

CHAPTER

34

Reproduction and Development

KEY CONCEPTS

34.1 Reproductive Anatomy

Female and male reproductive organs fully develop during puberty.

34.2 Reproductive Processes

Human reproductive processes depend on cycles of hormones.

34.3 Fetal Development

Development progresses in stages from zygote to fetus.

34.4 Birth and Development

Physical development continues through adolescence and declines with age.

Online

BIOLOGY

CLASSZONE.COM

**Animated
BIOLOGY**

View animated chapter concepts.

- Embryonic Development
- Human Aging
- Developmental Timeline

BIOZINE

Keep current with biology news.

- Featured stories
- Careers
- Polls



RESOURCE CENTER

Get more information on

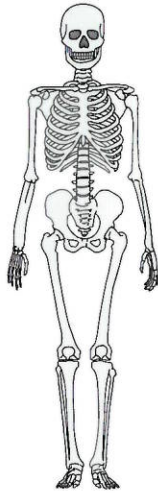
- Gametes, or Sex Cells
- Fetal Monitoring
- Human Development



STANDARDS-BASED ASSESSMENT

Test Practice
For more test practice,
go to ClassZone.com.

1.



Three-dimensional models of human skeletons are useful learning tools. However, they do *not* help to show how the

- A axial and appendicular skeletons join.
 - B vertebrae form the spinal column.
 - C bones meet to form joints.
 - D bones adjust to support the body's weight.
2. When you run a race, the muscles in your legs need extra oxygen. To get oxygen to your muscles, your lungs breathe harder. Your heart pumps more blood. The muscles that line your blood vessels change the size of the blood vessel to direct more blood to the active muscles and less blood to the inactive muscles. This situation is an example of
- A positive feedback.
 - B operant conditioning.
 - C multiple body systems working together.
 - D anaerobic respiration.
3. Which of these is the *best* example of the skin maintaining the body's stable environment, or homeostasis?
- A becoming sunburned after a day in the sun
 - B releasing acidic oils that prevent infection
 - C breaking out in acne after eating certain foods
 - D freckles appearing after sun exposure

4.

skin → sensory neuron → interneuron → motor neuron → ?

Imagine you place your finger on a hot pan. A sensory neuron generates an impulse that is passed along as shown in the diagram. Which of the following *best* describes the role of the motor neuron in this example?

- A The motor neuron stimulates the brain to feel a burning sensation.
 - B The motor neuron stimulates the sensory neuron to jerk the hand off of the hot pan.
 - C The motor neuron stores and processes the signal in the brain.
 - D The motor neuron stimulates a muscle to jerk the hand off of the hot stove.
5. In amyotrophic lateral sclerosis (ALS), or Lou Gehrig's disease, motor neurons lose their ability to send impulses. Which of the following is *most* likely to occur due to this disease?
- A The patient will lose sensory ability.
 - B The patient will lose memory ability.
 - C The patient will lose thought ability.
 - D The patient will lose speaking ability.
6. Calcium is an important nutrient that is involved in stimulating muscle contraction and sending nerve impulses. Depositing and removing calcium from bones is a continual process that reshapes bones and sends calcium to other parts of the body where it is needed. Which of the following events would *most* likely result in calcium moving into bones?
- A bone injury
 - B intense exercise
 - C digestion
 - D thinking

THINK THROUGH THE QUESTION

Read the first part of the question carefully. Then consider which one of the answer choices would *not* require calcium to be sent to another part of the body.



What protects this developing baby?

Connecting CONCEPTS

This developing baby, only about four months old, floats in a liquid world, receiving all its oxygen and nutrients from its mother's body. The journey from a single cell to a fully developed human being is guided by genetic instructions, environmental influences, and the complex actions of hormones in both mother and baby.



Amphibians This photograph shows a cluster of nine-day-old embryos of a tree frog. Unlike human babies, these embryos do not develop completely within the mother's body. Instead, they are deposited in special underwater nurseries. Once these eggs hatch, the tiny tadpoles are left to fend for themselves.

34.1

Reproductive Anatomy

KEY CONCEPT Female and male reproductive organs fully develop during puberty.

▶ MAIN IDEAS

- The female reproductive system produces ova.
- The male reproductive system produces sperm.

VOCABULARY

reproductive system, p. 1024
puberty, p. 1024
ovum, p. 1024
ovary, p. 1024

uterus, p. 1024
estrogen, p. 1024
fallopian tube, p. 1024
testis, p. 1025
testosterone, p. 1025

scrotum, p. 1026
epididymis, p. 1026
vas deferens, p. 1026
semen, p. 1026



REVIEW AT
CLASSZONE.COM

Connect You have something in common with every person ever born. Like everyone else, you began life as a single cell, produced when one male sex cell joined with one female sex cell. Sexual reproduction is the means by which the human species passes on genetic information to each generation.

▶ MAIN IDEA

The female reproductive system produces ova.

The **reproductive system** is a collection of specialized organs, glands, and hormones that help to produce a new human being. Females and males reach sexual maturity, or the ability to produce offspring, only after puberty.

Puberty marks a time in your life when your hypothalamus and your pituitary gland release hormones, such as follicle-stimulating hormone (FSH) and luteinizing hormone (LH). Such hormones begin the process of developing your sexual characteristics and reproductive system.

The main functions of the female reproductive system are to produce ova (singular, **ovum**), or egg cells, and to provide a place where a fertilized egg can develop. Unlike males, females have all of their reproductive organs located inside their bodies. This organization helps to protect a fertilized egg while it develops. The egg cells are produced in the ovaries. The **ovaries** are paired organs located on either side of the **uterus**, or womb, as shown in **FIGURE 34.1**. When a female baby is born, she already has about 2 million potential egg cells stored in her ovaries.

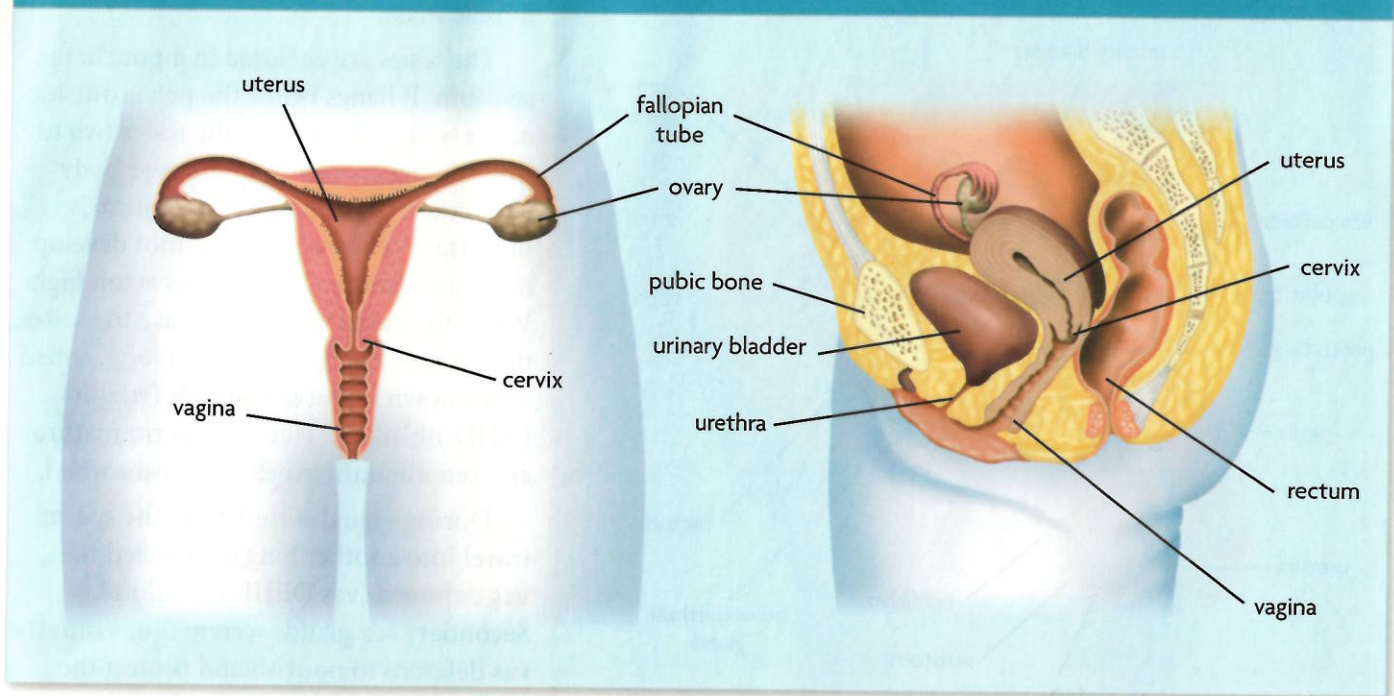
In the ovaries, FSH and LH stimulate the release of another important hormone, estrogen. **Estrogen** is a steroid hormone that has three main functions. First, it controls the development of female sexual characteristics, including widening the pelvis, increasing fat deposits and bone mass, and enlarging the breasts. Second, it is needed for egg cells to develop fully before they leave the ovaries. Third, estrogen helps to prepare the uterus for pregnancy every month and helps to maintain a pregnancy when it occurs.

When an egg cell matures each month, it is released from an ovary and enters the fallopian tube. The **fallopian tube** (fuh-LOH-pee-uhn) is an organ about 10 centimeters (4 in.) long that ends in the uterus. An egg takes several days to travel through this tube. During that time, it can be fertilized by sperm

Connecting CONCEPTS

Endocrine System You read in **Chapter 29** that the hypothalamus and pituitary glands are part of the endocrine system. These two glands are considered “master” glands because the hormones they secrete affect other glands that play key roles in human reproduction, growth, and development.

FIGURE 34.1 FEMALE REPRODUCTIVE ANATOMY



that enter the tube. A fertilized egg will attach to the wall of the uterus, but an unfertilized egg will eventually be broken down and discarded.

The uterus is about the size and shape of a pear. It is composed of three layers: a thin inner layer of epithelial cells, a thick middle layer of muscle, and an outer layer of connective tissue. The lower end of the uterus is called the cervix, which opens into the vagina. In a normal birth, a baby is pushed down the canal of the vagina to exit the mother's body. The complex processes of fertilization and human development are described in Sections 34.2 and 34.3.

Analyze How does the release of estrogen affect the female reproductive system during puberty?

TAKING NOTES

Use a two-column chart to list the major parts and functions of the female and male reproductive anatomy.

Female	Male
Ovaries — Paired organs where eggs are produced	Testes — Paired organs that produce sperm cells

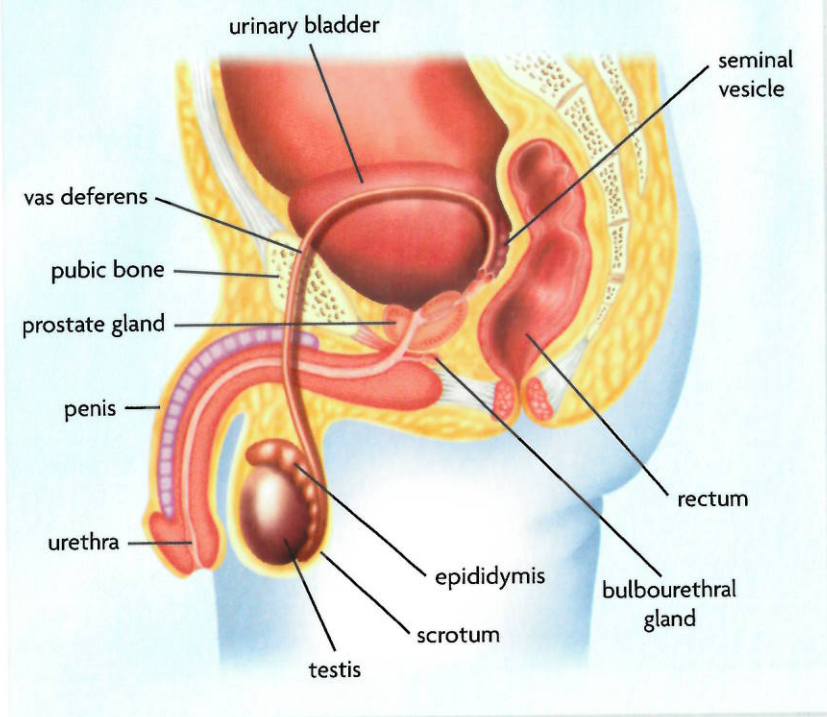
MAIN IDEA

The male reproductive system produces sperm.

The main functions of the male reproductive system are to produce sperm cells and to deliver them to the female reproductive system. The diagram in **FIGURE 34.2**, on the following page, shows the organs in which sperm are produced and stored and the organs that deliver the sperm.

Males do not produce sperm until puberty but afterward can produce sperm all their lives. Sperm production takes place in the testicles, or **testes** (TEHS-teez), which are paired organs. Each testis (singular of testes) contains hundreds of tiny tubules where millions of sperm cells are produced. In the testes, LH stimulates the release of testosterone. **Testosterone** (tehs-TAHS-tuh-ROHN) is a steroid hormone that, along with FSH, stimulates the production of sperm cells. Testosterone also controls the development of male sexual characteristics. These include a deeper voice than a female's, more body hair,

FIGURE 34.2 MALE REPRODUCTIVE ANATOMY



greater bone density, and increased muscle mass.

The testes are enclosed in a pouch, the **scrotum**. It hangs below the pelvis outside of the body, which keeps the testes two to three degrees cooler than the core body temperature. The lower temperature is important because sperm cannot develop if the temperature in the testes is too high. When the immature sperm leave the testes, they travel through a duct to a long, coiled tube known as the **epididymis** (EHP-ih-DIHD-uh-mihs). Here the sperm mature and remain until expelled or reabsorbed.

During sexual stimulation, the sperm travel into another long duct called the **vas deferens** (vas DEHF-uhr-uhnz). Secondary sex glands secrete fluids into the vas deferens to nourish and protect the sperm. The prostate gland, which surrounds the urethra, produces a fluid that helps sperm move more easily. The bulbo-

urethral gland (BUHL-boh-yu-REE-thruhl) and the seminal vesicle secrete basic fluids that help to neutralize the acidity in the urethra and in the female's vagina. The fluids from all three glands, together with the sperm, form a milky white substance known as **semen**.

During sexual arousal, blood flows into the penis, making it rigid. Semen moves from the vas deferens into the urethra, which runs the length of the penis. When ejaculation occurs, a muscle closes off the bladder to prevent urine from mixing with the semen in the urethra. Smooth muscle contractions then propel the semen along the urethra and eject it from the penis.

Apply Why might having a high fever affect sperm production?



For more information on the human reproductive systems, go to scilinks.org.
Keycode: MLB034

34.1 ASSESSMENT



REVIEWING MAIN IDEAS

1. Explain the function of the following parts of the female reproductive system: **ovary, fallopian tube, uterus**.
2. Explain the function of the following parts of the male reproductive system: **testes, scrotum, epididymis, vas deferens**.

CRITICAL THINKING

3. **Compare** In what ways are the effects of **testosterone** on males and **estrogen** on females similar?
4. **Infer** Both males and females have paired organs that produce sex cells. What survival advantage for our species might this pairing of organs provide?

Connecting CONCEPTS

5. **Plants** You read in Chapter 22 that flowering plants reproduce sexually. The stamen produces pollen grains, and the carpel contains an ovary where eggs are produced. How do these structures compare with human reproductive organs?

34.2 Reproductive Processes

KEY CONCEPT Human reproductive processes depend on cycles of hormones.

▶ MAIN IDEAS

- Eggs mature and are released according to hormonal cycles.
- Sperm production in the testes is controlled by hormones.
- Fertilization occurs when a sperm cell joins an egg cell.
- Sexually transmitted diseases affect fertility and overall health.

VOCABULARY

follicle, p. 1028

ovulation, p. 1028

menstrual cycle, p. 1028

endometrium, p. 1028

corpus luteum, p. 1029

menopause, p. 1029

zygote, p. 1031

infertility, p. 1031

sexually transmitted disease, p. 1032

Review

meiosis, ovary, uterus, ovum, fallopian tube, sperm, vas deferens

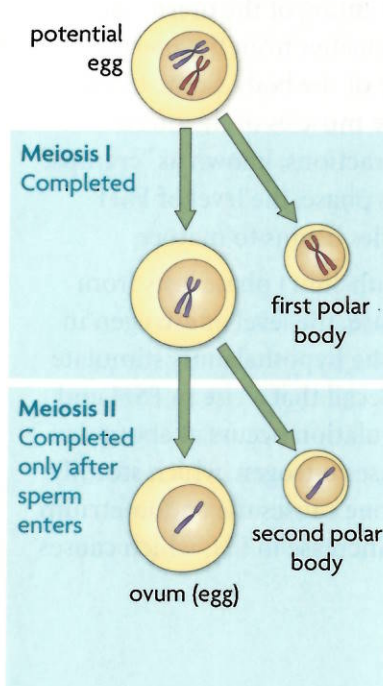
▶ REVIEW AT CLASSZONE.COM

Connect You may have heard the phrase “Timing is everything.” In football, for instance, precise timing between players can mean the difference between catching or dropping a key pass. Likewise, timing is everything for the hormones that regulate the reproductive processes in your body. Numerous feedback loops among these hormones help ensure that each process occurs at the right time and in the right order.

▶ MAIN IDEA

Eggs mature and are released according to hormonal cycles.

FIGURE 34.3 Potential eggs go through meiosis I and II to produce mature ova, or eggs with 23 chromosomes each.



A female’s reproductive cycle is controlled by hormones released by the hypothalamus, the pituitary gland, and the ovaries. Each month, the levels of these hormones rise and fall in well-timed feedback loops that regulate the development and release of an egg and prepare the uterus to receive it.

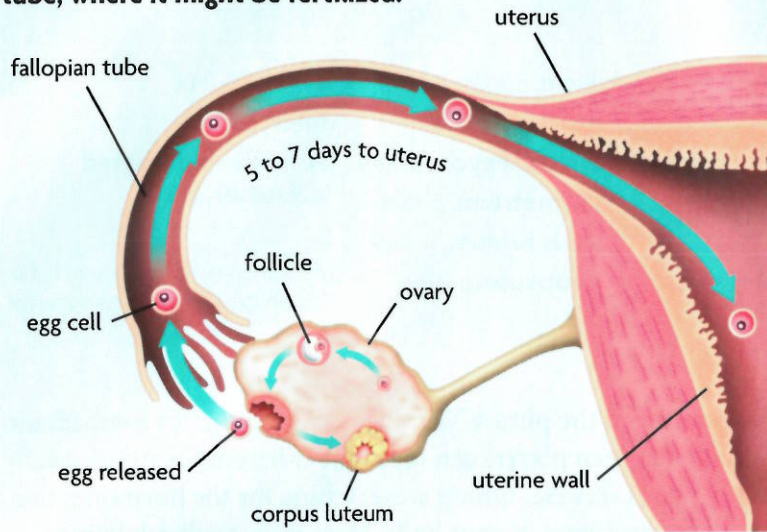
Production of Eggs

The production of eggs, or ova, begins before a female is born, as described in Section 34.1. Recall from Chapter 6 that meiosis is a type of cell division that produces sex cells, or gametes. After the chromosomes in each of the cells are duplicated, meiosis I can begin. The potential eggs then enter a resting phase that lasts until puberty. At birth, a female has about 2 million of these partially developed eggs in her ovaries. Before puberty begins, many of these cells break down until only about 400,000 are left.

At puberty, a monthly hormone cycle begins the second stage of egg production. Every 28 days or so, an increase in FSH stimulates a potential egg to complete meiosis I, as shown in **FIGURE 34.3**. The potential egg divides unevenly, producing two sex cells. The larger cell receives most of the organelles, cytoplasm, and nutrients an embryo will need when an egg is fertilized. The smaller cell, or polar body, simply breaks down. The larger sex cell completes meiosis II only after a sperm enters it. The cell divides again to produce an ovum, or egg, and a second polar body that also breaks down. Both the ovum and the second polar body contain 23 chromosomes from the mother.

FIGURE 34.4 Release of Egg

After an egg is released, it travels through the fallopian tube, where it might be fertilized.



Infer Why might it be an advantage that the egg takes several days to travel through the fallopian tube?

Release of Egg

Each developing sex cell, which you can think of as an egg, is surrounded by a group of cells called a **follicle** that helps the egg to mature. When an egg is ready to be released, the follicle ruptures, and the egg breaks through the ovary wall, as shown in **FIGURE 34.4**. The release of an egg from the ovary is called **ovulation**. The egg is swept into the fallopian tube, where it can be fertilized by a sperm. Over the next five to seven days, the egg moves through the tube to the uterus. An unfertilized egg is discarded during menstruation.

In most cases, only one egg is released during ovulation. About 400 to 500 eggs are released over a female's reproductive life. Which ovary releases an egg each month is entirely random. If one ovary is damaged, however, the other may take over and release an egg each month.

The Menstrual Cycle

The **menstrual cycle** is a series of monthly changes in the reproductive system that include producing and releasing an egg and preparing the uterus to receive it. The length of the cycle is slightly different for each female, but averages about 28 days. The cycle has three main phases—flow phase, follicular phase, and luteal phase, as **FIGURE 34.5** shows. The timing of each phase is regulated by specific hormones.

Connecting CONCEPTS

Animal Behavior As you read in **Chapter 27**, hormone cycles control more than reproduction. Certain glands and proteins in some animals detect seasonal changes in temperature and in the hours of daylight. As a result, the glands secrete hormones that control when an animal will hibernate or migrate.

- 1 Flow phase** Day 1 of the menstrual cycle is the first day that the menstrual flow begins. The flow occurs when the lining of the uterus, or **endometrium** (EHN-doh-MEE-tree-uhm), detaches from the uterine wall and passes through the vagina to the outside of the body. Some blood, mucus, and tissue fluid are also expelled. The muscles of the uterus contract to help expel the lining. These contractions, known as “cramps,” can be painful for some females. During this phase, the level of FSH starts to rise, and another follicle in the ovaries begins to mature.
- 2 Follicular phase** The follicular (fuh-LIHK-yuh-luhr) phase lasts from about day 6 to day 14. At the start of this phase, the level of estrogen in the blood is relatively low. Hormones from the hypothalamus stimulate the pituitary to release more FSH and LH. Recall that a rise in FSH and LH causes the egg and follicle to mature. Ovulation occurs at about day 14. As the egg is developing, the follicle releases estrogen, which steadily increases over the next few days. This hormone causes the endometrium to thicken. Estrogen also stimulates a sharp increase in LH, which causes the follicle to rupture, releasing the egg.

3 Luteal phase In the luteal (LOO-tee-uhl) phase, the release of hormones is now timed to stop egg production and to develop the endometrium to receive a fertilized egg. After ovulation, the empty follicle turns yellow and is called the **corpus luteum** (KAWR-puhs LOO-tee-uhm), or “yellow body.” The corpus luteum releases estrogen and another hormone, progesterone, which limits the production of LH. Progesterone and estrogen also increase the number of blood vessels in the endometrium. If the egg is not fertilized, rising levels of estrogen and progesterone cause the hypothalamus to stop releasing FSH and LH. The corpus luteum then breaks down and stops secreting estrogen and progesterone. As a result, the uterus lining begins to shed, and the next flow phase starts.

For most women, the menstrual cycle continues throughout their reproductive years, which may last from preteen years to the late 50s. Eventually, however, the levels of hormones decline with age. This decline disrupts the normal timing of the menstrual cycle. In a process called **menopause**, the cycle gradually becomes more and more irregular and finally stops altogether. Menopause can occur as early as a woman’s mid-30s.

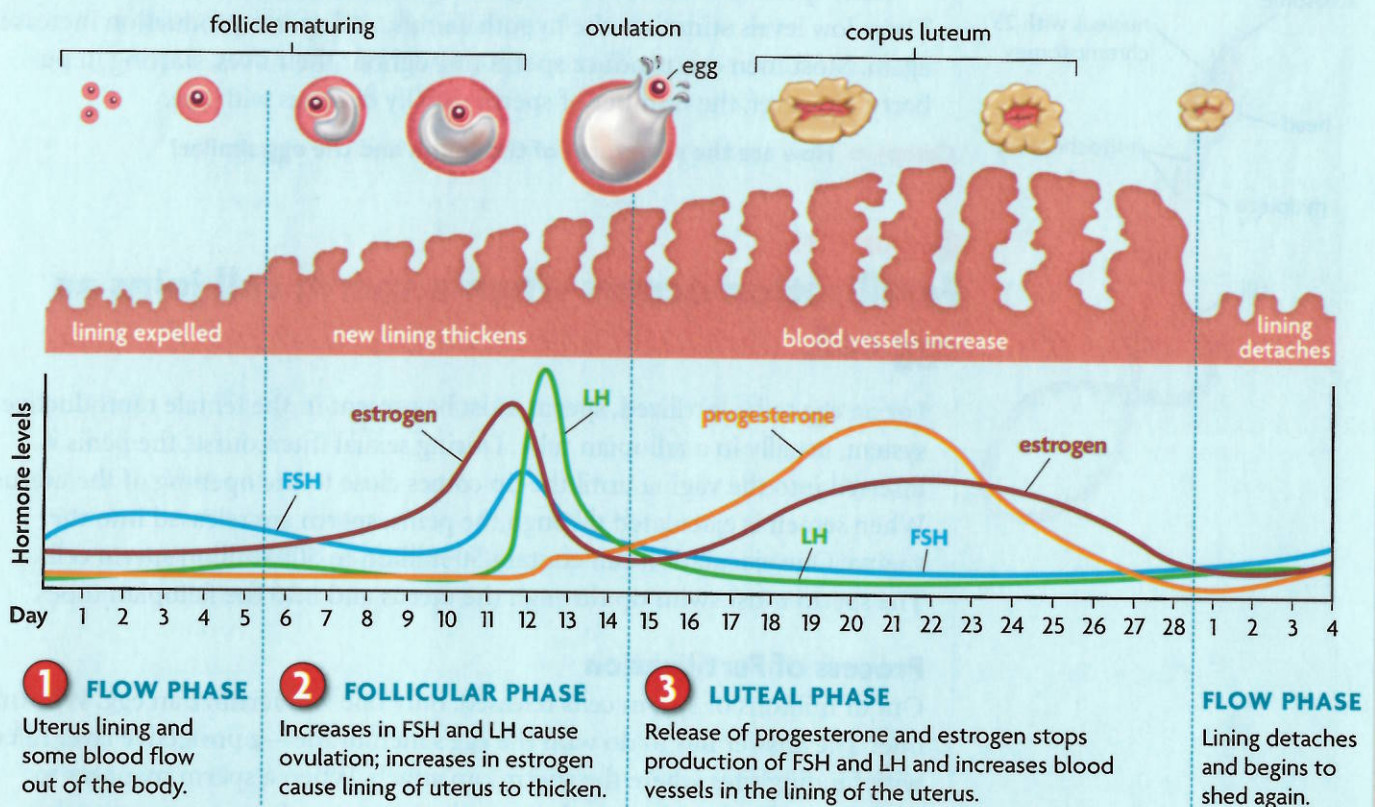
VOCABULARY

Menstruation and *menopause* are based on the Latin word *mensis*, which means “month.”

Summarize What are the main functions of estrogen and progesterone during the follicular and luteal phases?

FIGURE 34.5 Menstrual Cycle

Hormones cause changes in the **follicle**, egg, and lining of the uterus.

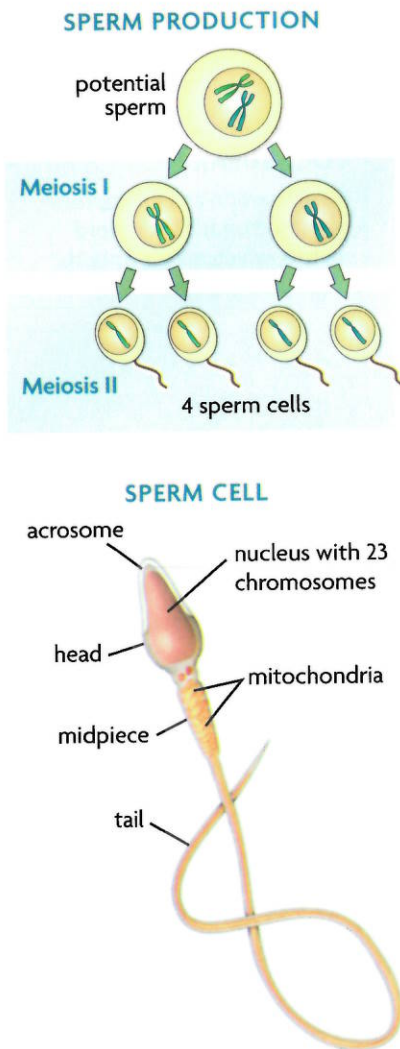


Analyze During which phase does the egg have the greatest chance of being fertilized?

MAIN IDEA

Sperm production in the testes is controlled by hormones.

FIGURE 34.6 Each potential sperm cell that undergoes meiosis produces four mature sperm cells with 23 chromosomes each. A mature sperm has a head, midpiece, and whiplike tail that enables it to move.



The reproductive cycles for males and females are different in two ways. First, females begin to produce eggs before they are born, but males do not produce sperm until they reach puberty. Second, females usually produce only one egg a month to be fertilized, while males produce millions of sperm almost daily.

The production of sperm begins when hormones from the hypothalamus stimulate the pituitary to release FSH and LH, which circulate to the testes. The testes start releasing testosterone, which causes specialized cells to go through meiosis to develop into mature sperm. As the levels of testosterone rise, the levels of FSH and LH begin to decline. This feedback loop among the hormones helps to control the number of sperm that are produced.

Unlike eggs, which produce polar bodies, the developing sperm divide into four equal sperm cells, as shown in **FIGURE 34.6**. Each cell is haploid, with 23 chromosomes. Sperm cells then fully mature in the epididymis. As the diagram shows, each sperm has a head, midpiece, and tail. The head contains a nucleus and a cap region called the acrosome. When a sperm cell contacts an egg, the acrosome releases enzymes that allow the sperm to penetrate the egg's membrane. The midpiece holds the mitochondria that supply the sperm with ATP for the energy it needs. The tail, or flagellum, propels the sperm from the vagina to the fallopian tubes, where fertilization can take place.

After sperm are released through the penis, testosterone levels decline. These low levels stimulate the hypothalamus, and sperm production increases again. Most men can produce sperm throughout their lives, starting in puberty. However, the number of sperm usually declines with age.

Compare How are the structures of the sperm and the egg similar?

MAIN IDEA

Fertilization occurs when a sperm cell joins an egg cell.

For an egg to be fertilized, sperm must be present in the female reproductive system, usually in a fallopian tube. During sexual intercourse, the penis is inserted into the vagina until the tip comes close to the opening of the uterus. When semen is ejaculated through the penis, sperm are released into the vagina. One ejaculation can contain 50 million to 500 million sperm cells. The sperm must swim up through the uterus and into the fallopian tubes.

Process of Fertilization

Out of millions of sperm cells released, only one will fertilize an egg. Why only one? The answer has to do with the egg's membrane—a protective layer filled with binding sites where the sperm can attach. When a sperm manages to contact and bind to the egg, the sperm's acrosome releases an enzyme that digests the membrane at that spot. The sperm can then enter the egg, as

QUICK LAB OBSERVING

Human Sex Cells

In this lab, you will examine prepared slides of mammalian male and female sex cells.

PROBLEM How do male and female sex cells differ?

PROCEDURE

1. Examine a slide of sperm cells under low power and high power. Draw a sperm cell and label its structures.
2. Examine a slide of egg cells under low power and high power. Draw an egg cell and label its different structures.

ANALYZE AND CONCLUDE

1. **Analyze** Why is the flagellum an important structure in a sperm cell?
2. **Contrast** How is the egg structurally different from the sperm?

MATERIALS

- slide of mammalian sperm cells
- slide of mammalian egg cells
- microscope

shown in **FIGURE 34.7**. Once the egg is penetrated, its surface changes to form a barrier that stops other sperm from entering. In effect, the egg lets in one sperm, then closes the door on the others. The egg then completes meiosis II. Then the 23 chromosomes of the sperm join with the 23 chromosomes of the egg to form a fertilized egg called a **zygote**. This combination of chromosomes helps preserve genetic diversity because chromosomes in a pair often have different alleles of genes. This is one reason children are never exact genetic copies of their parents.

In rare cases, more than one egg may be released into the fallopian tubes. If two eggs are fertilized, they will develop into fraternal twins. Fraternal twins are not genetically the same. They are just like any other siblings who are born separately.

Genetically identical twins occur only when a single fertilized egg splits into two zygotes, each one with 46 chromosomes. As a result, two identical but separate embryos develop in the uterus. In even rarer cases, a fertilized egg may split into three, four, or more zygotes. If they all develop, the mother will give birth to several genetically identical babies.

Problems in Fertilization

Infertility refers to any condition that makes reproduction difficult or impossible. In the male, for instance, the vas deferens may be too narrow or blocked, which prevents sperm from leaving the body. If the sperm count is too low or the sperm are weakened or deformed, fertilization may not occur. Certain illnesses, such as mumps in adults, can destroy the testes' ability to produce sperm. In females, diseases that damage the ovaries or fallopian tubes can prevent eggs from being produced or reaching the uterus. The eggs themselves may have defects that keep the sperm from getting through the membrane. Many infertility problems can be corrected through treatments such as medications, surgery, or even dietary changes.

Apply If twins are born and one is a boy and one is a girl, are they identical or fraternal siblings? Explain your answer.

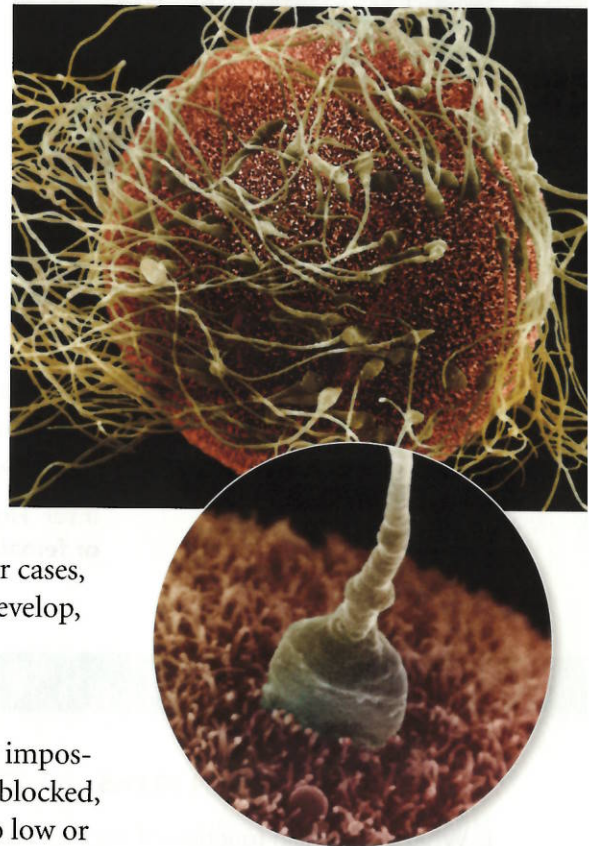


FIGURE 34.7 In the top image, sperm surround an egg. The bottom image shows one sperm penetrating an egg's membrane. (colored SEM; magnifications: egg with sperm 600 \times ; sperm detail 4,000 \times)

▶ MAIN IDEA

Sexually transmitted diseases affect fertility and overall health.

Diseases passed from one person to another during sexual contact are called **sexually transmitted diseases**, or STDs. These diseases affect millions of people in their peak reproductive years and cause thousands of deaths. Some STDs in the early stages produce few symptoms. People do not realize they are carrying the disease and continue to infect others through sexual contact.

Bacterial STDs include chlamydia, syphilis, and gonorrhea. Chlamydia is the most common infection in the United States. Bacterial STDs attack the reproductive organs, such as the ovaries, and often cause infertility. In the case of syphilis, an untreated infection can even be fatal. Another infection, trichomoniasis, is caused by a parasite, shown in **FIGURE 34.8**. Trichomoniasis and chlamydia mostly affect young women aged 15 to 24 and can cause a serious condition known as pelvic inflammatory disease. People with these infections show few symptoms at first. This may be one reason why rates for trichomoniasis and chlamydia are increasing. Most parasitic and bacterial STDs can be treated with antibiotics.

Viral STDs include hepatitis B, genital herpes, human papillomavirus (HPV), and human immunodeficiency virus (HIV), which causes AIDS. Although medications can control these diseases, there are no cures. Antibiotics have no effect on viruses. HPV has been linked to cervical cancer, and AIDS has caused millions of deaths worldwide.

People can avoid STDs, just as they avoid other diseases. The surest ways are to abstain from sexual contact before marriage and for partners who do not have STDs to remain faithful in a committed relationship. Using a condom is the next safest choice; however, a condom can break or tear.

Infer How might a bacterial STD infection affect the reproductive cycle of a male or female?



FIGURE 34.8 The parasite *Trichomonas vaginalis* causes a common STD infection, trichomoniasis, that can affect fertility. (colored SEM; magnification 9000×)

34.2 ASSESSMENT



REVIEWING ▶ MAIN IDEAS

1. What is the main function of each phase in the **menstrual cycle**?
2. How does the structure of the sperm cell aid its function?
3. Describe how an egg is fertilized.
4. **Sexually transmitted diseases** can affect fertility. Explain why.

CRITICAL THINKING

5. **Contrast** Name two ways that the production of eggs differs from the production of sperm.
6. **Apply** A woman gives birth to quadruplets, or four infants. Two of her children are identical twins. The other two are fraternal twins. How could this have happened?

Connecting CONCEPTS

7. **Developmental Biology** Every egg contains one X chromosome. Each sperm contains either one X or one Y chromosome. Explain why the sperm always determines a baby's gender.

MATERIALS

- graph paper
- colored markers
- Hormone Blood Levels Datasheet

PROCESS SKILLS

- **Graphing**
- **Interpreting Graphs**

Hormones in the Human Menstrual Cycle

Hormones, including follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, and progesterone, play critical roles in the human menstrual cycle. As blood levels of these hormones rise and fall, the follicle, the egg, and the lining of the uterus go through different stages of development. In this lab, you will graph and analyze the changes in the blood levels of these four hormones during a menstrual cycle.

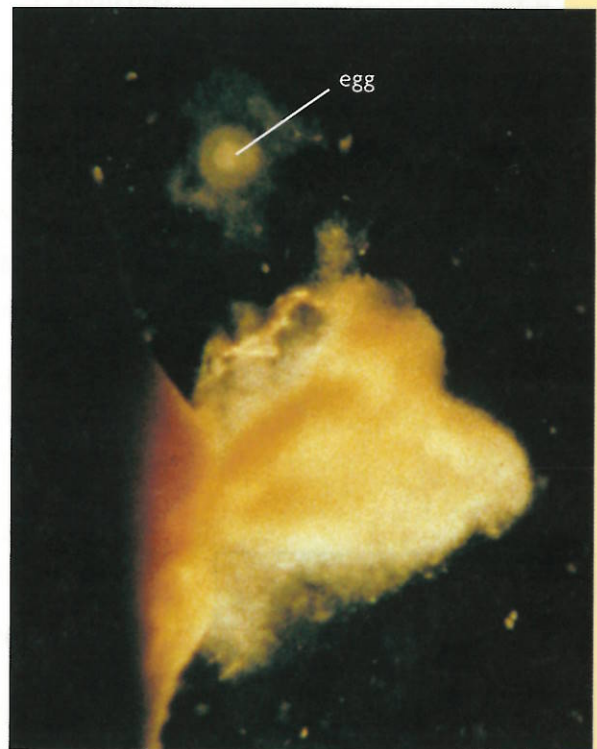
PROBLEM How do the blood levels of hormones change during the menstrual cycle?

PROCEDURE

1. Using the data sheet, construct a graph that shows the changes in the blood levels of hormones during a 28-day menstrual cycle in which fertilization does not occur.
2. Plot all hormones on one set of axes, and use different colors to represent the different hormones.

ANALYZE AND CONCLUDE

1. **Summarize** Describe the changes in levels that occur in each of the hormones throughout the month.
2. **Analyze** On what day of the cycle does LH peak? What is the significance of this fact?
3. **Analyze** When does the level of estrogen peak? What is the source of estrogen during this time?
4. **Explain** What is the significance of the rise in levels of estrogen and progesterone between days 10 and 22 of the cycle?
5. **Predict** How would the levels of hormones be affected if the egg were fertilized?



This micrograph captures the process of an egg breaking free from a rupturing follicle in the ovary. (LM; magnification unknown)

34.3

Fetal Development

KEY CONCEPT Development progresses in stages from zygote to fetus.

▶ MAIN IDEAS

- The fertilized egg implants into the uterus and is nourished by the placenta.
- A zygote develops into a fully formed fetus in about 38 weeks.
- The mother affects the fetus, and pregnancy affects the mother.

VOCABULARY

blastocyst, p. 1034

embryo, p. 1034

amniotic sac, p. 1035

placenta, p. 1035

umbilical cord, p. 1035

trimester, p. 1036

fetus, p. 1036



REVIEW AT
CLASSZONE.COM

Connect A human zygote develops from a single cell into a fully formed human in about nine months. The rate of growth in the first few weeks is astonishing. If you grew at the same rate after birth, you would be 4 meters (13 ft) tall at one month of age. The zygote's growth is directed by its DNA. However, the environment of the uterus and the mother's overall health also have a strong impact on how well the zygote develops.

▶ MAIN IDEA

The fertilized egg implants into the uterus and is nourished by the placenta.

After fertilization, the zygote begins to divide through mitosis as it travels down the fallopian tube. During this time, the corpus luteum continues to secrete progesterone and some estrogen. These hormones increase the number of blood vessels in the lining of the uterus and prepare it to receive the fertilized egg. After the zygote reaches the uterus, another chain of events takes place that helps it to develop.

Implantation in the Uterus

The zygote continues to undergo cell division until a hollow ball of cells called the **blastocyst** is formed. Cells on the surface of the blastocyst attach, or implant, into the uterine lining, as shown in **FIGURE 34.9**. Once the blastocyst is implanted, it goes through another stage in which three cell layers develop: the ectoderm, the mesoderm, and the endoderm.

The ectoderm layer develops into the skin and nervous system. The mesoderm layer forms many of the internal tissues and organs. The endoderm layer develops into many of the digestive organs and the lining of the digestive system. Once these structures begin to form, the ball of cells is known as an **embryo**.

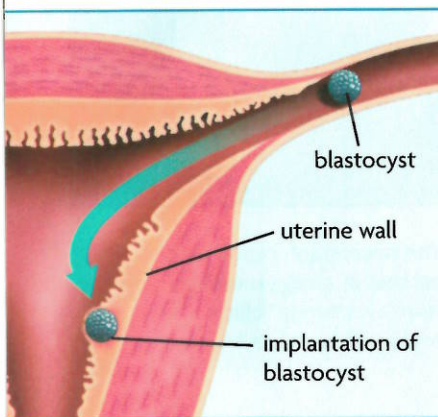


FIGURE 34.9 About seven days after fertilization, the blastocyst enters the uterus and attaches, or implants, into the uterine wall. Implantation is the beginning of a pregnancy.

VISUAL VOCAB

The **blastocyst** is a hollow ball of cells that implants in the uterus.

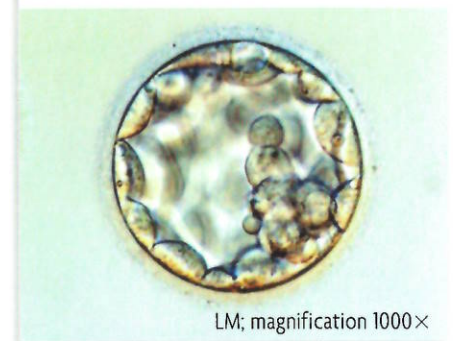
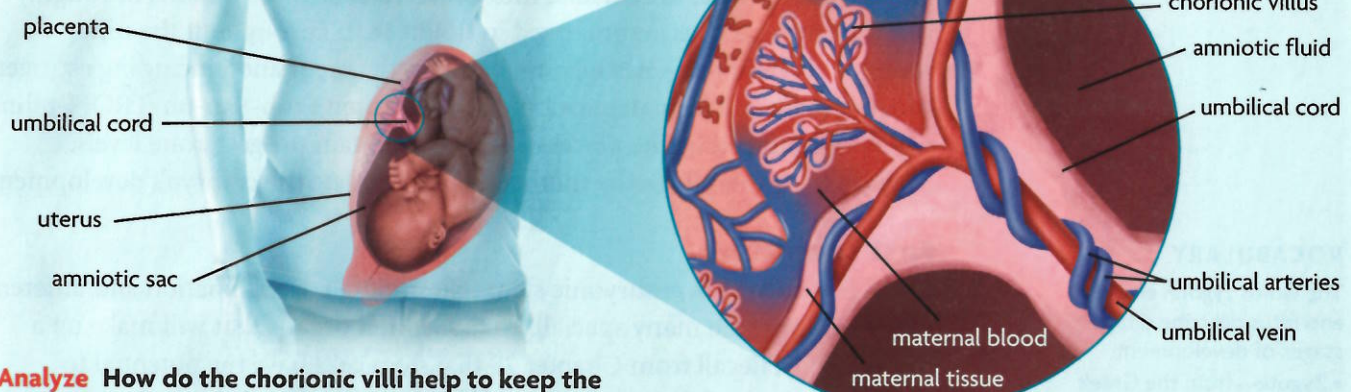


FIGURE 34.10 Membranes Protecting the Embryo

The **amniotic sac**, **placenta**, and **umbilical cord** connect the fetus and the mother.



Analyze How do the chorionic villi help to keep the baby's blood separate from the mother's blood?

Embryonic Membranes

As the pregnancy continues, membranes form that nourish and protect the developing embryo, as shown in **FIGURE 34.10**. One membrane, the amnion, becomes filled with fluid and is called the **amniotic sac** (AM-nee-AHT-ihk). This sac cushions the embryo within the uterus and protects it from sudden temperature changes. The amniotic sac surrounds the embryo until birth. Another membrane, the chorion (KAWR-ee-AHN), also begins to form. The chorion helps to nourish the embryo as it develops. The outer surface of the chorion has small projections called chorionic villi that extend into the uterine lining.

Together, the chorionic villi and the lining of the uterus form an important organ called the placenta. The **placenta** (pluh-SEHN-tuh) connects the mother and embryo to allow for the exchange of oxygen, nutrients, and wastes between them. Another structure, the **umbilical cord**, consists of two arteries and a vein that are twisted together. This cord connects the embryo inside the amniotic sac to the placenta. Nutrients and oxygen from the mother's blood diffuse into the chorionic villi, which contain blood from the embryo. The nutrients are carried to the embryo along the umbilical cord. In turn, wastes from the embryo are carried back along the umbilical cord to the chorionic villi. From there, the wastes diffuse into the mother's blood and are excreted in her urine.

The blood flows of the mother and the embryo move past each other but never mix. The placenta keeps the two flows separated. If proteins from the embryo leaked into the mother's circulatory system, they might be detected as foreign invaders by her immune system. The mother's immune system would then attack the proteins, which could end the pregnancy. The placenta provides a protective barrier for the embryo as it develops.

Apply Why might a pregnant woman need to be concerned about what she eats or drinks during pregnancy?

Connecting CONCEPTS

Circulatory System Like the pulmonary arteries and veins that you read about in **Chapter 30**, the umbilical arteries carry oxygen-poor blood and the umbilical vein carries oxygen-rich blood. The umbilical arteries carry blood away from the fetus's heart, and the umbilical vein carries blood to the fetus's heart.

▶ MAIN IDEA

A zygote develops into a fully formed fetus in about 38 weeks.

Human pregnancies are divided into **trimesters**, or three periods of roughly three months each, as summarized in **FIGURE 34.11**. Throughout the nine months, several hormones help to maintain the pregnancy, including estrogen, progesterone, and human chorionic gonadotropin (goh-NAD-uh-TROH-pihn), which is produced by the placenta to help maintain progesterone levels. Thyroid hormones from the mother help to regulate the embryo's development.

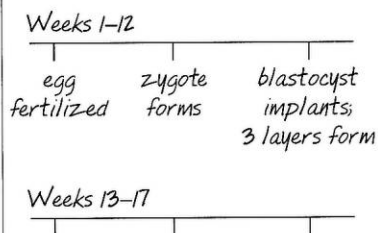
VOCABULARY

The words *zygote*, *embryo*, and *fetus* describe different stages of development.

- **Zygote**—from the Greek word *zugotos*, meaning “yoked,” or “joined,” as when the sperm joins the egg and cell division begins
- **Embryo**—from the Greek word *embruon*, meaning “to be full to bursting.” This stage covers weeks 1 to 8 when the entire body plan is developed.
- **Fetus**—from the Latin word *fetus*, meaning “offspring.” This stage covers weeks 9 to 36.

TAKING NOTES

Use a timeline to help you take notes on early fetal development.



First Trimester

In the first trimester, embryonic stem cells undergo determination and differentiation to form the many specialized tissues and organs that will make up a human body. Recall from Chapter 28 that stem cells have the potential to become any one of the hundreds of different types of cells in the human body. The embryo can be more easily damaged during this trimester as the result of genetic errors or mutations, nutritional deficiencies in the mother, and any toxic chemicals, such as alcohol or drugs, that the mother may consume.

Even at this early stage, the complete body plan is already becoming visible. The heart begins beating at about five weeks. The early structures for the vertebrae and spinal cord have been formed. The brain is developing, many internal organs have appeared, and the arms and legs are evident. The embryo at nine weeks—now called a **fetus**—is only about 3 centimeters (about 1 in.) long, but is beginning to look like a small human being.

Second Trimester

The second trimester is a time of continuing development and increased physical activity. The heartbeat can now be heard by placing a stethoscope over the uterus. As the fetus flexes its muscles, the mother can feel movement within her uterus. During these three months, the uterus expands enough to make the mother's pregnancy noticeable. As the fetus develops, the uterus continues to expand until it reaches four to five times its original size. At the end of the second trimester, the fetus may be only 30 centimeters (12 in.) long, but it looks more and more like a full-sized baby. Even its fingers and toes are fully formed, as shown in **FIGURE 34.11**.

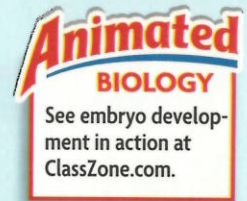
Third Trimester

In the third trimester, the fetus grows to its largest size. At birth, most babies weigh about 3 to 4 kilograms (7 to 9 lb) and are about 50 centimeters (20 in.) long. Babies born prematurely at the beginning of the third trimester have a difficult time surviving. Their organs, especially their lungs, are often too immature to function well. Babies born prematurely toward the middle of the third trimester often survive and thrive. In the last month, the lungs are strengthened as the fetus sucks in and pushes out the amniotic fluid.

Infer Why might a fetus be more easily damaged by genetic errors or toxic chemicals during the first trimester than during any other trimester?

FIGURE 34.11 Trimesters of Development

During each **trimester**, the **fetus** goes through different stages of growth and development.



FIRST TRIMESTER: WEEKS 1–12

Heart, brain, intestines, pancreas, kidneys, liver are forming.

Heartbeat can be detected after week 5.

Arms and legs begin to develop.

Lenses of the eye appear; eyelids will later fuse shut to allow irises to develop.

Individual fingers and toes begin to form.

Hair, fingernails, and toenails develop.

Cerebral hemispheres begin to form.

Early structure of bronchi begin to develop.

External sex organs show sex of the fetus.



Embryo at about 8 weeks



Hand at week 6



Hand at week 12

SECOND TRIMESTER: WEEKS 13–27

Most joints and bones have started to form.

Skin is protected by fine hair and waxy substance.

First movements are felt by mother.

Wake and sleep cycles are more regular.

Brain begins a stage of rapid growth.

Eyes open and blink; eyebrows and eyelashes have formed.

Fetus breathes in amniotic fluid, which strengthens lungs.

Fetus swallows amniotic fluid and makes urine.



Fetus at about 25 weeks



Hand at week 20

THIRD TRIMESTER: WEEKS 28–40

Fetus responds more strongly to light and sound outside the uterus.

Fetus has periods of dreaming; eyes are open when awake and closed when asleep.

Fine body hair thins and scalp hair grows in.

Bones are growing and hardening.

Synapses between neurons form in huge numbers.

Lungs complete development.

Fetus turns to head-down position.



Fetus at about 32 weeks



Hand at week 32

CRITICAL VIEWING

Study the pictures of the embryo and fetus. What are some of the structural changes that have taken place from week 8 to week 32?

DATA ANALYSIS

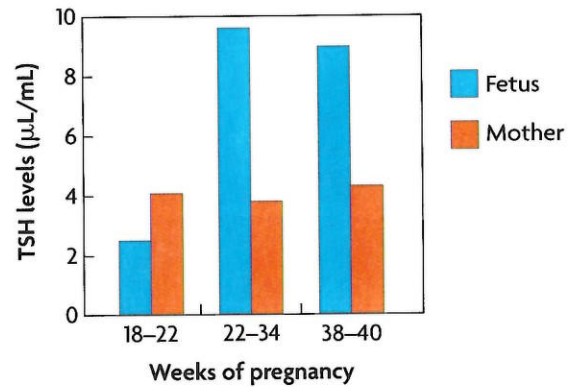
INTERPRETING GRAPHS

Scientists collected data on the amounts of thyroid-stimulating hormone (TSH) in mothers and in their developing fetuses. Researchers wanted to determine the point at which a fetus's own endocrine system begins to work independently of its mother's. The x-axis shows the different times during the pregnancy that levels of TSH were measured.

- The y-axis shows the amount of TSH in microliters per milliliter ($\mu\text{L}/\text{mL}$).
- The blue bar represents the fetus's levels of TSH.
- The orange bar represents the mother's levels of TSH.

1. **Analyze** What happens to both the mother's TSH levels and the fetus's TSH levels as the pregnancy progresses?
2. **Analyze** What is the relationship between the week of pregnancy and fetal TSH levels?

GRAPH 1. HORMONE LEVELS OF MOTHER AND FETUS



Source: D. Fisher, C. Hobel, R. Garza, C. Pierce, *Pediatrics*

▶ MAIN IDEA

The mother affects the fetus, and pregnancy affects the mother.

Throughout pregnancy, the mother and the fetus continually affect each other's health. For the most part, whatever the mother eats or drinks, the baby is exposed to through the placenta and the umbilical cord. On the other hand, the hormones released during pregnancy and the nutritional needs of the fetus present their own challenges to the mother's health.

Health of the Fetus

The fetus depends on the mother for all its nutrition. As a result, it is vitally important that the mother eat well throughout pregnancy. Her diet must include all the essential amino acids, vitamins, minerals, fats, and carbohydrates that the developing fetus needs. Vitamin and mineral supplements can provide extra amounts of these nutrients. For example, folic acid is an important B vitamin that can significantly lower the risk of serious birth defects in a fetus's brain and spinal cord. Folic acid is found in such foods as poultry, oranges, and dark green leafy vegetables. In contrast, toxic chemicals in alcohol, tobacco, and many other drugs can diffuse through the placenta and harm the fetus. These substances often interfere with fetal development and can cause many types of birth defects and produce learning disabilities in a child.

Studies have shown that many of these problems can be completely prevented if the mother avoids alcohol, tobacco, and drugs during the pregnancy. Even some over-the-counter medications can harm the fetus. As a result, the mother must check with a health care provider to be sure any medications she needs to take are safe for the fetus.

Health of the Mother

The mother's health is affected by pregnancy in a number of ways. To supply enough energy for herself and her baby, the mother must add roughly 300 more Calories a day to her diet after the first trimester. During pregnancy, most women will gain on average about 12 kilograms (26 lb). However, gaining too much or too little weight can affect the fetus. Women who gain too little weight often have underweight babies who may have impaired immune systems, learning disabilities, and delayed development.

Hormone levels also fluctuate, affecting the mother's ability to maintain homeostasis. For example, some pregnant women are unable to control their glucose levels and may develop pregnancy-related diabetes. This type of diabetes normally disappears after the pregnancy is over. Hormones may also affect the digestive tract, causing what is known as morning sickness, or vomiting, for a time. This condition generally clears up as the pregnancy progresses. After the baby is born, some women may experience some depression during the time that their hormone levels are stabilizing. To help ensure a healthy pregnancy, the mother should have regular physical checkups. The normal challenges of pregnancy can be managed through proper diet, exercise, and medical care.



FIGURE 34.12 Routine medical tests can be used to check the mother's blood pressure, glucose levels, nutrition, and other factors. The baby's growth and development in the uterus can also be monitored.

Infer When a woman first learns that she is pregnant, what lifestyle changes might she need to make?

34.3 ASSESSMENT



REVIEWING MAIN IDEAS

1. Explain the main functions of the **placenta** during a pregnancy.
2. List two milestones of fetal growth and development achieved in each **trimester**.
3. Give two examples of how the mother and **fetus** affect one another during pregnancy.

CRITICAL THINKING

4. **Apply** A woman doesn't want to gain more than 6 kg (13 lbs) during her pregnancy. What effects might this decision have on the fetus?
5. **Infer** A baby is born 12 weeks premature. The organs are developed, but the baby must breathe using a ventilator. Explain why this treatment is necessary.

Connecting CONCEPTS

6. **Tissue Rejection** A woman with type O Rh⁻ blood is pregnant for a second time. During her first pregnancy, she developed antibodies for Rh⁺ factor. Her second baby's blood is type O Rh⁺. What might happen if some fetal blood leaks into the mother's blood?

34.4

Birth and Development

KEY CONCEPT Physical development continues through adolescence and declines with age.

▶ MAIN IDEAS

- Birth occurs in three stages.
- Human growth and aging also occur in stages.

VOCABULARY

infancy, p. 1042
childhood, p. 1042
adolescence, p. 1042
adulthood, p. 1043



REVIEW AT
CLASSZONE.COM

Connect After birth, you will spend nearly two decades learning how to live on your own. Until recently, scientists thought that the most important learning period happened in the first three years of life. Now they have discovered that in adolescence the brain goes through a second period of development. During this time, you are maturing emotionally and mentally, not just physically. This may be one reason why humans take so long to grow up.

▶ MAIN IDEA

Birth occurs in three stages.

When the fetus has fully developed, the placenta can no longer provide enough nourishment. The time has come for the baby to be born. The birth process involves three stages: dilation of the cervix, emergence of the baby, and expulsion of the placenta, as shown in **FIGURE 34.13**. The physical changes that the mother's body goes through are known as labor.

Dilation of the Cervix

Labor begins with regular contractions of the uterus. The hormone oxytocin (AHK-sih-TOH-sihn), released by the mother and the fetus, stimulates the muscles in the wall of the uterus. However, not all contractions mean that the baby is about to be born. Expectant mothers are usually taught to count the number and strength of these contractions. When they become more frequent, intense, and painful over time, then true labor has begun. The amniotic sac usually breaks in the early stages of labor, although it can break earlier. The amniotic fluid is released through the vagina, which is also called the birth canal.

The contractions serve to push the walls of the cervix apart. The baby cannot leave the uterus until the cervix dilates, or widens, to at least 10 centimeters (4 in.). This space allows most babies to pass through. If the cervix does not dilate, the doctor must make an incision through the abdominal wall to remove the baby, a procedure called a cesarean section, or c-section.

Emergence of the Baby

This stage of the birth process is often the most stressful for the mother and the baby. If everything goes well, the powerful contractions of the uterus help rotate the baby so that its head is toward the cervix. In some cases, the baby

Connecting CONCEPTS

Marsupials In Chapter 26, you read about marsupial mammals that give birth to young that are little more than embryos. These tiny life forms must then find their way into the mother's pouch to complete their development. In contrast, human babies are born at an advanced stage of development.

FIGURE 34.13 Three Stages of Birth

Birth begins with contractions and continues until the baby and placenta emerge.



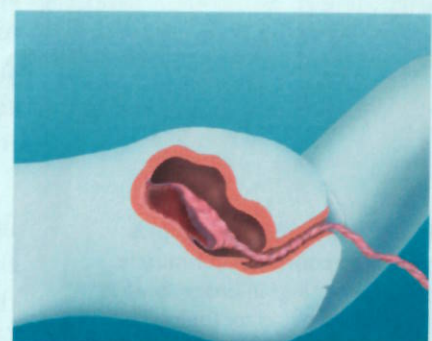
STAGE 1

As regular, strong contractions occur, the cervix dilates and the baby turns.



STAGE 2

The baby is pushed through the cervix and out of the vaginal canal.



STAGE 3

Contractions continue, expelling the placenta and helping to control bleeding.

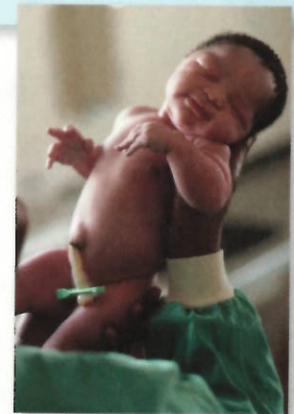
Predict At what point might the baby begin to breathe on its own?

does not turn and is born feet first, which is a more difficult birth process. Usually, however, the baby is in the right position. The muscles of the uterus then push the baby into the birth canal. Once the head emerges, the rest of the body usually slips out quickly. Within a short time, the baby is breathing on its own. The hormone oxytocin also stimulates the mother's breasts to produce milk and increases her desire to bond with her infant. This bond helps to ensure that she will care for the baby after it is born.

Expulsion of the Placenta

The third stage of birth happens soon after the baby emerges. As the uterine contractions continue, the placenta detaches from the wall of the uterus and is expelled. These contractions also help to constrict blood vessels and reduce the amount of bleeding the mother experiences. The baby's umbilical cord is clamped and cut a few inches from the abdomen. This bit of cord eventually dries up and falls away, leaving a scar called the navel, or belly button.

Infer Why might a head-first delivery be the safest for both mother and baby?



After living in the uterus for nine months, this newborn is breathing air for the first time. From now on it must live outside the protected environment of its mother's body.

MAIN IDEA

Human growth and aging also occur in stages.

Just as hormones regulate human reproduction, they are also involved in human growth after birth. Most children follow the same pattern of growth and development, but each child matures at his or her own pace. Rates of growth are also affected by factors such as genetics, nutrition, and environment.

Key hormones involved in growth include thyroxin, estrogen, testosterone, and human growth hormone (hGH), which is secreted by the pituitary gland. Human growth hormone increases the body's rate of fat metabolism and protein synthesis. These processes cause all body cells to divide, particularly bone and skeletal muscle cells. However, as a person ages, the pituitary secretes less and less hGH.

Infancy and Childhood

Infancy lasts from birth to about age 2. When babies are born, their homeostatic mechanisms are not completely developed. As a result, a newborn's body temperature, heart rate, and breathing rate vary more than they do in older children. Also, an infant's kidneys are less efficient at reabsorbing water, which can lead to rapid dehydration. As infancy progresses, homeostatic mechanisms mature and these variations decrease.

The first year of life is a period of rapid growth. Both male and female infants usually triple their weight and grow about 25 centimeters (10 in.) by their first birthday. Other changes are equally dramatic. Rapid development of the brain and nervous system occurs, and vision improves as babies learn to focus their eyes. They begin to coordinate muscle groups to sit, stand, and finally walk. By the end of infancy, children usually have a vocabulary of several words and may even express themselves using short sentences.

Childhood begins at age 2 and extends to about age 12. During childhood, physical growth slows down. Each year, most children grow only about 6 centimeters (3 in.) and gain about 4 kilograms (6 lb). Childhood is a time during which muscle skills and coordination improve as the nervous system matures. The continued development of sensory receptors, nerves, and muscles mean that children can learn both fine-motor skills such as writing and large-motor skills such as walking, as shown in **FIGURE 34.14**. Language and abstract reasoning abilities improve. Children begin to express more complex and varied emotions and become better able to understand the emotions of others.

Puberty and Adolescence

Puberty marks the beginning of sexual maturity and the development of sexual characteristics. As you read in Section 34.1, puberty begins when the hormones FSH and LH are released by the pituitary gland. For girls, the average age range for the onset of puberty is 10 to 14. For boys, the average age range is 10 to 16. During this time, young people experience a period of rapid growth stimulated by the release of testosterone and estrogen. Growth averages 5 to 7 centimeters (2 to 3 in.) and can reach up to 15 centimeters (6 in.) in one year. Young people often feel clumsy as they adjust to their changing bodies. They also experience rapid changes in their emotions and in their reasoning abilities as the brain continues to make new neural connections.

Adolescence begins at sexual maturity. In girls, sexual maturity is marked by ovulation and the first menstrual cycle. Although boys can ejaculate before sexual maturity, sexual maturity is indicated by the presence of sperm in the semen. During adolescence, bone growth continues until about age 15 in girls and about age 17 in boys. Adolescent boys and girls often experience greater strength and physical endurance in these years, and their coordination often improves. Although the brain stops increasing in size, the rearrangement of neural connections continues. In a very real sense, the adolescent brain is being "rewired" in preparation for adulthood.

FIGURE 34.14 The child (top) is learning to control major muscle groups in her legs in order to walk. The adolescent skater (below) is adapting her knowledge of walking to learn a more sophisticated skill.



Adulthood and Aging

You might think that **adulthood** marks a time when people reach their peak in terms of skills and abilities. For the most part, you would be right. During these years, most people establish independent lives, and many raise their own families. However, adulthood, like other life stages, also marks a time of distinct physical changes, as you can see in **FIGURE 34.15**.

Scientists are only now beginning to unlock the mysteries of how the body ages. As a person grows older, some of the most important changes include a decline in immune functions and in the production of many key hormones, such as growth hormone, testosterone, and estrogen. Most women around age 50 or so go through menopause. In men, the sperm count gradually decreases. For both sexes, the body's rates of metabolism and digestion slow down. Skin becomes thinner and less elastic, bones lose calcium, and muscle mass decreases and is replaced by fat deposits.

However, scientists are also finding that how one experiences the aging process may depend as much on genetics, lifestyle, and environment as it does on chronological age. In general, those who eat a healthy diet, remain physically active, and keep learning may be able to slow down or even counteract many of the changes that aging brings about. For example, regular weight-bearing exercise such as walking several miles a week can help to maintain bone and muscle mass. Also, studies have shown that if a person keeps learning throughout life, the brain continues to make new neural connections just as it did when the person was younger.

Compare Describe some of the ways that the process of aging is the reverse of the processes that occur during puberty and adolescence.

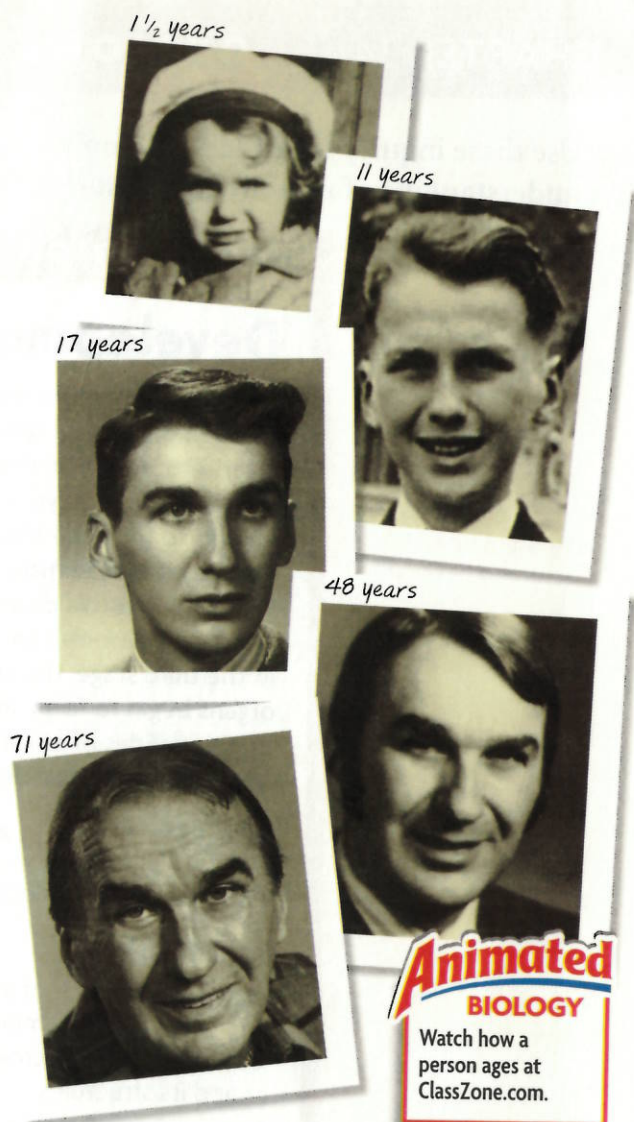


FIGURE 34.15 These photos show the changes that occur in the same person's face from childhood to the 70s.

34.4 ASSESSMENT



REVIEWING MAIN IDEAS

1. Briefly describe the three stages of the birth process. What are the signs that true labor has begun?
2. What are the basic stages of development after birth? During which stage(s) does the greatest amount of physical growth usually occur?

CRITICAL THINKING

3. **Compare and Contrast** What are some similarities and differences between the first year of life and the first year of puberty?
4. **Connect** Most large prey species, such as elk or antelope, are eutherian (placental), and not marsupial. What survival advantage might this give the offspring of the prey species?

Connecting CONCEPTS

5. **Reproductive Strategies** Many insects and fish give birth to hundreds of young at one time but do little to care for them. Most birds and mammals give birth to only one or a few young, but care for them until they are independent. What are some advantages and disadvantages to each type of reproduction?

Use these inquiry-based labs and online activities to deepen your understanding of reproductive systems.

INVESTIGATION

Development of an Embryo

Animals from echinoderms to humans go through three main stages of development after fertilization. In the first stage, cleavage, the embryo in an echinoderm divides to form the blastula, called a blastocyst in mammals. In the second stage, the blastula develops three distinct layers and becomes known as the gastrula. In the third stage, the embryo's internal organs begin to form. In this lab, you will examine slides of sea stars in the first two stages of embryonic development.

SKILLS Observing, Analyzing

PROBLEM How does a sea star embryo develop?

PROCEDURE

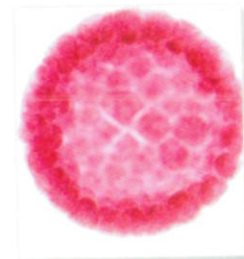
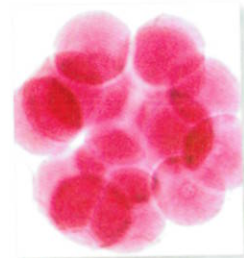
1. Obtain the slide of a sea star embryo in early cleavage and examine it under low power and high power on the microscope. Draw and label the cell and its structures.
2. Repeat step 1 with each of the remaining slides.

ANALYZE AND CONCLUDE

1. **Describe** What does a sea star embryo look like in the early stages of cleavage?
2. **Analyze** What type of cell division occurred to produce the multicellular embryo after fertilization?
3. **Compare** How does the appearance of the cells in the late stages of cleavage compare with the appearance of the cells in the blastula?
4. **Contrast** Sketch the different cell layers in the gastrula. What differences do you see among them?
5. **Compare** How are the developmental stages of a sea star embryo similar to the stages of development in a human embryo?

MATERIALS

- slide of sea star embryo in early cleavage
- slide of sea star embryo in late cleavage
- slide of sea star blastula
- slide of sea star gastrula
- microscope



Sea stars undergo several stages of development including the 16-cell stage (*top*), blastula stage (*middle*), and gastrula stage. (LM; magnification unknown)

INVESTIGATION

Effects of Chemicals on Reproductive Organs

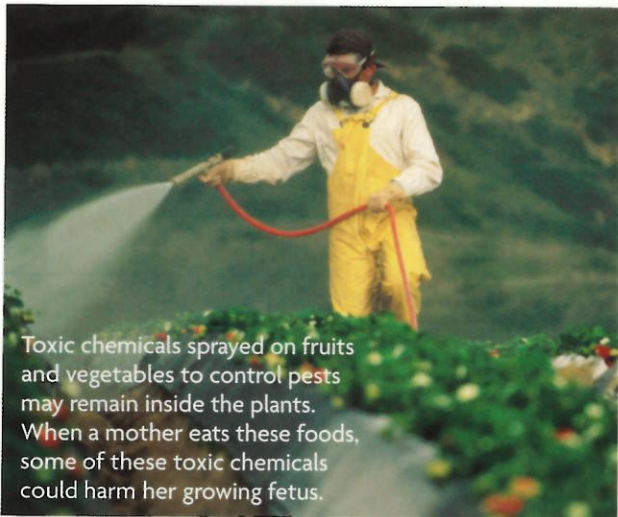
Like other organs in the human body, including the liver, kidneys, and lungs, reproductive organs can be harmed by chemicals. Exposure to certain chemicals or toxins through the use of alcohol, tobacco, or drugs or from the environment can affect the structure and functioning of both the male and female reproductive systems.

SKILL **Researching**

PROBLEM What effects do certain toxic chemicals have on the male and female reproductive systems?

PROCEDURE

1. Choose one of the substances listed below to research.
 - Anabolic steroids
 - Alcohol
 - Cocaine
 - Tobacco
 - Pesticides (herbicides and/or insecticides)
 - Environmental toxins (benzene, toluene)
2. Describe the chemical's effects on male and female reproductive organs.
3. Explain whether scientists know if the effects are permanent or reversible.
4. Identify what effects, if any, the chemical might have on future offspring.

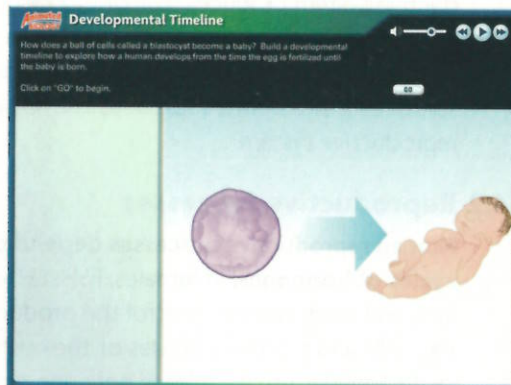


Toxic chemicals sprayed on fruits and vegetables to control pests may remain inside the plants. When a mother eats these foods, some of these toxic chemicals could harm her growing fetus.

ANIMATED BIOLOGY

Developmental Timeline

Does the heart develop in the first month or second month of pregnancy? When do fingers form? Use physical changes and other clues to place images along a developmental timeline.



WEBQUEST

Developing fetuses depend on their mothers for nutrition. In this WebQuest, you will find out why expectant mothers must get balanced, proper nutrition. Explore what a pregnant woman should eat and what she should avoid.



DATA ANALYSIS ONLINE

Graph the rise and fall of human growth hormone through adolescence for both girls and boys.

KEY CONCEPTS

Vocabulary Games

Concept Maps

Animated Biology

Online Quiz

34.1 Reproductive Anatomy

Female and male reproductive organs fully develop during puberty. Puberty in both males and females begins with the release of two hormones: FSH and LH. These two hormones stimulate the release of estrogen in females and of testosterone in males. The female reproductive system produces ova, or egg cells, and provides an environment for a fertilized egg to develop. The male reproductive system produces sperm cells and delivers sperm to the female reproductive system.

34.2 Reproductive Processes

Human reproductive processes depend on cycles of hormones. In females, FSH, LH, estrogen, and progesterone control the production of egg cells and the three phases of the menstrual cycle. Females usually release only one egg a month until menopause.

In males, FSH, LH, and testosterone control the production of sperm cells. Males release millions of sperm on ejaculation and can continue to produce sperm all their lives. When a sperm penetrates an egg and the two nuclei fuse, fertilization occurs. Reproductive organs can be damaged or destroyed by STDs.



34.3 Fetal Development

Development progresses in stages from zygote to fetus. The fetus is nourished and protected by the amniotic fluid, placenta, and umbilical cord, which connect the mother and fetus. Development takes roughly nine months, divided into three trimesters. To ensure the health of her baby, a mother needs to eat well, exercise, and have regular medical checkups.



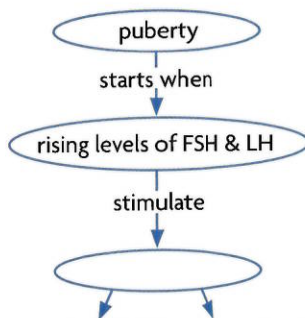
34.4 Birth and Development

Physical development continues through adolescence and declines with age. The birth process takes place in three stages: dilation of the cervix, emergence of the baby, and expulsion of the placenta. Key hormones regulate human growth and development throughout infancy, childhood, adolescence, and adulthood.

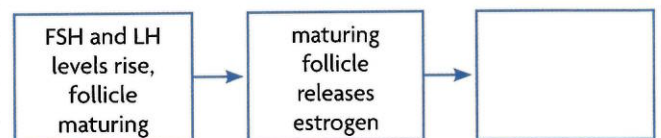


Synthesize Your Notes

Concept Map Use a concept map like the one below to take notes on topics such as puberty.



Process Diagram A process diagram like the one below is a good way to remember the steps in reproductive processes.



Chapter Assessment

Chapter Vocabulary

34.1 reproductive system, p. 1024
puberty, p. 1024
ovum, p. 1024
ovary, p. 1024
uterus, p. 1024
estrogen, p. 1024
fallopian tube, p. 1024
testis, p. 1025
testosterone, p. 1025
scrotum, p. 1026
epididymis, p. 1026
vas deferens, p. 1026
semen, p. 1026

34.2 follicle, p. 1028
ovulation, p. 1028
menstrual cycle, p. 1028
endometrium, p. 1028
corpus luteum, p. 1029
menopause, p. 1029
zygote, p. 1031
infertility, p. 1031
sexually transmitted disease, p. 1032

34.3 blastocyst, p. 1034
embryo, p. 1034
amniotic sac, p. 1035
placenta, p. 1035
umbilical cord, p. 1035
trimester, p. 1036
fetus, p. 1036

34.4 infancy, p. 1042
childhood, p. 1042
adolescence, p. 1042
adulthood, p. 1043

Reviewing Vocabulary

Term Relationships

For each pair of terms below, write a sentence that contains both terms and shows a relationship between them. For example, *fetus, umbilical cord*: *The fetus obtains nutrients through the umbilical cord.*

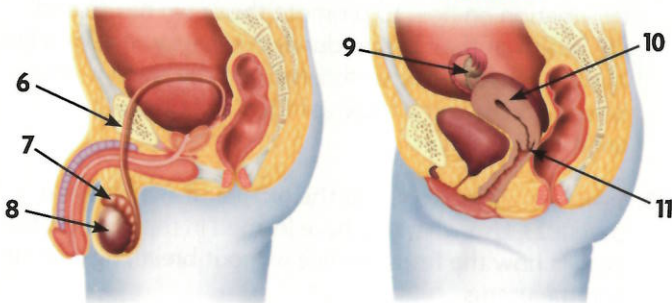
1. puberty, testosterone
2. follicle, ovulation
3. menstrual cycle, endometrium
4. embryo, amniotic sac
5. menopause, adulthood

Label Diagrams

In your notebook, write the vocabulary term that matches each item pointed out in the diagrams below.

MALE

FEMALE



Reviewing MAIN IDEAS

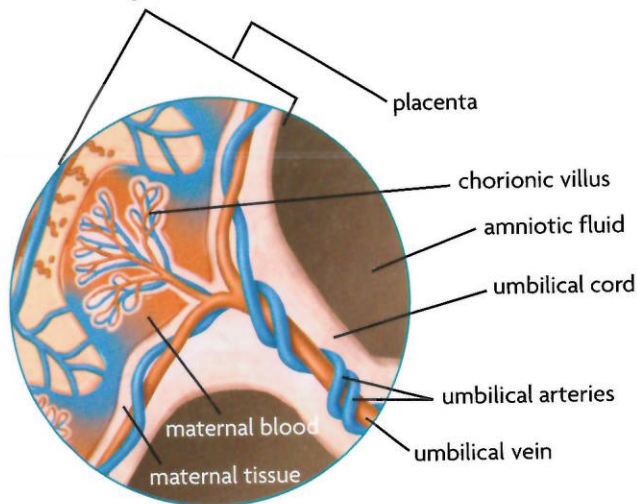
12. Describe the three main functions of estrogen.
13. The sperm move from the testes to the epididymis to the vas deferens as they develop. What happens at each location?
14. Explain what happens to the endometrium during the three phases of the menstrual cycle.
15. What process of cell division do eggs and sperm undergo to become mature sex cells?
16. What happens to their chromosomes when one sperm joins with an egg?
17. Why can chlamydia and syphilis be cured with antibiotics, but genital herpes and HIV cannot?
18. Explain how nutrients and oxygen from the mother's blood are transported to the embryo.
19. A premature baby is born near the end of the second trimester. Why would it have a harder time surviving than one born during the middle of the third trimester?
20. Discuss two ways in which a fetus's health could be harmed by a mother's actions during pregnancy.
21. Describe what marks the beginning of the birth process and what marks the end of the process.
22. In what two phases of human development might human growth hormone be the most active? Explain.

Critical Thinking

23. **Infer** A young woman discovers that she is not ovulating. What endocrine glands might a doctor suspect are not functioning well? Explain your answer.
24. **Analyze** Alcohol and drug abuse can damage the brain, including the hypothalamus. How would this condition affect sperm production?
25. **Synthesize** In a bird egg, the developing embryo is inside the *amnion*, which contains fluid. The embryo gets nourishment from the *yolk*. The *chorion* lines the inside of the shell and helps protect the embryo. What structures in a human provide the same functions as these structures in the bird egg?
26. **Connect** How do you think your ability to express complex emotions and use abstract reasoning changed between the ages of 5 and 15?

Interpreting Visuals

The structures shown below supply a fetus with oxygen and nutrients and remove its waste products. Use the diagram to answer the next three questions.

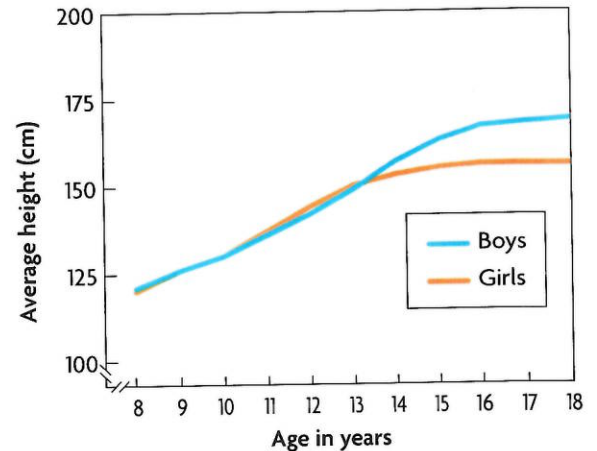


27. **Apply** Explain how the chorionic villi help move nutrients from the maternal blood to the fetus.
28. **Analyze** Look carefully at the umbilical arteries and vein. Which of these carries oxygen to the fetus? Explain.
29. **Predict** Suppose the umbilical arteries became blocked. Describe one way this condition would immediately affect the health of the fetus.

Analyzing Data

Puberty is a time of rapid physical development. The graph below shows average height increases for boys and girls in centimeters per year from ages 8 to 19. Study the data to answer the next two questions.

GROWTH RATES IN BOYS AND GIRLS



Source: Centers for Disease Control and Prevention

30. **Analyze** What does the graph show about the growth rates of boys and girls?
31. **Analyze** According to the graph, at about what age does the growth rate peak for boys? for girls?

Connecting CONCEPTS

32. **Write a Brochure** This chapter explained how a pregnant woman can affect the health of her fetus. Write the text for a brochure that gives women information on how to promote their own health and the health of their babies during pregnancy. Include a list of what to do and what to avoid and the reasons why. Be sure to cover the topics of food, checkups, and unhealthy activities.
33. **Synthesize** Look again at the picture of the fetus on page 1023. Use what you have learned in this chapter to explain how the fetus can live without breathing while it is in the uterus.