unit 2

Women's Health Throughout the Lifespan

chapter 3

Anatomy and Physiology of the Reproductive System

KeyTERMS

breasts
cervix
endometrium
estrogen
fallopian tubes
follicle-stimulating hormone (FSH)
luteinizing hormone (LH)
menstruation
ovaries
ovulation
penis
progesterone
testes
uterus
vagina
vulva

LearningOBJECTIVES

After studying the chapter content, the student should be able to accomplish the following:

1. Define the key terms.
2. Discuss the structure and function of the major external and internal female genital organs.
3. Outline the phases of the menstrual cycle, dominant hormones involved, and changes taking place in each phase.
4. Identify external and internal male reproductive structures and the function of each in hormonal regulation.

WOW

All nurses should take care of and respect the human body, for it is a wondrous, precision machine.

The reproductive system consists of organs that function in the production of offspring. In humans and other mammals, the female reproductive system produces the female reproductive cells (the eggs, or ova) and contains an organ (uterus) in which development of the fetus takes place; the male reproductive system produces the male reproductive cells (the sperm) and contains an organ (penis) that deposits the sperm within the female. Nurses need to have a thorough understanding of anatomy and physiology of the male and female reproductive systems to be able to care for them and the conditions that might affect their reproductive organs. This chapter will review the female and male reproductive systems and the menstrual cycle as it relates to reproduction.

Female Reproductive Anatomy and Physiology

The female reproductive system is composed of both internal and external reproductive organs.

Internal Female Reproductive Organs

The internal female reproductive organs consist of the vagina, the uterus, the fallopian tubes, and the ovaries. These structures develop and function according to the specific hormone influences that affect fertility and childbearing (Fig. 3-1).

Vagina

The **vagina** is a highly distensible musculomembranous canal situated in front of the rectum and behind the bladder. It is a tubular, fibromuscular organ lined with mucous membrane that lies in a series of transverse folds called rugae. The rugae allow for extreme dilatation of the canal during labor and birth. The vagina is a canal that connects the external genitals to the uterus. It receives the penis and the sperm ejaculated during sexual intercourse, and it serves as an exit passageway for menstrual blood and for the fetus during childbirth. The front and back walls normally touch each other so that there is no space in the vagina except when it is opened (e.g., during a pelvic examination or intercourse). In the adult, the vaginal cavity is 3 to 4 inches long. Muscles that control its diameter surround the lower third of the vagina. The upper two thirds of the vagina lies above these muscles and can be easily stretched. During a woman's reproductive years, the mucosal lining of the vagina has a corrugated appearance and is resistant to bacterial colonization. Before puberty and after menopause (if the woman is not taking estrogen), the mucosa is smooth secondary to lower levels of estrogen (Venes, 2005).

Uterus

The **uterus** is a pear-shaped muscular organ at the top of the vagina. It lies behind the bladder and in front of the rectum and is anchored in position by eight ligaments. It is not firmly attached or adherent to any part of the skeleton. A full bladder tilts it backward; a distended rectum, forward. It alters its position by gravity or with change of posture. It is the size and shape of an inverted pear. It is the site of menstruation, implantation of a fertilized ovum, development of the fetus during pregnancy, and labor. Before the first pregnancy, it measures approximately 3 inches long, 2 inches wide, and 1 inch thick. After a pregnancy, the uterus remains larger than before the pregnancy. After menopause, it becomes smaller and atrophies.

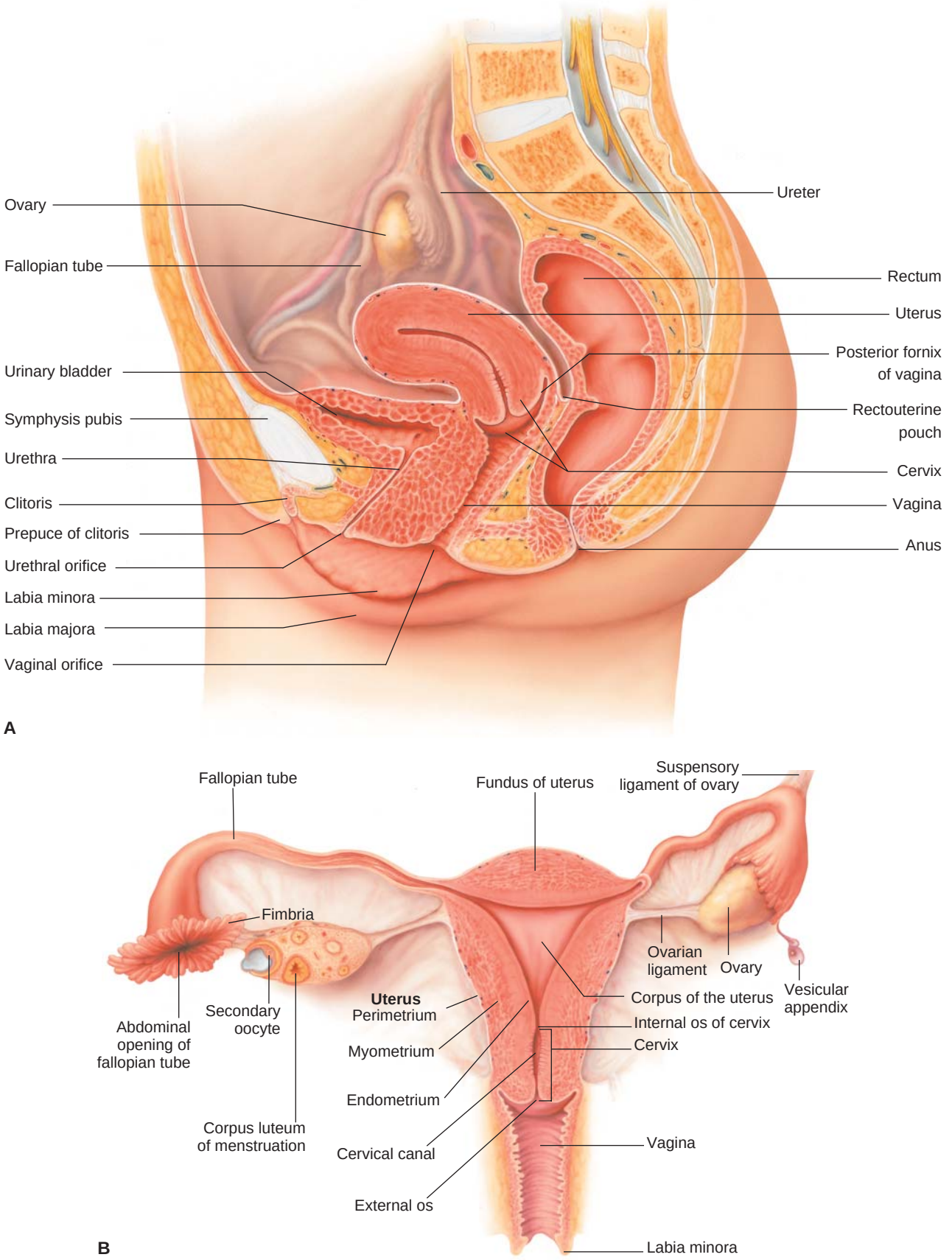
The uterine wall is relatively thick and composed of three layers: the endometrium (innermost layer), the myometrium (muscular middle layer), and the perimetrium (outer serosal layer that covers the body of the uterus). The **endometrium** is the mucosal layer that lines the uterine cavity in nonpregnant women. It varies in thickness from 0.5 mm to 5 mm and has an abundant supply of glands and blood vessels (Cunningham et al., 2004). The myometrium makes up the major portion of the uterus and is composed of smooth muscle linked by connective tissue with numerous elastic fibers. During pregnancy, the upper myometrium undergoes marked hypertrophy, but there is limited change in the cervical muscle content.

Anatomic subdivisions of the uterus include the convex portion above the uterine tubes (the fundus); the central portion (the corpus or body) between the fundus and the cervix; and the cervix, or neck, which opens into the vagina.

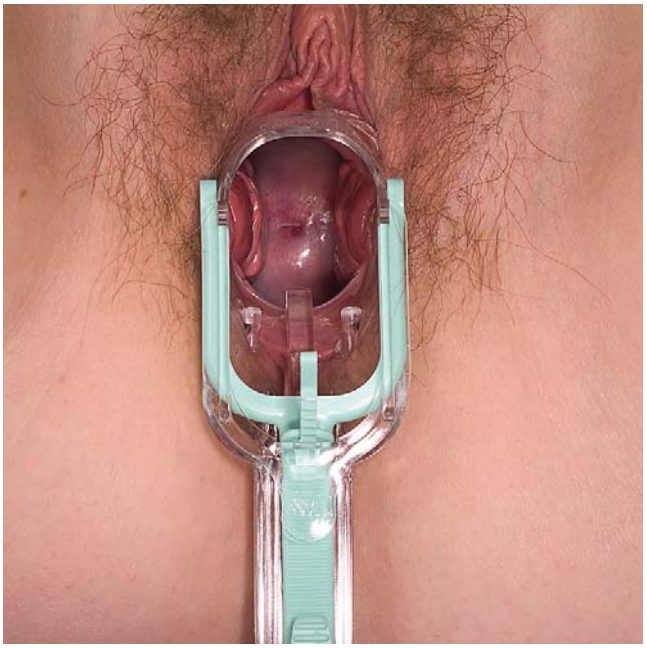
Cervix

The **cervix,** the lower part of the uterus, opens into the vagina and has a channel that allows sperm to enter the uterus and menstrual discharge to exit. It is composed of fibrous connective tissue. During a pelvic examination, the part of the cervix that protrudes into the upper end of the vagina can be visualized. Like the vagina, this part of the cervix is covered by mucosa, which is smooth, firm, and doughnut-shaped, with a visible central opening called the external os (Fig. 3-2). Before childbirth, the external cervical os is a small, regular, oval opening. After childbirth, the opening is converted into a transverse slit that resembles lips (Fig. 3-3). Except during menstruation or ovulation, the cervix is usually a good barrier against bacteria.

The canal or channel of the cervix is lined with mucus-secreting glands. This mucus is thick and impenetrable to sperm until just before the ovaries release an egg



● Figure 3-1 The internal female reproductive organs. (**A**) Lateral view. (**B**) Anterior view. (Source: The Anatomical Chart Company [2001]. *Atlas of human anatomy.* Springhouse, PA: Springhouse.)

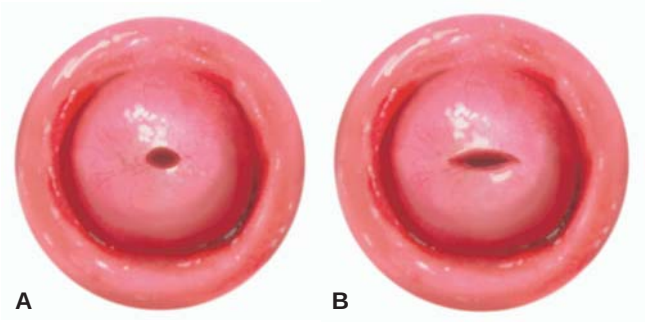


● Figure 3-2 Appearance of normal cervix. Note: This is the cervix of a multipara female. (Photo by B. Proud.)

(**ovulation**). At ovulation, the consistency of the mucus changes so that sperm can swim through it, allowing fertilization. At the same time, the mucus-secreting glands of the cervix actually become able to store live sperm for 2 or 3 days. These sperm can later move up through the corpus and into the fallopian tubes to fertilize the egg; thus, intercourse 1 or 2 days before ovulation can lead to pregnancy. Because some women do not ovulate consistently, pregnancy can occur at varying times after the last menstrual period. The channel in the cervix is narrow, too narrow for the fetus to pass through during pregnancy, but during labor it stretches to let the newborn through.

Corpus

The corpus, or the main body of the uterus, is a highly muscular organ that enlarges to hold the fetus during pregnancy. The inner lining of the corpus (endometrium) undergoes cyclic changes as a result of the changing levels of hormones secreted by the ovaries: it is thickest during the part of the menstrual cycle in which a fertilized egg would be expected to enter the uterus and is thinnest just after menstruation. If fertilization does not take place during this cycle, most of the endometrium is shed and bleeding occurs, resulting in the monthly period. If fertilization does take place, the embryo attaches to the wall of the uterus, where it becomes embedded in the endometrium (about 1 week after fertilization); this process is called implantation (Condon, 2004). Menstruation then ceases during the 40 weeks (280 days) of pregnancy. During labor, the muscular walls of the corpus contract to push the baby through the cervix and into the vagina.



● Figure 3-3 (**A**) Nulliparous cervical os. (**B**) Parous cervical os.

Fallopian Tubes

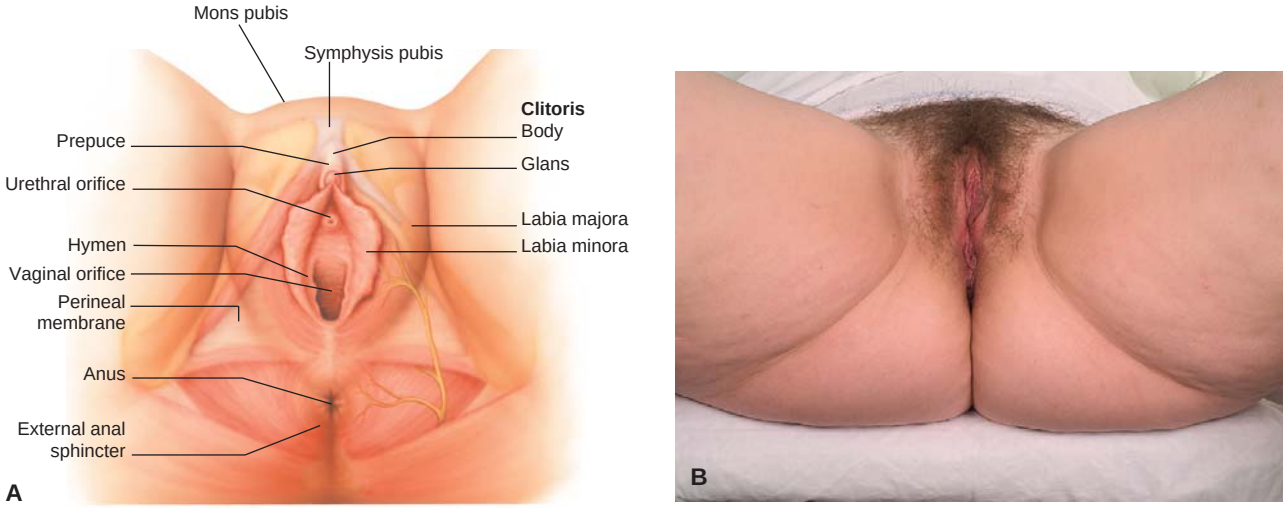
The **fallopian tubes** are hollow, cylindrical structures that extend 2 to 3 inches from the upper edges of the uterus toward the ovaries. Each tube is about 7 to 10 cm long (4 inches) and approximately 0.7 cm in diameter. The end of each tube flares into a funnel shape, providing a large opening for the egg to fall into when it is released from the ovary. Cilia (beating, hair-like extensions on cells) line the fallopian tube and the muscles in the tube's wall. The fallopian tubes convey the ovum from the ovary to the uterus and sperm from the uterus toward the ovary. This movement is accomplished via ciliary action and peristalsis. If sperm is present in the fallopian tube as a result of sexual intercourse or artificial insemination, fertilization of the ovum can occur. If the egg is fertilized, it will divide over a period of 4 days while it moves slowly down the fallopian tube and into the uterus.

Ovaries

The **ovaries** are a set of paired glands resembling unshelled almonds set in the pelvic cavity below and to either side of the umbilicus. They are usually pearl-colored and oblong. They are homologous to the testes. Each ovary weighs from 2 to 5 grams and is about 4 cm long, 2 cm wide, and 1 cm thick (Speroff & Fritz, 2005). Several ligaments help hold each ovary in position. The ovaries link the reproductive system to the body's system of endocrine glands, as they produce the ova (eggs) and secrete, in cyclic fashion, the female sex hormones **estrogen** and **progesterone.** After an ovum matures, it passes into the fallopian tubes. The ovaries are not attached to the fallopian tubes but are suspended nearby from a ligament.

External Female Reproductive Organs

The external female reproductive organs collectively are called the **vulva** (which means "covering" in Latin). The vulva serves to protect the urethral and vaginal openings and is highly sensitive to touch to increase the female's pleasure during sexual arousal (Sloane, 2002). The structures that make up the vulva include the mons pubis, the labia majora and minora, the clitoris, the structures within the vestibule, and the perineum (Fig. 3-4).



● Figure 3-4 (**A**) The external female reproductive organs. (**B**) Normal appearance of external structures. (Photo by B. Proud.)

Mons Pubis

The mons pubis is the elevated, rounded fleshy prominence over the symphysis pubis. This fatty tissue and skin is covered with pubic hair after puberty. It protects the symphysis pubis during sexual intercourse.

Labia

The labia majora (large lips), which are relatively large and fleshy, are comparable to the scrotum in males. The labia majora contain sweat and sebaceous (oil-secreting) glands; after puberty, they are covered with hair. Its function is to protect the vaginal opening. The labia minora (small lips) are the delicate hairless inner folds of skin that can be very small or up to 2 inches wide. They lie just inside the labia majora and surround the openings to the vagina and urethra. The labia minora grow down from the anterior inner part of the labia majora on each side. They are highly vascular and abundant in nerve supply. They lubricate the vulva, swell in response to stimulation, and are highly sensitive.

Clitoris and Prepuce

The clitoris is a small, cylindrical mass of erectile tissue and nerves. It is located at the anterior junction of the labia minora. There are folds above and below the clitoris. The joining of the folds above the clitoris forms the prepuce, a hood-like covering over the clitoris; the junction below the clitoris forms the frenulum. A rich supply of blood vessels gives it a pink color. The clitoris, like the penis, is very sensitive to touch, stimulation, and temperature and can become erect. The word "clitoris" is from the Greek word for key, which in ancient times was thought to be the key to a woman's sexuality. For its small size, it has a generous blood and nerve supply. There are more free nerve endings of sensory reception located on the clitoris than on any other part of the body, and it is, unsurprisingly, the most erotically sensitive part of the genitalia for most females. Its function is sexual stimulation (Mattson & Smith, 2004).

Vestibule

The vestibule is an oval area enclosed by the labia minora laterally. It extends from the clitoris to the fourchette and is perforated by six openings. Opening into the vestibule are the urethra from the urinary bladder, the vagina, and two sets of glands. The opening to the vagina is called the introitus, and the half-moon-shaped area behind the opening is called the fourchette. Through tiny ducts beside the introitus, Bartholin's glands, when stimulated, secrete mucus that supplies lubrication for intercourse. Skene's glands are located on either side of the opening to the urethra. They secrete a small amount of mucus to keep the opening moist and lubricated for the passage of urine (Olds et al., 2004).

The vaginal opening is surrounded by the hymen (maidenhead). The hymen is a tough, elastic, perforated, mucosa-covered tissue across the vaginal introitus. In a virgin, the hymen may completely cover the opening, but it usually encircles the opening like a tight ring. Because the degree of tightness varies among women, the hymen may tear at the first attempt at intercourse, or it may be so soft and pliable that no tearing occurs. In a woman who is not a virgin, the hymen usually appears as small tags of tissue surrounding the vaginal opening, but the presence or absence of the hymen can neither confirm nor rule out sexual experience (Mattson & Smith, 2004).

Perineum

The perineum is the most posterior part of the external female reproductive organs. This external region is located between the vulva and the anus. It is made up of skin, muscle, and fascia. The perineum can become lacerated or incised during childbirth and needs to be repaired with

sutures. Incising the perineum area to provide more space for the presenting part is called an episiotomy. Although still a common obstetric procedure, the use of episiotomy has decreased over the past 25 years. The procedure should be applied selectively rather than routinely. An episiotomy can add to postpartum discomfort, perineal trauma, and potential fecal incontinence (Cunningham et al., 2004).

Erection, Lubrication, and Orgasm

With sexual stimulation, tissues in the clitoris, in the breasts, and around the vaginal orifice fill with blood and the erectile tissues swell. At the same time, the vagina begins to expand and elongate to accommodate the penis. As part of the whole vasocongestive reaction, the labia majora and minor swell and darken in color. As sexual stimulation intensifies, the vestibular glands secrete mucus to moisten and lubricate the tissues to facilitate insertion of the penis.

The zenith of intense stimulation is orgasm, the spasmodic and involuntary contractions of the muscles in the region of the vulva, the uterus, and the vagina that produce a pleasurable sensation to the woman. Typically the woman feels warm and relaxed after an orgasm. Within a short time after orgasm, the two physiologic mechanisms that created the sexual response, vasocongestion and muscle contraction, rapidly dissipate.

Breasts

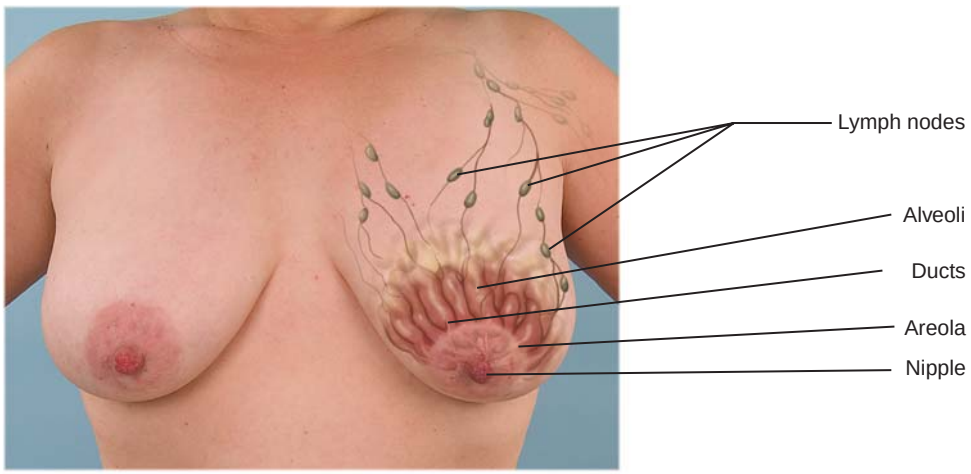
The two mammary glands, or **breasts,** are accessory organs of the female reproductive system that are specialized to secrete milk following pregnancy. They overlie the pectoralis major muscles and extend from the second to the sixth ribs and from the sternum to the axilla. Each breast has a nipple located near the tip, which is surrounded by a circular area of pigmented skin called the areola. Each breast is composed of 15 to 20 lobes, which contain glands (alveolar) and a duct (lactiferous) that leads to the nipple and opens to the outside (Fig. 3-5). The lobes are separated by dense connective and adipose tissues, which also help support the weight of the breasts.

During pregnancy, placental estrogen and progesterone stimulate the development of the mammary glands. Because of this hormonal activity, the breasts may double in size during pregnancy. At the same time, glandular tissue replaces the adipose tissue of the breasts.

Following childbirth and the expulsion of the placenta, levels of placental hormones (progesterone and lactogen) fall rapidly, and the action of prolactin (milk-producing hormone) is no longer inhibited. Prolactin stimulates the production of milk within a few days after childbirth, but in the interim, a deep yellow fluid called colostrum is secreted. Colostrum contains more minerals and protein but less sugar and fat than mature breast milk. Colostrum secretion may continue for approximately a week after childbirth, with gradual conversion to mature milk. Colostrum is rich in maternal antibodies, especially immunoglobulin A (IgA), which offers protection for the newborn against enteric pathogens.

The Female Reproductive Cycle

The female reproductive cycle is a complex process that encompasses an intricate series of chemical secretions and reactions to produce the ultimate potential for fertility and birth. The female reproductive cycle is a general term encompassing the ovarian cycle, the endometrial cycle, the hormonal changes that regulate them, and the cyclical changes in the breasts. The endometrium, ovaries, pituitary gland, and hypothalamus are all involved in the cyclic changes that help to prepare the body for fertilization. Absence of fertilization results in **menstruation,** the monthly shedding of the uterine lining. Menstruation marks the beginning and end of each menstrual cycle.



● Figure 3-5 Anatomy of the breasts. (Photo by B. Proud.)

In the United States, the average age at menarche is 12.8 years, with a range between 8 and 18. Most women will experience 300 to 400 menstrual cycles within their lifetime (Youngkin & Davis, 2004). Events preceding the first menses have an orderly progression: *thelarche,* the development of breast buds; *adrenarche,* the appearance of pubic and then axillary hair, followed by a growth spurt; and *menarche,* a girl's first menses. Cycles vary in frequency from 21 to 36 days, bleeding lasts 3 to 8 days, and blood loss averages 20 to 80 mL (Mattson & Smith, 2004). The average cycle is 28 days long. Irregular menses can be associated with irregular ovulation, stress, disease, and hormonal imbalances (Cunningham et al., 2004).

Menopause refers to the cessation of regular menstrual cycles. It is the end of menstruation and childbearing capacity. It is usually marked by atrophy of the breasts, uterus, tubes, and ovaries (Bachmann, 2004). Many women pass through menopause without untoward symptoms. These women remain active and in good health with little interruption of their daily routines. Other women experience vasomotor symptoms, which give rise to sensations of heat, cold, sweating, headache, insomnia, and irritability (Kessenich, 2004). The average age of natural menopause—defined as 1 year without a menstrual period—is 51 (Alexander et al., 2004). (See Chapter 4 for more information.)

Although menstruation is a normal process, the various world cultures have taken a wide variety of attitudes toward it, seeing it as everything from a sacred time to an unclean time. In a society where menstruation is viewed negatively, nurses can help women develop a more positive image of this natural physiologic process.

The female reproductive cycle involves two cycles that occur simultaneously: the ovarian cycle, during which ovulation occurs, and the endometrial cycle, during which menstruation occurs. Ovulation divides these two cycles at midcycle. Ovulation occurs when the ovum is released from its follicle; after leaving the ovary, the ovum enters the fallopian tube and journeys toward the uterus. If sperm fertilizes the ovum during its journey, pregnancy occurs. Figure 3-6 summarizes the menstrual cycle.

Ovarian Cycle

The ovarian cycle is the series of events associated with a developing oocyte (ovum or egg) within the ovaries. While men manufacture sperm daily, often into advanced age, women are born with a single lifetime supply of ova that are released from the ovaries gradually throughout the childbearing years. In the female ovary, 2 million oocytes are present at birth, and about 400,000 follicles are still present at puberty. The excess follicles are depleted during the childbearing years, with only 400 follicles ovulated during the reproductive period (Speroff & Fritz, 2005).

The ovarian cycle begins when the follicular cells (ovum and surrounding cells) swell and the maturation process starts. The maturing follicle at this stage is called a graafian follicle. The ovary raises many follicles monthly, but usually only one follicle matures to reach ovulation. The ovarian cycle consists of three phases: the follicular phase, ovulation, and the luteal phase.

Follicular Phase

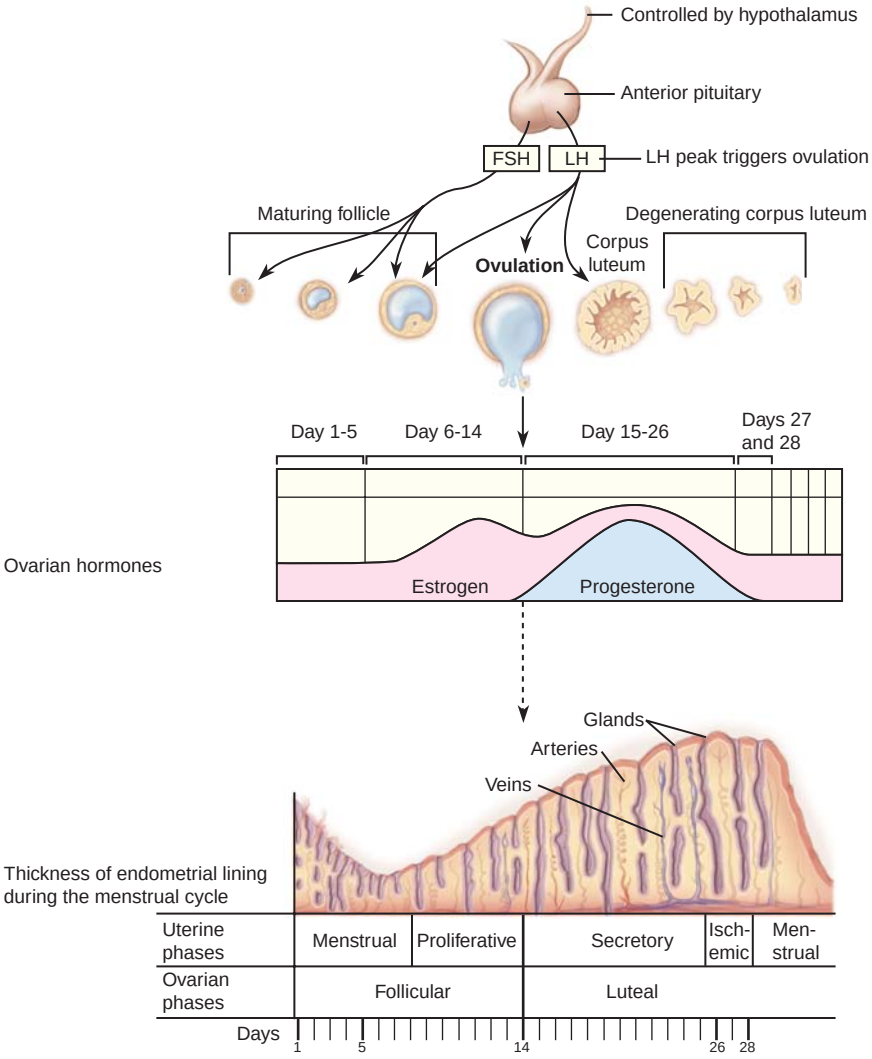
This phase is so named because it is when the follicles in the ovary grow and form a mature egg. This phase starts on day 1 of the menstrual cycle and continues until ovulation, approximately 10 to 14 days. The follicular phase is not consistent in duration because of the time variations in follicular development. These variations account for the differences in menstrual cycle lengths (Breslin and Lucas, 2003). The hypothalamus is the initiator of this phase. Increasing levels of estrogen secreted from the maturing follicular cells and the continued growth of the dominant follicle cell induce proliferation of the endometrium and myometrium. This thickening of the uterine lining supports an implanted ovum if pregnancy occurs.

Prompted by the hypothalamus, the pituitary gland releases **follicle-stimulating hormone (FSH),** which stimulates the ovary to produce 5 to 20 immature follicles. Each follicle houses an immature oocyte or egg. The follicle that is targeted to mature fully will soon rupture and expel a mature oocyte in the process of ovulation. A surge in **luteinizing hormone (LH)** from the anterior pituitary gland is actually responsible for affecting the final development and subsequent rupture of the mature follicle.

Ovulation

At ovulation, a mature follicle ruptures in response to a surge of LH, releasing a mature oocyte (ovum). This usually occurs on day 14 in a 28-day cycle. When ovulation occurs, there is a drop in estrogen. Typically ovulation takes place approximately 10 to 12 hours after the LH peak and 24 to 36 hours after estrogen levels peak (Speroff and Fritz, 2005). The distal ends of the fallopian tubes become active near the time of ovulation and create currents that help carry the ovum into the uterus. The lifespan of the ovum is only about 24 hours; unless it meets a sperm on its journey within that time, it will die.

During ovulation, the cervix produces thin, clear, stretchy, slippery mucus that is designed to help the sperm travel up through the cervix to meet the ovum for fertilization. Some women can feel a pain on one side of the abdomen around the time the egg is released. This is known as *mittelschmerz,* a German word meaning "middle pain." The one constant, whether a women's cycle is 28 days or 120 days, is that ovulation takes place 14 days before menstruation (Mattson & Smith, 2004).



● Figure 3-6 Menstrual cycle summary based on a 28-day (average) menstrual cycle.

ConsiderTHIS!

I had been married 2 years when my husband and I decided to start a family. I began thinking back to my high-school biology class and tried to remember about ovulation and what to look for. I also used the Internet to find the answers I was seeking. As I was reading, it all started to come into place. During ovulation, a woman's cervical mucus increases and she experiences a 'wet sensation' for several days midcycle. The mucus also becomes stretchable during this time. In addition, her temperature rises slightly and then falls if no conception takes place. Armed with this knowledge, I began to check my temperature daily before arising and checking the consistency of my mucus. I figured that if these signs could help prevent pregnancy by warning of the unsafe time, they could help me discover the best time to conceive. Within 3 months I became pregnant using my body's natural signals.

Thoughts: How does knowledge of the reproductive system help nurses take care of couples who are trying to become pregnant?

Luteal Phase

The luteal phase begins at ovulation and lasts until the menstrual phase of the next cycle. After the follicle ruptures as it releases the egg, it closes and forms a corpus luteum. The corpus luteum secretes increasing amounts of the hormone progesterone, which interacts with the endometrium to prepare it for implantation. At the beginning of the luteal phase, progesterone induces the endometrial glands to secrete glycogen, mucus, and other substances. These glands become tortuous and have large lumens due to increased secretory activity. The progesterone secreted by the corpus luteum causes the temperature of the body to rise slightly until the start of the next period. A significant increase in temperature, usually 0.5 to 1 degrees Fahrenheit, is generally seen within a day or two after ovulation has occurred; the temperature remains elevated for 12 to 16 days, until menstruation begins (Youngkin & Davis, 2004). This rise in temperature can be plotted on a graph and gives an indication of when ovulation has occurred. In the absence of fertilization, the corpus luteum

begins to degenerate, and consequently ovarian hormone levels decrease. As estrogen and progesterone levels decrease, the endometrium undergoes involution. In a 28-day cycle, menstruation then begins approximately 14 days after ovulation in the absence of pregnancy. FSH and LH are generally at their lowest levels during the luteal phase and highest during the follicular phase.

Endometrial Cycle

The endometrial cycle occurs in response to cyclic hormonal changes. The three phases of the endometrial cycle are the proliferative phase, the secretory phase, and the menstrual phase.

Proliferative Phase

The proliferative phase starts with enlargement of the endometrial glands in response to increasing amounts of estrogen. The blood vessels become dilated and the endometrium increases in thickness dramatically. It lasts from about day 5 of the menstrual cycle to the time of ovulation. This phase depends on estrogen stimulation resulting from ovarian follicles.

Secretory Phase

The secretory phase follows ovulation to about 3 days before the next menstrual period. Under the influence of progesterone, the endometrium becomes thickened and more vascular (growth of the spiral arteries) and glandular (secreting more glycogen and lipids). These dramatic changes are all in preparation for implantation, if it were to occur. Estrogen levels drop sharply during this phase as progesterone dominates.

Menstrual Phase

The menstrual phase begins as the spiral arteries rupture secondary to ischemia, releasing blood into the uterus, and the endometrium is sloughed off. If fertilization does not take place, the corpus luteum degenerates. As a result, both estrogen and progesterone levels fall and the thickened endometrial lining sloughs away from the uterine wall and passes out via the vagina. The beginning of the menstrual flow marks the end of one menstrual cycle and the start of a new one. Most women report bleeding for an average of 3 to 5 days (Mattson & Smith, 2004).

Menstrual Cycle Hormones

The menstrual cycle involves a complex interaction of hormones. The predominant hormones include gonadotropin-releasing hormone (GnRH), FSH, LH, estrogen, progesterone, and prostaglandins. Box 3-1 summarizes menstrual cycle hormones.

Gonadotropin-Releasing Hormone (GnRH)

Gonadotropin-releasing hormone (GnRH) is secreted from the hypothalamus in a pulsatile manner throughout the reproductive cycle. It pulsates slowly during the follicular phase and increases during the luteal phase. GnRH induces the release of FSH and LH to assist with ovulation.

BOX 3-1

SUMMARY OF MENSTRUAL CYCLE HORMONES

- Luteinizing hormone (LH) rises and stimulates the follicle to produce estrogen.
- As estrogen is produced by the follicle, estrogen levels rise, inhibiting the output of LH.
- Ovulation occurs after an LH surge damages the estrogen-producing cells, resulting in a decline in estrogen.
- The LH surge results in establishment of the corpus luteum, which produces estrogen and progesterone.
- Estrogen and progesterone levels rise, suppressing LH output.
- Lack of LH promotes degeneration of the corpus luteum.
- Cessation of the corpus luteum means a decline in estrogen and progesterone output.
- The decline of the ovarian hormones ends their negative effect on the secretion of LH.
- LH is secreted, and the menstrual cycle begins again.

Follicle-Stimulating Hormone (FSH)

FSH is secreted by the anterior pituitary gland and is primarily responsible for the maturation of the ovarian follicle. FSH secretion is highest and most critical during the first week of the follicular phase of the reproductive cycle.

Luteinizing Hormone (LH)

LH is secreted by the anterior pituitary gland and is required for both the final maturation of preovulatory follicles and luteinization of the ruptured follicle. As a result, estrogen production declines and progesterone secretion continues. Thus, estrogen levels fall a day before ovulation, and progesterone levels begin to rise.

Estrogen

Estrogen is secreted by the ovaries and is crucial for the development and maturation of the follicle. Estrogen is predominant at the end of the follicular phase, directly preceding ovulation. After ovulation, estrogen levels drop sharply as progesterone dominates. In the endometrial cycle, estrogen induces proliferation of the endometrial glands. Estrogen also causes the uterus to increase in size and weight because of increased glycogen, amino acids, electrolytes, and water. Blood supply is expanded as well. Estrogen inhibits FSH production and stimulates LH production.

Progesterone

Progesterone is secreted by the corpus luteum. Progesterone levels increase just before ovulation and peak 5 to

7 days after ovulation. During the luteal phase, progesterone induces swelling and increased secretion of the endometrium. This hormone is often called the hormone of pregnancy because of its calming effect (reduces uterine contractions) on the uterus, allowing pregnancy to be maintained.

Prostaglandins

Prostaglandins are a closely related group of oxygenated fatty acids that are produced by the endometrium, with a variety of effects throughout the body. Although they have regulatory effects and are sometimes called hormones, prostaglandins are not technically hormones because they are produced by all tissues rather than by special glands (Sloane, 2002). Prostaglandins increase during follicular maturation and play a key role in ovulation by freeing the ovum inside the graafian follicle. Large amounts of prostaglandins are found in menstrual blood. Research is ongoing as to the various roles prostaglandins have on the menstrual cycle (Cunningham et al., 2004).

Male Reproductive System

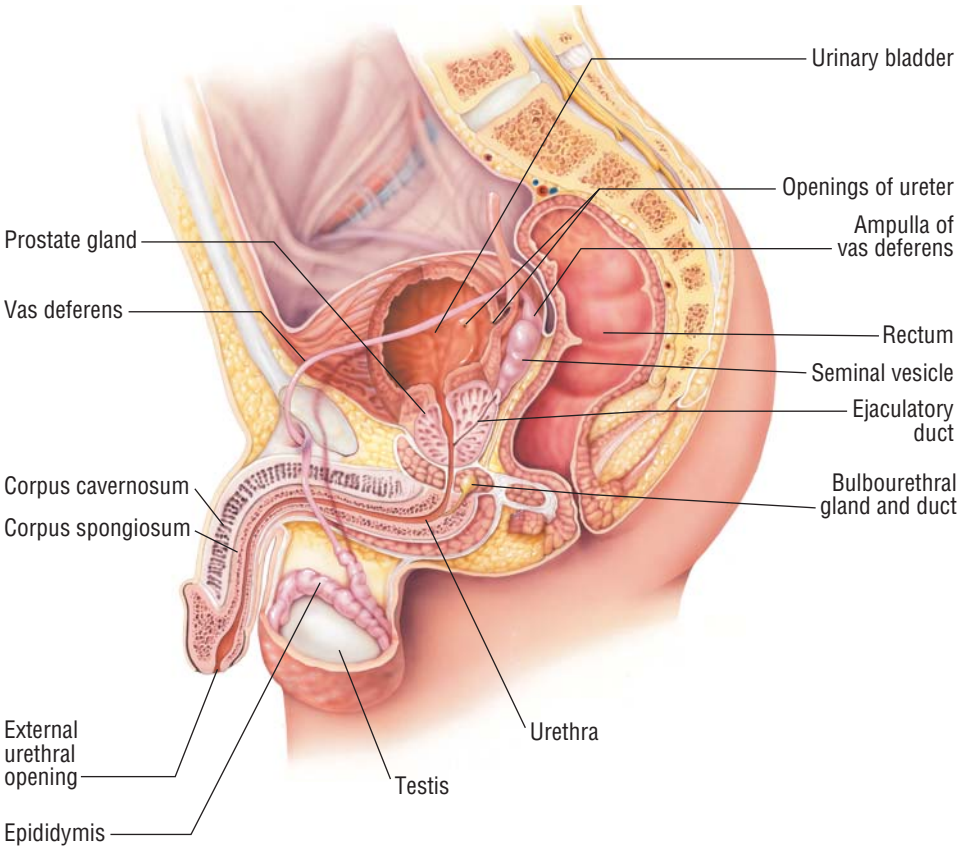
The male reproductive system, like that of the female, consists of those organs functioning to produce a new individual. The male organs are specialized to produce and maintain the male sex cells, or sperm; to transport them, along with supporting fluids, to the female reproductive system; and to secrete the male hormone testosterone. The organs of the male reproductive system include the two testes (where sperm cells and testosterone are made), the penis, the scrotum, and the accessory organs (epididymis, vas deferens, seminal vesicles, ejaculatory duct, urethra, bulbourethral glands, and prostate gland).

Internal Male Reproductive Organs

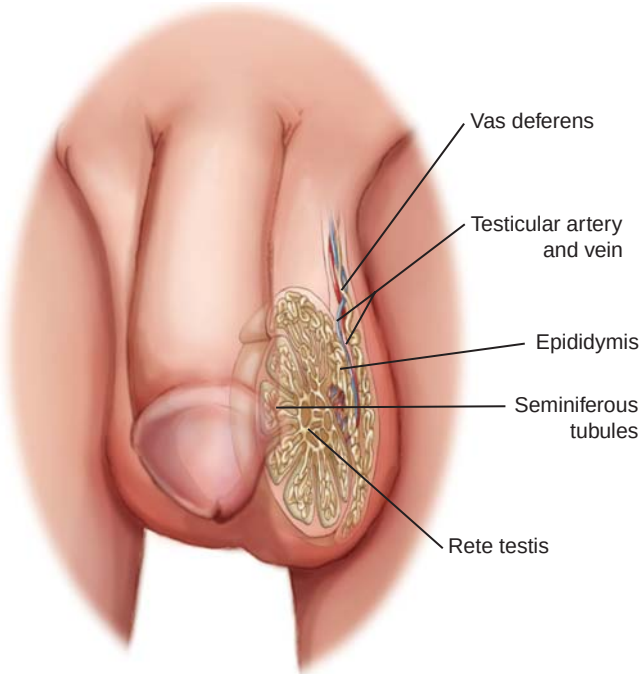
The internal structures include the testes, the ductal system, and accessory glands (Fig. 3-7).

Testes

The **testes** are oval bodies the size of large olives that lie in the scrotum; usually the left testis hangs a little lower than the right one. The testes have two functions: producing sperm and synthesizing testosterone (the primary male sex hormone). Sperm is produced in the seminiferous tubules of the testes. The testes also produce the male hormone testosterone and a portion of the seminal fluid, the liquid in which sperm are carried. The epididymis, which lies against the testes, is a coiled tube almost 20 feet long. It collects sperm from the testes and provides the space and environment for sperm to mature (Fig. 3-8).



● Figure 3-7 Lateral view of the internal male reproductive organs. (Source: The Anatomical Chart Company. [2001]. *Atlas of human anatomy.* Springhouse, PA: Springhouse.)



● Figure 3-8 Internal structures of a testis.

The Ductal System

The vas deferens is a cordlike duct that transports sperm from the epididymis. One such duct travels from each testis up to the back of the prostate and enters the urethra to form the ejaculatory ducts. Other structures, such as blood vessels and nerves, also travel along with each vas deferens and together form the spermatic cord. The urethra is the terminal duct of the reproductive and urinary systems, serving as a passageway for semen (fluid containing sperm) and urine. It passes through the prostate gland and the penis and opens to the outside.

Accessory Glands

The seminal vesicles, which produce nutrient seminal fluid, and the prostate gland, which produces alkaline prostatic fluid, are both connected to the ejaculatory duct leading into the urethra. The paired seminal vesicles are convoluted pouchlike structures lying posterior to and at the base of the urinary bladder in front of the rectum. They secrete an alkaline fluid that contains fructose and prostaglandins. The fructose supplies energy to the sperm on its journey to meet the ovum, and the prostaglandins assist in sperm mobility.

The prostate gland lies just under the bladder in the pelvis and surrounds the middle portion of the urethra. Usually the size of a walnut, this gland enlarges with age. The prostate and the seminal vesicles above it produce fluid that nourishes the sperm. This fluid provides most of the volume of semen, the secretion in which the sperm is expelled during ejaculation. Other fluid that makes up the semen comes from the vas deferens and from mucous glands in the head of the penis.

The bulbourethral glands (Cowper's glands) are two small structures about the size of peas, located inferior to the prostate gland. They are composed of several tubes whose epithelial linings secrete a mucuslike fluid. It is released in response to sexual stimulation and lubricates the head of the penis in preparation for sexual intercourse. Their existence is said to be constant, but they gradually diminish in size with advancing age.

External Male Reproductive Organs

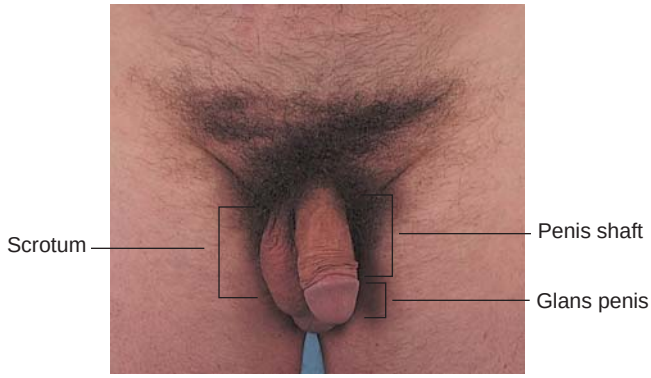
The penis and the scrotum form the external genitalia in the male (Fig. 3-9).

Penis

The **penis** is the organ for copulation and serves as the outlet for both sperm and urine. The skin of the penis is thin, with no hairs. The prepuce (foreskin) is a circular fold of skin that extends over the glans unless it is removed by circumcision shortly after birth. The urinary meatus, located at the tip of the penis, serves as the external opening to the urethra (Fig. 3-10). The penis is composed mostly of erectile tissue. Most of the body of the penis consists of three cylindrical spaces (sinuses) of erectile tissue. The two larger ones, the corpora cavernosa, are side by side. The third sinus, the corpus spongiosum, surrounds the urethra. Erection results when nerve impulses from the autonomic nervous system dilate the arteries of the penis, allowing arterial blood to flow into the erectile tissues of the organ.

Scrotum

The scrotum is the thin-skinned sac that surrounds and protects the testes. The scrotum also acts as a climate-control system for the testes, because they need to be slightly cooler than body temperature to allow normal



● Figure 3-9 The external male reproductive organs. (Photo by B. Proud.)

Figure 3-10 The urinary meatus. (Photo by B. Proud.)

sperm development. The cremaster muscles in the scrotal wall relax or contract to allow the testes to hang farther from the body to cool or to be pulled closer to the body for warmth or protection (Sloane, 2002). A medial septum divides the scrotum into two chambers, each of which encloses a testis.

Erection, Orgasm, and Ejaculation

With sexual stimulation, the arteries leading to the penis dilate and increase blood flow into erectile tissues. At the same time, the erectile tissue compresses the veins of the penis, reducing blood flow away from the penis. Blood accumulates, causing the penis to swell and elongate and producing an erection. As in women, the culmination of sexual stimulation is an orgasm, a pleasurable feeling of physiologic and psychological release.

Orgasm is accompanied by emission (movement of sperm from the testes and fluids from the accessory glands) into the urethra, where it is mixed to form semen. As the urethra fills with semen, the base of the erect penis contracts, which increases pressure and forces the semen through the urethra to the outside (ejaculation). During ejaculation, the ducts of the testes, epididymis, and vas deferens contract, causing expulsion of sperm into the urethra, where the sperm mixes with the seminal and prostatic fluids. These substances, together with mucus secreted by accessory glands, form the semen, which is discharged from the urethra.

KEY CONCEPTS

- The female reproductive system produces the female reproductive cells (the eggs, or ova) and contains an organ (uterus) where the fetus develops. The male reproductive system produces the male reproductive cells (the sperm) and contains an organ (penis) that deposits the sperm within the female.
- The internal female reproductive organs consist of the vagina, the uterus, the fallopian tubes, and the ovaries. The external female reproductive organs make up the vulva. These include the mons pubis, the labia majora and minora, the clitoris, structures within the vestibule, and the perineum.
- The breasts are accessory organs of the female reproductive system that are specialized to secrete milk following pregnancy.
- The main function of the reproductive cycle is to stimulate growth of a follicle to release an egg and prepare a site for implantation if fertilization occurs.
- Menstruation, the monthly shedding of the uterine lining, marks the beginning and end of the cycle if fertilization does not occur.
- The ovarian cycle is the series of events associated with a developing oocyte (ovum or egg) within the ovaries.
- At ovulation, a mature follicle ruptures in response to a surge of LH, releasing a mature oocyte (ovum).
- The endometrial cycle is divided into three phases: the follicular or proliferative phase, the luteal or secretory phase, and the menstrual phase.
- The menstrual cycle involves a complex interaction of hormones. The predominant hormones are gonadotropin-releasing hormone (GnRH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, progesterone, and prostaglandins.
- The organs of the male reproductive system include the two testes (where sperm cells and testosterone are made), penis, scrotum, and accessory organs (epididymis, vas deferens, seminal vesicles, ejaculatory ducts, urethra, bulbourethral glands, and prostate gland).

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Web Resources

Alan Guttmacher Institute: **www.agi-usa.org**
American Society for Reproductive Medicine: **www.asrm.com**
Kinsey Institution: **www.indiana.edu/~kinsey/index.html**
Sexuality Information of the United States: **www.siecus.org**
National Women's Health Information Center: **www.4woman.gov**
National Women's Health Resource Center: **www.healthywomen.org**
Society for Women's Health Research: **www.womens-health.org**

Chapter WORKSHEET

MULTIPLE CHOICE QUESTIONS

1. The predominant anterior pituitary hormones that orchestrate the menstrual cycle include:
   a. Thyroid-stimulating hormone (TSH)
   b. Follicle-stimulating hormone (FSH)
   c. Corticotropin-releasing hormone (CRH)
   d. Gonadotropin-releasing hormone (GnRH)
2. Which glands are located on either side of the female urethra and secrete mucus to keep the opening moist and lubricated for urination?
   a. Cowper's
   b. Bartholin's
   c. Skene's
   d. Seminal
3. The ovarian cycle comprises all of the following phases *except:*
   a. Secretory
   b. Follicular
   c. Ovulation
   d. Luteal
4. Which hormone is produced in high levels to prepare the endometrium for implantation just after ovulation by the corpus luteum?
   a. Estrogen
   b. Prostaglandins
   c. Prolactin
   d. Progesterone
5. Sperm maturation and storage in the male reproductive system occurs in the:
   a. Testes
   b. Vas deferens
   c. Epididymis
   d. Seminal vesicles

CRITICAL THINKING EXERCISE

1. The school health nurse was asked to speak to the 10th-grade biology class in the local high school about menstruation. The teachers felt that the students misunderstood this monthly event and wanted to dispel some myths about it. After explaining the factors influencing the monthly menses, one girl asks, "Could someone get pregnant if she had sex during her period?"
   a. How should the nurse respond to this question?
   b. What factor regarding the menstrual cycle was not clarified?
   c. What additional topics might this question lead into that might be discussed?

STUDY ACTIVITIES

1. Select a website under *Web Resources* to explore to find information concerning a topic of interest regarding women's health. Be prepared to discuss it in class.
2. List the predominant hormones and their function in the menstrual cycle.
3. The ovarian cycle describes the series of events associated with the development of the _____ within the ovaries.
4. Sperm cells and the male hormone testosterone are made in which of the following structures? Select all that apply:
   a. Vas deferens
   b. Penis
   c. Scrotum
   d. Ejaculatory ducts
   e. Prostate gland
   f. Testes
   g. Seminiferous tubules
   h. Bulbourethral glands