chapter

26 Reproductive Systems

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Key Terms

cervix (p. 499)
endometrium (p. 499)
epididymis (p. 492)
estrogen (p. 498)
fallopian tubes (p. 498)
gonadotropins (p. 501)
gonads (p. 490)
graafian follicle (p. 496)
menopause (p. 504)
menses (p. 501)
myometrium (p. 499)
ovarian follicles (p. 496)
ovulation (p. 496)
progesterone (p. 498)
prostate gland (p. 494)
scrotum (p. 490)
semen (p. 494)
spermatogenesis (p. 491)
testes (p. 490)
testosterone (p. 490)
uterus (p. 499)
vas deferens (p. 492)

Objectives

1. List and describe the structures and functions of the male reproductive system.
2. Describe the hormonal control of male reproduction, including the effects of testosterone.
3. List and describe the structures and functions of the female reproductive system.
4. Explain the hormonal control of the female reproductive cycle and the two reproductive cycles.
5. Describe the various methods of birth control.

Few biological drives are as strong as the urge to reproduce. As everyone knows and appreciates, human reproduction is sexual, meaning that both a female and male partner are required. In contrast, reproduction in single-cell organisms is asexual, meaning that no partner is required. They simply divide by themselves. Think of how different your life would be in an asexual environment!

To carry out its role, the reproductive system performs two functions: it produces, nurtures, and transports ova and sperm, and it secretes hormones. The reproductive organs include the primary reproductive organs and the secondary reproductive organs. The primary reproductive organs are the **gonads**. The female gonads are the ovaries; the male gonads are the testes.

The gonads perform two functions: They secrete hormones, and they produce the gametes. The gametes (GAM-eets) are the ova (eggs) and the sperm. All other organs, ducts, and glands in the reproductive system are secondary, or accessory, reproductive organs. The secondary reproductive structures nourish and transport the eggs and sperm. They also provide a safe and nourishing environment for the fertilized eggs.

MALE REPRODUCTIVE SYSTEM

The male reproductive system performs three roles: it produces, nourishes, and transports sperm; it deposits the sperm within the female reproductive tract; and it secretes hormones. Figure 26-1, *A*, shows the organs of the male reproductive tract.

TESTES

The **testes**, or testicles, are the male gonads. They perform two functions: the production of sperm and the secretion of the male hormone, **testosterone** (see Figure 26-1, *A*). The two oval testes are located outside the abdominal cavity and are suspended in a sac between the thighs called the **scrotum**.

The testes begin their development within the abdominal cavity but normally descend into the

Multiple Choice

1. Hyperkalemia
   a. refers to an elevated serum potassium level.
   b. is never serious.
   c. develops in response to kaliuresis.
   d. refers to dangerously high levels of plasma sodium.
2. Which of the following best indicates the role of albumin in water balance?
   a. Blocks the renal reabsorption of Na^+
   b. Enhances the renal excretion of K^+
   c. Maintains plasma oncotic pressure
   d. "Plugs up" capillary pores, keeping water within the plasma
3. A patient with a history of heart failure is admitted to the hospital in pulmonary edema. Over a 4-day period, his breathing improved and he experienced a loss of 8 lb. Which of the following best explains his clinical improvement?
   a. Increased hematocrit and oxygen-carrying capacity of the blood
   b. Increased secretion of aldosterone and Na^+ reabsorption
   c. Diuresis
   d. Volume expansion
4. Which of the following is not true of Na^+?
   a. Na^+ is the chief extracellular cation.
   b. Na^+ helps regulate extracellular volume.
   c. Na^+ is affected by aldosterone.
   d. Na^+ retention causes diuresis.
5. Impaired respiratory gas exchange and hypoventilation are most apt to cause
   a. volume expansion and heart failure.
   b. diuresis and dehydration.
   c. an increase in blood pH.
   d. respiratory acidosis.
6. Kussmaul respirations are the compensatory mechanism for
   a. pulmonary edema.
   b. respiratory acidosis.
   c. metabolic acidosis.
   d. anxiety-induced hyperventilation.
7. Which of the following is most apt to happen when fatty acids are broken down rapidly and incompletely?
   a. Plasma pH increases.
   b. The patient hypoventilates in an attempt to correct the pH disturbance.
   c. Ketoacids are produced causing metabolic acidosis.
   d. Plasma $[H^+]$ decreases.
8. Hypocalcemia is most apt to
   a. cause blood volume expansion (hypervolemia).
   b. be treated with IV potassium.
   c. cause tetany.
   d. be caused by excess parathyroid hormone activity.
9. An anxiety-induced hyperventilation
   a. decreases blood pH.
   b. causes alkalosis.
   c. increases $[H^+]$.
   d. decreases pO_2.
10. "Tenting" is
    a. a consequence of hypervolemia.
    b. best treated with a diuretic.
    c. due to volume depletion in the interstitial space.
    d. indicative of hyperkalemia.
11. Which of the following is least true of alkalosis?
    a. Can be caused by an anxiety-induced hyperventilation
    b. The blood pH >7.45
    c. Blood $[H^+]$ is decreased
    d. Usually caused by CO_2 retention

Go Figure

1. **According to Figure 25-1**
   a. Most fluid is located in the extracellular space.
   b. Interstitial fluid is the same as intravascular fluid.
   c. Plasma and interstitial fluid are extracellular fluids.
   d. Lymph is located intracellularly.
2. **According to Figure 25-2**
   a. Thirst is a major regulator of water intake.
   b. Most water is lost in the urine.
   c. Water can be lost by organs other than the kidneys.
   d. All of the above are true.
3. **According to Figure 25-3**
   a. As $[H^+]$ increases, pH increases.
   b. The pink end of the pH scale represents a more acidic pH.
   c. The blue end of the pH scale represents an increase in $[H^+]$.
   d. All of the above are true.
4. **According to Figure 25-4 and Table 25-2**
   a. Hypoventilation causes alkalosis.
   b. Hyperventilation causes alkalosis.
   c. Ventilation has no effect on blood pH.
   d. Hypoventilation decreases $[H^+]$ in the blood.
5. **According to Figure 25-4 and Table 25-2**
   a. Kussmaul respirations are compensatory for metabolic acidosis.
   b. Hypoventilation is compensatory for a drug-induced respiratory depression.
   c. An anxious person may hyperventilate, causing a respiratory acidosis.
   d. Persistent vomiting of stomach contents is most apt to induce a metabolic acidosis.

scrotum during the last 2 months of fetal development. Failure of the testes to descend into the scrotum is called *cryptorchidism*, a condition that can result in sterility if left untreated.

Do You Know...

Why Aristotle Called the Testicle the *Orchis?*

The root of the orchid plant is olive shaped; in Greek the shape is called an *orchis*. Noticing the similarity between the shape of the orchid root and the testicles, Aristotle dubbed the testicle *orchis*. The word *orchis* is still used in medical terms; for example, *orchitis* refers to inflammation of the testicles, and *orchiectomy* refers to the surgical removal of the testicles. The word *testis* comes from the Latin and means "to bear witness to." The word *testes* shares the same Latin root with the word *testify*. In ancient Rome, only men could bear witness, or testify, in a public forum. To show the importance of their testimony, they held their testicles as they spoke.

LOCATION, LOCATION, LOCATION

Why are undescended testicles associated with infertility? It's a temperature thing. Sperm cannot live at body temperature; instead, they prefer the cooler temperature of the scrotum. To avoid infertility, a surgeon pulls the undescended testicles into the scrotum. Wearing tight underwear and jeans can also elevate the temperature in the testes, thereby lowering sperm count. What happens when the outside environmental temperature becomes excessively cold during the winter months? The scrotum, with the assistance of the cremaster muscle, pulls the testes close to the body, thereby keeping the sperm toasty, happy, and motile.

LOBULES

The testis is divided into about 250 smaller units called *lobules* (Figure 26-2, *A*). Each lobule contains seminiferous tubules and interstitial cells. The tightly coiled seminiferous (seh-mih-NIF-er-us) tubules form sperm. The interstitial cells lie between the seminiferous tubules and produce the male hormones called *androgens*. The most important androgen is testosterone. Thus, the testes produce both sperm and testosterone.

SPERM CELLS

Every day, a man makes millions of sperm. Sperm are formed by the epithelium of the seminiferous tubules. The seminiferous tubules contain two types of cells: spermatogenic cells (cells that produce sperm) and supporting cells (cells that support, nourish, and regulate the spermatogenic cells). The supporting cells are also called *sustentacular cells* or *Sertoli cells*.

Spermatogenesis

Spermatogenesis (sper-mah-toh-JEN-eh-sis) is the formation of sperm. The undifferentiated spermatogenic cells are called *spermatogonia*. Each spermatogonium contains 46 chromosomes—the normal number of chromosomes for human body cells. Under the influence of testosterone, the spermatogonia enlarge to become primary spermatocytes. The primary spermatocytes divide by a special type of cell division called *meiosis*. The important point about meiosis is that it reduces the number of chromosomes by half, from 46 to 23. Thus, a sperm has only 23 chromosomes. When the sperm unites with an egg, which also has only 23 chromosomes (by meiosis), the fertilized egg then contains 46 chromosomes, the normal number for human body cells. Newly formed sperm are not functional and must undergo several maturational changes.

A sperm looks like a tadpole (see Figure 26-2, *B*). The mature sperm has three parts: a head, body, and tail. The head is primarily a nucleus. The nucleus is important because it contains the genetic information. The front part of the head has a specialized structure called the *acrosome*, which contains enzymes that help the sperm penetrate the egg at the time of fertilization. The body, or midpiece, of the sperm is a spiral-shaped structure that contains many mitochondria and supplies the sperm with the energy needed for the "big swim." The tail of the sperm is a flagellum. Its whiplike movements enable the sperm to swim. Most sperm live only hours after being deposited in the female reproductive tract, but the hardier ones may survive for up to 3 days.

Re-Think

1. What are the names of the male and female gonads? Gametes?
2. Differentiate between the functions of the seminiferous tubules and the interstitial cells.

2+2 Sum It Up!

The purpose of the reproductive system is to produce offspring. Human reproduction is achieved sexually through the union of an egg and a sperm. The primary reproductive organs are the gonads: the ovaries in the female and the testes in the male. The gonads produce the gametes; the ovaries produce the female gametes (eggs), and the testes produce the male gametes (sperm). The mature egg and sperm each contain 23 chromosomes. On union, the fertilized egg contains 46 chromosomes, the number of chromosomes that human cells contain.

GENITAL DUCTS

As the sperm form, they gather in the seminiferous tubules and move into a series of genital ducts, where they mature. They are then transported from the testes to outside the body. The ducts include two epididymides, two vas (ductus) deferens, two ejaculatory ducts, and one urethra.

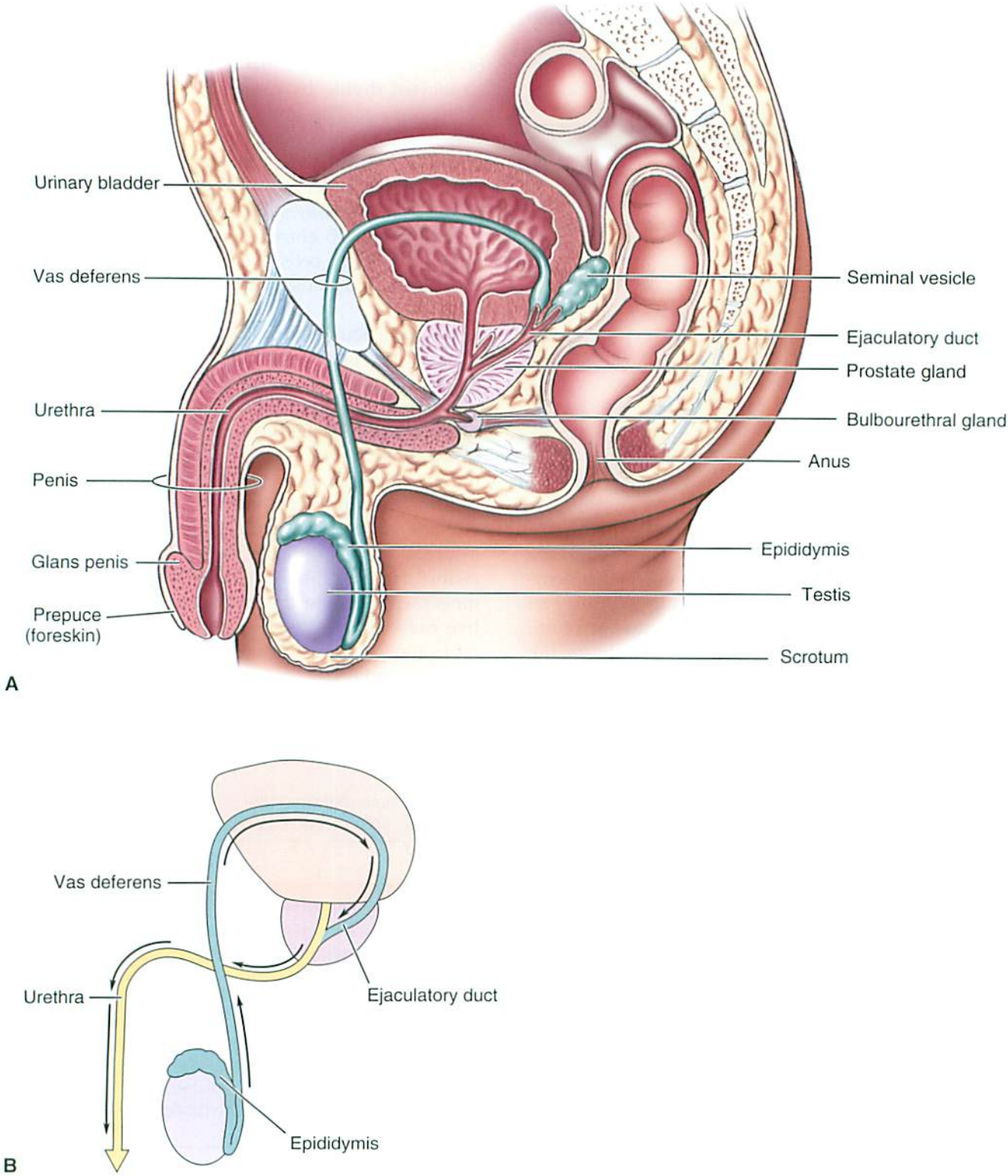


FIGURE 26-1 **A,** Male reproductive organs. **B,** The pathway for semen.

EPIDIDYMIS

The **epididymis** (ep-i-DID-i-miss) is the first part of the duct system. It is about 20 feet (6 m) in length, is tightly coiled, and sits along the top and posterior side of the testis (see Figure 26-1). While in the epididymis, the sperm mature, becoming motile and fertile. The walls of the epididymis contract and push the sperm into the next structure, the vas deferens.

VAS DEFERENS AND EJACULATORY DUCTS

The **vas deferens** (DEF-er-enz) is continuous with the epididymis. It ascends as part of the spermatic cord

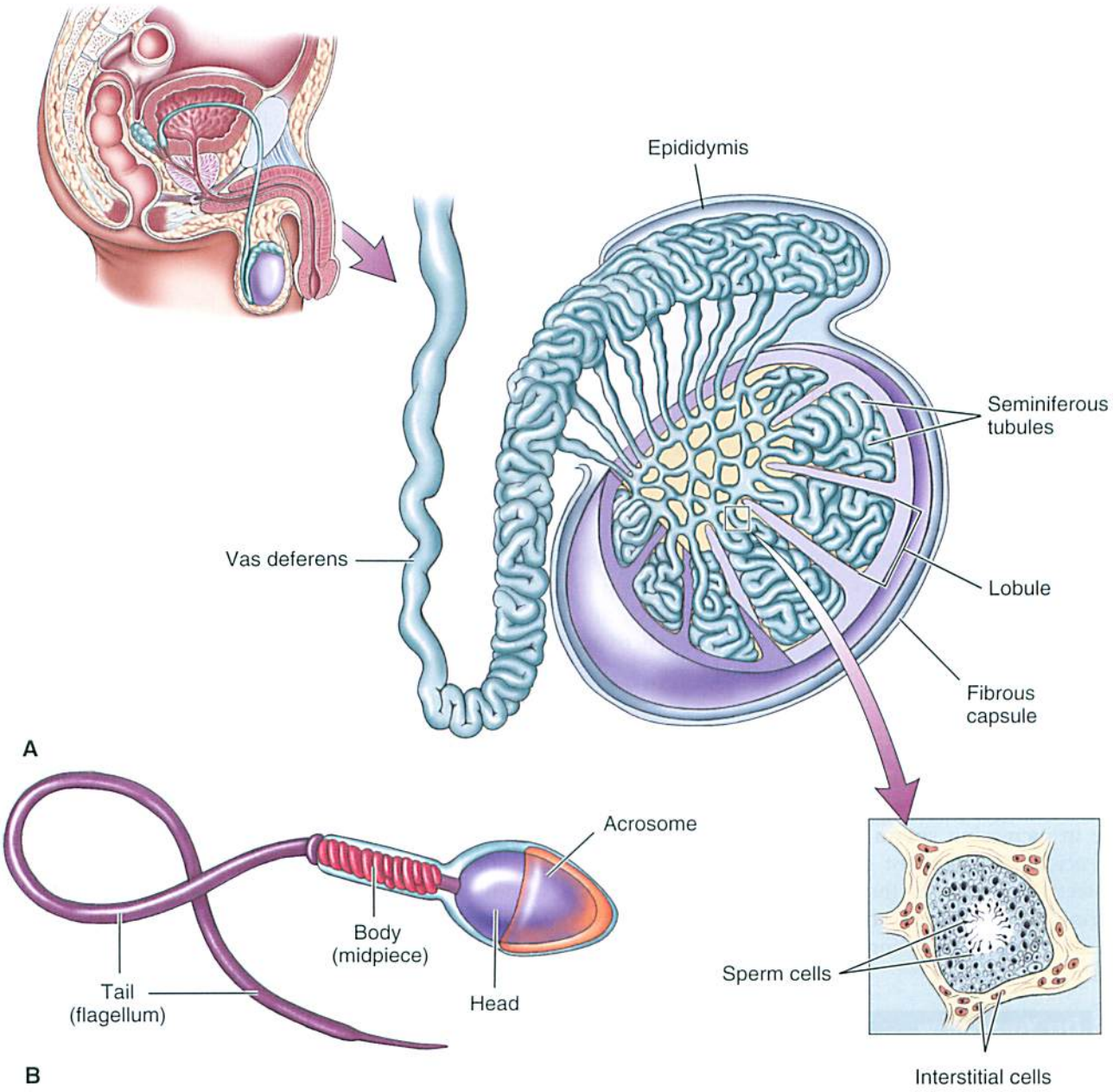
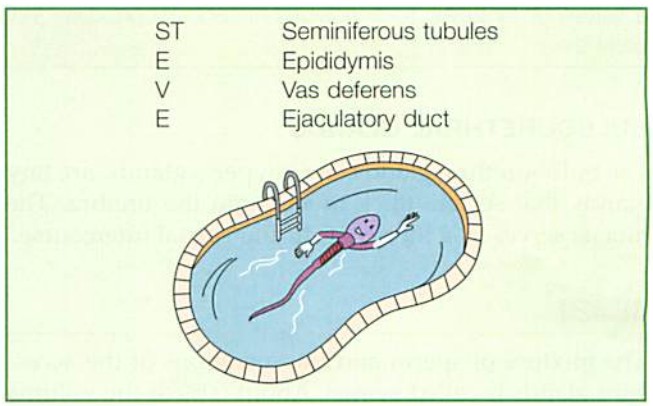


FIGURE 26-2 **A,** Male gonad. The testis consists of lobules containing seminiferous tubules surrounded by interstitial cells. **B,** Sperm.

through the inguinal canal in the groin region into the pelvic cavity. There are two spermatic cords: one coming from the right and one from the left groin region. In addition to the vas deferens, the spermatic cord includes blood vessels, lymphatic vessels, nerves, muscles, and connective tissue.

As the vas deferens courses through the pelvic cavity, it curves over the urinary bladder and joins with the duct of the seminal vesicle to form the ejaculatory duct (see Figure 26-1). The two ejaculatory ducts, from the right and left sides, pass through the prostate gland and join with the single urethra. Trouble remembering the directions? Let swimmer STEVE help!



URETHRA

The urethra extends from the base of the urinary bladder to the tip of the penis. The male urethra serves two organ systems: the reproductive and urinary systems. The urethra carries urine from the urinary bladder to the outside. It also carries semen from the ejaculatory ducts to the outside. However, the urethra can only do one thing at a time. It passes either urine or semen, but never both simultaneously.

ACCESSORY GLANDS

Various secretions are added to the sperm as they travel through the genital ducts. The secretions come from three glands: the seminal vesicles, the prostate gland, and the bulbourethral glands (see Figure 26-1, *A*).

SEMINAL VESICLES

The seminal vesicles are located at the base of the bladder and secrete a thick yellowish material rich in substances such as fructose (sugar), vitamin C, and prostaglandins. These substances nourish and activate the sperm as they pass through the ducts.

PROSTATE GLAND

The single doughnut-like **prostate gland** encircles the upper urethra just below the bladder. The prostate gland secretes a milky alkaline substance that plays a role in increasing sperm motility. It also counteracts the acidic environment of the vagina and so helps protect the sperm as they enter the woman's body. During ejaculation, the smooth muscle of the prostate gland contracts and forces the secretions into the urethra.

Do You Know...

If It Is a Prostrate or a Prostate Gland?

The doughnut-shaped gland of the male surrounds the urethra as it leaves the bladder. The word *prostate* means "one who stands before"; the prostate gland stands before the exit from the bladder. It sort of has a noble ring to it! However, sometimes the gland is mistakenly called the "prostrate" gland. A prostrate position is flat and helpless—definitely not a flattering name for such equipment. So, it's *prostate*, not prostrate.

BULBOURETHRAL GLANDS

The bulbourethral glands, or Cowper's glands, are tiny glands that secrete thick mucus into the urethra. The mucus serves as a lubricant during sexual intercourse.

SEMEN

The mixture of sperm and the secretions of the accessory glands is called **semen**. About 60% of the volume of semen comes from the seminal vesicles. The rest of it comes from the prostate gland. Semen is a milky white liquid with an alkaline pH.

The secretions of the accessory glands perform several other functions; they nourish the sperm, aid in the transport of sperm, and lubricate the reproductive tract. The amount of semen per ejaculation is small, about 2 to 6 mL, or 1 teaspoon. The number of sperm per ejaculation, however, is impressive—50 to 100 million!

EXTERNAL GENITALS

The external genitals (genitalia) of the male consist of the scrotum and the penis (see Figure 26-1). The scrotum is a sac, or pouch of skin, that hangs loosely between the legs and contains the testes.

The penis has two functions; it carries urine through the urethra to the outside of the body, and it acts as the organ of sexual intercourse (copulation). The penis deposits sperm in the female reproductive tract. The shaft, or body, of the penis contains three columns of erectile tissue and an enlarged tip called the *glans penis*. The opening of the urethra penetrates the glans penis.

The loose skin covering the penis extends downward and forms a cuff of skin around the glans called the *foreskin*, or *prepuce* (PREH-poos). Around puberty, small glands located in the foreskin and the glans secrete an oily substance. This secretion and the surrounding dead skin cells form a cheesy substance called *smegma*. As part of daily hygiene, a man should pull back the foreskin to remove the smegma. Occasionally, the foreskin is too tight and cannot be retracted (phimosis). The foreskin is often surgically removed after birth in a process called *circumcision*. Although parents often have their sons circumcised to promote cleanliness, circumcision is also a common religious ritual.

Re-Think

Trace the movement of a sperm from the seminiferous tubules to the urinary meatus.

MALE SEXUAL RESPONSE: ERECTION, EMISSION, EJACULATION, AND ORGASM

The urethra extends the length of the penis and is surrounded by three columns of spongy erectile tissue. When a man is sexually stimulated, the parasympathetic nerves fire, the penile arteries dilate, and the erectile tissue fills with blood. The accumulation of blood in the erectile tissue causes the penis to enlarge and become rigid. This process is an erection. It enables the penis to penetrate the reproductive tract of the female. For various reasons, a man may be unable to

achieve an erection and is said to have erectile dysfunction (ED). (The older term is *impotence*.)

Do You Know...

Who Was Priapus, and What Was His "Problem"?

In Greek mythology, Priapus, the son of Aphrodite, was god of the phallus (penis). As the story goes, Priapus was punished by the other gods for attempting to rape a goddess. His punishment? A huge, but useless, set of wooden genitals. Today, the term *priapism* is used to describe a potentially harmful and painful condition in which the erect penis does not return to its flaccid state within 4 hours after erection. (There is also a female version of priapism called *clitorism*.) Priapism can develop in response to many factors, including drugs, neurological conditions, blood dyscrasias, and trauma. Persons who die a swift and violent death, particularly by hanging, often have a death erection or terminal erection, considered a form of priapism. Postmortem priapism is of forensic interest in helping determine the manner of death.

Orgasm refers to the pleasurable sensations that occur at the height of sexual stimulation. Orgasm in the male is accompanied by emission and ejaculation. Emission is the movement of sperm and glandular secretions from the testes and genital ducts into the proximal urethra, where they mix to form semen. Emission is caused by the influence of the sympathetic nervous system on the ducts, causing rhythmic, peristalsis-type contractions.

An Autonomic Summary—Up and Out!

Up: Erection	Parasympathetic
Out: Emission	Sympathetic

Ejaculation is the expulsion of semen from the urethra to the outside. Ejaculation begins when the urethra fills with semen. Motor nerve impulses from the spinal cord stimulate the skeletal muscles at the base of the erectile columns in the penis to contract rhythmically. The rhythmic contraction provides the force necessary to expel the semen. (The flow of semen during ejaculation is illustrated in Figure 26-1, *B*.) Immediately after ejaculation, sympathetic nerve impulses cause the penile arteries to constrict, thereby reducing blood flow into the penis. This process is accompanied by increased venous drainage of blood from the penis. As a consequence, the penis becomes flaccid and returns to its unstimulated tiny size.

Up and Down!

Up: Erect	Parasympathetic
Down: Flaccid	Sympathetic

MALE SEX HORMONES

EFFECTS OF TESTOSTERONE

The male sex hormones are called *androgens*, the most important being testosterone. Most of the testosterone is secreted by the interstitial cells of the testes. A small amount is secreted by the adrenal cortex.

Secretion of testosterone begins during fetal development and continues at a very low level throughout childhood. When a boy reaches the age of 10 to 13, testosterone secretion increases rapidly, transforming the boy into a man. This phase in reproductive development is called *puberty*. After puberty, testosterone is secreted continuously throughout the life of the male.

Testosterone is necessary for the production of sperm and is responsible for the development of the male sex characteristics. The primary sex characteristics include the enlargement and development of the testes and the various accessory organs such as the penis. Secondary sex characteristics refer to special features of the male body and include the following:

- Increased growth of hair, particularly on the face, chest, axillary region, and pubic region
- Deepening of the voice, caused by enlargement of the vocal cords
- Thickening of the skin and increased activity of the oil and sweat glands; at puberty, the adolescent is faced with new challenges, such as acne and body odor
- Increased musculoskeletal growth and development of the male physique (broad shoulders and narrow waist)

HORMONAL CONTROL OF MALE REPRODUCTION

The male reproductive system is controlled primarily by the hormones secreted by the hypothalamus, anterior pituitary gland, and testes. The hypothalamus secretes a releasing hormone, which then stimulates the anterior pituitary gland to secrete two gonadotropins: follicle-stimulating hormone (FSH) and luteinizing hormone (LH) (Figure 26-3). FSH promotes spermatogenesis by stimulating the spermatogenic cells to respond to testosterone. Note that spermatogenesis comes about through the combined action of FSH and testosterone. LH, also known as *interstitial cell–stimulating hormone* (ICSH) in the male, promotes the development of the interstitial cells of the testes and the secretion of testosterone.

After puberty, a negative feedback loop regulates testosterone production. When the level of testosterone in the blood increases, it causes the hypothalamus and the anterior pituitary gland to decrease their hormonal secretions, thereby decreasing the production of testosterone. As blood levels of testosterone decrease, the anterior pituitary gland increases its secretion of LH (ICSH), thereby stimulating the interstitial cells to secrete testosterone once again. The negative feedback

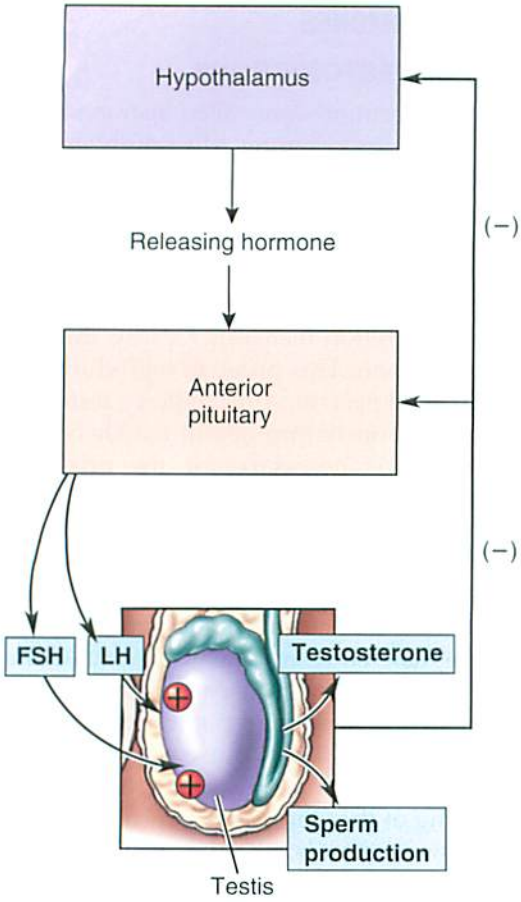


FIGURE 26-3 Hormonal control of sperm production and testosterone secretion.

mechanism maintains constant blood levels of testosterone.

2+2 Sum It Up!

Four hormones—releasing hormone, FSH, LH, and testosterone—control the male reproductive system. The releasing hormone (hypothalamus) stimulates the anterior pituitary gland to secrete FSH and LH (ICSH). FSH and testosterone stimulate spermatogenesis. LH stimulates the secretion of testosterone. Finally, testosterone stimulates the development of the male secondary sex characteristics. A male looks male because of testosterone.

? Re-Think

1. Differentiate between the following: erection, emission, and ejaculation.
2. Regarding male contraception, why is it medically more acceptable to ligate the vas deferens than to remove the testes?

FEMALE REPRODUCTIVE SYSTEM

The female reproductive system produces eggs, secretes hormones, and nurtures and protects a developing baby during the 9 months of pregnancy. Figure 26-4, *A*, shows the organs of the female reproductive system.

OVARIES

The female gonads are two almond-shaped ovaries, located on either side of the uterus in the pelvic cavity. The ovaries are anchored in place by several ligaments, including the ovarian and the broad ligaments. The ovaries, although not attached directly to the fallopian tubes, are close to them.

EGG DEVELOPMENT: THE OVARIAN FOLLICLE

Within the ovary are many tiny, saclike structures called **ovarian follicles**. A female is born with 2 million follicles—enough to start a small family. This number steadily declines with age, however, so that at puberty only about 400,000 follicles remain. Of these, only about 400 follicles ever fully mature, because a female usually produces only one egg per month throughout her reproductive years. The production of eggs begins at puberty and continues until menopause, at about 45 to 55 years of age. As with sperm, the supply of eggs far exceeds the actual need. This is Mother Nature's way of ensuring future generations.

Each ovarian follicle consists of an immature egg, called an *oocyte*, and the surrounding cells called *follicular cells* (see Figure 26-4, *B*). Beginning at puberty, several follicles mature every month, although usually only one fully matures. As the egg matures, it begins to undergo meiotic cell division, which reduces the number of chromosomes by half, from 46 to 23.

At the same time, the follicle enlarges, a fluid-filled center is formed, and the follicular cells begin to secrete estrogen. The mature ovarian follicle is known as the **graafian** (GRAH-fee-en) **follicle**. The graafian follicle looks like a blister on the surface of the ovary.

OVULATION

Once a month the ovarian follicle bursts—an "eggsplosion"! The ovary ejects a mature egg (ovum) with a surrounding layer of cells. This ejection phase is called **ovulation**. The egg travels from the surface of the ovary into the peritoneal cavity, where it is immediately swept into the fallopian tubes by the swishing motion of the fimbriae (finger-like projections at the end of the fallopian tubes). The egg travels through the fallopian tubes to the uterus. If the egg is fertilized, it implants itself in the uterine lining and grows into a baby. If the egg is not fertilized, the egg dies and is eliminated in the menstrual blood. Some women feel twinges of pain at the time of ovulation; the pain is called *mittelschmerz* (MIT-el-schmertz) (from the German, meaning "middle pain").

Once ovulation has occurred, the follicular cells that remain in the ovary develop into a glandular structure called the *corpus luteum* ("yellow body"). The corpus luteum secretes two hormones: large amounts of progesterone (proh-JES-ter-ohn) and smaller amounts of estrogen. If fertilization does not occur, the corpus luteum deteriorates in about 10 days and becomes

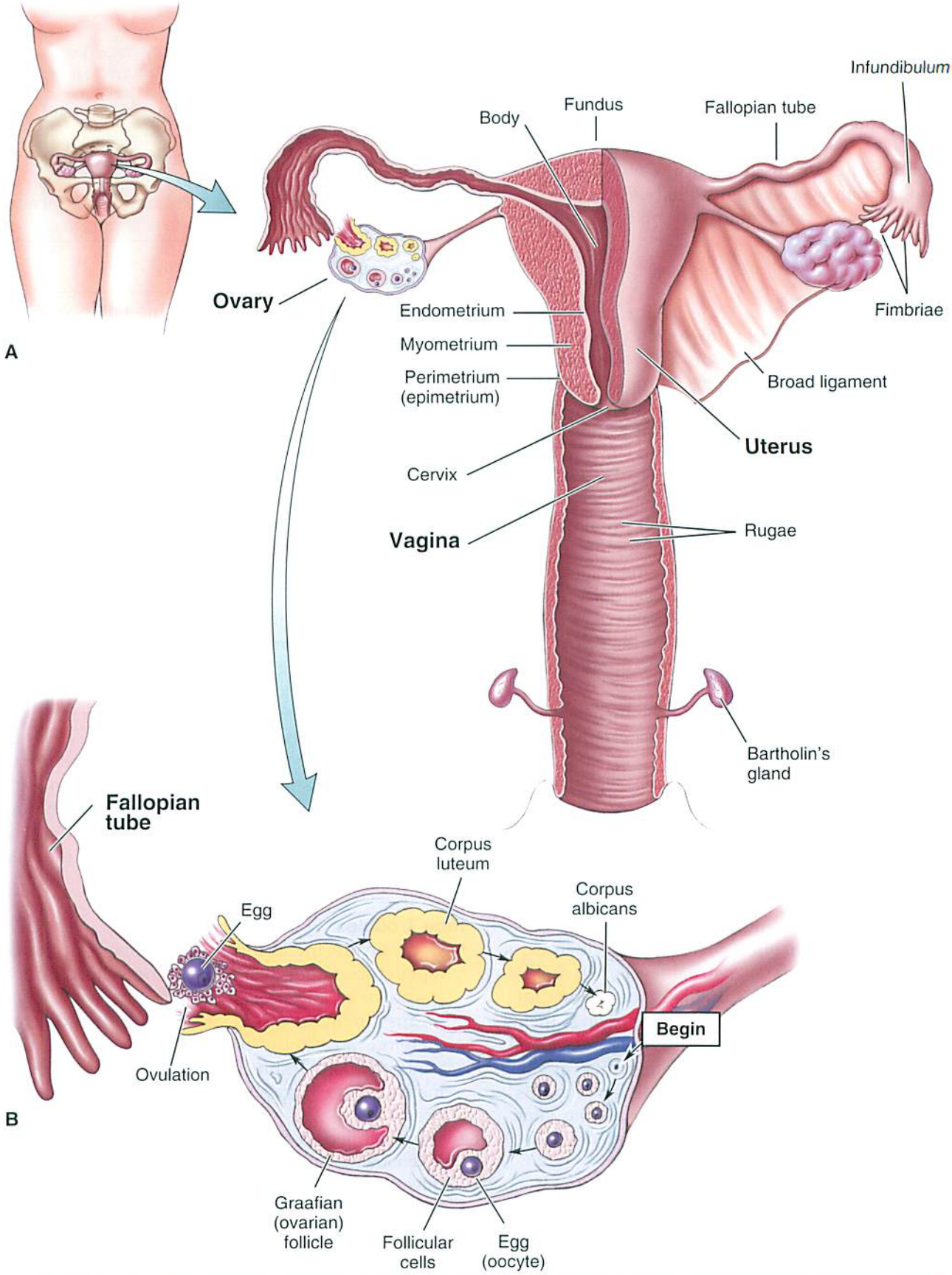


FIGURE 26-4 **A,** Female reproductive organs. **B,** Maturation of the ovarian follicle, ovulation, and formation of the corpus luteum.

known as the *corpus albicans* ("white body"). The dead corpus albicans is not capable of secreting hormones. If fertilization occurs, however, the corpus luteum does not deteriorate. It stays alive and continues to secrete its hormones until this role can be taken over by the placenta—a structure you will read about in Chapter 27.

Sometimes, the corpus luteum fills with fluid and forms an ovarian cyst. A blood-filled cyst is called a *chocolate cyst*. These cysts can resolve on their own but may require surgery.

OVARIAN HORMONES

At puberty, the ovaries begin to secrete the sex hormones estrogen and progesterone. The follicular cells of the maturing follicles secrete estrogen, and the corpus luteum secretes large amounts of progesterone and smaller amounts of estrogen. These hormones transform a girl into a woman.

Estrogen

Estrogen exerts two important effects: it promotes the maturation of the egg, and it helps develop the female secondary sex characteristics. Just as the male looks male because of testosterone, the female looks female because of estrogen. The feminizing effects of estrogen include the following:

- Enlargement and development of the organs of the female reproductive system
- Enlargement and development of the breasts
- Deposition of fat beneath the skin, especially in the thighs, buttocks, and breasts
- Widening of the pelvis
- Onset of the menstrual cycle
- Closure of the epiphyseal discs in long bones, thereby stopping further growth in height

Progesterone

The corpus luteum secretes **progesterone**. Progesterone has three important effects: it (1) works with estrogen in establishing the menstrual cycle, (2) helps maintain pregnancy, and (3) prepares the breasts for milk production after pregnancy, increasing their secretory capacity. Although the corpus luteum secretes enough progesterone to maintain pregnancy in the early months, the woman's body needs larger amounts of both estrogen and progesterone during the later stages of pregnancy. This role is performed by the placenta.

? Re-Think

1. Name the steps in the progression from the oocyte to the corpus albicans.
2. Explain the function of the corpus luteum.
3. List two ovarian hormones.

2+2 Sum It Up!

The female gonad is the ovary. Once a month, an ovarian follicle matures, forming a graafian follicle. The follicle contains an egg and estrogen-secreting follicular cells. Under the influence of LH, the egg is expelled from the mature follicle; this event is ovulation. Following ovulation, the corpus luteum begins to secrete large amounts of progesterone. Estrogen helps the egg mature and is primarily responsible for the secondary sex characteristics of the female. Progesterone plays an important role in preparing the reproductive system for pregnancy.

GENITAL TRACT

The female genital tract includes the fallopian tubes, uterus, and vagina (see Figure 26-4, *A*).

FALLOPIAN TUBES

The **fallopian** (fal-LOH-pee-an) **tubes** are also called the *uterine tubes* or the *oviducts*. Each of the two fallopian tubes is about 4 inches (10 cm) long and extends from either side of the uterus to the ovaries. The funnel-shaped end of the fallopian tube nearest the ovary is called the *infundibulum* and has fingerlike projections called *fimbriae* (FIM-bree-ay). The fallopian tube does not attach directly to the ovary; the fimbriae hang over the ovary.

At ovulation, the fimbriae sweep the egg from the surface of the ovary into the fallopian tube. Once in the fallopian tube, the egg moves slowly toward the uterus. Because the egg cannot swim like sperm, the peristaltic activity of the fallopian tubes moves it forward.

The fallopian tubes have two functions. First, the tube transports the egg from the ovary to the uterus. Second, the tube is the usual site of fertilization of the egg by the sperm. The fertilized egg moves through the fallopian tube into the uterus, where it implants and grows into a baby. The journey through the fallopian tubes takes about 4 to 5 days.

Tube Troubles

- Occasionally, the fertilized egg implants in the fallopian tube rather than in the uterus. This condition is known as an *ectopic pregnancy*. The word *ectopic* means "in an abnormal site"; a tubal pregnancy is therefore an ectopic pregnancy. An ectopic pregnancy usually results in a miscarriage. It causes maternal bleeding, possible hemorrhage, and even death.
- What happens if the tubes scar and close? Scarring and closing, as occurs with repeated gonorrheal infections, blocks the movement of the egg through the tubes. This can cause sterility.
- Pelvic inflammatory disease (PID). The fallopian tubes open directly into the pelvic cavity. An infection of the female reproductive tract can spread through the tubes into the pelvic cavity, causing PID. PID is most frequently associated with sexually transmitted diseases.

UTERUS

The **uterus**, or *womb*, is shaped like an upside-down pear and is located between the urinary bladder and the rectum. The broad ligament holds the uterus in place. The primary function of the uterus is to provide a safe and nurturing environment for the growing baby. It is the baby's cradle for 9 comfortable months. During pregnancy, the size of the uterus increases considerably to hold the growing baby and the placenta.

The uterus has three parts. The fundus is the upper dome-shaped region above the entrance of the fallopian tubes. The body is the central region. The **cervix** is the lower narrow region that opens into the vagina.

The uterus has three layers: an outer serosal layer called the *epimetrium*, or *perimetrium*; a middle, smooth muscular layer called the **myometrium**; and an inner layer called the **endometrium**. The endometrial uterine lining has two layers: the basilar layer and the functional layer. The basilar layer is thin and vascular and lies next to the myometrium. The functional layer responds to the ovarian hormones and thickens in preparation for the fertilized egg. It is also the layer that sloughs off during menstruation, when fertilization has not occurred.

The cervix is often associated with the Pap smear. The Pap smear is a diagnostic procedure used for detecting cancer of the cervix. The technique involves scraping cells from around the cervix and examining them for evidence of cancer. This simple and painless procedure has been used successfully to diagnose cancer in its early stages, when cure rates are high. The technique is named for its developer, Dr. George Papanicolaou.

Do You Know...

What Plato, Hysteria, and the Concept of the Wandering Womb Have in Common?

Plato believed that the womb (uterus), if unused for a long period, became "indignant." This indignant womb then wandered around the body, inhibiting the body's spirit and causing disease. According to the male thinkers of the day, a woman was so thoroughly controlled by her wandering womb that she was considered irrational and prone to emotional outbursts and fits of hysteria. This belief was the reason that the womb was named the *hystera*. The term has persisted in medical terminology; a hysterectomy refers to the surgical removal of the uterus.

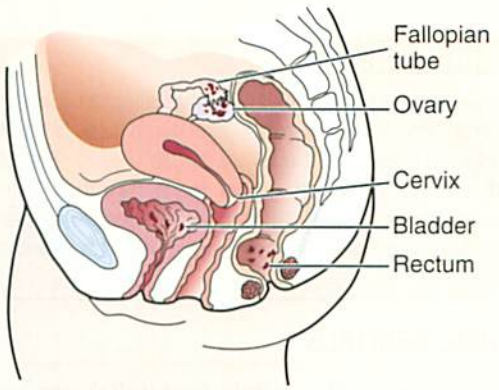
VAGINA

The vagina is a 4-inch muscular tube that extends from the cervix to the vaginal opening in the perineum. The vaginal opening is usually covered by a thin membrane called the *hymen*. The definition of hymen comes from the image of the vagina as a sanctuary of the virgin love goddess, Aphrodite. The hymen may be torn in a number of ways, such as during first intercourse, use of tampons, or strenuous exercise. Much has been written about the hymen and whether or not it is intact. The upper portion of the vagina receives the cervix of the uterus. The cervix dips into the vagina so that pockets, or spaces, form around the cervix. The pockets are called *fornices*. The deepest is the posterior fornix, located behind the cervix.

Do You Know...

What the Spots Are on the Outer Surfaces of These Organs?

These spots represent endometrial tissue adhering to the outer surface of the ovary, fallopian tube, rectum, and urinary bladder. How did the endometrial tissue get there? In some women, a portion of the menstrual discharge flows backward, into the fallopian tubes, and then into the pelvic cavity. The endometrial tissue adheres to the outer surface of the organs in the pelvic cavity. This condition is called *endometriosis*. The endometrial tissue acts as though it were still in the uterus. It responds to the ovarian hormones by thickening, becoming secretory, and then sloughing off. A woman feels the discomfort of menstruation throughout the pelvic cavity. In addition to causing severe pain, endometriosis causes scarring and the formation of adhesions.



Do You Know...

About Xtreme Sex "Down-Under"?

A little Aussie mouse, *Antechinus*, engages in sex for up to 12 hours, ignoring eating, drinking, and sleeping. He's definitely in a loop! Alas, the happy little fellow dies of exhaustion. What about Ms. Mouse? Going at a more leisurely pace, she calmly stores the sperm throughout the breeding season and in due time gives birth to an adorable litter. What's in this sex frenzy for Mother Nature? Preservation of the species, and more food for mama mouse and babies.

The mucosal lining of the vagina lies in folds (rugae) that are capable of expanding. The folding is important for childbearing because it permits the vagina to stretch and accommodate the baby during birth. In addition to forming a part of the birth canal, the vagina is also the organ that receives the penis during intercourse and serves as an exit for menstrual blood. The bacterial population (normal flora) in the vagina creates an acidic environment that discourages the growth of pathogens.

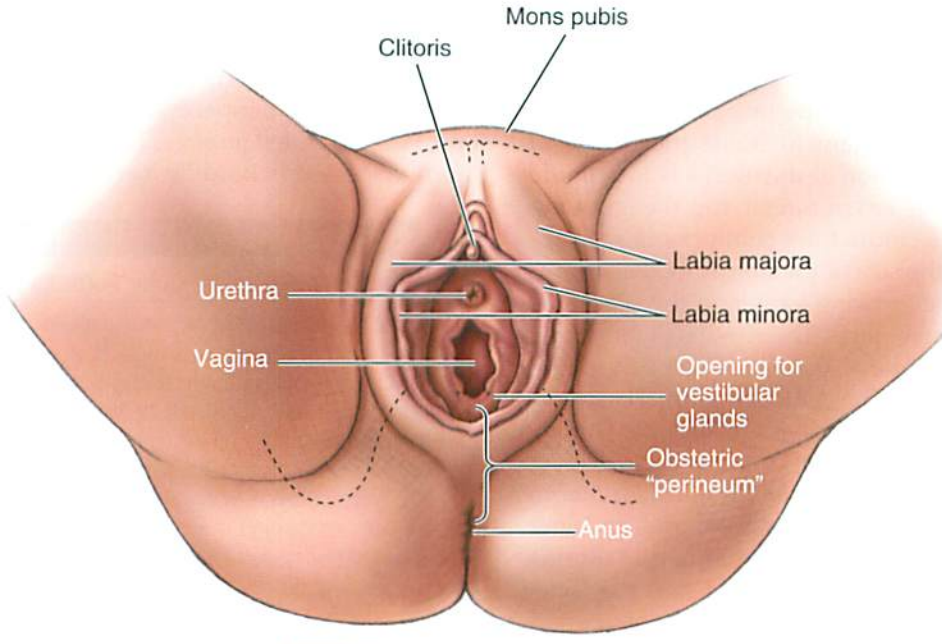


FIGURE 26-5 External genitals of the female.

2+2 Sum It Up!

The female genital tract consists of the fallopian tubes, uterus, and vagina. The fallopian tube, the usual site of fertilization, transports the egg from the ovary to the uterus. The uterus is where the fetus lives and grows for 9 months. The vagina receives the penis during intercourse and serves as part of the birth canal. A baby makes its entrance into the world through the vagina.

EXTERNAL GENITALS

The female external genitals (genitalia) are together called the *vulva* (Figure 26-5). The vulva includes the labia majora and labia minora, clitoris, and vestibular glands. (The external genitalia of the female are also called the *pudendum*, from a word meaning "shameful." Go figure!)

The two labia majora are folds of hair-covered skin that lie external to the two smaller labia minora. The labia (the word means "lips") are separated by a cleft containing the urethral and vaginal openings. The labia prevent drying of the mucous membranes. The labia majora merge anteriorly (in front) to form the rounded hair-covered region over the symphysis called the *mons pubis*.

The clitoris is the structure that resembles the penis. Although small, the clitoris contains erectile tissue and is capped by a thin membrane called the *glans*. The labia minora extend forward and partially surround the clitoris to form a foreskin. Like the penis, the clitoris contains sensory receptors that allow the female to experience pleasurable sexual sensations.

The vestibule is a cleft between the labia minora. It contains the openings of the urethra and the vagina. A pair of vestibular glands (Bartholin's glands) lies on either side of the vaginal opening and secrete a mucus-containing substance that moistens and lubricates the vestibule. Note that the female urinary system and the reproductive system are entirely separate, unlike in the male. The female urethra carries only urine, whereas the male urethra carries urine and semen.

The perineum refers to the entire pelvic floor. The common use of the word, however, is more limited. Most clinicians use the word *perineum* to mean the area between the vaginal opening and anus (called the "obstetric perineum").

FEMALE SEXUAL RESPONSE

The female responds to sexual stimulation with erection and orgasm. Erectile tissue in the clitoris and the tissue surrounding the vaginal opening swell with blood in response to parasympathetically induced dilation of the arteries. Erectile tissue in the vaginal mucosa, breasts, and nipples also swell. Other responses include an engorgement of the vagina and secretion by the vestibular glands. At the height of sexual stimulation, a woman experiences orgasm.

The orgasm also stimulates a number of reflexes. These reflexes cause muscle contractions in the perineum, uterine walls, and uterine tubes; the muscular activity is thought to aid in directing and transporting the sperm through the genital tract.

? Re-Think

1. What is the function of the fallopian tubes?
2. List the layers of the uterus.
3. Trace the movement of the egg from ovulation to implantation.

II. Female Reproductive System

A. Ovaries
1. The ovaries are the female gonads.
2. Each ovarian follicle consists of an oocyte and follicular cells.
3. On day 14 (of a 28-day cycle), ovulation occurs.
4. The ovarian follicular cells become the corpus luteum.
5. The ovaries secrete two hormones: estrogen and progesterone.

B. Genital tract
1. The genital tract includes the fallopian tubes, uterus, and vagina.
2. The fallopian tubes transport the egg from the ovaries to the uterus, and are where fertilization takes place.
3. The uterus is the baby's cradle during pregnancy.
4. The uterus has three layers: epimetrium, myometrium, and endometrium.

C. External genitals are called the *vulva* (labia majora, labia minora, clitoris, and the vestibular glands).

D. Female sexual response: erection and orgasm

E. Hormonal control of the female reproductive cycles
1. The two cycles are the ovarian cycle and the uterine cycle.
2. The ovarian cycle is divided into the follicular phase and the luteal phase.
3. During the follicular phase, the ovarian follicle matures and secretes estrogen.
4. The luteal phase of the ovarian cycle begins immediately after ovulation and is dominated by the secretion of progesterone by the corpus luteum.
5. In the nonpregnant state, the corpus luteum deteriorates. In the pregnant state, the corpus luteum stays alive because of human chorionic gonadotropin (hCG).
6. The uterine cycle is divided into the menstrual phase, proliferative phase, and secretory phase.
   a. The menstrual phase refers to the loss of a part of the endometrial lining and blood ("having your period").
   b. During the proliferative phase, the inner endometrial lining thickens and becomes vascular, primarily in response to estrogen.
   c. During the secretory phase, the endometrial lining becomes lush and moist from increased secretory activity; the secretory phase is dominated by progesterone.
7. See Figure 26-6 for a summary of the daily hormonal relationships among the anterior pituitary gland, ovaries, and uterus.

III. Methods of Birth Control

A. The regulation of childbearing can be achieved with the use of barrier methods, hormonal contraceptives, surgical methods, intrauterine devices, behavioral methods, and drugs used for emergency contraception.

Review Your Knowledge

Matching: Female Structures

Directions: Match the following words with their description below. Some words may be used more than once.

a. fallopian tubes
b. uterus
c. ovaries
d. vagina

1. ___ Fertilization occurs here.
2. ___ Female gonads
3. ___ Contains the fundus, body, and cervix
4. ___ Contains the endometrium, myometrium, and epimetrium
5. ___ Home of the corpus luteum
6. ___ Where implantation occurs
7. ___ Home of the graafian follicle
8. ___ Menstrual phase, proliferative phase, and secretory phase
9. ___ Follicular phase and luteal phase
10. ___ Birth canal; distal to the cervix

Matching: Male Structures

Directions: Match the following words with their description below. Some words may be used more than once.

a. interstitial cells
b. seminiferous tubules
c. urethra
d. epididymis
e. scrotum

1. ___ Structure that forms sperm
2. ___ Testosterone-secreting cells
3. ___ Tightly coiled ducts that sit on top of the testes
4. ___ Structure that is shared by both the reproductive and urinary tracts
5. ___ Pouch that contains the testes

Matching: Hormones

Directions: Match the following words with their descriptions below. Some words may be used more than once.

a. estrogen
b. progesterone
c. hCG
d. gonadotropins
e. testosterone

1. ___ Primary androgen secreted by the testes
2. ___ What FSH and LH are called
3. ___ The proliferative phase (uterus) is dominated by this ovarian hormone.
4. ___ The secretory phase (uterus) is dominated by this ovarian hormone.
5. ___ Secreted by trophoblastic cells; preserves the secretion of the corpus luteum
6. ___ The ovaries are the targets of this anterior pituitary secretion.
7. ___ Its secretion is a response to interstitial cell–stimulating hormone (ICSH).
8. ___ This hormone makes a female look like a woman.
9. ___ This hormone makes a male look like a man.
10. ___ The corpus luteum secretes large amounts of this hormone; it makes the endometrium juicy, or lush

Multiple Choice

1. In the male, the gonadotropins
   a. are aimed at the testes.
   b. include FSH and LH (ICSH).
   c. stimulate sperm development and the secretion of androgen.
   d. All of the above are true.
2. In the male, luteinizing hormone
   a. is also called ICSH and stimulates the interstitial cells to secrete testosterone.
   b. stimulates sperm production.
   c. causes emission.
   d. causes orgasm.
3. Estrogen and progesterone
   a. are gonadotropins.
   b. are secreted by the trophoblastic cells as they implant in the uterine wall.
   c. are secreted by the ovaries.
   d. exert their effects only on reproductive structures.
4. In the nonpregnant state
   a. the corpus albicans becomes hormonally active, secreting estrogen and progesterone.
   b. the endometrium secretes hCG.
   c. hormonal secretion of the corpus luteum gradually declines.
   d. the zygote becomes hormonally active.
5. Human chorionic gonadotropin (hCG)
   a. promotes the maturation of the egg.
   b. is responsible for female characteristics.
   c. maintains the corpus luteum.
   d. transforms the corpus luteum into the corpus albicans.
6. The luteal phase of the ovarian cycle
   a. is responsible for menstruation.
   b. is responsible for the uterine secretory phase.
   c. elevates plasma levels of estrogen, progesterone, and hCG.
   d. precedes the LH surge.
7. Menstruation occurs in response to
   a. an LH surge.
   b. diminished plasma levels of estrogen and progesterone.
   c. elevated plasma levels of hCG.
   d. elevated plasma levels of FSH and LH.
8. Which of the following is not true of testosterone?
   a. Classified as androgen
   b. Secreted by the anterior pituitary gland
   c. Is necessary for the maturation of sperm
   d. Is responsible for most of the male secondary sex characteristics
9. Which structure ejects both semen and urine?
   a. Epididymis
   b. Oviducts
   c. Urethra
   d. Vas deferens
10. The graafian follicle
    a. matures under the influence of hCG.
    b. is an ovarian structure.
    c. implants in the endometrial lining.
    d. secretes FSH and LH in an attempt to ripen an oocyte.

Go Figure

1. **According to Figure 26-1**
   a. The epididymis is located within the pelvic cavity.
   b. The testes are located within the pelvic cavity.
   c. The vas deferens is shared by both the urinary and reproductive tracts.
   d. The urethra extends the length of the penis.
2. **According to Figures 26-1 and 26-2**
   a. The seminiferous tubules are located within the testes.
   b. Testosterone is secreted by the prostate and seminal vesicles.
   c. Sperm are kept warm by migrating to the prostate gland until released.
   d. The acrosome is another name for the foreskin.
3. **According to Figure 26-4**
   a. Ovulation involves the expulsion of the ovum from the corpus albicans.
   b. The corpus luteum forms before the graafian follicle.
   c. The graafian follicle and corpus luteum develop within the uterus.
   d. The corpus luteum forms after ovulation.
4. **According to Figure 26-4**
   a. The reproductive tract opens into the pelvic cavity.
   b. The myometrium is the muscle layer of the ovary.
   c. The fallopian tubes attach to the cervix of the uterus.
   d. The endometrium refers to the hormonally sensitive ovarian tissue.
5. **According to Figure 26-6**
   a. The ovarian cycle includes the proliferative and secretory phases.
   b. The LH surge precedes the development of the graafian follicle.
   c. LH and FSH are gonadotropins secreted by the adenohypophysis and aimed at the endometrium.
   d. FSH stimulates the development of the graafian follicle in the ovary.
6. **According to Figure 26-6**
   a. Elevated blood levels of estrogen and progesterone prevent the secretion of gonadotropins through negative feedback control.
   b. The uterine lining is built up in direct response to FSH and LH.
   c. A surge of ovarian progesterone is responsible for ovulation.
   d. The source of estrogen and progesterone is the anterior pituitary gland.

causing the blood levels of estrogen to increase (see Figure 26-6, *C*).

Estrogen dominates the follicular phase. Estrogen affects both the ovary and uterus. Estrogen stimulates the maturation of the ovarian follicle and helps build up the uterine lining in the first half of the uterine cycle, days 1 to 14 (see Figure 26-6, *D*).

The follicular phase ends when a sharp rise (midcycle surge) of LH on day 14 causes ovulation. See Figure 26-6, *A*, for the midcycle surge of LH and Figure 26-6, *B*, for ovulation.

Luteal Phase

The luteal phase immediately follows ovulation. Follicular cells of the ruptured follicle on the surface of the ovary form the corpus luteum. LH then stimulates the corpus luteum to secrete progesterone and small amounts of estrogen. The progesterone and estrogen exert a negative feedback effect on the anterior pituitary gland, thereby inhibiting further secretion of FSH and LH. Progesterone also supports the endometrial lining of the uterus during the second half of the cycle (days 14 to 28). Progesterone dominates the luteal phase.

When the corpus luteum dies, secretion of progesterone and estrogen declines. As a result of the decrease in estrogen and progesterone, FSH and small amounts of LH are once again secreted, and the cycle is repeated.

UTERINE CYCLE

The uterine cycle, also called the *menstrual cycle*, consists of the changes that occur in the endometrium over a 28-day period (see Figure 26-6, *D*). Estrogen and progesterone secreted by the ovaries cause the endometrial changes; thus, the ovarian cycle controls the uterine cycle. The uterine cycle has three phases: the menstrual phase, the proliferative phase, and the secretory phase.

Menstrual Phase

Bleeding characterizes the menstrual phase. It begins on the first day and continues for 3 to 5 days, varying from person to person. During the menstrual phase, the functional layer of the endometrial lining and blood leave the uterus through the vagina as menstrual flow. This process is also called "having your period."

Proliferative Phase

The proliferative phase begins with the end of the menstrual phase. Repair and growth of the inner endometrial lining characterize the proliferative phase. The lining grows primarily because of estrogen secreted by the ovaries (see Figure 26-6, *B* and *C*). The proliferative phase is so named because the cells proliferate and thus repair the endometrial lining. Note in Figure 26-6, *D*, that the endometrial lining becomes thicker and acquires additional blood vessels during the proliferative phase.

Secretory Phase

The secretory phase is caused by the secretion of progesterone by the corpus luteum of the ovary (see Figure 26-6, *C* and *D*). Progesterone causes the endometrial lining to thicken, thereby forming a nutritious environment awaiting the arrival of a fertilized ovum.

2+2 Sum It Up!

Let's highlight the events of the ovarian and uterine cycles. Refer again to Figure 26-6.

- The development of the ovarian follicle, during the follicular phase of the ovarian cycle, is caused primarily by FSH. FSH stimulates the follicle to secrete estrogen. The estrogen performs two functions: it stimulates the growth of the follicle, and it is responsible for the proliferative phase of the uterine cycle.
- Ovulation is the expulsion of the egg at midcycle (day 14) and is caused by a surge of LH from the anterior pituitary gland.
- The follicular cells that remain on the surface of the ovary form the corpus luteum. The corpus luteum secretes progesterone and some estrogen. Blood carries the hormones to the uterus.
- Progesterone stimulates the uterine lining to become thick and lush, thereby forming a rich lining for the fertilized egg.
- When blood levels of estrogen and progesterone decline, the endometrial lining sloughs off and causes bleeding (menstruation).
- The ovarian hormones (estrogen and progesterone) exert a negative feedback effect on the anterior pituitary gland.

When blood levels of the ovarian hormones rise, secretions of FSH and LH are low. When the corpus luteum degenerates into the corpus albicans, however, the blood levels of estrogen and progesterone decrease. The decrease in the ovarian hormones in turn allows the anterior pituitary gland to secrete FSH and LH. The stimulated ovary then develops another follicle.

? Re-Think

1. List the two phases of the ovarian cycle.
2. List the three phases of the uterine cycle.
3. Explain how the ovarian cycle controls the uterine cycle.

IMPLANTATION: KEEPING THE CORPUS LUTEUM ALIVE

NOTE: The endometrial lining does not slough off if blood levels of estrogen and progesterone are adequate. These levels are adequate if the corpus luteum does not deteriorate. How does the body prevent the deterioration of the corpus luteum?

If fertilization occurs, preserving the uterine lining is crucial, for this is where Baby will live and grow. Menstruation must be prevented. How? Soon after fertilization, the egg implants in the uterine lining. Some of the cells at the site of implantation in the uterus secrete a hormone called *human chorionic gonadotropin* (hCG). Blood carries hCG from the uterus to the ovary, where it stimulates the corpus luteum. Deterioration of the corpus luteum is prevented by hCG, thereby

ensuring the continued secretion of estrogen and progesterone. The life of the corpus luteum is prolonged for 11 to 12 weeks by hCG, until the placenta can take over as the major estrogen- and progesterone-secreting gland. (See Chapter 27 for the rest of this story.)

Do You Know...

What the Missing Words in This "Scientific" Observation Are?

According to the ancient scientist Pliny, "When a _____ approaches, fermenting wine will be soured, seeds she touches become infertile, grass withers, garden plants shrivel, and fruit falls from the trees."

The missing words are "menstruating woman." Menstruating women were often feared, and a great lore grew up around menstrual blood. Casual observation might have suggested that the above charges were false. Pliny pondering periods! Not too observant for a scientist.

Re-Think

1. Explain why the corpus luteum deteriorates to the corpus albicans in the nonpregnant state.
2. Explain why the corpus luteum does not deteriorate in the pregnant state.

MENARCHE, MENSES, AND MENOPAUSE

In the female, puberty is marked by the first period of menstrual bleeding, or menarche (meh-NAR-kee). Thereafter, the menstrual periods (menses) occur regularly until the woman reaches her late 40s or early 50s. At this time, the periods gradually become more irregular until they cease completely. This phase is called **menopause**. Menopause is also called the change of life, or the climacteric. Female reproductive function lasts from menarche to menopause.

The effects of menopause are caused by a decrease in the ovarian secretion of estrogen and progesterone. Without ovarian hormones, the uterine cycle ceases and the woman stops menstruating. Other symptoms associated with menopause include hot flashes, sweating, depression, irritability, and insomnia. The symptoms are highly variable. Some women experience severe disturbances; others hardly notice any systemic effects.

METHODS OF BIRTH CONTROL

Birth control is the voluntary regulation of reproduction. Birth control can limit the number of offspring produced and help determine the timing of conception. Methods of contraception are forms of birth control that prevent the union of egg and sperm.

BARRIER METHODS OF BIRTH CONTROL

Barriers prevent the sperm from entering the female—no union means no baby. Barrier methods are mechanical or chemical. The female and male condoms and the diaphragm are mechanical barriers; spermicidal creams, foams, and jellies are chemical barriers. The effectiveness of the chemical barriers is improved considerably when they are used with a mechanical barrier.

HORMONAL CONTRACEPTIVES

The birth control pill is a pharmacological agent that contains estrogen and progesterone. As the blood levels of estrogen and progesterone increase, negative feedback inhibits the secretion of FSH by the anterior pituitary gland. This process, in turn, prevents ovulation; no egg means no baby.

Implants containing progesterone act in much the same way. Progesterone-containing capsules, or rods, can be surgically implanted under the skin of a woman's upper arm or scapular region. The progesterone is slowly but continuously released from the implant. As with the birth control pill, the elevated blood levels of progesterone prevent ovulation. The same effect can be achieved by the injection of synthetic progesterone two to four times per year.

A contraceptive patch can also be used as a form of birth control. A contraceptive patch is a transdermal patch applied to the skin, which releases synthetic estrogen and progestin hormones to prevent pregnancy.

SURGICAL METHODS OF BIRTH CONTROL

Surgical methods of contraception include a vasectomy in the male and a tubal ligation in the female (Figure 26-7). A vasectomy involves removing a small section of each vas deferens and tying the cut ends. A vasectomy is contraceptive because the sperm cannot leave the epididymis; no sperm means no baby.

In the female, a tubal ligation involves removing a small section of each fallopian tube and tying the cut ends. After a tubal ligation, the egg cannot be transported from the ovary through the fallopian tubes, where fertilization normally takes place. No egg means no baby.

INTRAUTERINE DEVICES

An intrauterine device (IUD) is a small solid object placed in the uterine cavity. The IUD prevents pregnancy because it stimulates the uterus to prevent implantation of the fertilized egg. Note that the IUD is not technically contraceptive. In other words, it does not prevent conception; instead, it prevents implantation.

BEHAVIORAL METHODS OF BIRTH CONTROL

Sexual partners can behave in ways to prevent pregnancy. Behavioral methods include abstinence, the

HORMONAL CONTROL OF THE REPRODUCTIVE CYCLES

Let us review the female reproductive cycle. Each month, an egg is produced by the ovary in anticipation of producing a baby. As the egg develops in the ovary, the uterus prepares to receive the fertilized egg. Its preparation consists of the building up of a thick, lush endometrial lining. If the egg is not fertilized, the endometrial lining is no longer needed to nourish the fetus, so it is shed in the menstrual flow. Then the monthly process begins again. A second egg ripens in the ovary, and the uterine lining starts the rebuilding process. This process repeats itself throughout the female reproductive years, all for the purpose of reproducing.

A number of hormones control the female reproductive cycle. Unlike male hormones, female hormonal secretion occurs in a monthly cycle, with a regular pattern of increases and decreases in hormone levels. In fact, the word **menses** (MEN-seez) comes from the Greek word for "month" or "moon." The hypothalamus, anterior pituitary gland, and ovaries secrete most of the hormones involved in the menstrual cycle. The hypothalamus secretes a releasing hormone that stimulates the anterior pituitary gland to secrete the two gonadotropins, FSH and LH. FSH and LH then stimulate the ovaries, causing them to secrete estrogen and progesterone. The hormones that regulate the female reproductive cycle are summarized in Table 26-1.

TWO REPRODUCTIVE CYCLES

There are two components of the female reproductive cycle: the ovarian cycle and the uterine cycle. These cycles begin at puberty and last about 40 years. (Refer to Figure 26-6 as you read about the cyclic changes.) Figure 26-6, *A*, illustrates the secretions of the anterior pituitary gland, FSH and LH, over a 28-day monthly cycle. (The 28-day cycle is an average length; a normal cycle may be shorter or longer than 28 days.) The hypothalamic-releasing hormones are responsible for stimulating the anterior pituitary secretion of the gonadotropins.

For each day of the cycle, you should be able to identify the secretions of the anterior pituitary gland, maturation of the ovarian follicle, changes in the blood levels of ovarian hormones, and growth of the endometrial lining of the uterus. Figure 26-6, *B*, illustrates the growth and maturation of the ovarian follicle, which results in ovulation and the development of the corpus luteum. Figure 26-6, *C*, shows the blood levels of the ovarian hormones estrogen and progesterone. Figure 26-6, *D*, illustrates the monthly changes in the uterine lining. Together, the parts of Figure 26-6 describe events that occur over a 28-day period.

OVARIAN CYCLE

The ovarian cycle consists of two phases: the follicular phase and the luteal phase.

Follicular Phase

The follicular phase (see Figure 26-6, *B*) begins with the hypothalamic secretion of releasing hormones. These hormones, in turn, stimulate the release of **gonadotropins** by the anterior pituitary gland. The FSH and small amounts of LH stimulate the growth and maturation of the ovarian follicle. The maturing ovarian follicle secretes large amounts of estrogen,

Table 26-1 Female Hormones

HORMONE	GLAND	TARGET ORGAN	EFFECTS
Releasing hormone	Hypothalamus	Anterior pituitary	Stimulates the secretion of the gonadotropins (FSH and LH)
Follicle-stimulating hormone (FSH)	Anterior pituitary	Ovary	Initiates development of the ovarian follicle Stimulates the secretion of estrogen by the follicular cells
Luteinizing hormone (LH)	Anterior pituitary	Ovary	Causes ovulation Stimulates the corpus luteum to secrete progesterone
Estrogen	Ovary (follicle)	Locally (ovary) Uterus (endometrium) Other tissues and organs	Stimulates maturation of the ovarian follicle Stimulates the proliferative phase of endometrial development Causes the development of the secondary sex characteristics
Progesterone	Ovary (corpus luteum)	Uterus (endometrium)	Stimulates the secretory phase of endometrial development
Human chorionic gonadotropin (hCG)	Trophoblastic cells of the embryo	Corpus luteum	Maintains the corpus luteum during early pregnancy

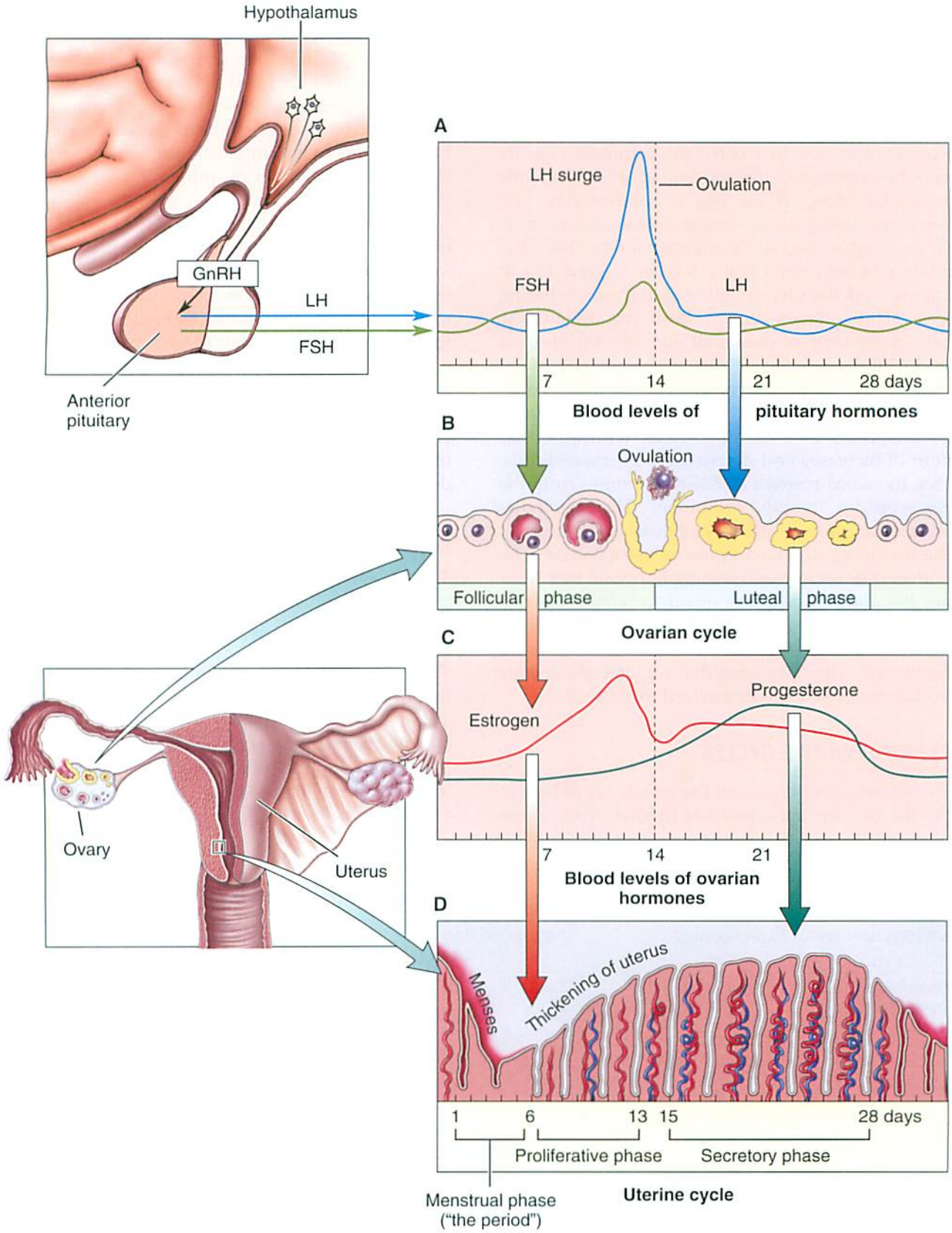


FIGURE 26-6 Hormonal control of the female reproductive cycle (28-day cycle). **A,** The anterior pituitary gland secretes the gonadotropins FSH and LH in response to hypothalamic-releasing hormones. **B,** Ovarian events. **C,** Blood levels of the ovarian hormones estrogen and progesterone. **D,** The uterine cycle.

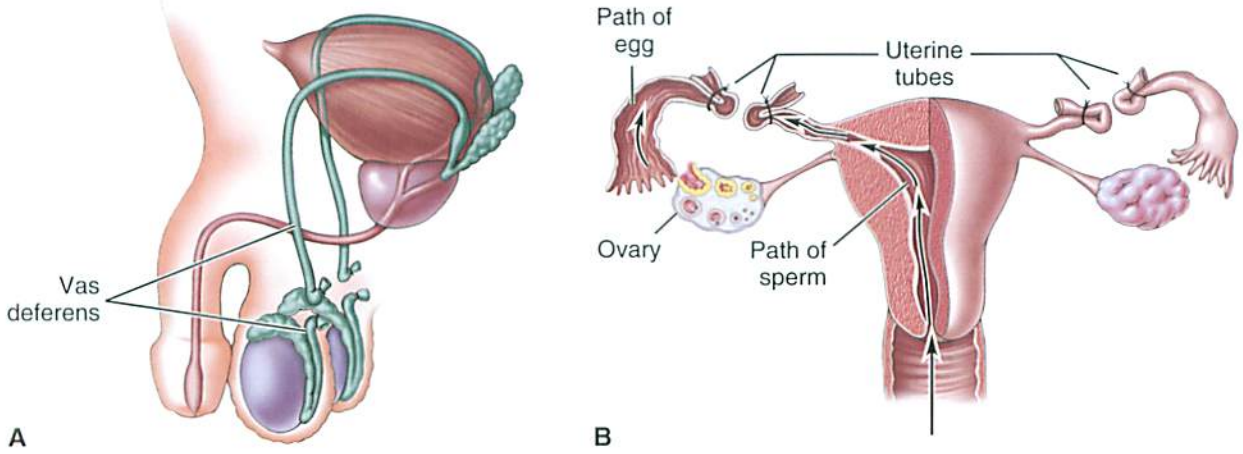


FIGURE 26-7 Surgical methods of birth control. **A,** Vasectomy. **B,** Tubal ligation.

rhythm method, and coitus interruptus. Abstinence, or the avoidance of sexual intercourse, is the most effective method of birth control.

The rhythm method, also called *natural family planning* or *timed coitus,* requires avoiding sexual intercourse at a time when the female is ovulating, generally at midcycle. Because the menstrual cycle (and ovulation) are not always regular, the rhythm method is associated with a high pregnancy rate. Coitus interruptus involves the withdrawal of the penis from the vagina before ejaculation. It too is associated with a high pregnancy rate.

EMERGENCY CONTRACEPTION

Emergency contraception refers to contraception that is implemented after intercourse. It is accomplished by two types of drugs. One group of drugs contains both estrogen and progesterone and works like "the pill" by preventing ovulation and inhibiting implantation in the event that fertilization occurs. A second drug group causes the loss of the implanted embryo by blocking progesterone receptors in the endometrium. The loss of progesterone receptors causes the endometrium to slough, carrying the implanted embryo with it.

2+2 Sum It Up!

In the female, puberty is marked by the first period of menstrual bleeding. This event is called *menarche.* Thereafter, monthly menstrual periods (menses) occur regularly until menopause. Menopause, also called the *climacteric* or *change of life,* generally occurs when a woman is in her late 40s or early 50s. Menopause is caused by the decreased ovarian secretion of estrogen and progesterone. Birth control is the voluntary regulation of reproduction. There are numerous methods of contraception.

As You Age

1. As a woman ages, her ovaries begin to atrophy, or shrink. Between the ages of 40 and 50, estrogen secretion decreases and symptoms of menopause appear; menstrual periods cease, signaling the end of her reproductive years.
2. The decrease in estrogen secretion causes a change in the accessory organs of reproduction. Tissues become thinner, with a decrease in secretions. The changes in these structures make the woman more prone to vaginal infections. Also, a decrease in vaginal secretions can make intercourse uncomfortable. The decrease in estrogen is also thought to cause weakening of bone, causing osteoporosis, and an increase in the incidence of cardiovascular diseases.
3. By the age of 50, the size of the uterus has decreased by 50%. The ligaments that anchor the uterus, urinary bladder, and rectum weaken, allowing these organs to drop down. Surgical correction is sometimes needed.
4. Breast tissue changes; the supporting ligaments weaken; fibrous cells replace glandular cells; and the amount of fat tissue decreases. These changes cause breast tissue to sag.
5. Around the age of 40, testicular function declines. This decline is accompanied by a decrease in the secretion of testosterone and a decreased sperm count (up to 50%). Despite these changes, a man continues to produce sperm and is capable of fathering children throughout most of his life span.

MEDICAL TERMINOLOGY AND DISORDERS Disorders of the Reproductive Systems

Medical Term	Word Parts	Word Part Meaning or Derivation	Description
General Terminology			
congenital	con-	together or with	*Refers to a condition that is present from birth,* as in a congenital heart defect.
	-gen/o-	origin or production	
	-al	pertaining to	
gonad		From the Greek word *gonos,* meaning "seed or act of generation"	**Gonads** are *organs that produce the seeds of generation or reproduction.* The female gonad is the ovary and the male gonad is the testis.
heredity	here(s)	From the Latin word *heres,* meaning "heir or heiress"	*Refers to the passing on of characteristics genetically from generation to generation.*
lactation	lact/o-	milk	*The formation or secretion of milk by the mammary (mammo- = breast) glands.* Lactation is stimulated by the hormone called *prolactin* (pro- = in favor of) or *lactogenic hormone.*
	-tion	process	
myometrium and the other "metriums"	my/o-	muscle	The **myometrium** is *the smooth muscle layer of the uterus.* The **endometrium** (endo- = within) is *the inner lining of the uterus.* The **perimetrium** (peri- = around) or **epimetrium** (epi- = upon) is *the outer serosal layer of the uterus.*
	-metr/o-	uterus or womb	
natal	nat/i-	birth	*Refers to the place or time of one's birth.* A **neonate** (neo- = new) is *a newborn infant.* The **prenatal period** is *the time before the birth;* the **perinatal period** is *the time around the birth;* and the **postnatal period** is *the time immediately after the birth.*
	-al	pertaining to	
placenta		From a Latin word meaning "a flat cake"	Called a "uterine cake" by the Italians, the **placenta** is *the vascular organ that develops within the uterus of a pregnant female in order to nourish the developing fetus.*
ovum	ov/i	egg	*Refers to the ovum or egg.* **Ovulation** is *the expulsion of the egg at midcycle from the* **ovary.** The **oviduct** is *the egg-carrying vessel also known as the fallopian tube.* The prefix oophor/o- derives from the Greek and also refers to the ovary, as in **oophorectomy** *(removal of the ovary).*
Disorders: General			
infertility	in-	not, opposite	**Infertility** can be caused by the male (accounts for one third of the cases), female (one third), or both partners (one third). **Male infertility** may be due to abnormal production of sperm (number or motility), problems with the delivery of sperm, and general health. **Female infertility** may be caused by blockage of the fallopian tubes, endometriosis, ovulation disorders, and hormonal imbalances. Cancer treatment and advancing age can adversely affect both male and female fertility.
	-fertile	From the Latin word *fertilis,* meaning "bearing in abundance"	
sexually transmitted diseases			Abbreviated as STDs; also known as *sexually transmitted infections* (STIs). STDs are a major health concern and are easily spread through sexual contact. Some STDs affect primarily the reproductive structures, whereas others extend their effects to major organ systems throughout the body. The common bacterial STDs include chlamydia (most common), gonorrhea *(Neisseria gonorrhoeae),* and syphilis *(Treponema pallidum).* The most common virally induced STDs are hepatitis B virus (HBV), herpes simplex virus type 2 (HSV-2), human immunodeficiency virus (HIV, progression to AIDS), and human papillomavirus (HPV, also called *genital* or *venereal warts*). Trichomoniasis *(Trichomonas vaginalis)* is the most common STD and is caused by a protozoan or parasitic organism.

MEDICAL TERMINOLOGY AND DISORDERS Disorders of the Reproductive Systems—cont'd

Medical Term	Word Parts	Word Part Meaning or Derivation	Description
Disorders: Male			
benign prostatic hypertrophy	benign	From the Latin word *bene*, meaning "well"	Also called **benign prostatic hyperplasia (BPH).** Hyperplasia of the prostate gland (not cancerous) is age related and commonly occurs in elderly men. Early symptoms include urinary dribbling, urinary incontinence, and incomplete emptying of the bladder.
	prostat/o-	prostate	
	-ic	pertaining to	
	hyper-	above or excessive	
	-troph/o-	nourishment, development	
	-y	condition of	
cancer		From a Latin word meaning *crab;* a reference to its tendency to extend outward and penetrate like claws	**Cancer,** or **malignant neoplasms,** can develop in any part of the male reproductive system. Cancer of the prostate is the second most frequently diagnosed cancer in the United States, whereas testicular cancer is the most common cancer in U.S. males from late teens to mid-30s.
erectile dysfunction			Also called **EDF** or **impotence;** refers to the inability to have or maintain an erection.
gynecomastia	gynec/o-	woman	**Gynecomastia** is *the development of mammary glands in the male; it occurs in response to altered hormonal secretion or as a side effect of drug therapy.*
	-mast/o-	breasts	
	-ia	condition of	
hydrocele	hydro-	water	A **hydrocele** is *a fluid-filled sac surrounding a testicle; it presents as a swollen scrotum.*
	-cele	pouching or hernia	
hypospadias	hypo-	deficient	A **hypospadias** is *a congenital opening of the urethra on the undersurface of the penis.*
	-spadias	to draw away	
prostatitis	prostat/o-	prostate	**Prostatitis** is *the inflammation of the prostate gland; usually caused by an infection.*
	-itis	inflammation	
varicocele	varic/o-	twisted vein	A **varicocele** is *an enlargement and distortion (varicosity) of the veins that drain the testis.* It appears bluish through the scrotum, feels like a sac of worms, and often causes discomfort.
	-cele	pouching or hernia	
vasectomy	vas/o-	vessel	A **vasectomy** is *the removal of a segment of the vas deferens in order to produce sterility in the male.* A **vasovasostomy** is *a surgical procedure performed to restore the vas deferens and fertility in the male; it reverses the effects of vasectomy.*
	-ectomy	removal	
Disorders: Female			
cervicitis	cervic/o-	cervix	*Inflammation of the cervix, the lower necklike part of the uterus that extends into the vagina.*
	-itis	inflammation of	
colporrhaphy	colp/o-	vagina (sheath)	A **colporrhaphy** is *the surgical repair of a tear in the vaginal wall.* The defect may be a cystocele, a protrusion of the bladder into the vagina. The defect may also be a rectocele, the bulging of part of the rectum into the vagina.
	-orrhaphy	repair	
displacement of the uterus			**Anteflexion** (ante = before; flexus = bend) is *the forward bending of the uterus.* **Retroflexion** (retro = back) is *an abnormal bending backward of the uterus.* **Retroversion** (retere = to turn) is *an abnormal backward turn of the whole uterus.*
dyspareunia	dys-	difficult or painful	**Dyspareunia** means *painful intercourse,* usually in women.
	-pareunia	From the Greek word *pareunos,* meaning "lying beside"	
endometriosis	endo-	within	**Endometriosis** is *a condition in which endometrial tissue grows in other parts of the body, particularly within the pelvic cavity.* Structures most commonly affected are the intestines, fallopian tubes, and ovaries (described in text).
	-metr/o-	uterus	
	-osis	condition of	

Continued

MEDICAL TERMINOLOGY AND DISORDERS Disorders of the Reproductive Systems—cont'd

Medical Term	Word Parts	Word Part Meaning or Derivation	Description
episiotomy	episi/o-	vulva (covering)	An **episiotomy** is *an incision into the perineum, the area between the vagina and anus; it is done during the delivery of a baby in order to prevent the tearing of the perineum during delivery.*
	-otomy	a cutting into	
leukorrhea	leuk/o-	white	**Leukorrhea** is *an abnormal white to yellow vaginal discharge.*
	-rrhea	discharge	
mammogram	mamm/o-	breast	**Mammogram** is *a screening procedure for the early diagnosis of breast cancer.*
	-gram	record	
mastitis	mast/o-	breast	**Mastitis** is *inflammation of the breasts.* A **mastectomy,** commonly performed for breast cancer, is *the surgical removal of a breast;* **amastia** refers to *the absence of a breast.* **Hypermastia** and **macromastia** refer to *abnormally large breasts,* whereas **hypomastia** and **micromastia** refer to *abnormally small breasts.*
	-itis	inflammation	
menarche	men/o-	menstruation; monthly	**Menarche** refers to *the beginning of menstruation.* **Amenorrhea** is *the absence of menstruation.* **Dysmenorrhea** is *painful or difficult menstruation.* **Menorrhagia** is *excessive bleeding at menstruation.* **Metrorrhagia** is *bleeding from the uterus at any time other than normal menstruation.* **Menopause** means *the cessation of menstruation.*
	-arche	beginning	
neoplasms	neo-	new	There are benign and malignant tumors that can develop in all reproductive structures. There is a benign **fibroid tumor** of the uterine muscle, or **leiomyoma** (leios- = smooth; -my/o- = muscle; -oma = tumor). **Fibrocystic breast disease** is characterized by multiple benign cysts in the breasts. **Breast cancer** is a common malignancy of the breast tissue. There are many types of benign **ovarian cysts,** some of which are permanently and successfully eliminated; others (e.g., **polycystic ovary syndrome [PCOS]**) may persist chronically and interfere with fertility and create other serious health issues. **Carcinoma in situ** (in situ = in place) refers to an early form of cancer in which there has been no spread of the malignant cells into surrounding tissue.
	-plasia	growth	
salpingitis	salping/o-	uterine or fallopian tube; comes from the Greek word meaning "trumpet" (because of its appearance)	**Salpingitis** is *the inflammation of the uterine or fallopian tubes.*
	-itis	inflammation of	

Get Ready for Exams!

Summary Outline

The reproductive system produces the cells and hormones necessary for reproduction.

I. Male Reproductive System

A. Testes
   1. The testes, or testicles, are the male gonads.
   2. Lobules with two types of cells: the seminiferous tubules and the interstitial cells

B. Genital ducts and glands
   1. The sperm move through a series of genital ducts: epididymis, vas deferens, ejaculatory ducts, and urethra.
   2. Three glands—the seminal vesicles, the prostate gland, and the bulbourethral glands—secrete into the genital ducts. The mixture of sperm and glandular secretions is called *semen*.

C. External genitals
   1. The male genitals consist of the scrotum and the penis.
   2. The penis performs two functions: It is the organ of copulation (sexual intercourse), and it carries urine.

D. Male sexual responses: erection, emission, ejaculation, and orgasm

E. Male sex hormones
   1. The most important is testosterone, determining the primary and secondary sex characteristics.
   2. Controlled by hormones from the hypothalamus and from the anterior pituitary gland