Chapter 38 Organizer

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

Section	Objectives	Activities/Features
Section 38.1 **Human Reproductive Systems** National Science Education Standards UCP.1-3, UCP.5; C.1, C.5; F.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 UCP.1-3, UCP.5; A.1, A.2; C.1, C.5, C.6; E.1, E.2; F.1, F.6; 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 **Investigate 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 UCP.1, UCP.3, UCP.5; A.1, A.2; C.6; E.1, E.2; F.1, F.6; G.1-3 (2 sessions, 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

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

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. 1045 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 above-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.
- P These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

Reproduction and Development

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 38.1 **Human Reproductive Systems**	Reinforcement and Study Guide, pp. 167-168 L2 Concept Mapping, p. 38 L3 ELL Critical Thinking/Problem Solving, p. 38 L3 Content Mastery, pp. 185-186, 188 L1	Section Focus Transparency 93 L1 ELL Basic Concepts Transparency 74 L2 ELL Basic Concepts Transparency 75 L2 ELL Reteaching Skills Transparency 55 L1 ELL
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, 187-188 L1	Section Focus Transparency 94 L1 ELL Reteaching Skills Transparency 56a, 56b L1 ELL
Section 38.3 **Birth, Growth, and Aging**	Reinforcement and Study Guide, p. 170 L2 BioLab and MiniLab Worksheets, pp. 171-172 L2 Content Mastery, pp. 185, 187-188 L1 Tech Prep Applications, pp. 53-54 L2	Section Focus Transparency 95 L1 ELL

Assessment Resources

Chapter Assessment, pp. 223-228
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 38 quiz

Additional Resources

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

NATIONAL GEOGRAPHIC Teacher's Corner

Products Available From Glencoe

To order the following products, call Glencoe at 1-800-334-7344:

Curriculum Kit

GeoKit: Human Body 2

Videodisc

STV: Human Body

Products Available From National Geographic Society

To order the following products, call National Geographic Society at 1-800-368-2728:

Videos

Incredible Human Machine
Reproductive Systems (Human Body Series)

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life

CD-ROM ELL

Video: *Fetal Development*

Videodisc Program

Human Fertilization
Fetal Development

The Secret of Life Series

Testis
Cross Section of Ovary

Getting Started Demo

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

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.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

Chapter

38 Reproduction and Development

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.

Getting Started

Looking at Sperm Cells

Examine a prepared microscope slide of sperm cells. *What feature of these cells suggests they might be capable of rapid motion?*

interNET CONNECTION 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

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Project, p. 1040

Visual-Spatial Meeting Individual Needs, pp. 1028, 1032, 1044; Quick Demo, pp. 1029, 1039, 1045; Reinforcement, p. 1030; Portfolio, pp. 1032, 1034, 1039; Biology Journal, pp. 1035, 1044; Check for Understanding, p. 1036; Reteach, pp. 1036, 1041

Intrapersonal Meeting Individual Needs, p. 1041

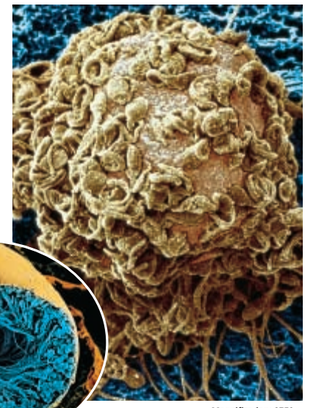
Linguistic Meeting Individual Needs, p. 1028; Biology Journal, pp. 1029, 1037; Portfolio, pp. 1041, 1045; Check for Understanding, p. 1041, Extension, p. 1041, Tech Prep, p. 1042

Logical-Mathematical Reinforcement, p. 1045

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.



Magnification: 9750×

Egg surrounded by sperm and sperm in the testes (inset).

Magnification: 165×

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. The **scrotum** is a sac that contains the testes and is suspended directly behind the base of the penis. 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 3°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.

Section Preview

Objectives

Identify the parts of the male and female reproductive systems.

Summarize the negative feedback control of reproductive hormones.

Sequence the stages of the menstrual cycle.

Vocabulary

scrotum
epididymis
vas deferens
seminal vesicle
prostate gland
bulbourethral gland
semen
puberty
oviduct
cervix
follicle
ovulation
menstrual cycle
corpus luteum

Prepare

Key Concepts

This section focuses on the anatomy and physiology of the male and female reproductive systems. It describes the negative-feedback control of sexual hormones, and hormonal control of the menstrual cycle.

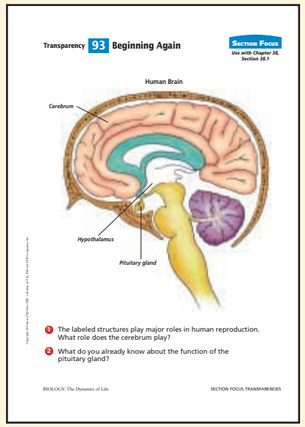
Planning

- Make photocopies of a SEM of a sperm cell for the Getting Started Demo.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 93** on the overhead projector and have students answer the accompanying questions. L1 ELL



Assessment Planner

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
MiniLab, TWE, pp. 1038, 1042
MiniLab, SE, pp. 1038, 1042
Problem-Solving Lab, TWE, p. 1043

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

Skill 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 and Master L1 ELL

2 Teach

Visual Learning

Figure 38.1 Have students use the illustration of the male reproductive system to trace the path of sperm from the testes to the outside of the body. *testes*, *epididymus*, *vas deferens*, *urethra* L1

Using Science Terms

The Latin word *testis* means "witness," while *testicle* means "little witness." Explain that these terms may have developed as a result of the Romans allowing only men to testify in court.

Tying to Previous Knowledge

Ask students to recall how sex cells are produced by meiosis. If necessary, remind them that meiosis produces haploid cells.

Assessment

Skill Have students make a table with the following headings: Organ, Reproductive Function. In the first column, have students list the organs of the male reproductive system. In the second column, they should describe each organ's function. L2

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Human Body
Vol. 3
Reproductive Systems
Unit 2, Side 2, 5 min. 41 sec.
The Male System

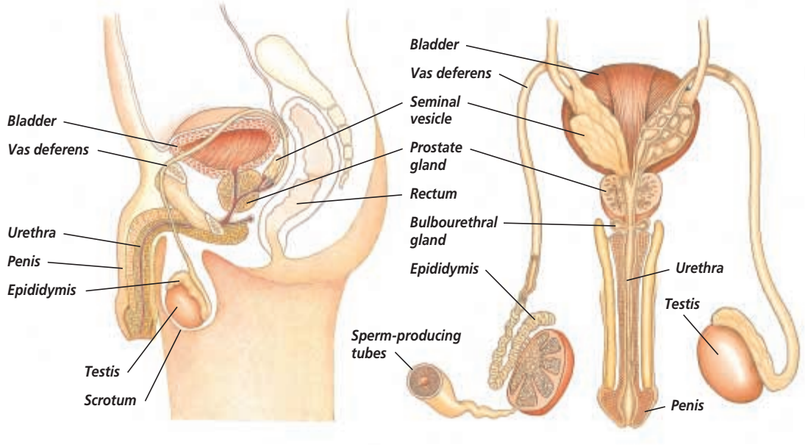


Figure 38.1 The organs and glands of the male reproductive system are shown in front and side views.

Within each testis is a fine network of highly coiled tubes. Sperm are produced by meiosis of the cells that line these tubes. Recall that meiosis produces 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 300 million mature sperm per day, each day of his life.

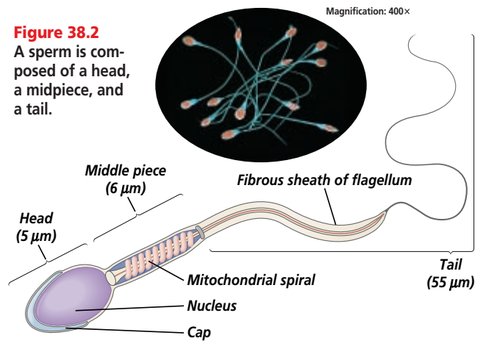


Figure 38.2 A sperm is composed of a head, a midpiece, and a tail.

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 DIHD uh mus) 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 runz) 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** (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 to a child's body 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—is reached. The changes associated with puberty are controlled by sex hormones secreted by the endocrine system.

WORD ORIGIN
epididymis
From the Greek words *epi*, meaning "upon," and *didymos*, meaning "testis." The epididymis tube is on top of the testis.

Figure 38.3 Puberty results in many physical and emotional changes. Generally, males undergo puberty sometime between the ages of 13 and 16.

Quick Demo

Visual-Spatial Using a microscope projector, show students a cross-section of the testis. Point out the tubules filled with sperm cells.

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.

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Testis

Resource Manager
Concept Mapping, p. 38
L3 ELL

Meeting Individual Needs

Learning Disabled

Visual-Spatial Have students use tracing paper to trace the structures of the male reproductive system shown in Figure 38.1. Ask them to label each structure and write a description of its function beside the label. Have them include the diagrams they have created in their journals and use them as study tools. L1

Gifted

Linguistic Have students conduct research on prostate cancer. Ask them to find out what factors place a man at risk for this type of cancer, the possible treatments, and what factors determine the likelihood of survival with treatment. Have students prepare written reports of their findings for their portfolios. L3

Biology Journal

Steroids

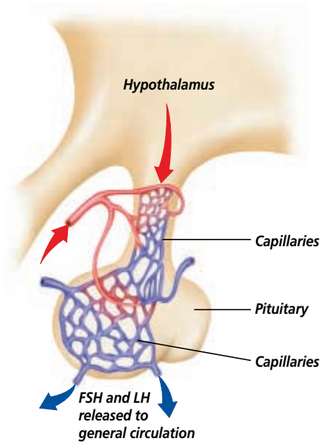
Linguistic Testosterone and estrogen are steroid hormones. Have students conduct library research to find out about these and other steroids and the functions they perform in the body. Ask students to research the steroids that are sometimes taken by athletes to build strength and muscle and the risks and drawbacks of using such steroids for this purpose. Have them prepare a table or a written report of their findings. L2

Reinforcement

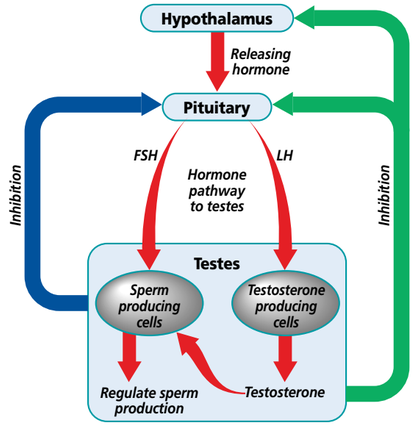
Visual-Spatial Have students use the diagram in Figure 38.4B and the text description of negative feedback systems to develop a flowchart that shows the sequence of events involved in the production and release of the hormones FSH and LH. L2

Revealing Misconceptions

Many people believe that only the sperm is an active player in the fusion of egg and sperm. Explain that a team of researchers at Johns Hopkins University have determined that sperm that reach an egg are held to the egg by receptor molecules on the egg's surface These molecules hook together with counterparts on the surface of the sperm. The receptor molecules fasten the sperm tightly until it can be absorbed by the egg.



A In the hypothalamus, neurons secrete releasing and inhibiting hormones. These hormones travel to the pituitary gland, where they increase or decrease the secretion of FSH and LH.



B Release of FSH and LH from the pituitary gland stimulates production of sperm and of testosterone. As testosterone levels increase, production of FSH and LH slows. When sperm and testosterone levels drop, production of FSH and LH increases again.

Figure 38.4
The activity of the male reproductive system is controlled by the hypothalamus and the pituitary gland in the brain.

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 38.4A***, the hypothalamus secretes a hormone that causes the pituitary to release two other hormones: follicle-stimulating hormone (FSH) and luteinizing (LEW teen i zing) 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 (tehs TAHS tuh rohn), which in turn influences sperm cell production.

The levels of these hormones in the body are regulated by a negative-feedback system. As the testosterone levels in the blood increase, the production of FSH and LH is inhibited, or decreased. Increased production of sperm in the testis also feeds back into the system to inhibit production of FSH and LH, as ***Figure 38.4B*** illustrates. When testosterone levels in the blood drop, production of FSH and LH increases.

Testosterone is the steroid hormone responsible for the growth and development of secondary sex characteristics in a male. These characteristics include growth and maintenance of male sex organs; the production of sperm; an increase in body hair, especially on the face, under the arms, and in the pubic area; an increase in muscle mass; increased growth of the long bones of the arms and legs; and deepening of the voice.

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. Each ovary is about the size and shape of an almond. One ovary 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 situated 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 doh MEE tree um). The lower end of the uterus, called the **cervix,** tapers to 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 hypothalamus 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 steroid hormone responsible for the secondary sex characteristics of females. These characteristics include the growth and maintenance of female sex

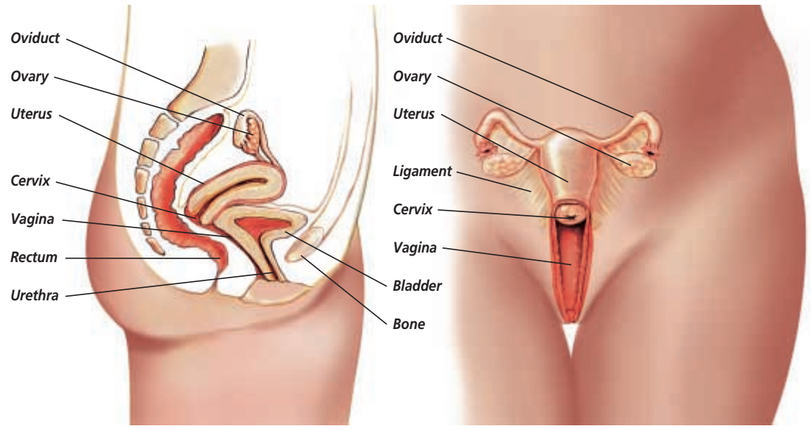


Figure 38.6
The female reproductive system includes two ovaries, two oviducts—sometimes called fallopian tubes—the uterus, and the vagina.

Visual Learning

Figure 38.5 Have students use the illustration of the female reproductive system to trace the path of an egg from the ovaries to the uterus. *ovary*, *oviduct*, *uterus* L1

Concept Development

Explain that a human female is born with about 400 000 potential eggs in her ovaries. Beginning at puberty, one egg matures each month until menopause occurs, accounting for approximately 400 eggs. Ask students to think about the probability of any one egg being released. *1 : 400 000* Point out that this rate of release makes the chances that any one sperm will fertilize any given egg very small.

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Human Body Vol. 3
Reproductive Systems
Unit 2, Side 2, 2 min. 41 sec.
The Female System

Resource Manager

Basic Concepts Transparency 74 and Master L2 ELL
Reteaching Skills Transparency 55 and Master L1 ELL

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
Prepare data sheets for students that include the information given here.

Data Table

Day	2	4	6	8	10	12	14	16	18	20	22	24	26	28
LH	17	17	17	17	17	46	35	20	19	18	17	16	14	13
FSH	14	14	14	13	10	8	15	8	7	7	6	6	6	7
Estrogen	4	4	5	6	10	13	13	10	9	10	11	11	11	8
Progesterone	1	1	1	1	1	1	2	4	7	12	14	14	9	3

Procedure
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).

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 pregnancy occurred. *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. L2

Enrichment

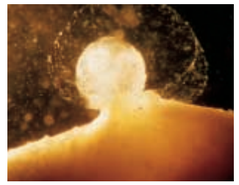
Have students do library research to find out how the normal menstrual cycle is affected by an individual's physical fitness. They may learn that, during intense exercise (as with Olympic athletes), the body produces endorphins, which reduce the production of sex hormones, including estrogen. This can stop the menstrual cycle. Smoking also has an anti-estrogenic effect. Another factor that can disrupt the normal menstrual cycle is the fat percentage in the body. Scientists have found that a critical weight and fat percentage act like a trip wire that triggers monthly ovulation. Thus, a too-low or too-high fat percentage can interfere with normal cycling. L2

Concept Development

Ask students to speculate about why the use of drugs (such as marijuana) by the mother might create a greater chance of producing genetic defects than drug use by the father. *Females do not replace eggs, but are born with all their potential eggs.*

Using an Analogy

Have students use a sharp pencil to make a small dot on a piece of paper. Explain that the dot is approximately the same size as a human egg.



Magnification: 170×
Ovulation

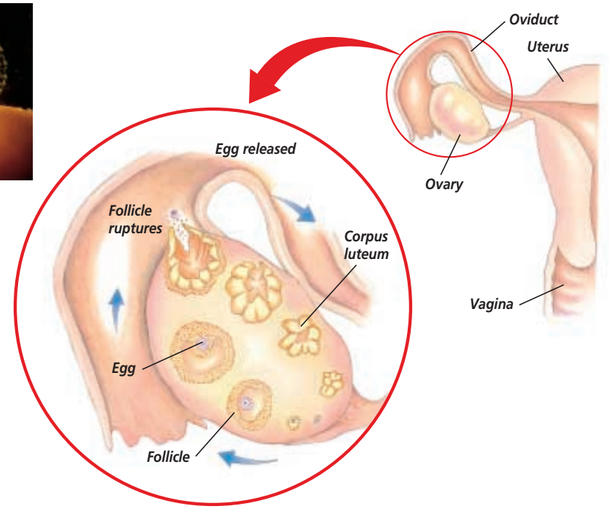


Figure 38.7
Once a female reaches puberty, follicles within her ovaries begin to mature and release an egg cell during each menstrual cycle.

organs; an increase in body hair, especially under the arms and in the pubic area; an increase in the growth rates of the long bones of the arms and legs; a broadening of the hips; an increase in fat deposits in the breasts, buttocks, and thighs; and the onset of the menstrual cycle.

Production of eggs

Recall that sperm production does not begin in males until they reach puberty, after which time it continues for the rest of their lives. Egg production is different. Even before a female is born, her body begins to develop eggs. During this prenatal period, cells in her ovaries divide until the first stage of meiosis, prophase I, is reached. At this point, the cells go into a resting stage. At birth, a female's ovaries contain about two million of these potential eggs, which are called primary oocytes. Many of these break down, or degenerate. At puberty, a female's ovaries contain about 40 000 primary oocytes. How does the production of sperm differ from the production of egg cells? To find out, read the *Inside Story*.

How eggs are released

About once a month, beginning at puberty, the process of meiosis starts up again in several of the prophase I cells. Each cell completes meiosis I and begins meiosis II. During meiosis II, one of the egg cells ruptures from the ovary and passes into the oviduct. The process of the egg rupturing through the ovary wall and moving into the oviduct is called **ovulation.** A total of about 400 eggs are ovulated during the reproductive life of a female. Fertilization, if it takes place, occurs in the oviduct. *Figure 38.7* shows the process leading to ovulation. Usually, only one follicle matures and releases an egg each month.

Portfolio

Negative-Feedback Systems

Visual-Spatial Have students create diagrams that explain how the thermostat in a home works as a negative-feedback system. Beside this drawing, have students make a second diagram that explains how the body's endocrine system works in a way comparable to the home thermostat. L2 P

Meeting Individual Needs

Learning Disabled

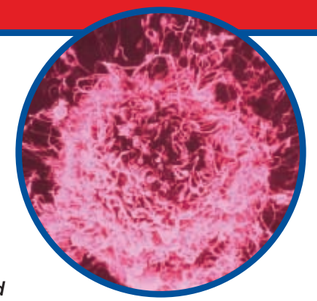
Visual-Spatial Have students use tracing paper to trace the structures of the female reproductive system shown in Figure 38.5. Instruct them to include the diagrams they have created in their journals to use as study tools. L1 ELL

INSIDE STORY

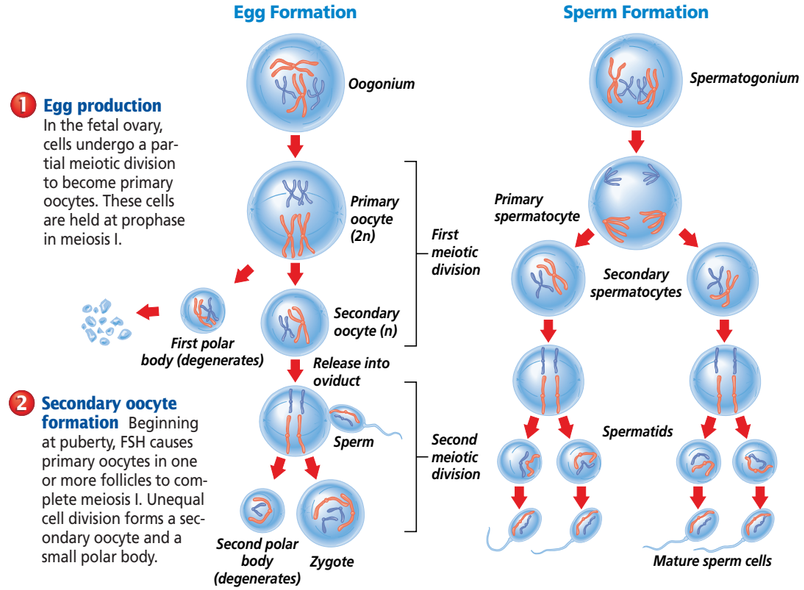
Sex Cell Production

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.***



Human egg and sperm



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

4 Sperm production Once puberty begins, cells within the testes undergo meiosis daily to begin the formation of sperm. Meiosis I and II take place in the tubules of the testes. Maturation takes place in the epididymis. Mature sperm are stored in the vas deferens.

Meeting Individual Needs

English Language Learners

Visual-Spatial Have students make a table with the following headings: Organ, Reproductive Function. In the first column, have students list the organs of the female reproductive system. In the second column, they should describe each organ's function. L1 ELL

INSIDE STORY

Purpose

Students will compare and contrast human egg production with sperm production.

Teaching Strategies

- Have students identify similarities and differences in egg and sperm production. *Egg production begins in the female fetus; sperm production begins in the male at puberty. Mature sperm are produced daily; mature eggs are produced only once a month.*

Visual Learning

- Using a microscope projector, show students a cross-section slide of an ovary. Point out developing follicles that contain a cell ready to complete meiosis (future egg cell). Project a cross-section of a testis, showing the sperm cells that result from meiosis.

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.

Enrichment

Have students use medical dictionaries to find out the difference between estrous and menstrual cycles. Ask students to create a visual essay that explains the differences in these processes. L3

Chalkboard Example

Using two different colors of chalk, prepare a graph that shows the actions of the hormones LH and FSH during the menstrual cycle. Explain each phase of the cycle as it is graphed. Label the hormones represented by each colored line.

Reinforcement

List on the chalkboard various events that occur during the menstrual cycle. These may include rising and falling levels of LH and FSH, increased body temperature, menstrual flow beginning, and ovulation occurring. Ask volunteers to come to the chalkboard and label during which of the three phases each event occurs.

Assessment

Skill Have students prepare a table contrasting anatomy, sex cells, and puberty in males and females. Suggest that they consult Making and Using Tables in the **Skill Handbook** if they need help. L2

Resource Manager

Critical Thinking/Problem Solving, p. 38 L3
Basic Concepts Transparency 75 and Master L2 ELL

The Menstrual Cycle

The series of changes in the female reproductive system 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 made up the lining of the uterus, the endometrium. This flow passes from the uterus through the cervix and the vagina to the outside of the body. Contractions of the uterine muscle help expel the uterine lining and can cause discomfort in some females. Generally, menstrual flow ends by day 5 of the cycle. During the flow phase, the level of FSH in the blood begins to rise, and another follicle in one of the ovaries begins to mature as meiosis of the prophase I cell proceeds.

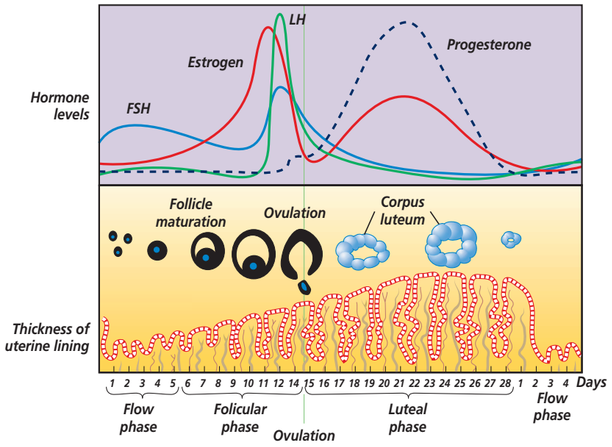


Figure 38.8
Changes in the uterine lining, follicles, and hormone levels take place during each phase of the menstrual cycle.

Follicular phase

The second phase of the menstrual cycle is more varied in length than the other phases. In a 28-day cycle, it lasts from about day 6 to day 14. As the follicle containing a primary oocyte continues to develop, it secretes estrogen, which stimulates the repair of the endometrial lining of the uterus. The endometrial cells undergo mitosis, and the lining thickens. The steady increase in estrogen also feeds back to the hypothalamus and pituitary gland, which slows the production of FSH and LH. Just before ovulation, estrogen levels peak, stimulating a sudden, sharp increase in the release of LH.

Ovulation occurs at about day 14, when the sharp increase in LH causes the follicle to rupture and release the egg into the oviduct. At this time, the female's body temperature increases

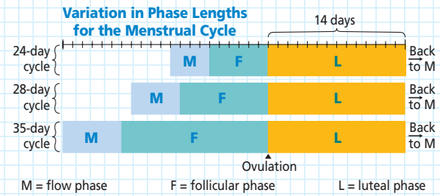
Problem-Solving Lab 38-1

Applying Concepts

What happens when the menstrual cycle is not exactly 28 days? How does the number of days spent in each phase differ?

Analysis

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



Thinking Critically

1. Which phase does not vary in length, regardless of the total time for a cycle? Which hormones are associated with this phase?
2. Offer a possible explanation for why the length of the follicular phase may vary.
3. How would these events differ for the cycle during which a female becomes pregnant?

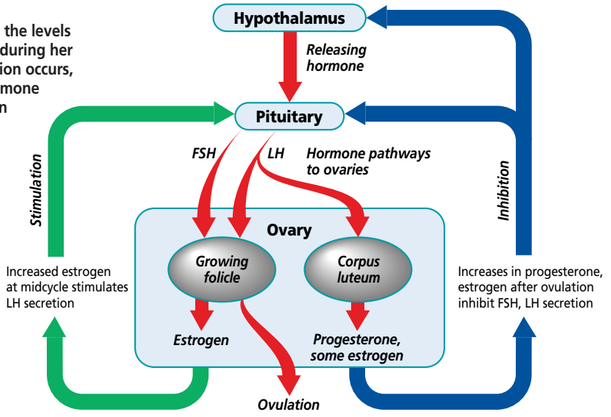


Figure 38.9
Negative feedback controls the levels of hormones in the female during her menstrual cycle. If fertilization occurs, this cycle is broken and hormone levels change in preparation for the developing embryo and fetus.

Portfolio

Tracing the Path of Sex Cells

Visual-Spatial Have students develop flowcharts or concept maps that trace the path of sperm from the testes through the reproductive system to outside the body. Have them make a similar diagram showing the path of an egg through the female reproductive system. L2 P

Biology Journal

Diagramming the Menstrual Cycle

Visual-Spatial Have students create flowcharts or concept maps showing the sequence of events that occurs during each phase of the menstrual cycle. Ask students to include information about all hormones involved in the regulation of the cycle. L2

Resource Manager

Reinforcement and Study Guide, pp. 167-168 L2
Concept Mastery, p. 186 L1

Problem-Solving Lab 38-1

Purpose

Students will study similarities and differences among menstrual cycles of differing lengths of time.

Process Skills

analyze information, apply concepts, compare and contrast, think critically, draw a conclusion, interpret data, make and use graphs

Teaching Strategies

- Make sure students are familiar with the three phases of the menstrual cycle.
- Suggest that students refer to the graph and diagrams in Figures 38.7 and 38.8 for further information, if needed.

Thinking Critically

1. luteal phase; progesterone and estrogen
2. Student answers may vary. The three hormones interact, and may influence one another so as to alter the exact timing of the follicular phase
3. The corpus luteum does not degenerate and continues to secrete hormones. The lining of the uterus is not shed, so there is no flow phase.

Assessment

Skill Have students prepare a graph that depicts the sequence of events in a menstrual cycle during which a female becomes pregnant. Use the Performance Task Assessment List for Graph from Data in **PASC,** p. 39. L2

3 Assess

Check for Understanding

Visual-Spatial Display a diagram of the female reproductive system. Ask students to identify where an egg would be located within the system at various stages of the menstrual cycle. L1

Reteach

Visual-Spatial Provide students with diagrams of the male and female reproductive systems. Have them draw a line to show how sperm and an unfertilized egg travel through their respective reproductive systems. L1

Extension

Have students research the development and specialization of sperm cells within the testis and epididymis. Ask them to prepare a report of their findings. L3

Assessment

Performance Ask students to label diagrams of the female and male reproductive systems. Have them indicate, using colored pencils and arrows, the pathways of sperm and egg through these systems. L2

4 Close

Discussion

Have each student anonymously submit three questions written on index cards. Read the questions aloud and have volunteers suggest possible answers. Clear up any misconceptions students may have. As an alternative, invite the school nurse or a physician to visit to address the questions.

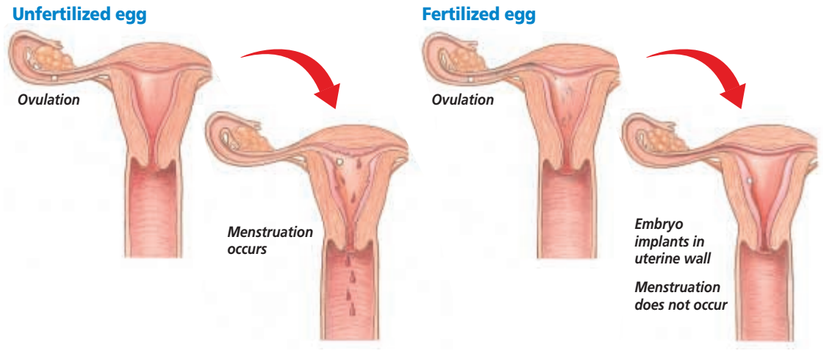


Figure 38.10 Events that take place in the uterine wall after ovulation depend on whether or not fertilization has occurred.

about 0.5°C. In addition, the cells of the cervix produce large amounts of mucus. Some females also experience discomfort in the area of one or both ovaries around the time of ovulation.

Luteal phase

The last stage of the menstrual cycle, from days 15 to 28, is named the luteal phase, for the corpus luteum. During the luteal phase, LH stimulates the corpus luteum to develop from the ruptured follicle. The corpus luteum produces progesterone and some estrogen. Progesterone increases the blood supply of the endometrium, causing it to accumulate lipids and tissue fluid. These changes correspond to the arrival of a fertilized egg. Through negative feedback, progesterone prevents the production of LH.

If the egg is not fertilized, the rising levels of progesterone and estrogen from the corpus luteum cause the hypothalamus to inhibit the release of FSH and LH. The corpus luteum degenerates and stops secreting progesterone or estrogen. As hormone levels drop, the thick lining of the uterus begins to shed. If fertilization occurs, as shown in ***Figure 38.10***, the endometrium begins secreting a fluid rich in nutrients for the zygote.

Section Assessment

Understanding Main Ideas

1. Describe the pathway of an unfertilized egg as it travels through the female reproductive system. Explain the function of each reproductive organ through which it travels.
2. Summarize the negative-feedback system of hormone regulation in a male, including the roles of the hypothalamus and pituitary gland.
3. What is the function of the menstrual cycle?
4. Describe how a sperm cell is adapted for its function.

Thinking Critically

5. What might happen to sperm production if a male has a high fever?

Skill Review

6. **Interpreting Scientific Illustrations** Study ***Figure 38.1.*** Using the terms dorsal, ventral, anterior, posterior, superior, and inferior, describe where the epididymis is located in relation to the vas deferens. Describe where the prostate is located in relation to the testes. For more help, refer to *Thinking Critically* in the **Skill Handbook.**

Section

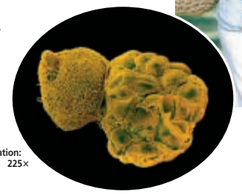
38.2 Development Before Birth

SECTION PREVIEW

Objective
Summarize the events during each trimester of pregnancy.

Vocabulary
implantation
umbilical cord
genetic counseling

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.



Magnification: 225×

A human blastocyst (inset) emerges from its protective membrane to travel to the uterus.

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 vagina of the female's reproductive system when strong, muscular contractions ejaculate semen from the male's penis. As many as 350 million sperm are forced out of the male's penis and into the female's vagina during intercourse. Because sperm can live for 48 hours after ejaculation, fertilization can occur if intercourse occurs anywhere from a few days before to a day after ovulation.

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 the vagina into the uterus. Of the sperm that reach the uterus, only a few hundred pass into the two oviducts. 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

Prepare

Key Concepts

This section summarizes fertilization and implantation of the egg and development of the human fetus, and discusses the importance of genetic counseling.

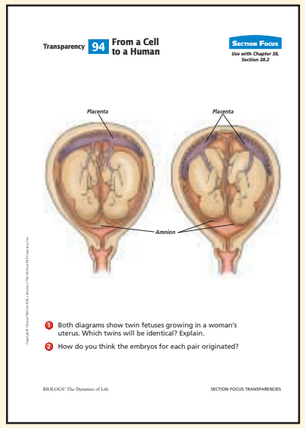
Planning

- Save articles about unusual births for the Discussion.
- Gather images for the Display and reteach.
- Obtain modeling clay for the Project.
- Gather materials for the BioLab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 94** on the overhead projector and have students answer the accompanying questions. L1 ELL



Resource Manager

Section Focus Transparency 94 and Master L1 ELL

Section Assessment

1. The egg ruptures from the ovary and is swept into the oviduct. Beating cilia move the egg toward the uterus, where a fertilized egg implants and develops. An unfertilized egg or fully developed fetus passes through the vagina to the outside of the body.
2. Increased testosterone levels cause a decrease in FSH and LH; decreased testosterone results in an increase in FSH and LH.
3. produce an egg; prepare for pregnancy
4. streamlined, with mitochondria to provide ATP and a flagellum for movement
5. Sperm may be killed by the high fever.
6. The epididymis is inferior (or ventral) to the vas deferens. The prostate is superior and dorsal to the testes.

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. L2

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Human Fertilization*
Video: *Human Fertilization*
Disc 5

2 Teach

MiniLab 38-1

Purpose
Students will determine whether sperm are attracted to eggs.

Process Skills
observe and infer, recognize cause and effect, experiment, analyze

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.

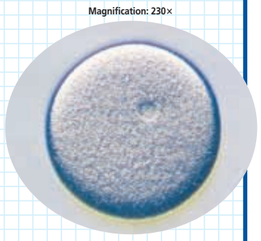
Expected Results
Sperm will collect around the egg, indicating that they are attracted to the egg.

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. L1

MiniLab 38-1 Observing and Inferring

Examining Sperm and Egg Attraction Most animals that reproduce by external fertilization live in water and release their sperm and eggs into the water. Somehow, a sperm and egg must meet. One adaptation of these animals that helps ensure fertilization is the release of thousands of sex cells at one time. The large number of sex cells increases the odds that at least some eggs will be fertilized. Chemical attraction could be another adaptation that encourages fertilization. If eggs give off a chemical that attracts sperm, each sperm would have help "finding" an egg.



Sea urchin egg

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.

Analysis
1. Describe the motion of a single sperm.
2. What cell structures are involved in providing energy for the sperm motion?
3. Are the sperm attracted to the eggs? How do you know?

crosses 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

As the zygote passes down the oviduct, it begins to divide by repeated mitotic division. During its journey, pictured in ***Figure 38.11***, the zygote obtains nutrients from fluids secreted by the mother. By the sixth day, the zygote passes into the uterus. Continuous cell divisions result in the formation of a hollow ball of cells called a blastocyst. Blastocyst is the term used when discussing human embryonic development. Recall that the term blastula is used for the embryonic development of other animals.

The blastocyst attaches to the uterine lining seven to eight days after fertilization. Attachment of the blastocyst to the lining of the uterus is called **implantation.** A small, inner mass of cells within the blastocyst will soon become a human embryo.

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 and nourishing it. The amnion is a thin, inner membrane filled with a clear, watery amniotic fluid. Amniotic fluid serves as a shock absorber and helps regulate the body temperature of the developing embryo.

The allantois membrane is an outgrowth of the digestive tract of the embryo. Blood vessels of the allantois form the **umbilical cord,** a ropelike structure that attaches the embryo to the wall of the uterus. The chorion is the outer membrane that surrounds the amniotic sac and the embryo within it. About 14 days after fertilization, fingerlike projections of the chorion, called chorionic villi, begin to grow into the uterine wall, as shown in ***Figure 38.12.*** The chorionic villi combine with part of the uterine lining to form the placenta.

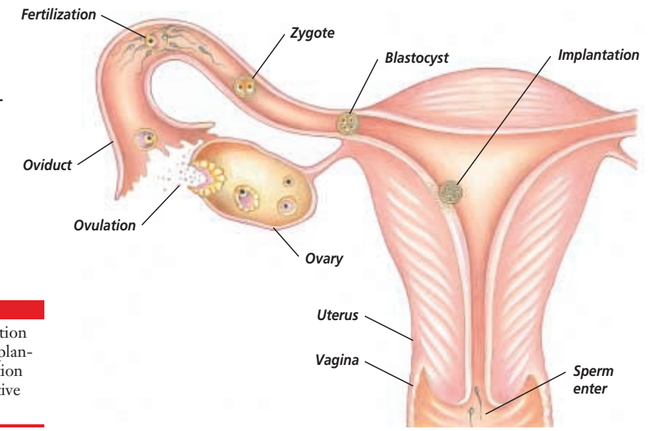


Figure 38.11
To reach the egg, sperm travel through the female's reproductive system, greatly decreasing in number along the way.

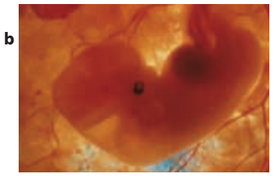
CD-ROM
View an animation of fertilization and implantation in the Presentation Builder of the Interactive CD-ROM.

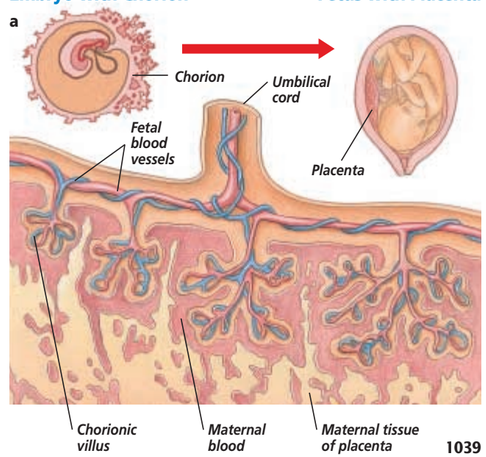
Exchange between embryo and mother

To survive and grow, the embryo must obtain the proper nutrients and eliminate the wastes its cells produce. The placenta delivers nutrients to the embryo and carries wastes away.

In the placenta, blood vessels from the mother's uterine wall lie close to the blood vessels of the embryo's chorionic villi. Although they are close together, they are not directly connected to one another. Instead, oxygen and nutrients transported by the mother's blood diffuse into the blood vessels of the chorionic villi in the placenta. These vital substances are then carried by the blood in the umbilical cord to the embryo. In turn, waste products from the embryo travel in the umbilical blood vessels to the placenta. Here they diffuse out of the vessels in the chorionic villi into the blood of the mother. These waste products are then removed by the mother's excretory system.

Figure 38.12
The placenta contains tissue from both mother and fetus (a). This embryo is shown at approximately seven weeks of development (b).


b



Quick Demo
Visual-Spatial Using a microscope projector, show students images of sea star embryos at various stages of development, such as the two-cell stage and four-cell stage.

Display
Prepare a bulletin board display that shows the development of the human fetus. Use medical journals or photographs from biological supply houses. Refer to the display as various stages of development are discussed.

Discussion
Using recent newspaper and magazine articles, initiate a class discussion of how a woman's body changes during pregnancy and the importance of prenatal care. Elicit what factors might prevent women from receiving proper prenatal care and what the results of such neglect might be.

Assessment
Skill Ask students to prepare a time line that plots the changes that take place in a developing embryo and fetus. Have them use different-colored pencils to indicate clearly where each trimester of pregnancy begins and ends. L2 ELL

GLENCOE TECHNOLOGY
VIDEODISC
The Secret of Life
Placenta Portion

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
Human Fertilization (Ch. 41)
Disc 2, Side 1, 40 sec.

VIDEODISC
Biology: The Dynamics of Life
Human Fertilization (Ch. 42)
Disc 2, Side 1, 20 sec.

Portfolio
Body System Formation
Visual-Spatial Assign each student a body system. Have students research the fetal development of the assigned body system and prepare a visual display that traces the development of the system. Have them include labels and captioned summaries of the changes that occur at different stages. L2 ELL P

Resource Manager
BioLab and MiniLab Worksheets, p. 169 L2
Reteaching Skills Transparencies 56a, 56b and Masters L1 ELL

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?

INVESTIGATE BioLab

The BioLab at the end of the chapter can be used at this point in the lesson.

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
Fetal Development (Ch. 43)
Disc 2, Side 1, 1 min. 6 sec.

CD-ROM
Biology: The Dynamics of Life
Video: *Fetal Development*
Disc 5

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Human Body Vol. 3
Reproductive Systems
Unit 2, Side 2, 2 min. 52 sec.
Fetal Development

Figure 38.13
The embryo and fetus undergo significant changes during the first two trimesters of pregnancy.

A A five-week-old embryo is about 7 mm long. The heart—the large, red, circular structure protruding out of the embryo—begins as two muscular tubes. It starts to beat on about the 21st day of development. The arms and legs are beginning to bud, and the tissue that will form the eyes is beginning to darken.

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***. During this time of development, the woman may not even realize she is pregnant. Yet, the first seven weeks following fertilization are critical because during this time, the embryo is more sensitive to outside influences—such as alcohol, tobacco, and other drugs that cause malformations—than at any other time.

B A two-month-old fetus is 4 cm long. The heart is fully formed, bones are beginning to harden, and nearly all muscles have appeared. As a result, the fetus can move spontaneously.

C A second-trimester fetus is 15 to 30 cm long. Its skin is covered by a white, fatty substance that protects it from the amniotic fluid. Movements are commonly felt by the mother as the fetus exercises its muscles.

By the eighth week, all the organ systems have been formed, and the embryo is now referred to as a fetus. You can see this stage of fetal development in ***Figure 38.13B***. At the end 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. ***Figure 38.13C*** shows a fetus during the second trimester. By the end of the second 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

3 Assess

Check for Understanding

Linguistic Ask students to describe orally how a fertilized egg changes after it is implanted in the uterus. L2

Reteach

Visual-Spatial Photocopy and distribute sketches showing fetal development in the later stages of pregnancy. Have students label the embryonic membranes and the placenta as you discuss them. L1

Extension

Linguistic Ask student groups to interview one of their mothers to find out what types of prenatal care and tests she received during her pregnancy. Ask students to record this information in their journals. L2 COOP LEARN

Assessment

Knowledge Ask students to write a summary of the role of the embryonic membranes and hormones during pregnancy. L2

Resource Manager

Laboratory Manual, pp. 277-284 L2

PROJECT

Modeling Fetal Development

Kinesthetic Have students use modeling clay to show the changes a human egg undergoes fertilization to implantation. Students should label the zygote and embryo stages, and summarize on index cards the changes and approximate time period involved between changes. Have students work in groups to carry out the project by having gifted students work with less able students. If necessary, have students refer to discussions of embryonic development elsewhere in this textbook. Have students wear a lab apron and safety goggles when working with modeling materials. Have them wash their hands after working with the modeling materials. L2 ELL COOP LEARN

Portfolio

The Story of Life

Linguistic Have students write a story or poem using any topic in this section. Encourage them to include some of the biology of this section in their writings. L2 P

MEETING INDIVIDUAL NEEDS

Gifted

Intrapersonal Have students research the medical techniques used to examine fetal development and genetics. Techniques may include ultrasound, amniocentesis, and chorionic villi sampling. L3

MiniLab 38-2

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 change in units between the 6th and 7th weeks of development.

Expected Results
Graphs will show that the embryo grows fastest during the early periods of development.

Analysis
1. The embryo doubles in size during two 1-week periods: 3 to 4 weeks and 7 to 8 weeks.
2. All body systems are beginning to form.
3. 5th month

Assessment

Performance Have students write a summary of the MiniLab and place it in their journals along with the graph and the answers to the Analysis questions. Use the Performance Task Assessment List for Lab Report in **PASC,** p. 47. L2

Resource Manager

BioLab and MiniLab Worksheets, p. 170 L2
Reinforcement and Study Guide, p. 169 L2

MiniLab 38-2 Making and Using Graphs

Making a Graph of Fetal Size You started out as a single cell. That cell divided by 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.

Table 38.1 Growth of a Fetus

Source of sample	Time after fertilization	Size
First trimester	3 weeks	3 mm
	4 weeks	6 mm
	6 weeks	12 mm
	7 weeks	2 cm
	8 weeks	4 cm
	9 weeks	5 cm
	3 months	7.5 cm
Second trimester	4 months	15 cm
	5 months	25 cm
	6 months	30 cm
Third trimester	7 months	35 cm
	8 months	40 cm
	9 months	51 cm

Procedure
1. Prepare a graph that plots time on the horizontal axis and length in centimeters on the vertical axis. Equally divide the horizontal axis into nine months. Then equally divide each of the first three months into four weeks.
2. Plot the data 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?

Figure 38.14
Genetic counselors use a variety of medical tests to provide couples with information about the risks of hereditary disorders.

space suit at the beginning of the chapter. During the eighth month, its eyes open. To examine the growth of a fetus, graph the data in the *MiniLab.*

During the final weeks of pregnancy, the fetus has grown large enough to fill the space within the embryonic membranes. Sometime during the ninth month, the fetus rotates its position so that its head is down, partly as a result of the shape of the uterus, but also because the head is the heaviest part of the body. By the end of the third trimester, the fetus weighs about 3300 g and is about 51 cm long. All of its body systems have developed, and it can now survive independently outside the uterus.

Genetic counseling

Most expectant parents desperately want just one thing—a healthy, normal baby. 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 potential child will be healthy. As advances have been made in the detection and treatment of genetic disorders, including those you studied earlier, the demand for genetic services, especially prenatal testing, has increased.

Most people do not even think about genetics until they are considering having children or are already expecting a child. If there is no history of genetic disorders in the family of either prospective parent, there may be no need for genetic services. However, if one or both prospective parents have a family history of some genetic disorder, they will likely want to get additional information. To find out how an expectant mother can help prevent one type of birth defect, try the *Problem-Solving Lab* shown here.

The job of a genetic counselor

Couples who seek information from trained professionals about the probabilities of hereditary disorders and what can be done if they occur are receiving **genetic counseling.** Genetic counselors like the one shown in ***Figure 38.14*** have a medical background with additional training in genetics. Sometimes, a team of professionals works with prospective parents. The team may include geneticists, clinical psychologists, social workers, and other consultants.

How do genetic counselors go about their work? First, they develop medical histories of both families. These histories may include pedigrees, biochemical analyses of blood, and karyotypes. Once the counselor has collected and analyzed all the available information, he or she explains to the couple their risk factors for giving birth to children with genetic disorders. If the probabilities of having a severely affected child are high, a couple must decide whether or not to have biological children together.

Problem-Solving Lab 38-2 Interpreting Data

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 known as spina bifida. This condition occurs if, during early embryonic development, the bones of the spine fail to form properly. As a result, the spinal cord forms outside of 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.***

Table 38.2 Effect of folic acid on birth defects

Folic acid used before or during pregnancy	Neural-tube defects per 1000 births
Did use	0.9
Did not use	3.5

Thinking Critically
1. Folic acid is a vitamin. Can a mother's diet during pregnancy influence her fetus? Explain your answer.
2. Does the use of folic acid totally prevent neural-tube defects? Explain your answer, using data to support it.
3. What additional questions might scientists want to ask regarding folic acid's role in fetal development?

Section Assessment

Understanding Main Ideas
1. What changes occur in the zygote as it passes along the oviduct and into the uterus?
2. What is the function of the placenta?
3. Why is an embryo most vulnerable to drugs and other harmful substances taken by its mother when it is between two and seven weeks old?
4. What is the function of human chorionic gonadotropin?

Thinking Critically
5. Compare the functions of human embryonic membranes with those inside a bird's egg.

Skill Review
6. **Sequencing** Prepare a table listing the events in the three trimesters of pregnancy. For more help, refer to *Organizing Information* in the **Skill Handbook.**

TechPrep

Genetic Counseling

Linguistic Have students interested in a career in genetic counseling visit with a local genetic counselor or school counselor to find out what a specialty in genetic counseling involves. L2

Glencoe Technology

VIDEODISC
VIDEOTAPE
The Secret of Life
Tinkering With Our Genes: Genetic Medicine

Section Assessment

1. The zygote divides as it passes down the oviduct; cells organize into a small hollow ball.
2. Nutrients and wastes are exchanged between the mother's and embryo's blood.
3. This is when all body systems are forming.
4. It keeps the corpus luteum alive to maintain pregnancy.
5. both protect the developing embryo and allow for the exchange of materials
6. First trimester: organ systems start forming; partially formed heart begins beating. External sex organs become apparent. Second trimester: heart is fully formed; size increases; bones harden and fetus begins to move. Third trimester: Growth continues; fetus moves freely; eyes open.

Problem-Solving Lab 38-2

Purpose
Students will learn that folic acid can reduce the incidence of certain birth defects.

Process Skills
analyze information, compare and contrast, draw a conclusion, think critically

Teaching Strategies
- Relate the body's need for folic acid to a healthy diet. Foods rich in folic acid include spinach, beans, whole grains, oranges.
- Explain that, during the third week of development, a groove forms in 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.

Thinking Critically
1. Increasing folic acid helps prevent neural tube defects.
2. No, the incidence of defects with folic acid is still 0.9.
3. Possible question: How does folic acid decrease incidence of neural-tube defects?

Assessment

Performance Have students look up the recommended daily allowance (RDA) of folic acid in the normal diet and in the diet of pregnant females. Ask them to write an article informing people why pregnant women should receive plenty of folic acid. Use the Performance Task Assessment List for Newspaper Article in **PASC,** p. 69. L3

4 Close

Discussion
Have students summarize the development of the human fetus. Discuss how changes in this orderly development may result in birth defects. L2

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 birth.

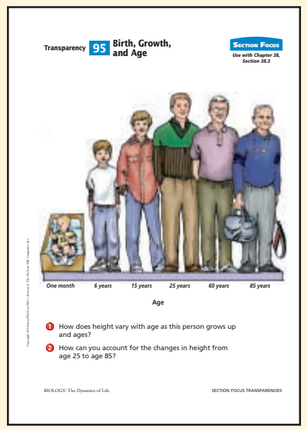
Planning

- 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. L1 ELL



Resource Manager

Section Focus Transparency 95 and Master L1 ELL

SECTION PREVIEW

Objectives

Describe the three stages of birth.

Summarize the developmental stages of humans after they are born.

Vocabulary

labor

Section

38.3 Birth, Growth, and Aging

How often have you heard the comment, "My, you've grown since I last saw you"? It may seem that you have grown a lot in the last few years. Yet the most rapid stage of growth in the life cycle of a human takes place within the uterus. From fertilization to birth, mass increases about 3000 times. Even so, although growth slows after birth, changes certainly do not stop.

The human body changes throughout life.

Birth

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, uterus, and placenta may all be involved in stimulating the uterus. Birth occurs in three recognizable stages: dilation, expulsion, and the placental stage.

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

Dilation of the cervix

The physiological and physical changes a female goes through to give birth are called **labor.** Labor begins with a series of mild contractions of the uterine muscles. These contractions are stimulated by oxytocin, a peptide hormone released by the pituitary. The contractions open, or dilate, the cervix to allow for passage of the baby, as shown in ***Figure 38.16A.*** As 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 amniotic sac ruptures and the amniotic 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.

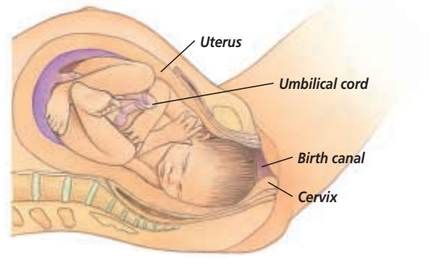
Expulsion of the baby

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 38.16B,*** 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

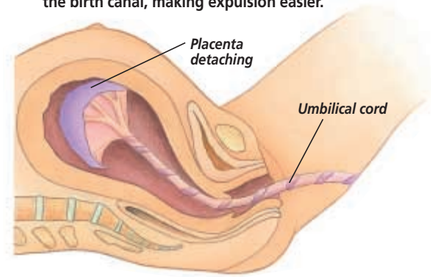
As shown in ***Figure 38.16C,*** within ten to 15 minutes after the birth of the baby, the placenta separates from the uterine wall and is expelled with the remains of the embryonic membranes. Collectively, these materials are known as the afterbirth. The uterine muscles continue to contract forcefully, constricting uterine blood vessels to prevent the mother from hemorrhaging. After the baby is born, the umbilical cord is clamped and cut near the baby's abdomen. The bit of cord that is left eventually dries up and falls off, leaving an abdominal scar called the navel.

Figure 38.16
The stages of birth are dilation, expulsion, and the placental stage.



A Dilation Labor contractions open the cervix.

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



C 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 somewhat sex dependent.

A hormone controls growth

Human growth is regulated by human growth hormone (hGH), a protein secreted by the pituitary gland. Although hGH 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 thyroxin, estrogen, and testosterone.

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. L2

MEETING INDIVIDUAL NEEDS

English Language Learners/ Learning Disabled

Visual-Spatial Have students prepare flash cards of the vocabulary terms 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. L1 ELL COOP LEARN

Portfolio

Senior Survey

Linguistic Have students prepare interview questions to ask senior citizens. Questions should focus on the biology of aging as well as how senior citizens view aging. Collect questions from all students and photocopy them. Distribute copies of all the questions to students in their groups and ask each group to prepare a survey made up of ten questions. Have each group member use the survey to interview someone older than 65. Each group should tally the results obtained by its members. L2 P COOP LEARN

2 Teach

Quick Demo

Visual-Spatial Project photographs or slides of newborn infants and elderly individuals. Ask students to write down what they perceive as differences between the two.

Reinforcement

Logical-Mathematical An aging person's resting heartbeat stays about the same throughout life. However, the beats get weaker as the heart muscle ages. Have students graph the following data regarding the amount of blood pumped by the resting hearts of people at various ages. Ask them to summarize the data shown in their graph. L2

Age	Qts/Min
30	3.6
40	3.4
50	3.2
60	2.9
70	2.6

Assessment

Skill Ask students to create a chart of the stages of birth and growth. Have students list the stages in the left-hand column and a brief description of corresponding events in the right-hand column. L2

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Human Body
Vol. 3, *Newborn Baby*

Careers in Biology

Career Path

Courses in high school: sciences, mathematics, psychology

College: bachelor's degree to become a registered nurse; up to two years of training in midwifery

Career Issue

Tell students that some people think midwives should not be allowed to deliver babies without a doctor present. Invite the class to explore both sides of this issue.

For More Information

To learn more about becoming a midwife, students can contact:

American College of Nurse Midwives
818 Connecticut Avenue, NW
Suite 900
Washington, DC 20006

Resource Manager

Tech Prep Applications, p. 53 L2
Reinforcement and Study Guide, p. 170 L2
Content Mastery, pp. 185, 187-188 L1

Careers in Biology

Midwife

Giving birth is one of the most exciting experiences life can offer. If you would like to help expectant mothers through the birth process, you might consider becoming a midwife.

Skills for the Job

Midwives have helped women give birth since ancient times, sometimes with little training. However, today's midwives are professionally trained and well able to guide women with low-risk pregnancies safely through the birth process. Midwives first become registered nurses and then complete up to two years of clinical instruction in midwifery. They must also pass a national test and meet state requirements before they can become certified nurse-midwives. Many midwives work in hospitals or birthing centers; some help deliver babies at home. All midwives provide care, support, and monitoring throughout the pregnancy and afterward.

*inter*NET CONNECTION For more careers in related fields, be sure to check the Glencoe Science Web Site.
www.glencoe.com/sec/science

The first stage of growth: Infancy

The first two years of life are known as infancy. During infancy, a child shows tremendous growth 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.

From child to adult

Childhood is the period of growth and development that extends from infancy to adolescence, when puberty begins. Physically, the childhood years are a period of relatively steady growth. Mentally, a child develops the ability to reason and to solve problems.

Figure 38.17
Changes in the size and shape of the body are associated with growth. These photos show the changes that Shirley Temple Black has undergone as she has aged.

Figure 38.18
In 1962, astronaut John Glenn made history as the first American to orbit the Earth. He enthusiastically returned to space in 1998, at 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.

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 thinner and more brittle, resulting in an increased risk of fracture. Stature may shorten because the disks between the vertebrae become compressed. Vision and hearing might diminish, but, as ***Figure 38.18*** shows, many people continue to be both intellectually and physically active as they grow older.

Word Origin

infancy
From the Latin word *infantia*, meaning "inability to speak." Infants are in the growth stage that involves learning to speak.

Section Assessment

Understanding Main Ideas

1. What events occur during the dilation stage of the birth process?
2. How does the human growth hormone produce growth?
3. How does the human body change during childhood?
4. 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 Review

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**.

3 Assess

Check for Understanding

Ask students to describe the aging process. L2

Reteach

Have students choose a system of the body and describe how it changes from birth through old age. L2

Extension

Ask students to research and report on current theories about infant learning. Encourage them to include illustrations in their reports. L3

Assessment

Knowledge Ask students to choose a hormone discussed in this chapter and diagram a negative-feedback loop for the hormone. L2

4 Close

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.

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.

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 brittle. 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.

INVESTIGATE BioLab

Time Allotment
One class period

Process Skills
acquire information, apply concepts, compare and contrast, draw a conclusion, formulate models, think critically

Safety Precautions
Remind students to use caution when working with scissors.

Preparation

To save class time, trace models A, B, and C onto tracing paper prior to class. Provide each student group with one set of tracing paper shapes to use in making their copies on heavy paper.

Resource Manager

BioLab and MiniLab Worksheets, pp. 171-172 L2

INVESTIGATE BioLab

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.

Preparation

Problem
How can you test for the presence of hCG?

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

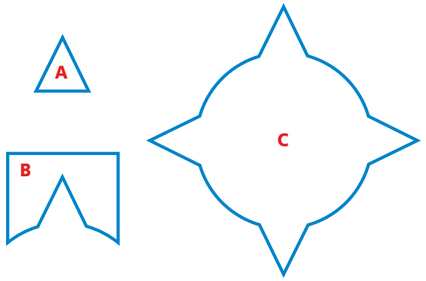
Materials
scissors
heavy paper
tracing paper

Safety Precautions
Handle scissors with caution.

Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.

Procedure

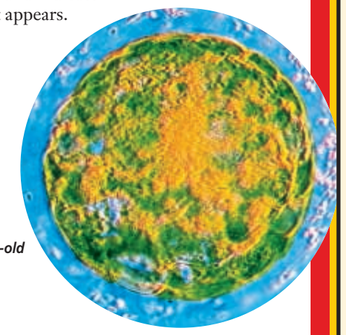
1. Copy the data table.
2. Copy models **A**, **B**, and **C** onto tracing paper.



3. Copy the tracings 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, then Chemical C is added.
   c. Draw the resulting chemical in the data table and indicate the color that appears.

Data Table

Condition	hCG in urine?	+ Anti-hCG	= Joined hCG and anti-hCG?	+ Chemical C with anti-hCG?	Color
Not pregnant					
Pregnant					



Eight-day-old embryo

Analyze and Conclude

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 anti-hCG is added to the sample before Chemical C is added.

Going Further

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

interNET CONNECTION To find out more about embryonic hormones, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

INVESTIGATE BioLab

Analyze and Conclude

1. The chorion begins to release hCG as early as eight days after fertilization.
2. There is no chorion to release hCG.
3. If pregnant, hCG joins with anti-hCG, preventing attachment to chemical C's hCG. No color appears. If not pregnant, anti-hCG attaches to chemical C's hCG and color appears.
4. To get an accurate result, hCG and anti-hCG must have a chance to bind before chemical C is added.

Assessment
Performance Have students prepare a puzzle-piece model to show how the presence of a hormone such as FSH or estrogen might be detected. Use the Performance Task Assessment List for Model in **PASC,** p. 51. L2

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. L3

Procedure

Teaching Strategies
- 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.
- 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 non-pregnant female.
- When joined together, hCG and anti-hCG cannot attach to chemical C.

Data Table

Condition	hCG in urine?	+ Anti-hCG	= Joined hCG and anti-hCG?	+ Chemical C with anti-hCG?	Color
Not pregnant	—		—		Green
Pregnant					Colorless

BIO Technology

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 option for the continuation of extremely rare species.

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.

BIO Technology

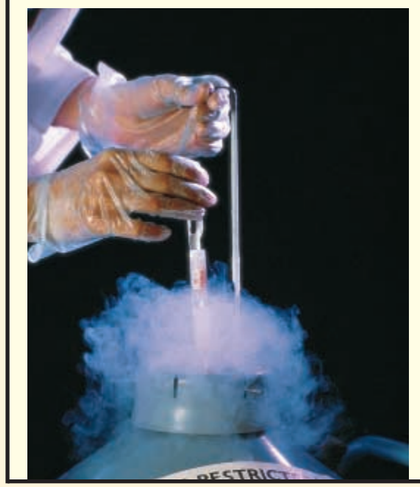
Frozen Embryos

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.*

In vitro fertilization is a process in which a man's sperm and a woman's eggs are combined in the laboratory. Eggs are removed from the woman's ovaries, fertilized with sperm, and allowed to divide in culture dishes. Up to four of the resulting embryos are then carefully transferred into the woman's uterus. If all goes well, at least one of the embryos will implant in the uterine wall and grow into a healthy baby.

Cryopreservation Many embryos may be produced during the laboratory phase of *in vitro* fertilization. The "extra" embryos are frozen and stored by cryopreservation, a process in which living tissue is frozen at an extremely low temperature so that the tissue can be revived and restored to the same condition as before it was stored. Embryos are mixed with protective chemicals and submerged in liquid nitrogen, which has a temperature of –196° C. During the freezing process, water moves from inside the cells to outside by osmosis, dehydrating and shrinking the cells. Metabolism stops. As the temperature decreases, the water around the outside of the cells freezes. The rate of cooling must be carefully controlled. If the rate of cooling is too slow, too much dehydration occurs. On the other hand, too rapid cooling causes the formation of ice crystals inside the cells, which might tear the cell membranes. A cooling rate of –1° C per minute has been found to be optimal. When the frozen tissue is needed, it is removed from liquid nitrogen storage and warmed rapidly to room temperature. Cells begin to grow within one or two days.

As many as 100 000 human embryos are currently "on ice" in the United States, and about 10 000 are added every year. For couples who are trying to get pregnant through *in vitro* fertilization, being able to keep some of their embryos frozen has advantages. If the first attempt at implantation is unsuccessful (and it often is), some of the frozen embryos can be thawed and the transfer process repeated fairly easily—hopefully with better results.



Frozen embryos are stored in liquid nitrogen

Investigating the Technology

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

internet CONNECTION To find out more about cryopreservation, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Going Further

Have interested students make a poster explaining the osmotic relationships between the embryo and the surrounding environment during cryopreservation. L2

Internet Address Book

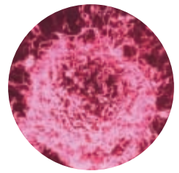
internet CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Chapter 38 Assessment

Summary

Section 38.1

Human Reproductive Systems



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 males 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.

Vocabulary

bulbourethral gland (p.1029)
cervix (p.1031)
corpus luteum (p.1034)
epididymis (p.1028)
follicle (p.1031)
menstrual cycle (p.1034)
oviduct (p.1031)
ovulation (p.1032)
prostate gland (p.1029)
puberty (p.1029)
scrotum (p.1027)
semen (p.1029)
seminal vesicle (p.1029)
vas deferens (p.1028)

Section 38.2

Development Before Birth

Main Ideas

- Fertilization occurs in the oviduct. The ball of cells that develops from the fertilized egg implants in the uterine wall.
- The embryo changes from a small ball of cells to a well-developed fetus over the course of nine months.
- Genetic counseling offers people information about their chances of having a child with a genetic disorder.

Vocabulary

genetic counseling (p.1043)
implantation (p.1038)
umbilical cord (p.1038)

Section 38.3

Birth, Growth, and Aging

Main Ideas

- Birth involves dilation of the cervix, expulsion of the baby, and expulsion of the placenta.
- Infancy, childhood, adolescence, and adulthood are the stages of human development. Human growth hormone (hGH) produces growth in all body cells, especially in cells of the skeleton and muscles.

Vocabulary

labor (p.1044)

Understanding Main Ideas

1. Which of the following is NOT a part of the male reproductive system?
   a. scrotum **c.** testis
   b. vas deferens **d.** cervix
2. Which of these is NOT found in a sperm?
   a. head **c.** tail
   b. chloroplasts **d.** mitochondria
3. What tubule transports both urine and semen?
   a. testes **c.** epididymis
   b. vas deferens **d.** urethra

Glencoe Technology

VIDEOTAPE
MindJogger Videoquizzes
Chapter 38: *Reproduction and Development*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 223-228
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 38 quiz

Chapter 38 Assessment

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.sec/science

THE PRINCETON REVIEW ***All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.***

Understanding Main Ideas

1. d
2. b
3. d

4. a
5. d
6. c
7. b
8. b
9. a
10. testes
11. vas deferens
12. puberty
13. testosterone
14. ovary, oviduct
15. follicle
16. oviduct, uterus
17. implantation, uterus
18. ovulation, oviduct
19. infancy
20. luteinizing, testosterone

Applying Main Ideas

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

Chapter 38 Assessment

4. Fertilization of an egg to form a zygote takes place in _____.
   a. oviduct
   b. uterus
   c. vagina
   d. ovary

5. Which of these does NOT produce a fluid that surrounds sperm as they travel from the testes?
   a. seminal vesicles
   b. bulbourethral glands
   c. prostate gland
   d. pituitary gland

6. When there is a surge of LH during the menstrual cycle, what event occurs?
   a. luteinization
   b. fertilization
   c. ovulation
   d. menstruation
7. What happens to a follicle after it releases an egg?
   a. It degenerates.
   b. It changes into the corpus luteum.
   c. It is released into the oviduct.
   d. It turns into the placenta after fertilization of the egg.

The Princeton Review 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.

8. Once one sperm enters an egg, no other sperm can enter because the egg's membrane _____.
   a. changes its shape
   b. changes its electrical charge
   c. hardens
   d. closes off its pores
9. During which trimester does the embryo's heart start beating?
   a. first
   b. second
   c. third
   d. fourth
10. Sperm production takes place in the _____.
11. The _____ transports sperm from the testes to the urethra.
12. Secondary sex characteristics begin to develop during _____.
13. When luteinizing hormone is released by the pituitary, it causes cells in the testes to produce _____.
14. In females, eggs are produced in the _____, and when they mature, the eggs rupture into the _____.
15. An undeveloped egg is surrounded by a group of epithelial cells known as a(n) _____.
16. The _____ is a tube that transports the egg from the ovary to the _____ for implantation.
17. _____ occurs when the blastocyst attaches to the lining of the _____.
18. _____ occurs when an egg ruptures through the ovary wall and moves into the _____.
19. Human development occurs most rapidly during the _____ stage.
20. _____ hormone stimulates the testis to produce the hormone _____.

Applying Main Ideas

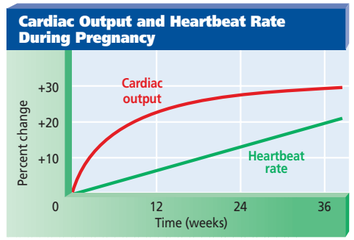
21. Why does the presence of human chorionic gonadotropin in the urine indicate pregnancy?

Chapter 38 Assessment

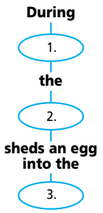
22. A pregnant woman tells her physician that she is 50 days past the first day of her last menstrual period. How many days has the embryo been developing?

Thinking Critically

23. **Interpreting Data** This graph indicates changes in cardiac output and heartbeat rate in a woman over the course of her pregnancy. Explain the changes.



24. **Concept Mapping** Complete the concept map by using the following terms: follicle, ovulation, oviduct.

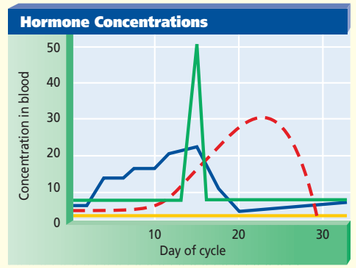


CD-ROM

For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

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



Interpreting Data Study the graph and answer the following questions.

1. Which line represents luteinizing hormone?
   a. red line
   b. blue line
   c. yellow line
   d. green line
2. Which hormone increases during the last half of the menstrual cycle?
   a. estrogen
   b. progesterone
   c. LH
   d. FSH
3. Which hormone is responsible for stimulating the egg development each month?
   a. estrogen
   b. progesterone
   c. LH
   d. FSH
4. **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.

Chapter 38 Assessment

22. about 36 days

Thinking Critically

23. During pregnancy, the heartbeat 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. d
2. b
3. d
4. This hormone is secreted only when women are pregnant.