

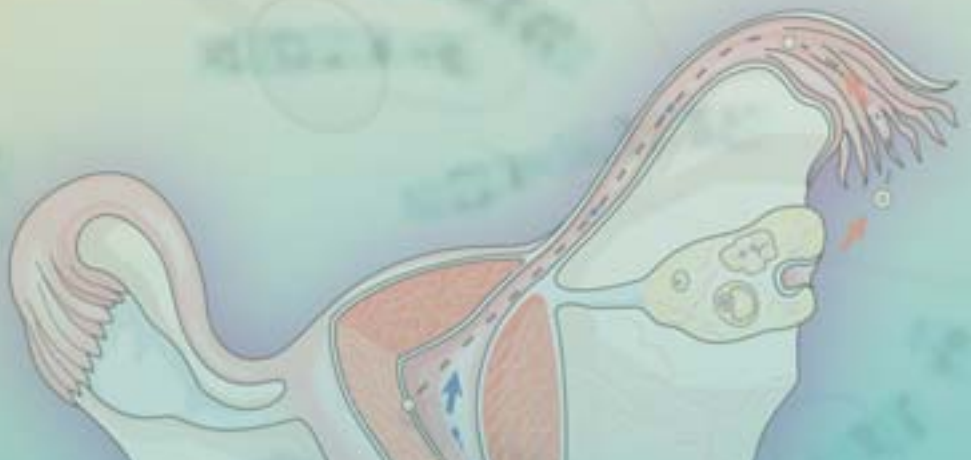
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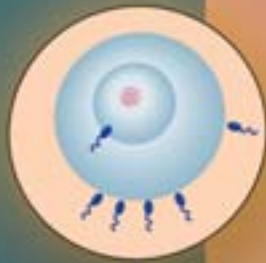
unit



Perpetuation of Life

The last unit includes three chapters on the structures and functions related to reproduction and heredity. The reproductive system is not necessary for the continuation of the life of the individual but rather is needed for the continuation of the human species. The reproductive cells and their genes have been studied intensively during recent years as part of the rapidly advancing science of genetics.





SELECTED KEY TERMS

The following terms and additional boldface terms in the chapter are defined in the Glossary

contraception

corpus luteum

endometrium

estrogen

follicle

FSH

Gamete

infertility

LH

menopause

menses

menstruation

ovary

ovulation

ovum (pl., ova)

progesterone

semen

spermatozoon

(pl., spermatozoa)

testis (pl., testes)

testosterone

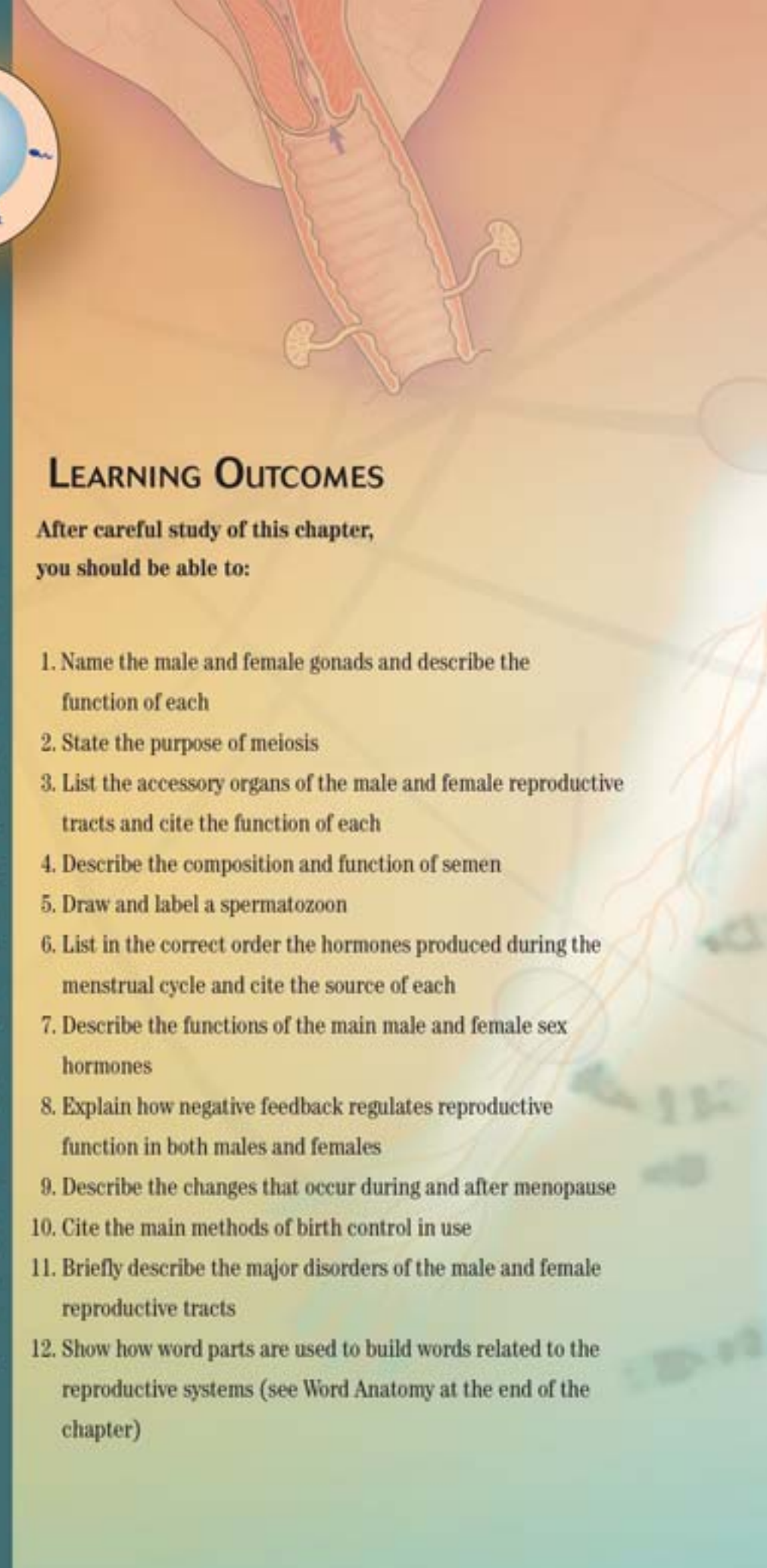
uterus



LEARNING OUTCOMES

After careful study of this chapter, you should be able to:

1. Name the male and female gonads and describe the function of each
2. State the purpose of meiosis
3. List the accessory organs of the male and female reproductive tracts and cite the function of each
4. Describe the composition and function of semen
5. Draw and label a spermatozoon
6. List in the correct order the hormones produced during the menstrual cycle and cite the source of each
7. Describe the functions of the main male and female sex hormones
8. Explain how negative feedback regulates reproductive function in both males and females
9. Describe the changes that occur during and after menopause
10. Cite the main methods of birth control in use
11. Briefly describe the major disorders of the male and female reproductive tracts
12. Show how word parts are used to build words related to the reproductive systems (see Word Anatomy at the end of the chapter)



chapter

23

The Male and Female Reproductive Systems



Reproduction

The chapters in this unit deal with what is certainly one of the most interesting and mysterious attributes of life: the ability to reproduce. The simplest forms of life, one-celled organisms, usually need no partner to reproduce; they simply divide by themselves. This form of reproduction is known as **asexual** (nonsexual) reproduction.

In most animals, however, reproduction is **sexual**, meaning that there are two kinds of individuals, males and females, each of which has specialized cells designed specifically for the perpetuation of the species. These specialized sex cells are known as **germ cells**, or **gametes** (GAM-etes). In the male, they are called **spermatozoa** (sper-mah-to-ZO-ah) (sing. spermatozoon), or simply sperm cells, and in the female, they are called **ova** (O-vah) (sing., ovum) or egg cells.

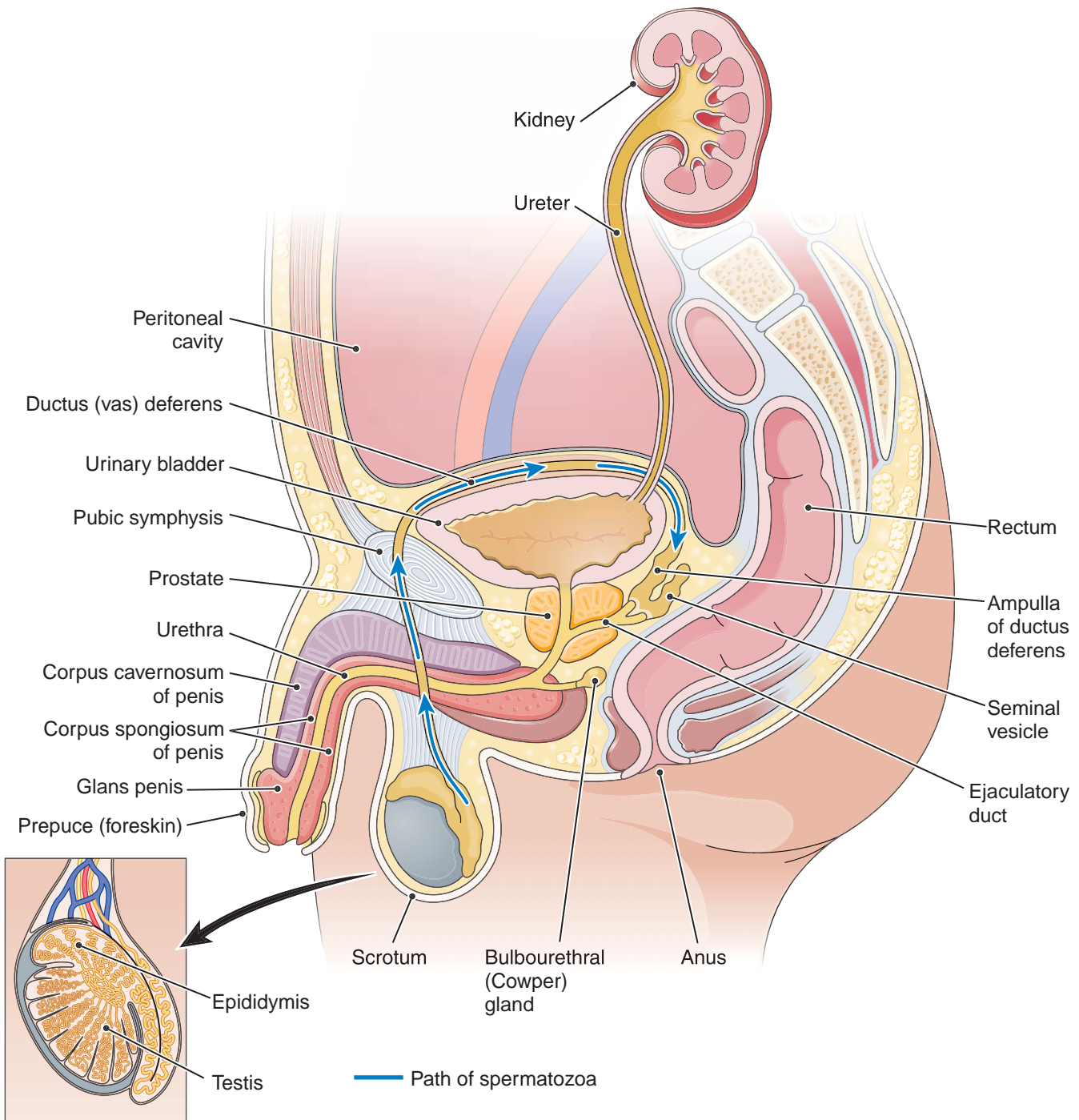


Figure 23-1 Male reproductive system. Organs of the urinary system are also shown. **ZOOMING IN** ♦ What four glands empty secretions into the urethra?

Meiosis

Gametes are characterized by having half as many chromosomes as are found in any other body cell. During their formation, they go through a special process of cell division, called **meiosis** (mi-O-sis), which halves the number of chromosomes. In humans, meiosis reduces the chromosome number in a cell from 46 to 23. The role of meiosis in reproduction is explained in more detail in Chapter 25.

Checkpoint 23-1: What is the process of cell division that halves the chromosome number in a cell to produce a gamete?

The Male Reproductive System

The male reproductive system, like that of the female, may be divided into two groups of organs: primary and accessory (see Fig. 23-1).

- ▶ The primary organs are the **gonads** (GO-nads), or sex glands; they produce the germ cells and manufacture hormones. The male gonad is the testis. (In comparison, the female gonad is the ovary, as explained below.)
- ▶ The **accessory organs** include a series of ducts that transport the germ cells as well as various exocrine glands.

The Testes

The male gonads, the **testes** (TES-teze) (sing. testis) are located outside the body proper, suspended between the thighs in a sac called the **scrotum** (SKRO-tum). The testes are oval organs measuring about 4.0 cm (1.5 inches) in length and about 2.5 cm (1 inch) in each of the other two dimensions. During embryonic life, each testis develops from tissue near the kidney.

A month or two before birth, the testis normally descends (moves downward) through the **inguinal** (ING-wih-nal) **canal** in the abdominal wall into the scrotum. Each testis then remains suspended by a **spermatic cord** (Fig. 23-2) that extends through the inguinal canal. This cord contains blood vessels, lymphatic vessels, nerves, and the tube (ductus deferens) that transports spermatozoa away from the testis. The gland must descend completely if it is to function normally; to produce spermatozoa, the testis must be kept at the temperature of the scrotum, which is several degrees lower than that of the abdominal cavity.

Internal Structure Most of the specialized tissue of the testis consists of tiny coiled **seminiferous** (seh-mih-NIF-er-us) **tubules**. Primitive cells in the walls of these tubules develop into mature spermatozoa, aided by neighboring cells called **sustentacular** (sus-ten-TAK-ular) (Sertoli) **cells**. These so-called “nurse” cells nourish and protect the developing spermatozoa. They also se-

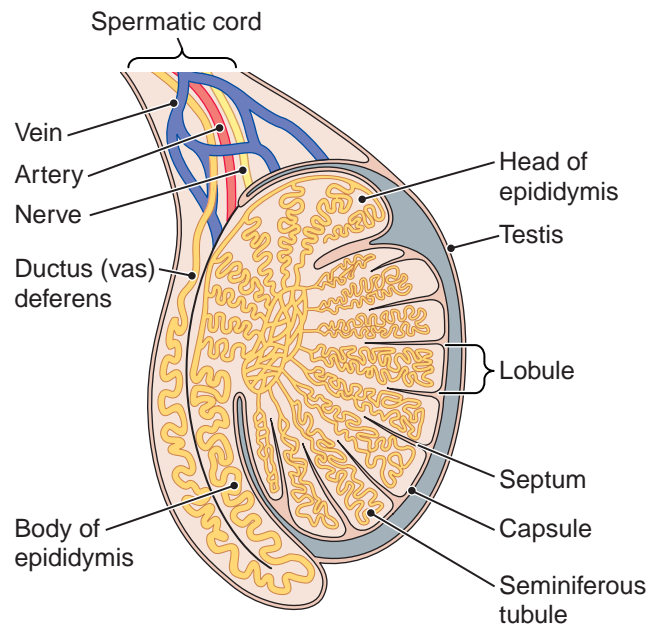


Figure 23-2 Structure of the testis. The epididymis and spermatic cord are also shown. **ZOOMING IN** ♦ *What duct receives secretions from the epididymis?*

crete a protein that binds testosterone in the seminiferous tubules.

Specialized **interstitial** (in-ter-STISH-al) **cells** that secrete the male sex hormone **testosterone** (*tes-TOS-teh-ron*) are located between the seminiferous tubules. **Figure 23-3** is a microscopic view of the testis in cross-section, showing the seminiferous tubules, interstitial cells, and developing spermatozoa.

Testosterone After its secretion, testosterone is absorbed directly into the bloodstream. This hormone has three functions:

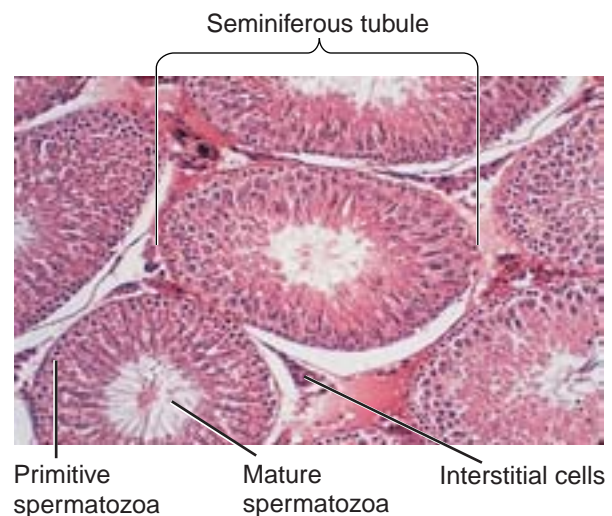


Figure 23-3 Microscopic view of the testis. (Courtesy of Dana Morse Bittus and B. J. Cohen.)

- ▶ Development and maintenance of the reproductive structures
- ▶ Development of spermatozoa
- ▶ Development of **secondary sex characteristics**, traits that characterize males and females but are not directly concerned with reproduction. In males, these traits include a deeper voice, broader shoulders, narrower hips, a greater percentage of muscle tissue, and more body hair than are found in females.

The Spermatozoa Spermatozoa are tiny individual cells illustrated in [Figure 23-4](#). They are so small that at least 200 million are contained in the average ejaculation (release of semen). After puberty, sperm cells are manufactured continuously in the seminiferous tubules of the testes.

The spermatozoon has an oval head that is largely a nucleus containing chromosomes. The **acrosome** (AK-ro-some), which covers the head like a cap, contains enzymes that help the sperm cell to penetrate the ovum.

Whiplike movements of the tail (flagellum) propel the sperm through the female reproductive system to the ovum. The cell's middle region (midpiece) contains many mitochondria that provide energy for movement.

Checkpoint 23-2: What is the male gonad?

Checkpoint 23-3: What is the main male sex hormone?

Checkpoint 23-4: What is the male sex cell (gamete) called?

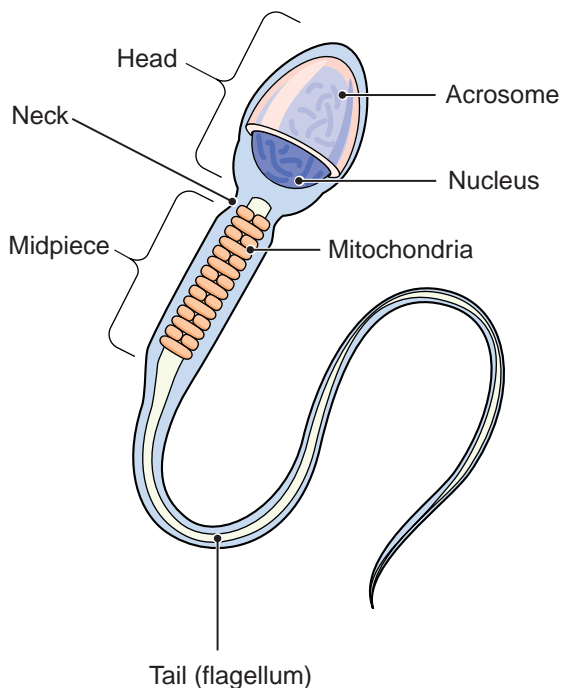


Figure 23-4 Diagram of a human spermatozoon. Major structural features are shown. **ZOOMING IN** ♦ *What organelles provide energy for sperm cell motility?*

Accessory Organs

The system of ducts that transports the spermatozoa begins with tubules inside the testis itself. From these tubules, the cells collect in a greatly coiled tube called the **epididymis** (ep-ih-DID-ih-mis), which is 6 meters (20 feet) long and is located on the surface of the testis inside the scrotal sac (see [Fig. 23-2](#)). While they are temporarily stored in the epididymis, the sperm cells mature and become motile, able to move or “swim” by themselves.

The epididymis finally extends upward as the **ductus deferens** (DEF-er-enz), also called the **vas deferens**. This tube, contained in the spermatic cord, continues through the inguinal canal into the abdominal cavity. Here, it separates from the remainder of the spermatic cord and curves behind the urinary bladder. The ductus deferens then joins with the duct of the **seminal vesicle** (VES-ih-kl) on the same side to form the **ejaculatory** (e-JAK-uh-lah-to-re) **duct**. The right and left ejaculatory ducts travel through the body of the prostate gland and then empty into the urethra.

Checkpoint 23-5: What is the order in which sperm cells travel through the ducts of the male reproductive system?

Semen

Semen (SE-men) (meaning “seed”) is the mixture of sperm cells and various secretions that is expelled from the body. It is a sticky fluid with a milky appearance. The pH is in the alkaline range of 7.2 to 7.8. The secretions in semen serve several functions:

- ▶ Nourish the spermatozoa
- ▶ Transport the spermatozoa
- ▶ Neutralize the acidity of the male urethra and the female vaginal tract
- ▶ Lubricate the reproductive tract during sexual intercourse
- ▶ Prevent infection with antibacterial enzymes and antibodies

The glands discussed next contribute secretions to the semen (see [Fig. 23-1](#)).

The Seminal Vesicles The seminal vesicles are twisted muscular tubes with many small outpouchings. They are about 7.5 cm (3 inches) long and are attached to the connective tissue at the posterior of the urinary bladder. The glandular lining produces a thick, yellow, alkaline secretion containing large quantities of simple sugar and other substances that provide nourishment for the sperm. The seminal fluid makes up a large part of the semen’s volume.

The Prostate Gland The prostate gland lies immediately inferior to the urinary bladder, where it surrounds the first part of the urethra. Ducts from the prostate carry

its secretions into the urethra. The thin, alkaline prostatic secretion helps neutralize the acidity of the vaginal tract and enhance the motility of the spermatozoa. The prostate gland is also supplied with muscular tissue, which, upon signals from the nervous system, contracts to aid in the expulsion of the semen from the body.

Bulbourethral Glands The **bulbourethral** (bul-bo-URE-thral) **glands**, also called **Cowper glands**, are a pair of pea-sized organs located in the pelvic floor just inferior to the prostate gland. They secrete mucus to lubricate the urethra and tip of the penis during sexual stimulation. The ducts of these glands extend about 2.5 cm (1 inch) from each side and empty into the urethra before it extends into the penis.

Other very small glands secrete mucus into the urethra as it passes through the penis.

Checkpoint 23-6: What glands, aside from the testis, contribute secretions to semen?

The Urethra and Penis

The male urethra, as discussed in Chapter 22, serves the dual purpose of conveying urine from the bladder and carrying the reproductive cells with their accompanying secretions to the outside. The ejection of semen into the receiving canal (vagina) of the female is made possible by the **erection**, or stiffening and enlargement, of the penis, through which the longest part of the urethra extends. The penis is made of spongy tissue containing many blood spaces that are relatively empty when the organ is flaccid but fill with blood and distend when the penis is erect. This tissue is subdivided into three segments, each called a **corpus** (body) (Fig. 23-5). A single, ventrally located **corpus spongiosum** contains the urethra. On either side is a larger **corpus cavernosum** (pl., corpora cavernosa). At the distal end of the penis, the corpus spongio-

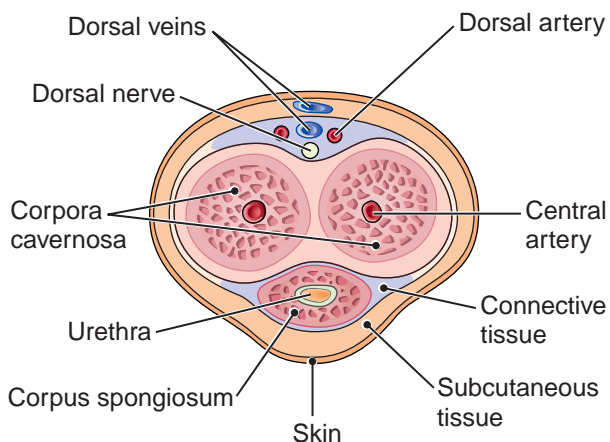


Figure 23-5 Cross-section of the penis. **ZOOMING IN** ♦ What subdivision of the penis contains the urethra?

sum enlarges to form the **glans penis**, which is covered with a loose fold of skin, the **prepuce** (PRE-puse), commonly called the **foreskin**. It is the end of the foreskin that is removed in a **circumcision** (sir-kum-SIZH-un), a surgery frequently performed on male babies for religious or cultural reasons. Experts disagree on the medical value of circumcision with regard to improved cleanliness and disease prevention.

The penis and scrotum together make up the *external genitalia* of the male.

Ejaculation Ejaculation (e-jak-u-LA-shun) is the forceful expulsion of semen through the urethra to the outside. The process is initiated by reflex centers in the spinal cord that stimulate smooth muscle contraction in the prostate. This is followed by contraction of skeletal muscle in the pelvic floor, which provides the force needed for expulsion. During ejaculation, the involuntary sphincter at the base of the bladder closes to prevent the release of urine.

A male typically ejaculates 2 to 5 mL of semen containing 50 to 150 million sperm cells per mL. Out of the millions of spermatozoa in an ejaculation, only one, if any, can fertilize an ovum. The remainder of the cells live from only a few hours up to a maximum of 3 days.

Checkpoint 23-7: What are the main subdivisions of a spermatozoon?

Hormonal Control of Male Reproduction

The activities of the testes are under the control of two hormones produced by the anterior pituitary. These hormones are named for their activity in female reproduction (described later), although they are chemically the same in both males and females.

- ▶ **Follicle-stimulating hormone (FSH)** stimulates the sustentacular (Sertoli) cells and promotes the formation of spermatozoa.
- ▶ **Luteinizing hormone (LH)** stimulates the interstitial cells between the seminiferous tubules to produce testosterone, which is also needed for sperm cell development. An older name for this hormone, which describes its action in males, is *interstitial cell-stimulating hormone (ICSH)*.

Starting at puberty, the hypothalamus begins to secrete hormones that trigger the release of FSH and LH. These hormones are secreted continuously in the male.

The activity of the hypothalamus is in turn regulated by a negative feedback mechanism involving testosterone. As the blood level of testosterone increases, the hypothalamus secretes less releasing hormone; as the level of testosterone decreases, the hypothalamus secretes more releasing hormone (see Fig. 12-3 in Chap. 12).

Checkpoint 23-8: What two pituitary hormones regulate both male and female reproduction?

The Effects of Aging on Male Reproduction

A gradual decrease in the production of testosterone and spermatozoa begins as early as 20 years of age and continues throughout life. Secretions from the prostate and seminal vesicles decrease in amount and become less viscous. In a few men (less than 10%), sperm cells remain late in life, even to 80 years of age.

Disorders of the Male Reproductive System

A variety of disorders can contribute to **infertility**, a significantly lower than normal ability to reproduce. If the inability is complete, the condition is termed **sterility**. The proportion of infertility in couples that can be attributed to defects involving the male has been estimated from 40% to 50%. (See also Box 23-1 on erectile dysfunction.)

The tubules of the testes are sensitive to x-rays, infections, toxins, and malnutrition, all of which bring about degenerative changes. Such damage may cause a decrease in the numbers of spermatozoa produced, leading to a condition called **oligospermia** (ol-ih-go-SPER-me-ah). Adequate numbers of sperm are required to disperse the coating around the ovum so that one sperm can fertilize it. Absence of or an inadequate number of male sex cells is a significant cause of infertility.

A male may be intentionally sterilized by an operation called a **vasectomy** (vah-SEK-to-me). In this procedure, a portion of the ductus deferens on each side is removed, and the cut end is closed to keep spermatozoa from reaching the urethra. The tiny sperm cells are simply reabsorbed. A man who has had a vasectomy retains the ability to produce hormones and all other seminal secretions as well as the ability to perform the sex act, but no fertilization can occur.

Structural Disorders

Cryptorchidism (kript-OR-kid-izm) is a disorder characterized by failure of the testis to descend into the scrotum. Unless corrected in childhood, this condition results in sterility. Undescended testes are also particularly subject to tumor formation. Most testes that are undescended at birth descend spontaneously by 1 year of age. Surgical correction is the usual remedy in the remaining cases.

Torsion of the testis is a twisting of the spermatic cord that results from rotation of the testis (Fig. 23-6). This turning may occur during descent of the testis or later in life, most commonly between the ages of 8 to 18 years. The condition is accompanied by acute pain, swelling and shortening of the spermatic cord. It requires emergency surgery to correct the defect, and may involve removal of the testis (orchectomy). Torsion of the testis is a developmental disorder that often affects both glands, so the other testis must be examined to determine whether or not preventive surgery is needed.

Hernia (HER-ne-ah), or rupture, refers to the abnormal protrusion of an organ or organ part through the wall of the cavity in which it is normally contained (Fig. 23-7). Hernias most often occur where there is a weak area

Box 23-1 Clinical Perspectives

Treating Erectile Dysfunction: When NO Means Yes

Approximately 25 million American men and their partners are affected by **erectile dysfunction** (ED), the inability to achieve an erection. Although ED is more common in men over the age of 65, it can occur at any age and can have many causes. Until recently, ED was believed to be caused by psychological factors, such as stress or depression. It is now known that many cases of ED are caused by physical factors, including cardiovascular disease, diabetes, spinal cord injury, and damage to penile nerves during prostate surgery. Antidepressant and antihypertensive medications also can produce erectile dysfunction.

Erection results from interaction between the autonomic nervous system and penile blood vessels. Sexual arousal stimulates parasympathetic nerves in the penis to release a compound called nitric oxide (NO), which activates the vascular smooth muscle enzyme guanylyl cyclase. This enzyme catalyzes production of cyclic GMP (cGMP), a potent vasodilator that increases blood flow into the penis to cause erection.

Physical factors that cause ED prevent these physiological occurrences.

Until recently, treatment options for ED, such as penile injections, vacuum pumps, and insertion of medications into the penile urethra were inadequate, inconvenient, and painful. Today, drugs that target the physiologic mechanisms that underlie erection are giving men who suffer from ED new hope. The best known of these is sildenafil (Viagra), which works by inhibiting the enzyme that breaks down cGMP, thus prolonging the effects of NO.

Although effective in about 80% of all ED cases, Viagra can cause some relatively minor side effects, including headache, nasal congestion, stomach upset, and blue-tinged vision. Viagra should never be used by men who are taking nitrate drugs to treat angina. Because nitrate drugs elevate NO levels, taking them with Viagra, a drug that prolongs the effects of NO, can cause life-threatening hypotension.

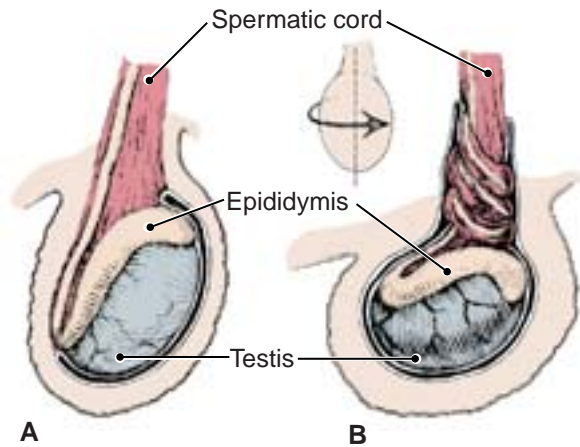


Figure 23-6 Torsion of the testis. (A) Normal. (B) Torsion. The testis rotates, twisting the spermatic cord. (Reprinted with permission from LifeART Pediatrics 1 [CD-ROM]. Baltimore: Lippincott Williams & Wilkins, 2000.)

in the abdominal wall, at the inguinal canal for example. In this region, during development, the testis pushes its way through the muscles and connective tissues of the abdominal wall, carrying with it the blood vessels and other structures that form the spermatic cord.

Normally, in the adult, the inguinal area is fairly well reinforced with connective tissue, and there is no direct connection between the abdominal cavity and the scrotal sac. As in other regions where an opening permits structure's passage through the abdominal wall, however, this area constitutes a weak place where a hernia may occur.

Phimosis (fi-MO-sis) is a tightness of the foreskin (prepuce), so that it cannot be drawn back. Phimosis may

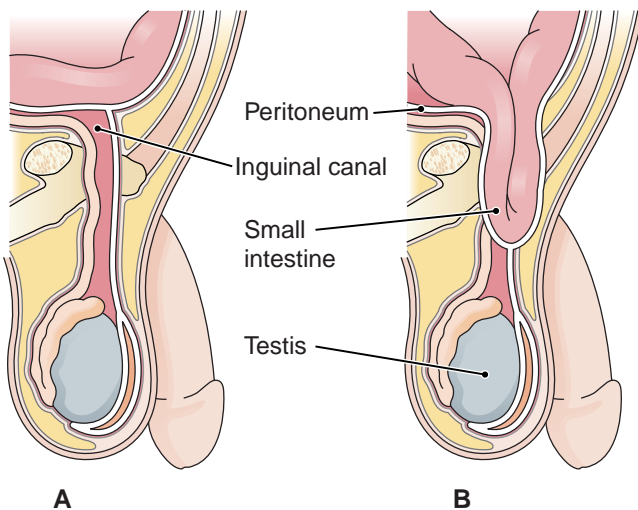


Figure 23-7 Inguinal hernia. (A) Normal. (B) Hernia. The intestine protrudes through a weakness in the abdominal wall at the inguinal canal. (Reprinted with permission from Cohen BJ. Medical Terminology. 4th ed. Philadelphia: Lippincott Williams & Wilkins, 2004.)

be remedied by circumcision, in which part or all of the foreskin is surgically removed.

Infections

Sexually transmitted infections (STI), formerly known as sexually transmitted diseases (STD) or *venereal diseases* (VD), are spread through sexual contact in both males and females. They most commonly involve chlamydial infections and gonococcal infections (gonorrhea). In males, these diseases are manifested by a discharge from the urethra, which may be accompanied by burning and pain, especially during urination. The infection may travel along the mucous membrane into the prostate gland and the epididymis; if both sides are affected and enough scar tissue is formed to destroy the tubules, sterility may result.

Another common STI is a persistent infection called **genital herpes**. Caused by a virus, this disorder is characterized by fluid-filled vesicles (blisters) on and around the genital organs.

The sexually transmitted disease **syphilis** is caused by a spirochete (*Treponema pallidum*). Because syphilis spreads quickly in the bloodstream, it is regarded as a systemic disorder (see Appendix 5, Table 1). The genital ulcers caused by syphilis increase the chances of infection with the AIDS virus. HIV itself is considered an STI because of its most common route of spread. (See Box 23-2 on lowering risks for STIs.)

Epididymitis Organisms from an STI or urinary tract infection (UTI) may travel through the ducts of the reproductive system to the epididymis. A congenital malformation in the urinary tract can predispose to **epididymitis** (ep-ih-did-ih-MI-tis), and infection may also be carried to the organ systemically by blood or lymph. Treatment includes an antibiotic along with bed rest and support of the scrotum to promote lymphatic drainage.

Prostatitis The usual cause of prostatic inflammation is bacterial infection secondary to an ascending urinary tract infection. A variety of intestinal organisms and bacteria from other sources may be involved, but *E. coli* is the most common. Treatment with antibiotics usually clears the infection, but tests to diagnose the source of infection may be needed if the condition persists. Other possible causes of **prostatitis** (pros-tah-TI-tis) are bladder-neck obstruction that forces urine into the prostate, and autoimmunity.

Orchitis Orchitis (or-KI-Is) is inflammation of the testis, which also may follow from infection of the urinary or reproductive tract. The testes also may be involved in mumps, a viral infection of the parotid salivary gland. A mumps infection during or after puberty may result in inflammation of the testes, which could lead to sterility.

Checkpoint 23-9: What are some infectious diseases of the reproductive tract?

Box 23-2 • Health Maintenance

Sexually Transmitted Infections: Lowering Your Risks

Sexually transmitted infections (STIs) such as chlamydia, gonorrhea, genital herpes, HIV, and syphilis are some of the most common infectious diseases in the United States, affecting more than 13 million men and women each year. These diseases are associated with complications such as pelvic inflammatory disease, epididymitis, infertility, liver failure, neurological disorders, cancer, and AIDS. Women are more likely to contract STIs than are men. The same mechanisms that transport sperm cells through the female reproductive tract also move infectious organisms. The surest way to prevent STIs is to avoid sexual contact with others. If you are sexually active, the following techniques can lower your risks:

- ▶ Maintain a monogamous sexual relationship with an uninfected partner.
- ▶ Correctly and consistently use a condom. While not 100% effective, condoms greatly reduce the risk of contracting an STI.
- ▶ Avoid having sex during menstruation. Women may be more infectious as well as more susceptible to certain STIs during this time.
- ▶ Avoid contact with body fluids such as blood, semen, and vaginal fluids, all of which may harbor infectious organisms.
- ▶ Urinate and wash the genitals after sex. This may help remove infectious organisms before they cause disease.
- ▶ Have regular checkups for STIs. Most of the time STIs cause no symptoms, particularly in women.

Tumors

Tumors of the prostate may be benign or malignant. Both types cause such pressure on the urethra that urination becomes difficult. Back pressure may destroy kidney tissue and may lead to stasis of urine in the bladder with a resulting susceptibility to infection. Men with benign prostate enlargement, known as benign prostatic hyperplasia (BPH), may respond to medication to shrink the prostate. An herbal remedy that may help to slow progress of BPH is an extract of berries of the saw palmetto, a low-growing palm tree. If urinary function is threatened, however, surgery is performed to reduce the obstruction. Most commonly, surgery is performed through the urethra, in a transurethral prostatectomy (TURP). Newer methods include use of laser and ultrasound to destroy excess tissue or placement of a stent to widen the urethra.

Prostatic cancer is the most common cancer of males in the U.S., especially among men older than 50 years of age. Other risk factors, in addition to age, are race, family history and certain environmental agents. A high fat diet may increase risk by promoting production of male sex hormones. Prostatic cancer is frequently detected as a nodule during rectal examination. Early detection has improved with annual blood tests for prostate-specific antigen (PSA). This protein increases in cases of prostate cancer, although it may increase in other prostatic disorders as well. Depending on the age of the patient and the nature of the cancer, the course of treatment may include surveillance, radiation therapy, surgery or hormone treatments.

Testicular cancer affects young to middle-aged adults. Almost all testicular cancers arise in the germ cells, and a tumor can metastasize through the lymphatic system at an early stage of development. Early detection with regu-

lar testicular self-examination (TSE), however, improves the chances for effective treatment. The 5-year survival rate for this form of cancer is now greater than 95%. Often fertility can be preserved, although sperm banking is an option for men about to undergo treatment for testicular cancer.

▶ The Female Reproductive System

The female gonads are the ovaries (O-vah-reze), where the female sex cells, or ova, are formed (Fig. 23-8). The remainder of the female reproductive tract consists of an organ (uterus) to hold and nourish a developing infant, various passageways, and the external genital organs.

The Ovaries

The ovary is a small, somewhat flattened oval body measuring about 4 cm (1.6 inches) in length, 2 cm (0.8 inch) in width, and 1 cm (0.4 inch) in depth. Like the testes, the ovaries descend, but only as far as the pelvic portion of the abdomen. Here, they are held in place by ligaments, including the broad ligament, the ovarian ligament, and others, that attach them to the uterus and the body wall.

The Ova and Ovulation

The outer layer of the ovary is made of a single layer of epithelium. Beneath this layer, the female gametes, the ova, are produced. The ovaries of a newborn female contain a large number of potential ova. Each month during the reproductive years, several ripen, but usually only one is released.

The complicated process of maturation, or “ripening,” of an ovum takes place in a small fluid-filled cluster of

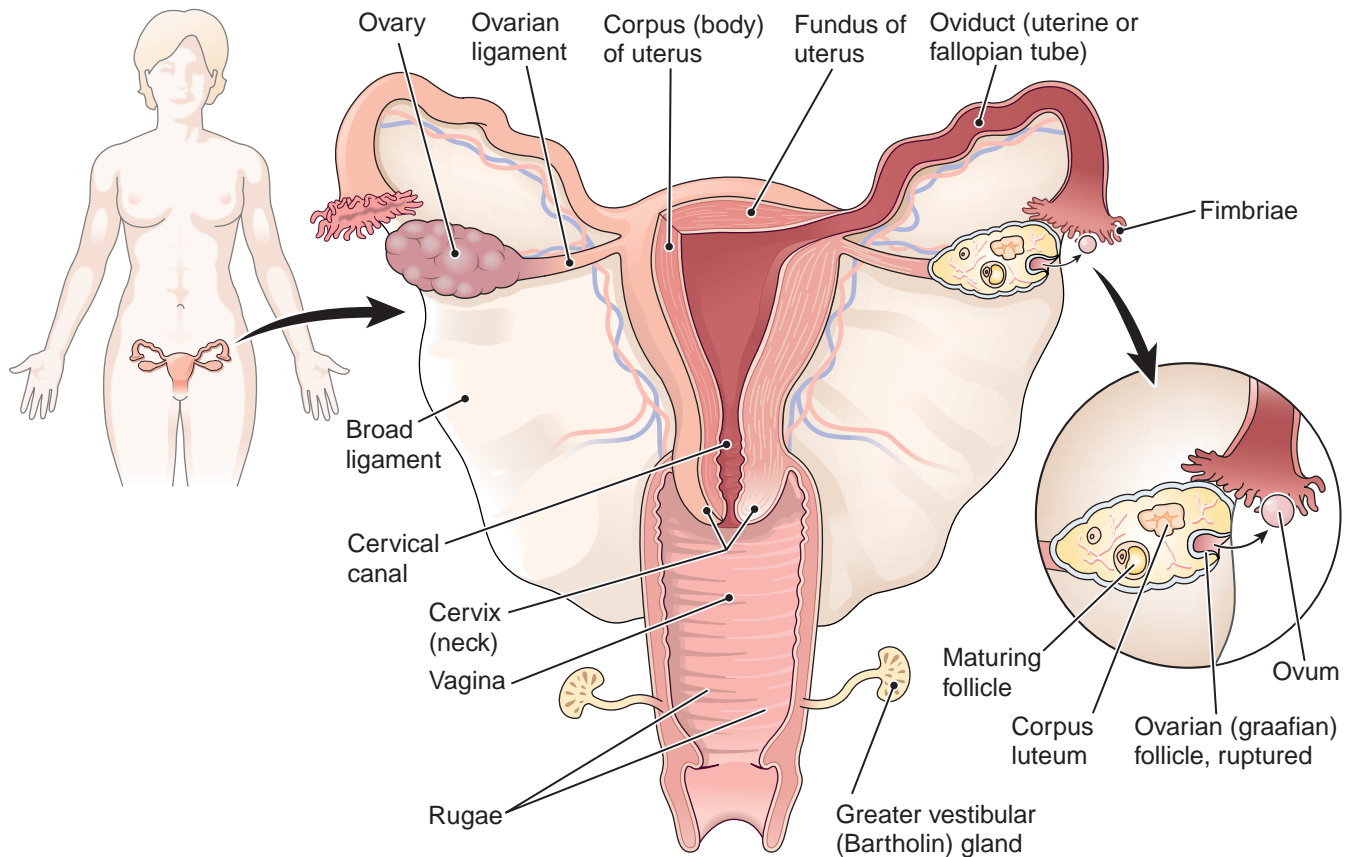


Figure 23-8 Female reproductive system. The enlargement (right) shows ovulation. **ZOOMING IN** ♦ What is the deepest part of the uterus called?

cells called the **ovarian follicle** (o-VA-re-an FOL-ih-kl) or **graafian** (GRAF-e-an) follicle (Fig. 23-9). As the follicle develops, cells in its wall secrete the hormone estrogen, which stimulates growth of the uterine lining. When an ovum has ripened, the ovarian follicle may rupture and discharge the egg cell from the ovary's surface. The rupture of a follicle allowing the escape of an ovum is called **ovulation** (ov-u-LA-shun). Any developing ova that are not released simply degenerate.

After it is released, the egg cell makes its way to the nearest **oviduct** (O-vih-dukt), a tube that arches over the ovary and leads to the uterus (see Fig. 23-8).

Checkpoint 23-10: What is the female gonad called?

Checkpoint 23-11: What is the female gamete called?

The Corpus Luteum After the ovum has been expelled, the remaining follicle is transformed into a solid glandular mass called the **corpus luteum** (LU-te-um). This structure secretes estrogen and also progesterone, another hormone needed in the reproductive cycle. Commonly, the corpus luteum shrinks and is replaced by scar tissue. When a pregnancy occurs, however, this structure

remains active. Sometimes, as a result of normal ovulation, the corpus luteum persists and forms a small ovarian cyst (fluid-filled sac). This condition usually resolves without treatment.

Checkpoint 23-12: What is the structure that surrounds the egg as it ripens?

Checkpoint 23-13: What is the process of releasing an egg cell from the ovary called?

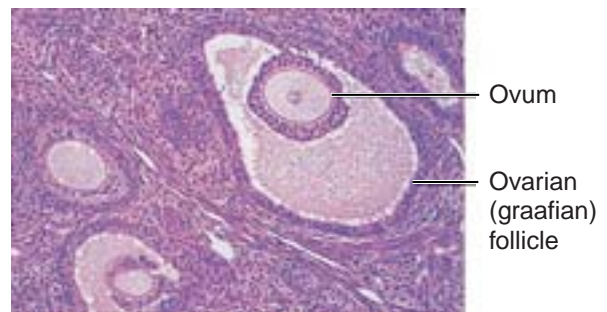


Figure 23-9 Microscopic view of the ovary. The photomicrograph shows egg cells (ova) developing within ovarian (graafian) follicles. (Courtesy of Dana Morse Bittus and B. J. Cohen)

Accessory Organs

The accessory organs in the female are the oviducts, the uterus, the vagina, the greater vestibular glands, and the vulva and perineum.

The Oviducts The tubes that transport the ova in the female reproductive system, the oviducts, are also known as **uterine** (U-ter-in) **tubes**, or **fallopian** (fah-LO-pe-an) **tubes**. Each is a small, muscular structure, nearly 12.5 cm (5 inches) long, extending from a point near the ovary to the uterus (womb). There is no direct connection between the ovary and this tube. The ovum is swept into the oviduct by a current in the peritoneal fluid produced by the small, fringelike extensions called **fimbriae** (FIM-bre-e) that are located at the edge of the tube's opening into the abdomen (see Fig. 23-8)

Unlike the sperm cell, the ovum cannot move by itself. Its progress through the oviduct toward the uterus depends on the sweeping action of cilia in the tube's lining and on peristalsis of the tube. It takes about 5 days for an ovum to reach the uterus from the ovary.

Checkpoint 23-14: What does the follicle become after ovulation?

The Uterus The oviducts lead to the **uterus** (U-ter-us), an organ in which a fetus can develop to maturity. The uterus is a pear-shaped, muscular organ about 7.5 cm (3 inches) long, 5 cm (2 inches) wide, and 2.5 cm (1 inch) deep. (The organ is typically larger in women who have borne children and smaller in postmenopausal women). The superior portion rests on the upper surface of the urinary bladder; the inferior portion is embedded in the pelvic

floor between the bladder and the rectum. The wider upper region of the uterus is called the **corpus**, or **body**; the lower, narrower region is the **cervix** (SER-viks), or **neck**. The small, rounded region above the level of the tubal entrances is known as the **fundus** (FUN-dus) (see Fig. 23-8).

The broad ligaments support the uterus, extending from each side of the organ to the lateral body wall. Along with the uterus, these two portions of peritoneum form a partition dividing the female pelvis into anterior and posterior areas. The ovaries are suspended from the broad ligaments, and the oviducts lie within the upper borders. Blood vessels that supply these organs are found between the layers of the broad ligament (see Fig. 23-8).

The muscular wall of the uterus is called the **myometrium** (mi-o-ME-tre-um) (Fig. 23-10). The lining of the uterus is a specialized epithelium known as **endometrium** (en-do-ME-tre-um). This inner layer changes during the menstrual cycle, first preparing to nourish a fertilized egg, then breaking down if no fertilization occurs to be released as the menstrual flow. The cavity inside the uterus is shaped somewhat like a capital T, but it is capable of changing shape and dilating as a fetus develops.

Checkpoint 23-15: In what organ does a fetus develop?

The Vagina The cervix leads to the **vagina** (vah-JI-nah), the distal part of the birth canal, which opens to the outside of the body. The vagina is a muscular tube about 7.5 cm (3 inches) long connecting the uterine cavity with the outside. The cervix dips into the superior portion of the vagina forming a circular recess known as the **fornix** (FOR-niks). The deepest area of the fornix, located behind the cervix, is the **posterior fornix** (Fig. 23-11). This recess in the poste-

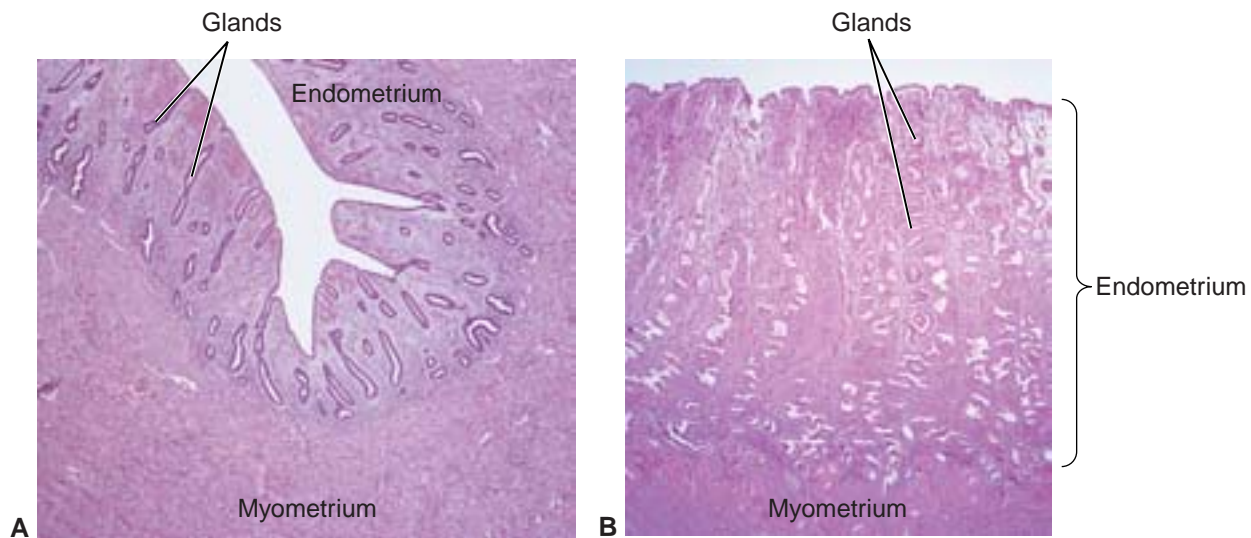


Figure 23-10 The uterus as seen under the microscope. The photomicrographs show the myometrium and endometrium and illustrate the changes that occur in the endometrium during the menstrual cycle. (A) Proliferative phase (first part of cycle). (B) Secretory phase (second part of cycle). (Reprinted with permission from Cormack DH. *Essential Histology*. 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2001.) **ZOOMING IN** ♦ In which part of the menstrual cycle is the endometrium most highly developed?

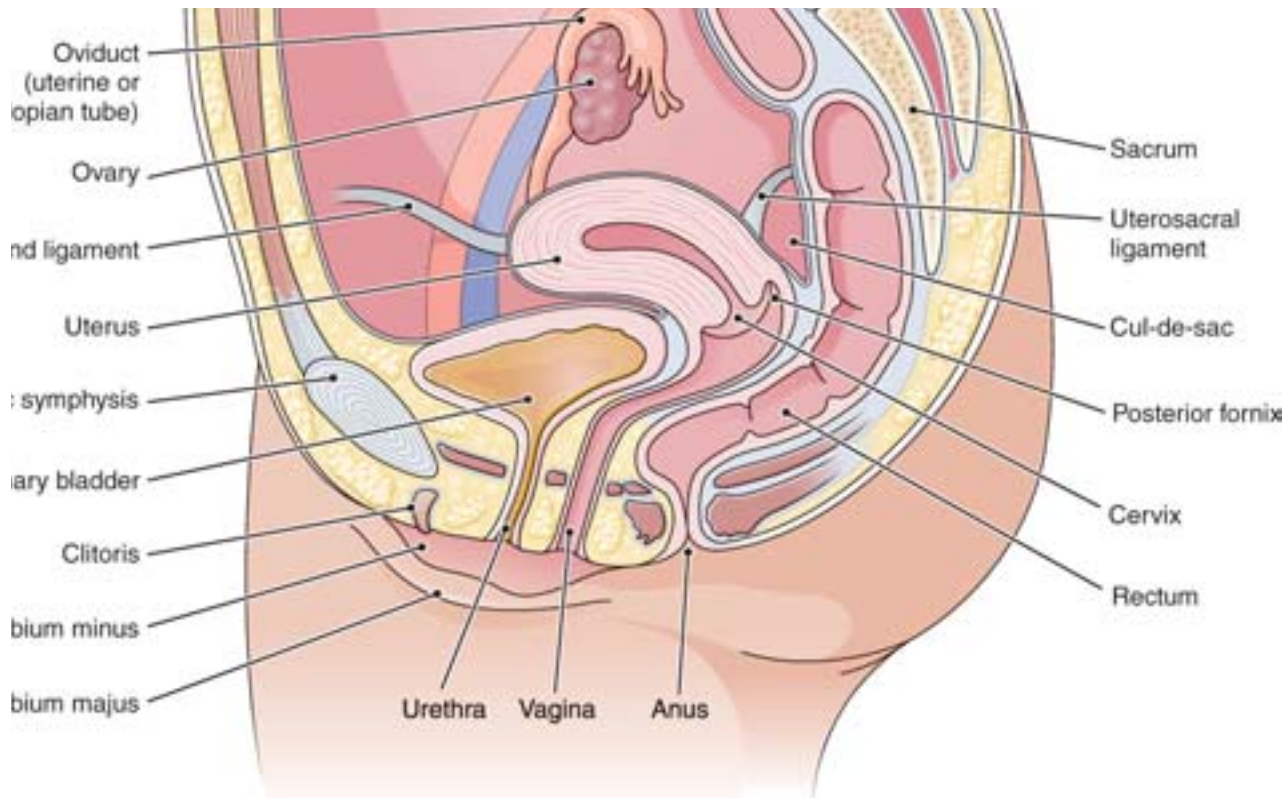


Figure 23-11 Female reproductive system (sagittal section). This view shows the relationship of the reproductive organs to each other and to other structures in the pelvic cavity. *ZOOMING IN ♦ Which has the more anterior opening, the vagina or the urethra?*

rior vagina lies adjacent to the most inferior portion of the peritoneal cavity, a narrow passage between the uterus and the rectum named the **cul-de-sac** (from the French meaning “bottom of the sack”). This area is also known as the *rectouterine pouch* or the *pouch of Douglas*. A rather thin layer of tissue separates the posterior fornix from this region, so that abscesses or tumors in the peritoneal cavity can sometimes be detected by vaginal examination.

The lining of the vagina is a wrinkled mucous membrane similar to that found in the stomach. The folds (*rugae*) permit enlargement so that childbirth usually does not tear the lining. In addition to being a part of the birth canal, the vagina is the organ that receives the penis during sexual intercourse. A fold of membrane called the **hymen** (HI-men) may sometimes be found at or near the vaginal (VAJ-ih-nal) canal opening (see Fig. 23-12).

The Greater Vestibular Glands Just superior and lateral to the vaginal opening are the two mucus-producing

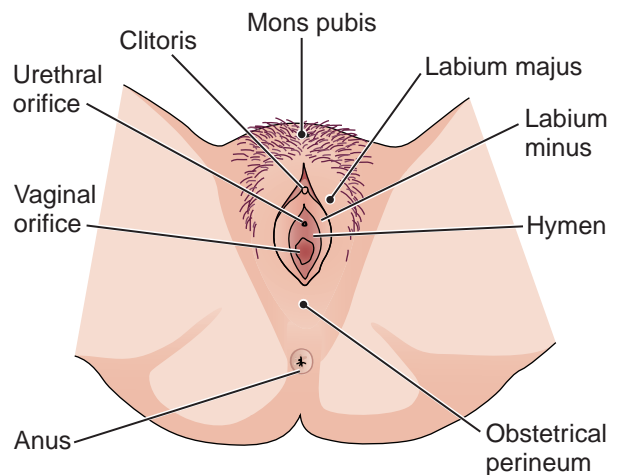


Figure 23-12 External parts of the female reproductive system. Related structures are also shown.

greater vestibular (ves-TIB-u-lar) (Bartholin) **glands** (see Fig. 23-8). These glands secrete into an area near the vaginal opening known as the **vestibule**. Like the Cowper glands in males, these glands provide lubrication during intercourse. If a gland becomes infected, a surgical incision may be needed to reduce swelling and promote drainage.

The Vulva and the Perineum The external parts of the female reproductive system form the **vulva** (VUL-vah), which includes two pairs of lips, or **labia** (LA-be-ah); the **clitoris** (KLIT-o-ris), which is a small organ of great sensitivity; and related structures. Although the entire pelvic floor in both the male and female (see Fig. 8-15 in Chapter 8) is properly called the **perineum** (per-ih-NE-um), those who care for pregnant women usually refer to the limited area between the vaginal opening and the anus as the perineum or obstetrical perineum.

► The Menstrual Cycle

In the female, as in the male, reproductive function is controlled by pituitary hormones that are regulated by the hypothalamus. Female activity differs, however, in that it is cyclic; it shows regular patterns of increases and decreases in hormone levels. These changes are regulated by hormonal feedback. The typical length of the menstrual cycle varies between 22 and 45 days, but 28 days is taken as an average, with the first day of menstrual flow being considered the first day of the cycle (Fig. 23-13).

Beginning of the Cycle

At the start of each cycle, under the influence of pituitary FSH, several follicles, each containing an ovum, begin to develop in the ovary. Usually, only one of these follicles will ultimately release an ovum from the ovary in a single month. The follicle produces increasing amounts of **estrogen** as it matures (see Fig. 23-13). (*Estrogen* is the term used for a group of related hormones, the most active of which is estradiol.) The estrogen is carried in the bloodstream to the uterus, where it starts preparing the endometrium for a possible pregnancy. This preparation includes thickening of the endometrium and elongation of the glands that produce the uterine secretion. Estrogen in the blood also acts as a feedback messenger to inhibit the release of FSH and stimulate the release of LH from the pituitary (see Fig. 12-3 in Chap. 12). (Note that there is an unexplained rise in FSH at the time of ovulation, as shown in Fig. 23-13.)

Ovulation

In an average 28-day cycle, ovulation occurs on day 14 and is followed two weeks later by the start of the menstrual flow. However, an ovum can be released any time from day 7 to 21, thus accounting for the variation in the

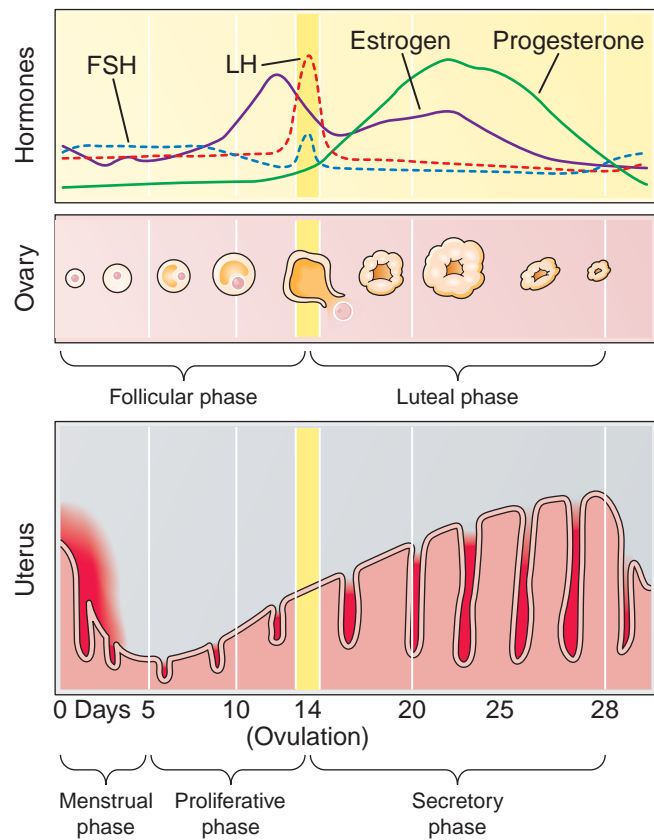


Figure 23-13 The menstrual cycle. Changes in hormones, the ovary, and the uterus are shown during a typical 28-day menstrual cycle with ovulation on day 14. (Pituitary hormones are shown with dashed lines, ovarian hormones with solid lines.) **ZOOMING IN** ♦ What hormone peaks closest to ovulation?

length of normal cycles. About 1 day before ovulation, there is an **LH surge**, a sharp rise of LH in the blood. This hormone causes ovulation and transforms the ruptured follicle into the corpus luteum, which produces some estrogen and large amounts of **progesterone**. Under the influence of these hormones, the endometrium continues to thicken, and the glands and blood vessels increase in size. The rising levels of estrogen and progesterone feed back to inhibit the release of FSH and LH from the pituitary. During this time, the ovum makes its journey to the uterus by way of the oviduct. If the ovum is not fertilized while passing through the uterine tube, it dies within 2 to 3 days and then disintegrates.

During each menstrual cycle, changes occur in both the ovary and the uterus (see Fig. 23-13). The time before ovulation is described as the follicular phase in the ovary, because it encompasses development of the ovarian follicle. The uterus during this same time is in a proliferative phase, marked by growth of the endometrium. After ovulation, the ovary is in a luteal phase, with conversion of the follicle to the corpus luteum, and the uterus is described as being in a secretory phase, based on activity of the endometrial glands.

Checkpoint 23-16: What are the two hormones produced in the ovaries?

The Menstrual Phase

If fertilization does not occur, the corpus luteum degenerates, and the levels of estrogen and progesterone decrease. Without the hormones to support growth, the endometrium degenerates. Small hemorrhages appear in this tissue, producing the bloody discharge known as **menstrual flow**, or **menses** (MEN-seze). Bits of endometrium break away and accompany the blood flow during this period of **menstruation** (men-stru-A-shun). The average duration of menstruation is 2 to 6 days.

Even before the menstrual flow ceases, the endometrium begins to repair itself through the growth of new cells. The low levels of estrogen and progesterone allow the release of FSH from the anterior pituitary. FSH causes new follicles to begin to ripen within the ovaries, and the cycle begins anew.

The activity of ovarian hormones as negative feedback messengers is the basis of hormonal methods of contraception (birth control). Estrogen and progesterone inhibit the release of FSH and LH from the pituitary, resulting in a menstrual period but no ovulation.

Menopause

Menopause (MEN-o-pawz) is the period during which menstruation ceases altogether. It ordinarily occurs gradually between the ages of 45 and 55 years and is caused by a normal decline in ovarian function. The ovary becomes chiefly scar tissue and no longer produces ripe follicles or appreciable amounts of estrogen. Eventually, the uterus, oviducts, vagina, and vulva all become somewhat atrophied and the vaginal mucosa becomes thinner, dryer and more sensitive.

Menopause is an entirely normal condition, but its onset sometimes brings about effects that are temporarily disturbing. The decrease in estrogen levels can cause nervous symptoms, such as anxiety, insomnia, and “hot flashes.”

Hormone Replacement Therapy

Physicians may prescribe hormone replacement therapy (HRT) to relieve the discomforts associated with menopause. This medication is usually a combination of estrogen with a synthetic progesterone (progestin), which is included to prevent overgrowth of the endometrium and the risk of endometrial cancer. Early assumptions about the role of estrogen in preventing heart attacks have been disproved by carefully controlled studies, at least with regard to the most commonly prescribed form of HRT. The hormone therapy did lower the incidence of colorectal cancer and hip fractures, a sign of osteoporosis. Studies are continuing with estrogen alone, generally pre-

scribed for women who have undergone a hysterectomy and do not have a uterus.

In addition to an increased risk of breast cancer, HRT also carries a risk of thrombosis and embolism, which is highest among women who smoke. All HRT risks increase with the duration of therapy. Therefore, treatment should be given for a short time and at the lowest effective dose. Women with a history or family history of breast cancer or circulatory problems should not take HRT.

Checkpoint 23-17: What is the definition of menopause?

Birth Control

Birth control is most commonly achieved by **contraception**, which is the use of artificial methods to prevent fertilization of the ovum. Birth control measures that prevent implantation of the fertilized ovum are also considered contraceptives, although technically they do not prevent conception and are more accurately called **abortifacients** (ah-bor-tih-FA-shents) (agents that cause abortion). Some of the birth control methods act by both mechanisms. **Table 23-1** presents a brief description of the main contraceptive methods currently in use along with some advantages and disadvantages of each. The list is given in rough order of decreasing effectiveness. Unless specifically mentioned as doing so, a given method does *not* prevent the transmission of STIs.

The various hormonal methods of birth control basically differ in how they administer the hormones. The emergency contraceptive pill (ECP) is a synthetic progesterone (progestin) taken within 72 hours after intercourse, usually in two doses 12 hours apart. It reduces the risk of pregnancy following unprotected intercourse. This so-called “morning after pill” is intended for emergency use and not as a regular birth control method. Birth control hormones can also be implanted as capsules under the skin of the upper arm. This method is highly effective and lasts for 3-5 years, but the capsules must be implanted and removed by a health professional, and they have been difficult to remove in some cases. (See Box 23-3 on hormonal contraception for men.)

The female condom is a sheath that fits into the vagina. It does protect against STIs, but is not very convenient to use. Researchers have also done trials with a male contraceptive pill, but none is on the market as yet. Mefipristone (RU 486) is a drug taken after conception to terminate an early pregnancy. It blocks the action of progesterone, causing the uterus to shed its lining and release the fertilized egg. It must be combined with administration of prostaglandins to expel the uterine tissue. Mefipristone is not in widespread use in the U.S., but it has been used in other countries.

Checkpoint 23-18: What is the definition of contraception?

Table 23•1 Main Methods of Birth Control Currently in Use

METHOD	DESCRIPTION	ADVANTAGES	DISADVANTAGES
Surgical Vasectomy/tubal ligation	Cutting and tying of tubes carrying gametes	Nearly 100% effective; involves no chemical or mechanical devices	Not usually reversible; rare surgical complications
Hormonal Birth control pills	Estrogen and progestin or progestin alone taken orally to prevent ovulation	Highly effective; requires no last-minute preparation	Alters physiology; return to fertility may be delayed. Risk of cardiovascular disease in older women who smoke or have hypertension.
Birth control shot	Injection of synthetic progesterone every 3 months to prevent ovulation	Highly effective; lasts for 3 to 4 months	Alters physiology; same possible side effects as birth control pill; also possible menstrual irregularity, amenorrhea
Birth control patch	Adhesive patch placed on body that administers estrogen and progestin through the skin; left on for 3 weeks and removed for a fourth week	Protects long-term; less chance of incorrect use; no last-minute preparation	Alters physiology; same possible side effects as birth control pill
Birth control ring	Flexible ring inserted into vagina that releases hormones internally; left in place for three weeks and removed for a fourth week.	Long-lasting, highly effective; no last minute preparation	Possible infections, irritation; same possible side effects as birth control pill
Barrier Male condom	Sheath that fits over erect penis and prevents release of semen	Easily available; does not effect physiology; protects against sexually transmitted disease (STI)	Must be applied just before intercourse; may slip or tear
Diaphragm (with spermicide)	Rubber cap that fits over cervix and prevents entrance of sperm	Does not affect physiology; some protection against STI; no side effects	Must be inserted before intercourse and left in place for 6 hours; requires fitting by physician
Contraceptive sponge (with spermicide)	Soft, disposable foam disk containing spermicide, which is moistened with water and inserted into vagina	Protects against pregnancy for 24 hours; non-hormonal; some STI protection; available without prescription; inexpensive	85–90% effective depending on proper use; skin irritation
Intrauterine device (IUD)	Metal or plastic device inserted into uterus through vagina; prevents fertilization and implantation by release of copper or birth control hormones	Highly effective for 5–10 years depending on type; reversible; no last-minute preparation	Must be introduced and removed by health professional; heavy menstrual bleeding
Other Spermicide	Chemicals used to kill sperm; best when used in combination with a barrier method	Available without prescription; inexpensive; does not affect physiology; some protection against STI	Local irritation; must be used just before intercourse
Fertility awareness	Abstinence during fertile part of cycle as determined by menstrual history, basal body temperature, or quality of cervical mucus	Does not affect physiology; accepted by certain religions	High failure rate; requires careful record keeping

Box 23-3 Hot Topics

Hormonal Contraception: New Options for Men

At present, sexually active men have few effective options for contraception, the most reliable being condoms or vasectomy. While condoms have the additional benefit of preventing sexually transmitted infections, their failure rate for preventing pregnancy is about 10%. With a failure rate of about 1%, vasectomies are much more reliable but are suitable only for couples who do not want children or are finished having children. A new option is on the horizon, however—male hormonal contraception.

Like female contraception, the male version of “the pill” works by suppressing the release of gonadotropin releasing hormone (GnRH) from the hypothalamus. This, in turn, blocks the pituitary’s release of luteinizing hormone (LH) and follicle stimulating hormone (FSH), both of which play an important role in spermatogenesis.

Several therapies that decrease LH and FSH production in men are under investigation. One method already in clinical trials uses

high levels of testosterone to negatively feed back to the hypothalamus and suppress GnRH secretion. Currently, this method requires regular testosterone injections, which makes it impractical for general use. In addition, doses of testosterone high enough to stop spermatogenesis may be associated with side effects such as acne, weight gain, mood changes, and increased risk of cardiovascular disease. More practical methods of drug delivery, such as pills, transdermal patches, and implants are being developed and may be effective at lower testosterone doses.

Another promising method uses the female hormone progesterone to block GnRH production. While this method suppresses spermatogenesis more effectively than does testosterone alone, it also suppresses normal testosterone production. Thus, the progesterone must be combined with testosterone to prevent the loss of secondary sex characteristics. Investigation is still underway to determine the best way to deliver such combination therapy.

Disorders of the Female Reproductive System

Female reproductive disorders include menstrual disturbances, various forms of tumors, and infections, any of which can contribute to infertility.

Menstrual Disorders

Absence of menstrual flow is known as **amenorrhea** (ah-men-o-RE-ah). This condition can be symptomatic of insufficient hormone secretion or congenital abnormality of the reproductive organs. Stress and other psychological factors often play a part in cessation of the menstrual flow. For example, any significant change in a woman’s general state of health or change in her living habits, such as a shift in working hours, can interfere with menstruation. Very low body weight with a low percentage of body fat can lead to amenorrhea by reducing estrogen synthesis, as may occur in athletes who over-train without eating enough and in women who are starving or have eating disorders.

Dysmenorrhea (dis-men-o-RE-ah) means painful or difficult menstruation. In young women, this may be due to immaturity of the uterus. Dysmenorrhea is frequently associated with cycles in which ovulation has occurred. Often, the pain can be relieved by drugs that block prostaglandins, because some prostaglandins are known to cause painful uterine contractions.

In many cases, women have been completely relieved of menstrual cramps by their first pregnancies. Apparently, enlargement of the cervical opening remedies the condition. Artificial dilation of the cervical opening may alleviate dysmenorrhea for several months. Often, such

health measures as sufficient rest, a well-balanced diet, and appropriate exercise remedy the disorder. In cases of dysmenorrhea, the application of heat over the abdomen usually relieves the pain, just as it may ease other types of muscular cramps.

Premenstrual syndrome (PMS), also called **premenstrual tension**, is a condition in which nervousness, irritability, and depression precede the menstrual period. It is thought to be due to fluid retention in various tissues, including the brain. Sometimes, a low-salt diet and appropriate medication for 2 weeks before the menses prevent this disorder. This treatment may also avert dysmenorrhea.

Abnormal uterine bleeding includes excessive menstrual flow, too-frequent menstruation, and nonmenstrual bleeding. Any of these may cause serious anemias and deserve careful medical attention. Nonmenstrual bleeding may be an indication of a tumor, possibly cancer.

Benign and Malignant Tumors

Fibroids, which are more correctly called *myomas*, are common tumors of the uterus. Studies indicate that about 50% of women who reach the age of 50 have one or more of these growths in the walls of the uterus. Often, these tumors are small, and usually they remain benign and produce no symptoms. They develop between puberty and menopause and ordinarily stop growing after a woman has reached the age of 50 years. In some cases, these growths interfere with pregnancy, and in a patient younger than 40 years of age, a surgeon may simply remove the tumor and leave the uterus fairly intact. Normal pregnancies have occurred after such surgery.

Fibroids may become so large that pressure on adjacent structures causes grave disorders. In some cases, invasion of blood vessels near the uterine cavity causes serious hemorrhages. For these and other reasons, it may be necessary to remove the entire uterus or a large part of it. Surgical removal of the uterus is called a **hysterectomy** (his-ter-EK-to-me).

Breast Cancer Cancer of the breast is the most commonly occurring malignant disease in women. The risk factors in breast cancer are age past 40, family history of breast cancer, and factors that increase exposure to estrogen, such as early onset of menstruation, late menopause, late or no pregnancies, long-term HRT, and obesity (fat cells produce estrogen). Mutations in two genes (BRCA1 and BRCA2) are responsible for hereditary forms of breast cancer, which make up only about 8% of all cases. These same genetic mutations are associated with an increased risk of ovarian cancer.

The tumor is usually a painless, movable mass that is often noticed by a woman and all too frequently ignored. In recent years, however, there has been increasing emphasis on the importance of regular breast self-examination (BSE). (Most breast lumps are discovered by women themselves.) Any lump, no matter how small, should be reported to a physician immediately. The **mammogram**, a radiographic study of the breast, has improved the detection of early breast cancer. Guidelines recommend regular mammograms after the age of 40 years unless there is a history of breast cancer in the family, in which case earlier studies are recommended. Suspicious areas require further study by ultrasonography or biopsy, either a needle aspiration, removal of a core of tissue or excision of the lump.

Breast cancer treatment consists of surgery with follow-up therapy of radiation, chemotherapy, or both. Surgical treatment by removal of the lump (“lumpectomy”) or a segment of the breast is most common. Removal of the entire breast and dissection of the lymph nodes in the axilla (armpit) is called **modified radical mastectomy** (mas-TEK-to-me). The extent of tumor spread through the lymph nodes is an important factor in prognosis. In a sentinel lymph node biopsy, the first (sentinel) lymph nodes to receive lymph from the tumor are identified and tested for cancerous cells. Treatment is based on how much spread has occurred (see Box 16-2). Treatment of breast cancer is often followed by administration of drugs to block estrogen receptors in breast tissue or drugs that inhibit tumor growth factors.

Note that the incidence of the various types of cancer should not be confused with the death rates for each type. Owing to education of the public and increasingly better methods of diagnosis and treatment, some forms of cancer have a higher cure rate than others. For example, breast cancer appears much more often in women than lung cancer, but more women now die each year from lung cancer than from breast cancer.

Endometrial Cancer The most common cancer of the female reproductive tract is cancer of the endometrium (the lining of the uterus). This type of cancer usually affects women during or after menopause. It is seen most frequently in women who have been exposed to high levels of estrogen, which causes overgrowth of the endometrium. This group includes those who have received estrogen therapy unopposed by progesterone, those who have had few or no pregnancies, and the obese. Symptoms include an abnormal discharge or irregular bleeding; later there is cramping and pelvic pain. This type of cancer is diagnosed by endometrial biopsy. The usual methods of treatment include surgery and irradiation. Endometrial cancer grows slowly in its beginning stages, so early, aggressive treatment usually saves a patient’s life.

Ovarian Cancer Ovarian cancer is the second most common reproductive tract cancer in the female, usually occurring in women between the ages of 40 and 65 years. It is a leading cause of cancer deaths in women. Although most ovarian cysts are not malignant, they should always be investigated for possible malignant change. Ovarian cancer is highly curable if treated before it has spread to other organs. However, these malignancies tend to progress rapidly, and they are difficult to detect because symptoms are vague, there are few recognized risk factors, and at present there is no screening test.

Cervical Cancer Cancer of the cervix is linked to infection with human papilloma virus (HPV), which causes genital warts and is spread through sexual contact. Thus, cervical cancer can be considered a sexually transmitted disease. Risk factors for the disease are related to exposure to HPV, such as early age of sexual activity and multiple sex partners. Certain strains of the virus are found in cervical carcinomas and precancerous cervical cells.

Early detection is often possible because the cancer develops slowly from atypical cervical cells. The decline in the death rate from cervical cancer is directly related to use of the **Papanicolaou** (pap-ah-nik-o-LAH-o) test, also known as the *Pap test* or *Pap smear*. The Pap smear is a microscopic examination of cells obtained from cervical scrapings and swabs of the cervical canal. All women should be encouraged to have this test every year. Even girls younger than 18 years of age should be tested if they are sexually active. Guidelines now recommend less frequent testing after normal results are obtained in three annual tests.

Infections

Infections that affect the male reproductive system also infect the female genital organs (Fig. 23-14), although these diseases may be less apparent in women. The most common STIs in women are chlamydial infections, gonorrhea, HIV and genital herpes, caused by herpes simplex virus (HSV). Syphilis also occurs in women and can be

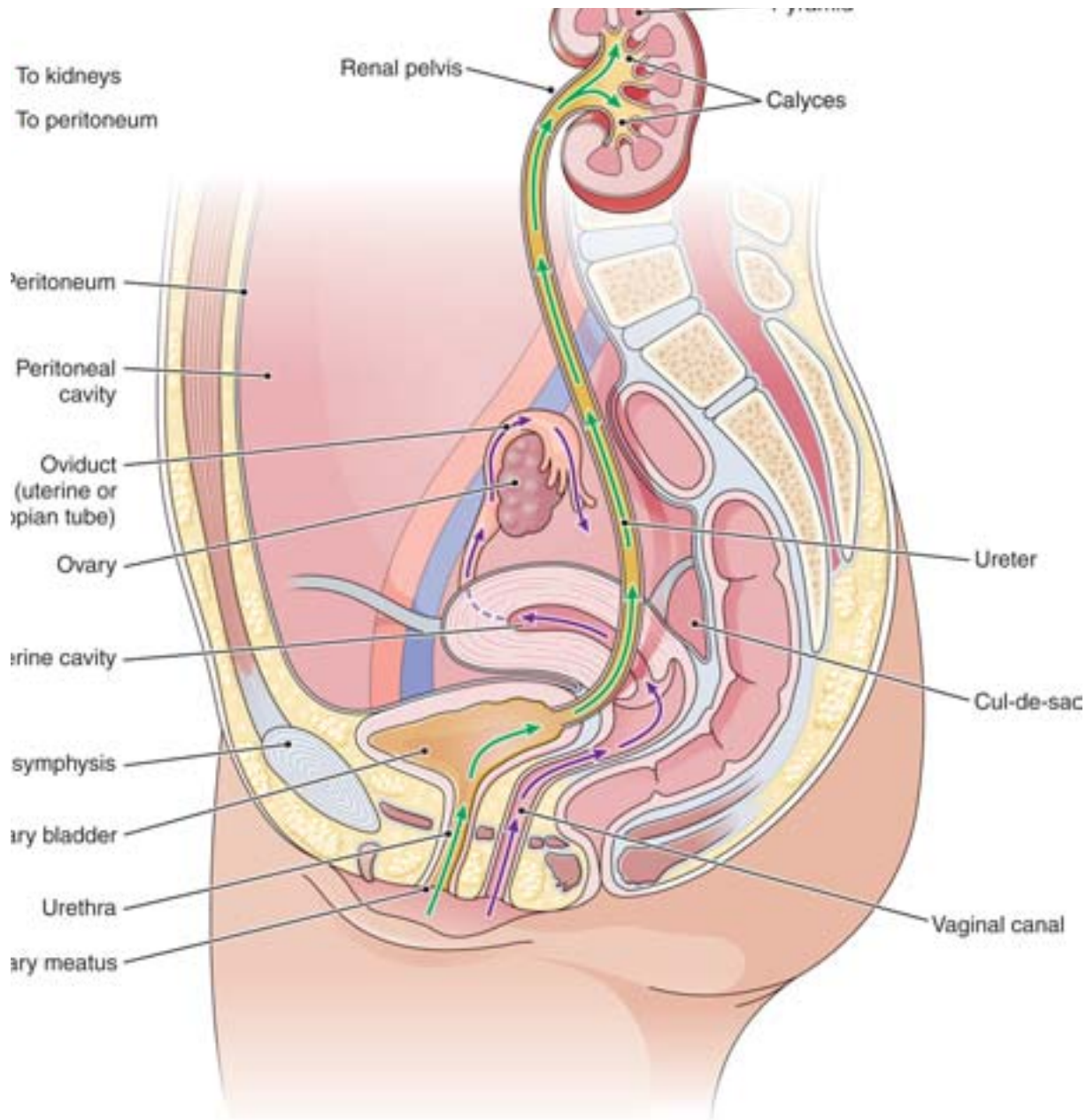


Figure 23-14 Pathway of infection. Disease organisms can travel from outside to the peritoneum and into the urinary system.

passed through the placenta from mother to fetus, causing stillbirth or birth of an infected infant.

The incidence of **genital warts**, caused by human papillomavirus, (HPV) has increased in recent years. These infections have been linked to cancer of the reproductive tract, especially as noted, cancer of the uterine cervix.

Salpingitis (sal-pin-JI-tis) means inflammation of any tube, but usually refers to disease of the uterine tubes (oviducts). Most uterine tube infections are caused by gonococci or by the bacterium *Chlamydia trachomatis*, but other bacteria may be the cause. Salpingitis may cause sterility by obstructing the tubes, thus preventing the passage of ova.

Pelvic inflammatory disease (PID) is due to extension of infections from the reproductive organs into the pelvic cavity, and it often involves the peritoneum. (See the red arrow pathway in Fig. 23-14.) Gonococcus or chlamydia is usually the initial cause of infection, but most cases of PID involve multiple organisms.

Infertility

Infertility is much more difficult to diagnose and evaluate in the female than in the male. Whereas a microscopic examination of properly collected semen may be enough to determine the presence of abnormal or too few sperm

cells in the male, no such simple study can be made in the female. Infertility in women, as in men, may be relative or absolute. Causes of female infertility include infections, endocrine disorders, psychogenic factors, and abnormalities in the structure and function of the reproductive or-

gans themselves. In all cases of apparent infertility, the male partner should be investigated first because the procedures for determining lack of fertility in the male are much simpler and less costly than those in the female, as well as being essential for the evaluation.

Word Anatomy

Medical terms are built from standardized word parts (prefixes, roots, and suffixes). Learning the meanings of these parts can help you remember words and interpret unfamiliar terms.

WORD PART	MEANING	EXAMPLE
The Male Reproductive System		
semin/o	semen, seed	Sperm cells are produced in the <i>seminiferous</i> tubules.
test/o	testis	The hormone <i>testosterone</i> is produced in the testis.
acr/o	extreme end	The <i>acrosome</i> covers the head of a sperm cell.
fer	to carry	The ductus <i>deferens</i> carries spermatozoa away from (de-) the testis.
circum-	around	A cut is made around the glans to remove part of the foreskin in a <i>circumcision</i> .
Disorders of the Male Reproductive System		
olig/o-	few, deficiency	<i>Oligospermia</i> is a deficiency in the numbers of spermatozoa produced.
crypt/o-	hidden	<i>Cryptorchidism</i> refers to an undescended testis (orchid/o).
orchid/o, orchi/o	testis	<i>Orchiectomy</i> is removal of the testis.
The Female Reproductive System		
ov/o, ov/i	egg	An <i>ovum</i> is an egg cell.
ovar, ovari/o	ovary	The <i>ovarian</i> follicle encloses a maturing ovum.
metr/o	uterus	The <i>myometrium</i> is the muscular (my/o) layer of the uterus.
rect/o	rectum	The <i>rectouterine</i> pouch is between the uterus and rectum.
Disorders of the Female Reproductive System		
men/o	uterine bleeding; menses	<i>Amenorrhea</i> is absence of menstrual flow
hyster/o	uterus	<i>Hysterectomy</i> is surgical removal of the uterus.
mamm/o	breast, mammary gland	A <i>mammogram</i> is radiographic study of the breast.
mast/o	breast	A <i>mastectomy</i> is surgical removal of the breast.
salping/o	tube	<i>Salpingitis</i> is inflammation of a tube, such as the oviduct.

Summary

I. Reproduction

- A. Meiosis—reduces chromosome number from 46 to 23
1. Gametes (sex cells)
 - a. Spermatozoa (sperm cells)—male
 - b. Ova (egg cells)—female

II. Male reproductive system

1. Primary organs—gonads
 2. Accessory organs—ducts and exocrine glands
- A. Testes
1. Scrotum—sac that holds the testes
 2. Inguinal canal—channel through which testis descends
 3. Internal structure
 - a. Seminiferous tubules—tubes in which sperm cells are produced
 - (1) Sustentacular (Sertoli) cells—aid in development of spermatozoa

- b. Interstitial cells (between tubules)—secrete hormones
 - (1) Testosterone
 - (a) Maintains reproductive structures
 - (b) Promotes development of secondary sex characteristics
 4. Spermatozoa
 - a. Head—contains chromosomes
 - b. Acrosome—covers head; has enzymes to help penetration of ovum
 - c. Midpiece—contains mitochondria
 - d. Tail (flagellum)—propels sperm
- B. Ducts
1. Epididymis—stores spermatozoa until ejaculation
 2. Ductus (vas) deferens—conducts sperm cells through spermatic cord
 3. Ejaculatory duct—empties into urethra

C. Semen

1. Functions
 - a. Nourish spermatozoa
 - b. Transport spermatozoa
 - c. Neutralize male urethra and vaginal tract
 - d. Lubricate reproductive tract during intercourse
 - e. Prevent infection
2. Glands
 - a. Seminal vesicles
 - b. Prostate—around first portion of urethra
 - c. Bulbourethral (Cowper) glands

D. Urethra and penis

1. Urethra
 - a. Conveys urine and semen through penis
2. Penis
 - a. Structure
 1. Corpus spongiosum—central; contains urethra
 2. Corpora cavernosa—lateral
 3. Glans—distal enlargement of corpus spongiosum
 4. Prepuce—foreskin
 - b. Erection—stiffening and enlargement of penis
 - c. Ejaculation—forceful expulsion of semen

III. Hormonal control of male reproduction

1. Pituitary hormones
 - a. FSH (follicle stimulating hormone)
 - (1) Stimulates Sertoli cells
 - (2) Promotes formation of spermatozoa
 - b. LH (luteinizing hormone)
 - (1) Stimulates interstitial cells to produce testosterone
 - (2) Also called ICSH (interstitial cell-stimulating hormone)

B. Effects of aging on male reproduction

1. Decline in testosterone, spermatozoa, and semen

IV. Disorders of the male reproductive system

- A. Infertility—lower than normal ability to reproduce
- B. Structural disorders
 1. Cryptorchidism—failure of testis to descend
 2. Torsion of the testis—twisting of spermatic cord
 3. Inguinal hernia
 4. Phimosis—tightness of the foreskin
- C. Infections
 1. Sexually transmitted infections (STI)
 2. Epididymitis—inflammation of the epididymis
 3. Prostatitis—inflammation of the prostate
 4. Orchitis—inflammation of the testis
- D. Tumors
 1. Tumors of the prostate
 - a. Benign prostatic hyperplasia (BPH)
 2. Cancer of the testis.

V. Female reproductive system**A. Ovaries—gonads in which ova form**

1. Ova and ovulation
 - a. Egg ripens in graafian follicle
 - b. Ovulation—release of ovum from ovary
2. Corpus luteum
 - a. Remainder of follicle in ovary

- b. Continues to function if egg fertilized
- c. Disintegrates if egg not fertilized

B. Oviducts (uterine tubes, fallopian tubes)

1. Fimbriae—fringelike extensions that sweep egg into oviduct

C. Uterus

1. Holds developing fetus
2. Supported by broad ligament
3. Endometrium—lining of uterus
4. Myometrium—muscle layer
5. Cervix—narrow, lower part

D. Vagina

1. Tube connecting uterus to outside
2. Hymen—fold of membrane over vaginal opening
3. Greater vestibular (Bartholin) glands—secrete mucus

E. Vulva and perineum

1. Vulva—external genitalia
 - a. Labia—two sets of folds (majora, minora)
 - b. Clitoris—organ of great sensitivity
2. Perineum—pelvic floor
 - a. In obstetrics—area between vagina and anus

VI. Menstrual cycle—average 28 days**A. Beginning of the cycle**

1. FSH stimulates follicle- follicular phase
2. Follicle secretes estrogen
3. Estrogen thickens lining of uterus—proliferative phase

B. Ovulation

1. LH surge 1 day before
2. Corpus luteum produces progesterone—luteal phase
3. Progesterone continues growth of endometrium—secretory phase
4. Ovum disintegrates if not fertilized

C. Menstrual phase (menstruation)

1. If egg not fertilized, corpus luteum degenerates
2. Lining of uterus breaks down releasing menses

VII. Menopause—period during which menstruation stops**A. Hormone replacement therapy (HRT)**

1. Reduces adverse symptoms of menopause
2. Risks of HRT—cardiovascular disorders, breast cancer

VIII. Birth control**A. Contraception—use of artificial methods to prevent fertilization or implantation of fertilized egg****B. Methods—surgery, hormonal, barrier, IUD, spermicides, fertility awareness****IX. Disorders of the female reproductive system****A. Menstrual disorders**

1. Amenorrhea—absence of menstrual flow
2. Dysmenorrhea—painful or difficult menstruation
3. Premenstrual syndrome
4. Abnormal uterine bleeding

B. Benign and malignant tumors

1. Fibroids (myomas)—common tumors of uterus
2. Breast cancer
 - a. Mammogram—radiographic study of the breast

- b. Mastectomy—removal of breast or breast tissue
- 3. Endometrial cancer—cancer of uterine lining
- 4. Ovarian cancer
- 5. Cervical cancer—due to human papilloma virus (HPV) infection
 - a. Pap test (smear) for cervical cancer
- D. Infections
 - 1. Sexually transmitted diseases
 - 2. Genital warts—caused by HPV
 - 3. Salpingitis—inflammation of uterine tubes
 - 4. Pelvic inflammatory disease (PID)
- E. Infertility

Questions for Study and Review

Building Understanding

Fill in the blanks

1. Gametes go through a special process of cell division called _____.
2. Spermatozoa begin their development in tiny coiled _____.
3. An ovum matures in a small fluid-filled cluster of cells called the _____.
4. Failure of the testis to descend into the scrotum results in the disorder _____.
5. Surgical removal of the uterus is called a(n) _____.

Matching

Match each numbered item with the most closely related lettered item.

- | | |
|---|---|
| <ul style="list-style-type: none"> ___ 6. A hormone released by the pituitary that promotes follicular development in the ovary ___ 7. A hormone released by developing follicles that promotes thickening of the endometrium ___ 8. A hormone released by the pituitary that stimulates ovulation ___ 9. A hormone released by the corpus luteum that promotes thickening of the endometrium | <ul style="list-style-type: none"> a. follicle stimulating hormone b. estrogen c. luteinizing hormone d. progesterone |
|---|---|

Multiple choice

- ___ 10. A month or two before birth, the testis travels from the abdominal cavity to the scrotum through the
 - a. spermatic cord
 - b. inguinal canal
 - c. seminiferous tubule
 - d. vas deferens
- ___ 11. Enzymes that help the sperm cell to penetrate the ovum are found in the
 - a. acrosome
 - b. head
 - c. midpiece
 - d. flagellum
- ___ 12. Inflammation of the testis is called
 - a. phimosis
 - b. epididymitis
 - c. prostatitis
 - d. orchitis
- ___ 13. The uterus and ovaries are supported by the
 - a. uterine tubes
 - b. broad ligaments
 - c. fimbriae
 - d. fornix
- ___ 14. The area between the vaginal opening and the anus is referred to as the
 - a. vestibule
 - b. vulva
 - c. hymen
 - d. perineum
- ___ 15. The most common site of cancer in the female reproductive tract is the
 - a. endometrium
 - b. myometrium
 - c. ovaries
 - d. cervix

Understanding Concepts

16. Compare and contrast the following terms:
 - a. asexual reproduction and sexual reproduction
 - b. spermatozoa and ova
 - c. sustentacular cell and interstitial cell
 - d. ovarian follicle and corpus luteum
 - e. myometrium and endometrium
17. Trace the pathway of sperm from the site of production to the urethra.
18. Describe the components of semen, their sites of production, and their functions.
19. List the hormones that control male reproduction and state their functions.
20. Trace the pathway of an ovum from the site of production to the site of implantation.
21. Beginning with the first day of the menstrual flow, describe the events of one complete cycle, including the role of the hormones involved.

22. Define *contraception*. Describe methods of contraception that involve (1) barriers; (2) chemicals; (3) hormones; (4) prevention of implantation.
23. Compare and contrast the following disorders:
 - a. epididymitis and prostatitis
 - b. benign prostatic hyperplasia and prostatic cancer
 - c. amenorrhea and dysmenorrhea
 - d. fibroids and endometrial cancer
 - e. ovarian cancer and cervical cancer

Conceptual Thinking

24. Theoretically, it is possible for a brain-dead man to ejaculate. What anatomical and physiological feature makes this possible?
25. Nicole, a middle-aged mother of three, is considering a tubal ligation, a contraceptive procedure that involves cutting the uterine tubes. Nicole is worried that this might cause her to enter early menopause. Should she be worried?