

## Biology

## THE REPRODUCTIVE SYSTEM

## Chapter

## FEMALE REPRODUCTIVE SYSTEM

**T**he female reproductive system includes the ovaries, fallopian tubes, uterus, vagina, vulva, mammary glands and breasts. These organs are involved in the production and transportation of gametes and the production of sex hormones. The female reproductive system also facilitates the fertilization of ova by sperm and supports the development of offspring during pregnancy and infancy.

## ANATOMY

## Ovaries

The **ovaries** are a pair of small glands about the size and shape of almonds, located on the left and right sides of the pelvic body cavity lateral to the superior portion of the uterus. Ovaries produce female sex hormones such as estrogen and progesterone as well as ova (commonly called "eggs"), the female gametes. Ova are produced from oocyte cells that slowly develop throughout a woman's early life and reach maturity after puberty. Each month during ovulation, a mature ovum is released. The ovum travels from the ovary to the fallopian tube, where it may be fertilized before reaching the uterus.

## Fallopian Tubes

The **fallopian tubes** are a pair of muscular tubes that extend from the left and right superior corners of the uterus to the edge of the ovaries. The fallopian tubes end in a funnel-shaped structure called the infundibulum, which is covered with small finger-like projections called fimbriae. The **fimbriae** swipe over the outside of the ovaries

to pick up released ova and carry them into the infundibulum for transport to the uterus. The inside of each fallopian tube is covered in cilia that work with the smooth muscle of the tube to carry the ovum to the uterus.

## Uterus

The **uterus** is a hollow, muscular, pear-shaped organ located posterior and superior to the urinary bladder. Connected to the two fallopian tubes on its superior end and to the vagina (via the **cervix**) on its inferior end, the uterus is also known as the womb, as it surrounds and supports the developing fetus during pregnancy. The inner lining of the uterus, known as the **endometrium**, provides support to the embryo during early development. The visceral muscles of the uterus contract during childbirth to push the fetus through the birth canal.

## Vagina

The **vagina** is an elastic, muscular tube that connects the **cervix of the uterus** to the exterior of the body. It is located inferior to the uterus and posterior to the **urinary bladder**. The vagina functions as the receptacle for the **penis** during sexual intercourse and carries sperm to the uterus and fallopian tubes. It also serves as the birth canal by stretching to allow delivery of the fetus during childbirth. During menstruation, the menstrual flow exits the body via the vagina.

## Vulva

The vulva is the collective name for the external female genitalia located in the pubic region of the body. The vulva surrounds the



external ends of the urethral opening and the vagina and includes the mons pubis, labia majora, labia minora, and clitoris. The mons pubis, or pubic mound, is a raised layer of adipose tissue between the skin and the pubic bone that provides cushioning to the vulva. The inferior portion of the mons pubis splits into left and right halves called the labia majora. The mons pubis and labia majora are covered with pubic hairs. Inside of the labia majora are smaller, hairless folds of skin called the labia minora that surround the vaginal and urethral openings. On the superior end of the labia minora is a small mass of erectile tissue known as the clitoris that contains many nerve endings.

### **Breasts and Mammary Glands**

The breasts are specialized organs of the female body that contain mammary glands, milk ducts, and adipose tissue. The two breasts are located on the left and right sides of the thoracic region of the body. In the center of each breast is a highly pigmented nipple that releases milk when stimulated. The areola, a thickened, highly pigmented band of skin that surrounds the nipple, protects the underlying tissues during breastfeeding. The mammary glands are a special type of sudoriferous glands that have been modified to produce milk to feed infants. Within each breast, 15 to 20 clusters of mammary glands become active during pregnancy and remain active until milk is no longer needed. The milk passes through milk ducts on its way to the nipple, where it exits the body.

## **PHYSIOLOGY**

### **The Reproductive Cycle**

The female reproductive cycle is the process of producing an ovum and readying the uterus to receive a fertilized ovum to begin pregnancy. If an ovum is produced but not

fertilized and implanted in the uterine wall, the reproductive cycle resets itself through menstruation. The entire reproductive cycle takes about 28 days on average, but may be as short as 24 days or as long as 36 days for some women.

### **Oogenesis and Ovulation**

Under the influence of follicle stimulating hormone (FSH), and luteinizing hormone (LH), the ovaries produce a mature ovum in a process known as ovulation. By about 14 days into the reproductive cycle, an oocyte reaches maturity and is released as an ovum. Although the ovaries begin to mature many oocytes each month, usually only one ovum per cycle is released.

### **Fertilization**

Once the mature ovum is released from the ovary, the fimbriae catch the egg and direct it down the fallopian tube to the uterus. It takes about a week for the ovum to travel to the uterus. If sperm are able to reach and penetrate the ovum, the ovum becomes a fertilized zygote containing a full complement of DNA. After a two-week period of rapid cell division known as the germinal period of development, the zygote forms an embryo. The embryo will then implant itself into the uterine wall and develop there during pregnancy.

### **Menstruation**

While the ovum matures and travels through the fallopian tube, the endometrium grows and develops in preparation for the embryo. If the ovum is not fertilized in time or if it fails to implant into the endometrium, the arteries of the uterus constrict to cut off blood flow to the endometrium. The lack of blood flow causes cell death in the endometrium and the eventual shedding of tissue in a process known as menstruation. In a normal menstrual



cycle, this shedding begins around day 28 and continues into the first few days of the new reproductive cycle.

### **Pregnancy**

If the ovum is fertilized by a sperm cell, the fertilized embryo will implant itself into the endometrium and begin to form an amniotic cavity, umbilical cord, and placenta. For the first 8 weeks, the embryo will develop almost all of the tissues and organs present in the adult before entering the fetal period of development during weeks 9 through 38. During the fetal period, the fetus grows larger and more complex until it is ready to be born.

### **Lactation**

Lactation is the production and release of milk to feed an infant. The production of milk begins prior to birth under the control of the hormone prolactin. Prolactin is produced in response to the suckling of an infant on the nipple, so milk is produced as long as active breastfeeding occurs. As soon as an infant is weaned, prolactin and milk production end soon after. The release of milk by the nipples is known as the "milk-letdown reflex" and is controlled by the hormone oxytocin. Oxytocin is also produced in response to infant suckling so that milk is only released when an infant is actively feeding.

## **MALE REPRODUCTIVE SYSTEM**

The male reproductive system includes the scrotum, testes, spermatic ducts, sex glands, and penis. These organs work together to produce sperm, the male gamete, and the other components of semen. These organs also work together to deliver semen out of the body and into the vagina where it can fertilize egg cells to produce offspring.

## **Anatomy**

### **Scrotum**

The scrotum is a sac-like organ made of skin and muscles that houses the testes. It is located inferior to the penis in the pubic region. The scrotum is made up of 2 side-by-side pouches with a testis located in each pouch. The smooth muscles that make up the scrotum allow it to regulate the distance between the testes and the rest of the body. When the testes become too warm to support spermatogenesis, the scrotum relaxes to move the testes away from the body's heat. Conversely, the scrotum contracts to move the testes closer to the body's core heat when temperatures drop below the ideal range for spermatogenesis.

### **Testes**

The 2 **testes**, also known as testicles, are the male gonads responsible for the production of sperm and testosterone. The testes are ellipsoid glandular organs around 1.5 to 2 inches long and an inch in diameter. Each testis is found inside its own pouch on one side of the scrotum and is connected to the abdomen by a spermatic cord and cremaster muscle. The cremaster muscles contract and relax along with the scrotum to regulate the temperature of the testes. The inside of the testes is divided into small compartments known as lobules. Each lobule contains a section of seminiferous tubule lined with epithelial cells. These epithelial cells contain many stem cells that divide and form sperm cells through the process of spermatogenesis.

### **Epididymis**

The epididymis is a sperm storage area that wraps around the superior and posterior edge of the testes. The epididymis is made up of several feet of long, thin tubules that are tightly coiled into a small mass. Sperm



produced in the testes moves into the epididymis to mature before being passed on through the male reproductive organs. The length of the epididymis delays the release of the sperm and allows them time to mature.

### ***Spermatic Cords and Ductus Deferens***

Within the scrotum, a pair of spermatic cords connects the testes to the abdominal cavity. The spermatic cords contain the ductus deferens along with nerves, veins, arteries, and lymphatic vessels that support the function of the testes.

The **ductus deferens**, also known as the vas deferens, is a muscular tube that carries sperm superiorly from the epididymis into the abdominal cavity to the ejaculatory duct. The ductus deferens is wider in diameter than the epididymis and uses its internal space to store mature sperm. The smooth muscles of the walls of the ductus deferens are used to move sperm towards the ejaculatory duct through peristalsis.

### ***Seminal Vesicles***

The seminal vesicles are a pair of lumpy exocrine glands that store and produce some of the liquid portion of semen. The seminal vesicles are about 2 inches in length and located posterior to the urinary bladder and anterior to the rectum. The liquid produced by the seminal vesicles contains proteins and mucus and has an alkaline pH to help sperm survive in the acidic environment of the vagina. The liquid also contains fructose to feed sperm cells so that they survive long enough to fertilize the oocyte.

### ***Ejaculatory Duct***

The ductus deferens passes through the prostate and joins with the urethra at a structure known as the ejaculatory duct. The ejaculatory duct contains the ducts from the seminal vesicles as well. During ejaculation,

the ejaculatory duct opens and expels sperm and the secretions from the seminal vesicles into the urethra.

### ***Urethra***

Semen passes from the ejaculatory duct to the exterior of the body via the urethra, an 8 to 10 inch long muscular tube. The urethra passes through the prostate and ends at the external urethral orifice located at the tip of the penis. Urine exiting the body from the urinary bladder also passes through the urethra.

### ***Prostate***

The prostate is a walnut-sized exocrine gland that borders the inferior end of the urinary bladder and surrounds the urethra. The prostate produces a large portion of the fluid that makes up semen. This fluid is milky white in color and contains enzymes, proteins, and other chemicals to support and protect sperm during ejaculation. The prostate also contains smooth muscle tissue that can constrict to prevent the flow of urine or semen.

### ***Cowper's Glands***

The Cowper's glands, also known as the bulbourethral glands, are a pair of pea-sized exocrine glands located inferior to the prostate and anterior to the anus. The Cowper's glands secrete a thin alkaline fluid into the urethra that lubricates the urethra and neutralizes acid from urine remaining in the urethra after urination. This fluid enters the urethra during sexual arousal prior to ejaculation to prepare the urethra for the flow of semen.

### ***Penis***

The penis is the male external sexual organ located superior to the scrotum and inferior to the umbilicus. The penis is roughly cylindrical in shape and contains the urethra and the external opening of the urethra. Large





pockets of erectile tissue in the penis allow it to fill with blood and become erect. The erection of the penis causes it to increase in size and become turgid. The function of the penis is to deliver semen into the **vagina** during sexual intercourse. In addition to its reproductive function, the penis also allows for the excretion of urine through the urethra to the exterior of the body.

### **Semen**

Semen is the fluid produced by males for sexual reproduction and is ejaculated out of the body during sexual intercourse. Semen contains sperm, the male reproductive gametes, along with a number of chemicals suspended in a liquid medium. The chemical composition of semen gives it a thick, sticky consistency and a slightly alkaline pH. These traits help semen to support reproduction by helping sperm to remain within the vagina after intercourse and to neutralize the acidic environment of the vagina. In healthy adult males, semen contains around 100 million sperm cells per milliliter. These sperm cells fertilize oocytes inside the female fallopian tubes.

## **PHYSIOLOGY**

### **Spermatogenesis**

Spermatogenesis is the process of producing sperm and takes place in the testes and epididymis of adult males. Prior to puberty, there is no spermatogenesis due to the lack of hormonal triggers. At puberty, spermatogenesis begins when luteinizing hormone (LH) and follicle stimulating hormone (FSH) are produced. LH triggers the production of testosterone by the testes while FSH triggers the maturation of germ cells. Testosterone stimulates stem cells in the testes known as spermatogonium to undergo the process of developing into spermatocytes.

Each diploid spermatocyte goes through the process of meiosis I and splits into 2 haploid secondary spermatocytes. The secondary spermatocytes go through meiosis II to form 4 haploid spermatid cells. The spermatid cells then go through a process known as spermiogenesis where they grow a flagellum and develop the structures of the sperm head. After spermiogenesis, the cell is finally a sperm cell, or spermatozoa. The spermatozoa are released into the epididymis where they complete their maturation and become able to move on their own.

### **Fertilization**

Fertilization is the process by which a sperm combines with an oocyte, or egg cell, to produce a fertilized zygote. The sperm released during ejaculation must first swim through the vagina and uterus and into the fallopian tubes where they may find an oocyte. After encountering the oocyte, sperm next have to penetrate the outer corona radiata and zona pellucida layers of the oocyte. Sperm contain enzymes in the acrosome region of the head that allow them to penetrate these layers. After penetrating the interior of the oocyte, the nuclei of these haploid cells fuse to form a diploid cell known as a zygote. The zygote cell begins cell division to form an embryo.

### **Amniocentesis**

The Amniocentesis Test is a medical procedure done during pregnancy where a fine needle is inserted into the abdominal wall to take out a sample of amniotic fluid from the uterus. Amniocentesis measures the amount of foetal protein both in the mother's blood as well as in the amniotic fluid surrounding the baby. Depending on genetic risks and indications, a number of other tests may be performed on that sample of amniotic fluid. During pregnancy, the baby lies within the



amniotic sac in the uterus. The amniotic sac is a sealed bag filled with amniotic fluid which contains live cells shed from the baby's skin. Because each skin cell comprises an entire set of the foetus' DNA, the amniotic fluid can help one glean important information regarding the health of the baby and any potential disorders even before birth. However ultrasound and amniocentesis are being misused by doctors and prospective parents to for sex detection and female foeticide.

### SEXUALLY TRANSMITTED DISEASES

Sexually transmitted diseases (STDs), or sexually transmitted infections (STIs), are generally acquired by sexual contact. The organisms that cause sexually transmitted diseases may pass from person to person in blood, semen, or vaginal and other bodily fluids. Some such infections can also be transmitted nonsexually, such as from mother to infant during pregnancy or childbirth, or through blood transfusions or shared needles. It's possible to contract sexually transmitted diseases from people who seem perfectly healthy — people who, in fact, aren't even aware of being infected. Many STDs cause no symptoms in some people, which is one of the reasons experts prefer the term "sexually transmitted infections" to "sexually transmitted diseases."

#### Chlamydia

Chlamydia is one of the most common bacterial STIs and is easily passed on during sex. Most people don't experience any symptoms so are unaware they are infected. In women, chlamydia can cause pain or a burning sensation when urinating, a vaginal discharge, pain in the lower abdomen during or after sex, and bleeding during or after sex, or between periods. In men, chlamydia can cause pain or a burning sensation when

urinating, a white, cloudy or watery discharge from the tip of the penis, and pain or tenderness in the testicles. It's also possible to have a chlamydia infection in your rectum (bottom), throat or eyes. The infection is easily treated with antibiotics, but can lead to serious long-term health problems if left untreated, including infertility.

#### Genital warts

Genital warts are small fleshy growths, bumps or skin changes that appear on or around your genital or anal area. They're caused by the human papilloma virus (HPV). The warts are usually painless, but you may notice some itching or redness. Occasionally, they can cause bleeding. HPV is spread by skin-to-skin contact.

Several treatments are available for genital warts, including creams and cryotherapy (freezing the warts).

#### Genital herpes

Genital herpes is a common infection caused by the herpes simplex virus (HSV), which is the same virus that causes cold sores.

Small, painful blisters or sores usually develop, which may cause itching or tingling or make it painful to urinate.

#### Gonorrhoea

Gonorrhoea is a bacterial STI easily passed on during sex. About 50% of women and 10% of men don't experience any symptoms and are unaware they're infected. In women, gonorrhoea can cause pain or a burning sensation when urinating, a vaginal discharge (often watery, yellow or green), pain in the lower abdomen during or after sex, and bleeding during or after sex or between periods, sometimes causing heavy periods.

In men, gonorrhoea can cause pain or a burning sensation when urinating, a white,



yellow or green discharge from the tip of the penis, and pain or tenderness in the testicles. It's also possible to have a gonorrhoea infection in your rectum, throat or eyes. The infection is easily treated with antibiotics, but can lead to serious long-term health problems if left untreated, including infertility.

### Syphilis

Syphilis is a bacterial infection that in the early stages causes a painless but highly infectious sore on your genitals or around the mouth. The sore can last for up to six weeks before disappearing.

Secondary symptoms such as a rash, flu-like illness or patchy hair loss may then develop. These may disappear within a few weeks, after which you will have a symptom-free phase. The late or tertiary stage of syphilis usually occurs after many years and can cause serious conditions, such as heart problems, paralysis and blindness. It can be treated with antibiotics, usually penicillin injections. When syphilis is treated properly, the later stages can be prevented.

### HIV

HIV is most commonly passed on through unprotected sex. It can also be transmitted by coming into contact with infected blood - for example, sharing needles to inject steroids or drugs. The HIV virus attacks and weakens the

immune system, making it less able to fight infections and disease. There's no cure for HIV but there are treatments that allow most people to live a long and otherwise healthy life.

AIDS is the final stage of an HIV infection, when your body can no longer fight life-threatening infections.

Most people with HIV will look and feel healthy and have no symptoms. When you first develop HIV you may experience a flu-like illness with a fever, sore throat or rash. This is called a seroconversion illness.

A simple blood test is usually used to test for an HIV infection. Some clinics may also offer a rapid test using a finger prick blood test or saliva sample.

### Trichomonas vaginalis

Trichomonas vaginalis (TV) is an STI caused by a tiny parasite. It can be easily passed on through sex and most people are unaware they are infected. In women, TV can cause a frothy yellow or watery vaginal discharge which has an unpleasant smell, soreness or itching around the vagina, and pain when passing urine.

In men, TV rarely causes symptoms. You may experience pain or burning after passing urine, a whitish discharge, or an inflamed foreskin. Once diagnosed, TV can usually be treated with antibiotics.

