.

**Analysis**

1. When is the fastest period of growth?
2. What structures are developing during this period of growth?
3. At what point does growth begin to slow down?

---

**MiniLab 38-2 Making and Using Graphs**

**Making a Graph of Fetal Growth**

- You started out as a single cell. That cell divided into two, and the process of mitosis to produce organ systems capable of maintaining an independent existence outside your mother’s uterus. During the time you were in your mother’s uterus, major changes took place. One of these changes involved your growth in length.

**Expected Results**

- The zygote divides as it passes down the oviduct; cells organize into a small hollow ball.

**Discussion**

- Have students summarize the development of the human fetus.

**Close**

- Discuss how changes in this orderly development may result in birth defects.
Section 38.3

Birth, Growth, and Aging

Prepare

Key Concepts
This section describes the three stages of birth—dilation, expulsion, and the placental stage—and summarizes the developmental stages of humans after they are born.

Planning
- Gather additional pictures to add to the Display begun in Section 38.2.
- Gather photographs of newborn infants and elderly individuals for the Quick Demo.

1 Focus

Bellringer
Before presenting the lesson, display Section Focus Transparency 95 on the overhead projector and have students answer the accompanying questions.

Biology Journal

Aging Assessment
Visual-Spatial Have students write an essay expressing their personal views on aging. Ask them to explain why they feel as they do.

Meeting Individual Needs

English Language Learners/ Learning Disabled
Visual-Spatial Have students prepare flash cards of the vocabulary words from this chapter by writing the term on one side of the card and its definition on the other side. Have student groups review the terms and their meanings.

Portfolio

Resource Manager

Section Focus Transparency 95 and Master

Section

38.3 Birth, Growth, and Aging

Human growth is regulated by hormones. As a baby grows, it must develop the ability to control its body growth. The physical and physiological changes that take place in the body as it grows are shown in Figure 38.15.

Birth is the process by which a fetus is pushed out of the uterus and the mother's body, and into the outside world, like the newborn in Figure 38.15. What triggers the onset of birth is not fully understood. Different hormones released from the pituitary gland, such as oxytocin, a hormone released by the pituitary gland, can cause uterine contractions, open the cervix, and allow birth to occur. The cervix is about 10 cm, it is fully dilated, and labor progresses, the contractions begin to occur at regular intervals and intensify as the time between them shortens. When the opening of the cervix is about 10 cm, it is fully dilated. Usually, the amnionic sac ruptures and the amnionic fluid is released through the vagina, which is also referred to as the birth canal. This first stage of labor is usually the longest, sometimes lasting up to 24 hours.

Dilation of the cervix
The physiological and physical changes that take place in the body as it grows are shown in Figure 38.15. What triggers the onset of birth is not fully understood. Different hormones released from the pituitary gland, such as oxytocin, a hormone released by the pituitary gland, can cause uterine contractions, open the cervix, and allow birth to occur. The cervix is about 10 cm, it is fully dilated, and labor progresses, the contractions begin to occur at regular intervals and intensify as the time between them shortens. When the opening of the cervix is about 10 cm, it is fully dilated. Usually, the amnionic sac ruptures and the amnionic fluid is released through the vagina, which is also referred to as the birth canal. This first stage of labor is usually the longest, sometimes lasting up to 24 hours.

Expulsion of the baby
Expulsion occurs when the involuntary uterine contractions become so forceful that they push the baby through the cervix into the birth canal. The mother assists with expelling the baby by contracting her abdominal muscles in time with the uterine contractions. As shown in Figure 38.16A, the baby moves from the uterus, through the birth canal, and out of the mother's body. The expulsion stage usually lasts from 20 minutes to an hour.

Placental stage
As shown in Figure 38.16C, within ten to 15 minutes after the birth of the baby, the placenta separates from the uterus wall and is expelled with the remains of the embryonic membranes. Collectively, these materials are known as the afterbirth. The afterbirth consists of the placenta and umbilical cord. After the baby is born, the umbilical cord is clamped and cut near the baby's abdomen. The cord can be left to dry and falls off, leaving an abdominal scar called the navel.

Expulsion
The baby rotates as it moves through the birth canal, making expulsion easier.

Placental stage
During the placental stage, the placenta and umbilical cord are expelled.

Growth and Aging
Once a baby is born, growth continues and learning begins. Human growth varies with age and is sex dependent.

A hormone controls growth
Human growth is regulated by hormones, such as growth hormone, a hormone secreted by the pituitary gland that stimulates growth. Although IGF1 causes all body cells to grow, it acts principally on the skeleton and skeletal muscles. The hormone works by increasing the rate of protein synthesis and the metabolism of fat molecules. Other hormones that influence growth include thyroid hormone and testosterone.

Figure 38.15
A mature infant continues growth and development outside the mother's body.

The human body changes throughout life.

Figure 38.16
The stages of birth are dilation, expulsion, and the placental stage.
The first stage of growth: infancy
The first two years of life are known as infancy. During infancy, a child grows tremendously as well as an increase in physical coordination and mental development. Generally, an infant will double its birth weight by the time it is five months of age, and triple its weight in a year. By two years of age, most infants weigh approximately four times their birth weight. During this time, the infant learns to control its limbs, roll over, sit, crawl, and walk. By the end of infancy, the child also utters his or her first words.

An adult ages
As an adult ages, his or her body undergoes many distinct changes. Metabolism and digestion become slower. The skin loses some of its elasticity, and less pigment is produced in the hair follicles; that is, the hair turns white. Bones often become brittle, and the rate of protein synthesis inside cells diminish, but, as mentioned in the hair follicles, that is, the hair turns white. Bones often become brittle, and the rate of protein synthesis inside cells. Bones may become thin and more prone to fracture. Stature is usually maintained until the age of 77, when he joined the crew of space shuttle Discovery.

Adolescence follows childhood. At puberty, the onset of adolescence, there is often a growth spurt, sometimes quite a dramatic one. Increases of 5 to 8 cm of height in one year are not uncommon in teenage boys. During the teen years, adolescents reach their maximum physical stature, which is determined by heredity, nutrition, and their environment. By the time a young person reaches adulthood, his or her organs have reached their maximum mass, and physical growth is complete. You can see in Figure 38.17 how the physical appearance of a person changes from birth to adulthood.

Cultural Diversity
Rites of Passage
In many cultures and religions, traditional celebrations mark the transition from childhood to adulthood. For example, in Mexican tradition, a girl celebrates her transition from childhood to adulthood on her fifteenth birthday in a celebration known as quinceanera. Discuss with students examples of initiation rites in various cultures. You may wish to have students research topics by asking them to identify a culture and then determine whether that culture has a traditional rite of passage.

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Resource Manager
Tech Prep Applications, p. 53
Reinforcement and Study Guide, p. 170
Content Mastery, pp. 185, 187-188
Understanding Main Ideas
1. What events occur during the dilation stage of the birth process? How does the human growth hormone produce growth? How does human body change during child; how? What changes to the body are usually associated with aging?

Thinking Critically
5. Compare the birth of a human baby with that of a marsupial mammal.

Skill Practice
6. Recognizing Cause and Effect: Someone tells you that as people age, their personalities normally change. Do you think this statement is valid? Why or why not? For more help, refer to Thinking Critically in the Skill Handbook.

Section Assessment
1. Muscle contractions expand the cervix to about 10 cm. 2. Human growth hormone increases the rate of protein synthesis inside cells and increases the metabolism of fat molecules. 3. Muscle coordination, reasoning, and problem-solving abilities increase; the body grows; the child develops the ability to reason and solve problems. 4. Metabolism and digestion slow. Skin loses elasticity and hair follicles lose pigment. Bones may become thin and more prone to fracture. Vision and hearing may diminish. 5. When compared with humans, marsupials are born earlier in development. After birth, marsupials continue to develop within the mother’s pouch. Both humans and marsupials are dependent upon the mother at birth. 6. Students are likely to agree that most people function effectively throughout life without experiencing changes in personality.

Assessment
Knowledge Ask students to choose a hormone discussed in this chapter and diagram a negative-feedback loop for the hormone.

Discussion
Ask students to state several misconceptions about aging. List their statements on the chalkboard. As a class, discuss evidence that supports why each statement is a misconception.
What hormone is produced by an embryo?

The chorion of an eight-day-old embryo produces a hormone called human chorionic gonadotropin (hCG). This hormone stimulates the corpus luteum to continue its production of progesterone, which in turn maintains the attachment of the embryo to the uterine lining. There is such a high concentration of hCG present in the blood of the mother that the kidneys excrete it in urine.

Problem
How can you test for the presence of hCG?

Objectives
In this BioLab, you will:
1. Model the chemicals used to test for the presence of hCG.
2. Interpret the results of chemical reactions involving hCG in a pregnant and nonpregnant female.

Materials
scissors
heavy paper
tracing paper

Safety Precautions
Remind students to use caution when handling scissors.

Procedure
1. Copy the data table.
2. Copy models A, B, and C onto tracing paper.
3. Copy the tracing onto heavy paper and cut them out. You will need 4 models of A, 4 of B, and 1 of C.
4. Model A represents a molecule of the hCG hormone. Model B represents a chemical called anti-hCG hormone. Model C represents a chemical that has four hCG molecules attached to it.
5. Note that the shapes of hCG and anti-hCG join together like puzzle pieces. These two chemicals react, or join together, when both are present in a solution. The shapes of anti-hCG and Chemical C also join, indicating that they chemically react when both are present. The combination of Chemical C and anti-hCG is green. Chemical C without anti-hCG attached is colorless.
6. Model the following events for the "Not pregnant" condition. Record them in the data table using drawings of the models.
   a. The hormone hCG is not present in the urine.
   b. Anti-hCG is added to a urine sample, then chemical C is added.
   c. Draw the resulting chemical in the data table and indicate the color that appears.
7. Model the following events for the "Pregnant" condition. Record them in the data table using drawings of the models.
   a. The hormone hCG is present.
   b. Anti-hCG is added to urine.
   c. Chemical C is added.
   d. Draw the resulting chemical in the data table and indicate the color that appears.

Data Table
<table>
<thead>
<tr>
<th>Condition</th>
<th>hCG is present?</th>
<th>Anti-hCG</th>
<th>Joined hCG and anti-hCG?</th>
<th>Chemical C with anti-hCG?</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not pregnant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Green</td>
</tr>
<tr>
<td>Pregnant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Colorless</td>
</tr>
</tbody>
</table>

INVESTIGATE BioLab

Resource Manager

Biolab and MiniLab Worksheets, pp. 171-172

1. Analyzing Explain the origin of hCG in a pregnant female.
2. Analyzing Explain why hCG is absent in a nonpregnant female.
3. Concluding Describe the roles of anti-hCG and Chemical C in both tests.
4. Observing and Inferring Explain why hCG is added to the sample before Chemical C is added.

ANALYZE AND CONCLUDE

Going Further

Analyzing Information Using references, look up the meaning of the words "chorionic" and "gonadotropin." Explain why the name hCG suits this hormone.

Going Further

Ask students who are interested to check on the meaning of "antigen-antibody reaction" and determine if the completed activity fits this description.

Teaching Strategies

1. This lab simulates a home pregnancy test. Each manufacturer of home pregnancy tests has a variation on the final color and its interpretation. Students may be familiar with TV commercials for products in which the final color may not be green or colorless.
2. Students do not have to diagram all four molecules of chemical A and B on the data chart. However, they must diagram at least one to represent the concept of what is occurring.

Troubleshooting

Remind students that each model represents a molecule. When two models fit together, this represents a chemical reaction.

Students must realize that there is no hCG in the urine of a nonpregnant female.

When joined together, hCG and anti-hCG cannot attach to chemical C.

ANALYZE AND CONCLUDE

Data Table
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Frozen Embryos

In February 1998, an 8-pound, 15-ounce baby boy was born in Los Angeles, California. What’s so special about that? This particular baby developed from an embryo that had been frozen for more than seven years. Freezing human embryos that can be implanted in a mother’s uterus at some later date has become a fairly routine part of in vitro fertilization.

Main Ideas
- The male reproductive system produces sperm and the female reproductive system produces eggs.
- Through the control of the hypothalamus and pituitary, hormones act on the reproductive system as well as on other body systems. Hormone levels are regulated by negative feedback.
- Changes in male and females at puberty are the result of the production of FSH, LH, and other sex hormones.
- Under the control of hormones, the menstrual cycle produces a mature egg and prepares the uterus for receiving a fertilized egg.

Purpose
Students learn how the process of cryopreservation is used to preserve embryos that are implanted during in vitro fertilization.

Background
Cryopreservation could help save critically endangered animals. In zoos around the world, eggs and sperm of endangered species are being frozen and stored. One day, it may be possible to implant embryos produced from these rare cells into other species that will act as surrogate mothers. This approach may be the only way to save critically endangered species. In many zoos, eggs from endangered animals are collected, fertilized, and cryopreserved. If a species becomes extinct, these eggs can be implanted in a surrogate mother, thus ensuring that the species does not become extinct.

Teaching Strategies
- Have students research the use of cryopreservation in the breeding of racehorses and cattle.
- Have students research the properties of liquid nitrogen to learn why it is used for cryopreservation.

Investigating the Technology
Possible answers: The protective chemicals that are mixed with the embryos cause the concentration of water outside the cells to be lower than the concentration of water inside the cells. Because water flows from high to low concentration in osmosis, it flows out of the cells into the surrounding environment.

Investigating the Technology
Thinking Critically
Use your knowledge of osmosis to explain why water leaves the cells of an embryo during cryopreservation.

Going Further
Have interested students make a poster explaining the osmotic relationships between the embryo and the surrounding environment during cryopreservation.

Internet Address Book
Note Internet addresses that you find useful in the space below for quick reference.

GLENCOE TECHNOLOGY
VIDEO TAPE
Mindbogger Videodiscs
Chapter 38: Reproduction and Development
Have students work in groups as they play the videodisc game to review key chapter concepts.

Resource Manager
Chapter Assessment, pp. 223-228
Mindbogger Videodiscs
Computer Test Bank
BDQ Interactive CD-ROM
Chapter 38 quiz

1. Which of the following is NOT a part of the male reproductive system?
   a. testes
   b. epididymis
   c. scrotum
   d. vas deferens

2. Which of these is NOT found in a sperm?
   a. nucleus
   b. flagellum
   c. mitochondria
   d. chloroplasts

3. What tubule transports both urine and semen?
   a. vas deferens
   b. epididymis
   c. urethra
   d. ureter

Vocabulary
- sperm (p.1025)
- ovum (p.1025)
- cornerstone (p.1034)
- epidermis (p.1038)
- follicle (p.1031)
- menstrual cycle (p.1034)
- ovulation (p.1031)
- prostate gland (p.1029)
- puberty (p.1029)
- semen (p.1029)
- ovum (p.1029)
- vas deferens (p.1028)
18. This hormone is secreted by the ovary, oviduct.

19. Testosterone

20. Puberty

21. Why does the presence of human chorionic gonadotropin in the urine indicate pregnancy?

22. A pregnant woman tells her physician that she is 10 days past the first day of her last menstrual period. How many days has the embryo been developing?

The following graph represents the average blood concentration of four circulating hormones collected from 50 healthy adult women who were not pregnant.

**Interpreting Scientific Illustrations**

The yellow line represents the hormone human chorionic gonadotropin. Explain why this hormone remained at an extremely low level during the women’s menstrual cycles.

**Test-Taking Tip**

The "Best" Answer Is Often the One "Left Over"

If none of the answer choices look right, use the process of elimination to eliminate the worst ones. The one you’ve got left is the best choice.

**APPLYING MAIN IDEAS**

21. This hormone is secreted by the embryo/fetus, so it indicates pregnancy.

22. About 36 days

23. During pregnancy, the heart-beat rate and cardiac output increase. This increase compensates for blood delivery to the developing fetus.

24. 1. Ovulation; 2. Follicle; 3. Oviduct

**ASSESSING KNOWLEDGE & SKILLS**

1. Which hormone increases during the last half of the menstrual cycle?
   a. estrogen
   b. LH
   c. progesterone
   d. FSH

2. Which hormone increases during the second month?
   a. estrogen
   b. LH
   c. progesterone
   d. FSH

3. Which hormone is responsible for stimulating the egg development each month?
   a. estrogen
   b. LH
   c. progesterone
   d. FSH

4. Interpreting Scientific Illustrations
   a. The yellow line represents the hormone human chorionic gonadotropin. Explain why this hormone remained at an extremely low level during the women’s menstrual cycles.

**ASSESSING KNOWLEDGE & SKILLS**

1. Which line represents luteinizing hormone?
   a. red line
   b. blue line
   c. green line
   d. pink line

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   a. red line
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**THINKING CRITICALLY**

During pregnancy, the heart-beat rate and cardiac output increase. This increase compensates for blood delivery to the developing fetus.

**Assessing Knowledge & Skills**

1. d
2. b
3. d
4. This hormone is secreted only when women are pregnant.

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