

## 17.3 Female Reproductive System

The female reproductive system includes the organs depicted in Figure 17.8. The primary sex organs of a female are the paired **ovaries** that lie in shallow depressions, one on each side of the upper pelvic cavity. The ovaries are the primary sex organs because they produce eggs and the female sex hormones, estrogen and progesterone.

The other organs depicted in Figure 17.8 are the accessory (or secondary) sex organs of a female. When an egg leaves an ovary, it is usually swept into a uterine (fallopian) tube by the combined action of the fimbriae (fingerlike projections of a uterine tube) and the beating of cilia that line the uterine tube.

Once in a uterine tube, the egg is transported toward the uterus. Fertilization, and therefore zygote formation, usually takes place in the uterine tube. The developing embryo normally arrives at the **uterus** several days later, and then **implantation** occurs as the embryo embeds in the uterine lining, which has been prepared to receive it.

Development of the embryo and fetus normally takes place in the uterus. The lining of the uterus, called the **endometrium**,

participates in the formation of the placenta (see Chapter 18, page 378), which supplies nutrients needed for embryonic and fetal development.

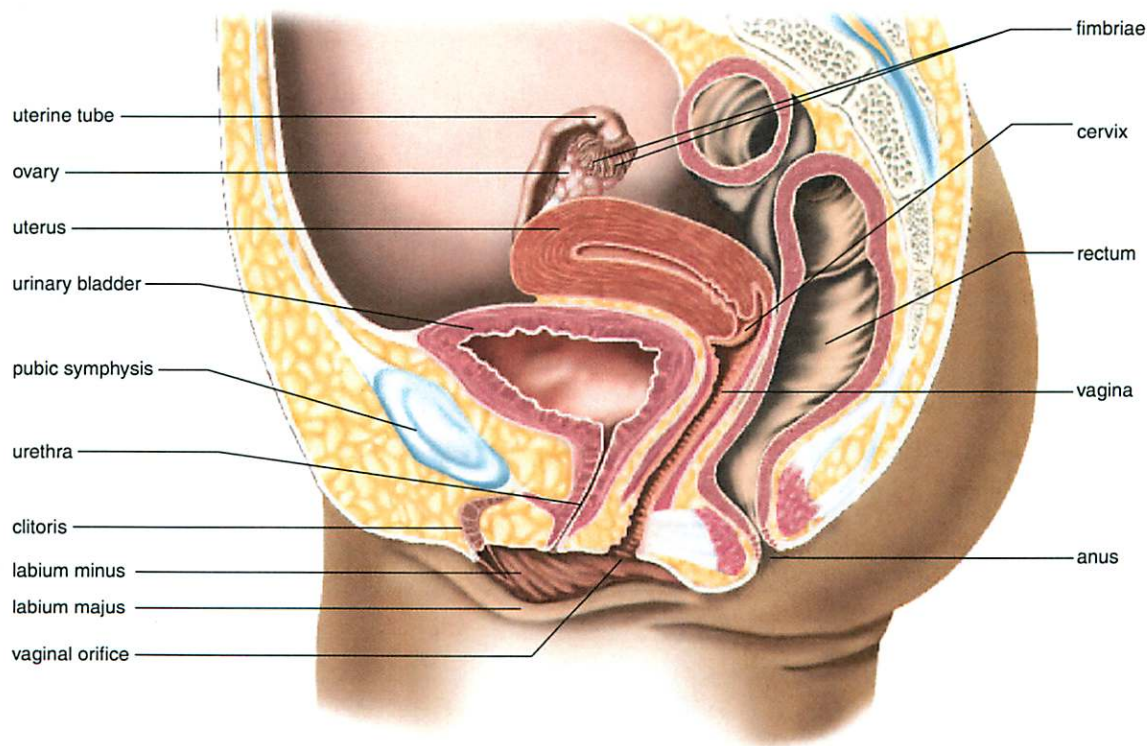
The uterine tubes join the uterus at its upper end, while at its lower end, the **cervix** enters the vagina nearly at a right angle. A small opening in the cervix leads from the uterus to the vagina.

The **vagina** is the birth canal and organ of sexual intercourse in females. The vagina also acts as an exit for menstrual flow. If fertilization and implantation do not occur, the endometrium is sloughed off during menstruation.

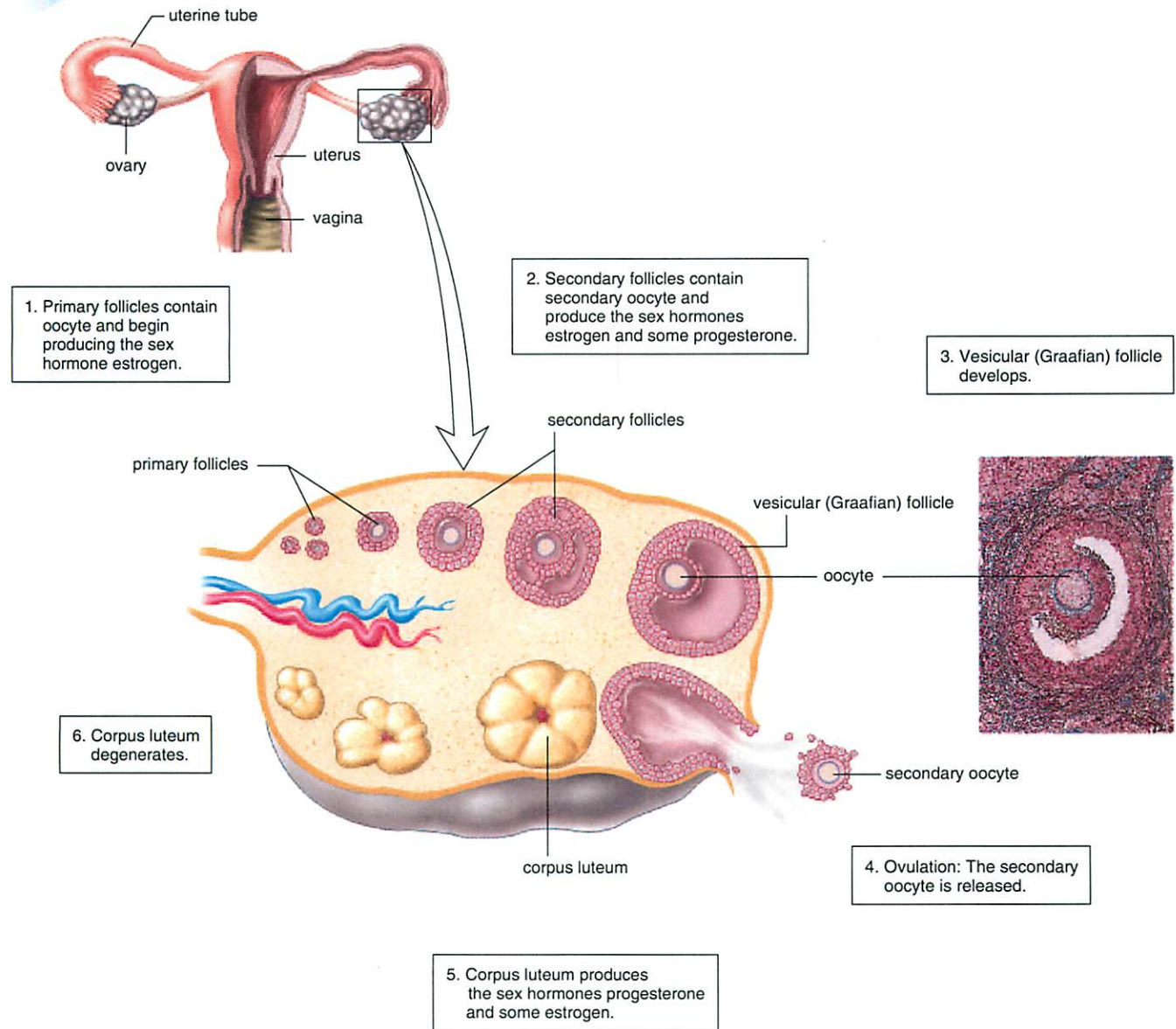
The external genital organs of the female are known collectively as the **vulva**. The vulva is recognized by two folds of skin, the **labia majora** and the **labia minora**. The cleft between the labia minora contains the openings of the urethra and the vagina.

Notice that the urinary and reproductive systems in the female are entirely separate. For example, the urethra carries only urine, and the vagina has functions that pertain only to reproduction.

**Figure 17.8** The female reproductive system. The ovaries release one egg per month. Fertilization occurs in the uterine tube, and development occurs in the uterus. The vagina is the birth canal as well as the organ of sexual intercourse.



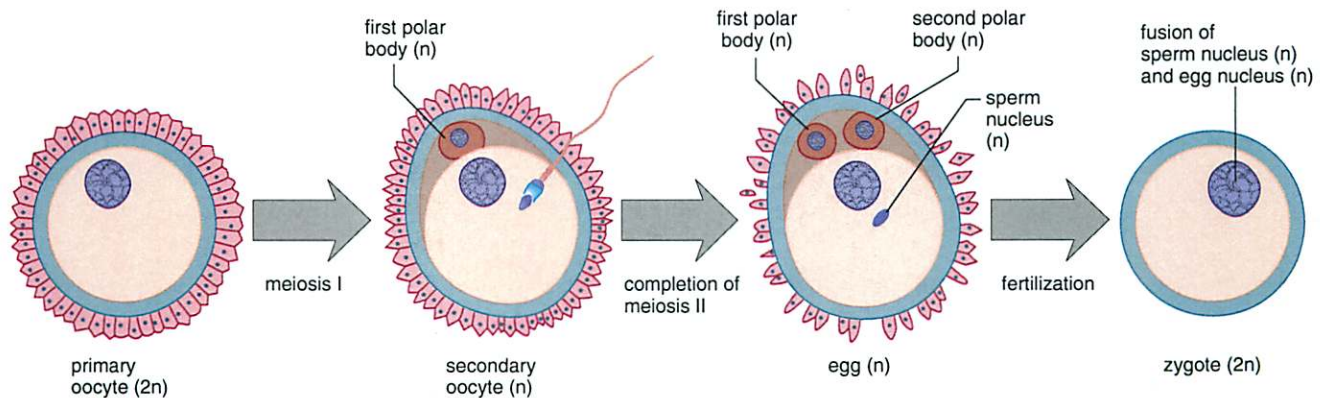
## visual focus



**Figure 17.9** Anatomy of ovary and follicle. As a follicle matures, the oocyte enlarges and is surrounded by layers of follicular cells and fluid. The micrograph shows the mature vesicular (Graafian) follicle. Eventually, ovulation occurs, the mature follicle ruptures, and the secondary oocyte is released. A single follicle actually goes through all the stages in one place within the ovary.



**Figure 17.10** Oogenesis in an ovary. Oogenesis involves meiosis I, during which the chromosome number is reduced, and meiosis II, which results in a single egg. Meiosis II takes place after a sperm enters the secondary oocyte. At the end of oogenesis, there are also at least two polar bodies, nonfunctional cells that later disintegrate.



## The Ovary

The ovaries are paired, oval bodies about 3 to 4 cm in length by 2 cm in width and less than 1 cm thick. They lie to either side of the uterus on the lateral walls of the pelvic cavity.

Several ligaments hold the ovaries in place (see Fig. 17.11). The largest of these, the broad ligament, is also attached to the uterine tubes and the uterus. The suspensory ligament holds the upper end of the ovary to the pelvic wall, and the ovarian ligament attaches the lower end of the ovary to the uterus.

A sagittal section through an ovary shows that it is made up of an outer cortex and an inner medulla. In the cortex are many **follicles**, each one containing an immature egg, called an **oocyte** (Fig. 17.9). A female is born with as many as 2 million follicles, but the number is reduced to 300,000–400,000 by the time of puberty. Only a small number of follicles (about 400) ever mature because a female usually produces only one egg per month during her reproductive years. Because oocytes are present at birth, they age as the woman ages. This may be one reason older women are more likely to produce children with genetic defects.

Cancer of an ovary, or ovarian cancer, which is discussed in the Medical Focus on page 352, causes more deaths than cervical and uterine cancer.

## Oogenesis

**Oogenesis**, the production of an egg, includes the process of meiosis. Similar to spermatogenesis, oogenesis begins with a primary oocyte that undergoes meiosis I to become a secondary oocyte having 23 chromosomes. The secondary oocyte undergoes meiosis II to produce an egg.

Oogenesis begins within a follicle. As the follicle matures, it develops from a primary follicle to a secondary follicle to a **vesicular (Graafian) follicle** (see Fig. 17.9). The epithelium of a primary follicle surrounds a primary oocyte. Pools of follicular fluid surround the oocyte in a secondary follicle. In a vesicular follicle, a fluid-filled cavity increases to the point that the follicle wall balloons out on the surface of the ovary.

Figure 17.10 traces the steps of oogenesis. As a follicle matures, the primary oocyte divides, producing two cells. One cell is a secondary oocyte, and the other is a polar body. A **polar body** is a nonfunctioning cell that occurs only during oogenesis. The vesicular follicle bursts, releasing the secondary oocyte surrounded by a clear membrane and attached follicular cells. This process is referred to as **ovulation**.

The secondary oocyte, often called an **egg** for convenience, enters a uterine tube. If fertilization occurs, a sperm enters the secondary oocyte, which then completes meiosis II. An egg with 23 chromosomes and a second polar body result. When the sperm nucleus unites with the egg nucleus, a **zygote** with 46 chromosomes is produced.

A follicle that has lost its egg develops into a **corpus luteum**, a glandlike structure. If implantation does not occur, the corpus luteum begins to degenerate after about 10 days. The remains of a corpus luteum is a white scar called the **corpus albicans**. If implantation does occur, the corpus luteum continues for about six months and produces hormones that help keep the uterine lining intact.

Although a number of follicles grow during each month, only one reaches full maturity and ruptures to release a secondary oocyte. Presumably the ovaries alternate in producing functional ova. The number of secondary oocytes produced by a female during her lifetime is minuscule compared to the number of sperm produced by a male.



# Medical Focus

## Ovarian Cancer

Ovarian cancer is often “silent,” showing no obvious signs or symptoms until late in its development. The most common sign is enlargement of the abdomen, which is caused by the accumulation of fluid. Rarely is there abnormal vaginal bleeding. In women over 40, vague digestive disturbances (stomach discomfort, gas, distention) that persist and cannot be explained by any other cause may indicate the need for a thorough evaluation for ovarian cancer.

The risk for ovarian cancer increases with age. The highest rates are for women over age 60. Women who have never had children are twice as likely to develop ovarian cancer as those who have. Early age at first pregnancy, early menopause, and the use of oral contraceptives, which reduces ovulation frequency, appear to be protective against ovarian cancer. If a woman has had breast cancer, her chances of developing ovarian cancer double. Certain

rare genetic disorders are associated with increased risk. The highest incidence rates are reported in the more industrialized countries, with the exception of Japan.

Early detection requires periodic, thorough pelvic examinations. The Pap smear, useful in detecting cervical cancer, does not reveal ovarian cancer. Women over age 40 should have a cancer-related checkup every year. Testing for the level of tumor marker CA-125, a protein antigen, is helpful.

Surgery, radiation therapy, and drug therapy are treatment options. Surgery usually includes the removal of one or both ovaries (oophorectomy), the uterus (hysterectomy), and the uterine tubes (salpingectomy). In some very early tumors, only the involved ovary is removed, especially in young women. In advanced disease, an attempt is made to remove all intra-abdominal cancerous tissue to enhance the effect of chemotherapy.

## Female Internal Accessory Organs

Table 17.2 lists and Figure 17.11 depicts the internal accessory organs, as well as the other reproductive organs, of a female.

### Uterine Tubes

The uterine tubes, also called fallopian tubes or oviducts, extend from the uterus to the ovaries. Usually the secondary oocyte enters a uterine tube because the fimbriae sweep over the ovary at the time of ovulation, and the beating of the cilia that line uterine tubes creates a suction effect. Once in the uterine tube, the egg is propelled slowly toward the uterus by action of the cilia and by muscular contractions in the wall of the uterine tubes.

Fertilization, the completion of oogenesis, and zygote formation normally occur in the upper one-third of a uterine tube. The developing embryo usually does not arrive at the

uterus for several days, and then it embeds itself in the uterine lining, which has been prepared to receive it.

Occasionally, the embryo becomes embedded in the wall of a uterine tube, where it begins to develop. Tubular pregnancies cannot succeed because the tubes are not anatomically capable of allowing full development to occur. Any pregnancy that occurs outside the uterus is called an ectopic pregnancy.

### Uterus

The uterus is a thick-walled, muscular organ about the size and shape of an inverted pear. Normally, it lies above and is tipped over the urinary bladder. The uterus has three sections. The fundus is the region superior to the entrance of the uterine tubes. The body of the uterus is the major region. The cervix is the narrow end of the uterus that projects into the vagina. A cervical orifice leads to the lumen of the vagina.

Development of the embryo normally takes place in the uterus. This organ, sometimes called the womb, is approximately 5 cm wide in its usual state but is capable of stretching to over 30 cm to accommodate the growing baby. The lining of the uterus, called the endometrium, participates in the formation of the placenta (see Chapter 18), which supplies nutrients needed for embryonic and fetal development. In the nonpregnant female, the endometrium varies in thickness during a monthly menstrual cycle, discussed later in this chapter.

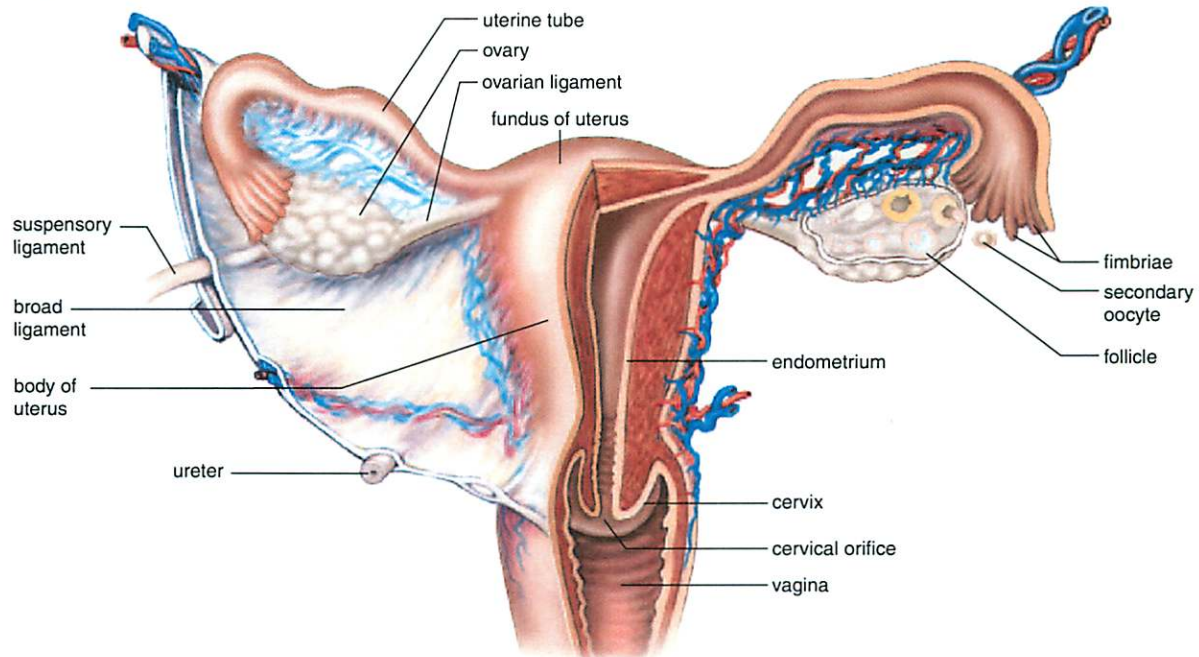
Cancer of the cervix is a common form of cancer in women. Early detection is possible by means of a Pap smear, which entails the removal of a few cells from the region of the cervix for microscopic examination. If the cells are cancerous, a hysterectomy (the removal of the uterus) may be recommended. Removal of the ovaries in addition to the uterus is termed an

**Table 17.2 Female Internal Accessory Organs**

Organ	Function
Uterine tubes (fallopian tubes, oviducts)	Transport egg; location of fertilization
Uterus (womb)	Houses developing fetus
Cervix	Contains opening to uterus
Vagina	Receives penis during sexual intercourse; serves as birth canal and as an exit for menstrual flow



**Figure 17.11** Female reproductive system, posterior view.



**ovariohysterectomy.** Because the vagina remains intact, the woman can still engage in sexual intercourse.

### Vagina

The vagina is a tube that makes a 45° angle with the small of the back. The mucosal lining of the vagina lies in folds that extend when the fibromuscular wall stretches. This capacity to extend is especially important when the vagina serves as the birth canal, and it can also facilitate intercourse, when the vagina receives the penis.

### External Genitals

The female external genitals (Fig. 17.12) are known collectively as the vulva. The vulva includes two large, hair-covered folds of skin called the **labia majora** (sing., labium majus). They extend posteriorly from the **mons pubis**, a fatty prominence underlying the pubic hair. The **labia minora** (sing., labium minus) are two small folds of skin lying just inside the labia majora. They extend forward from the vaginal opening to encircle and form a foreskin for the **clitoris**, an organ that is homologous to the penis. Although quite small, the clitoris has a shaft of erectile tissue and is capped by a pea-shaped glans. The clitoris also has sensory receptors that allow it to function as a sexually sensitive organ.

The **vestibule**, a cleft between the labia minora, contains the orifices of the urethra and the vagina. The vagina can be partially closed by a ring of tissue called

the hymen. The hymen ordinarily is ruptured by initial sexual intercourse; however, it can also be disrupted by other types of physical activities. If the hymen persists after sexual intercourse, it can be surgically ruptured.

The urinary and reproductive systems in the female are entirely separate: The urethra carries only urine, and the vagina serves only as the birth canal and as the organ for sexual intercourse.

**Figure 17.12** External genitals of the female. At birth, the opening of the vagina is partially blocked by a membrane called the hymen. Physical activities and sexual intercourse disrupt the hymen.

