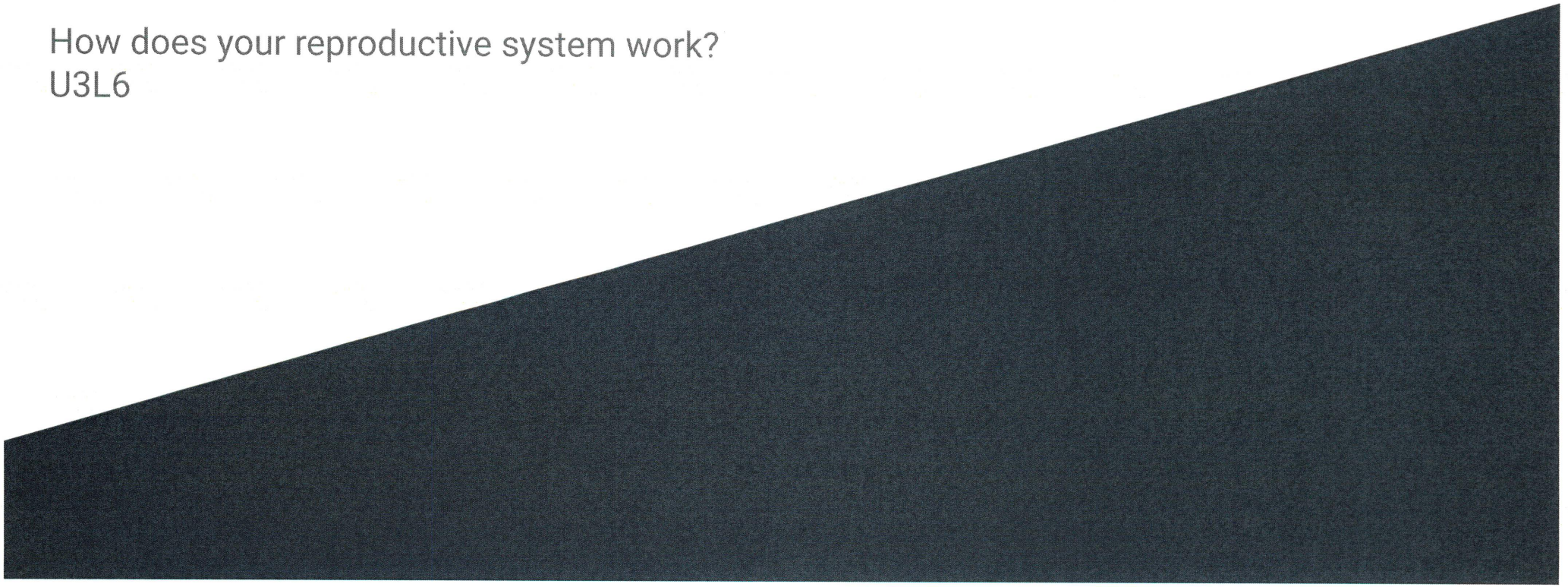
Life Science (Grade 7)

M/J Life Science (#2000010)

The Reproductive System

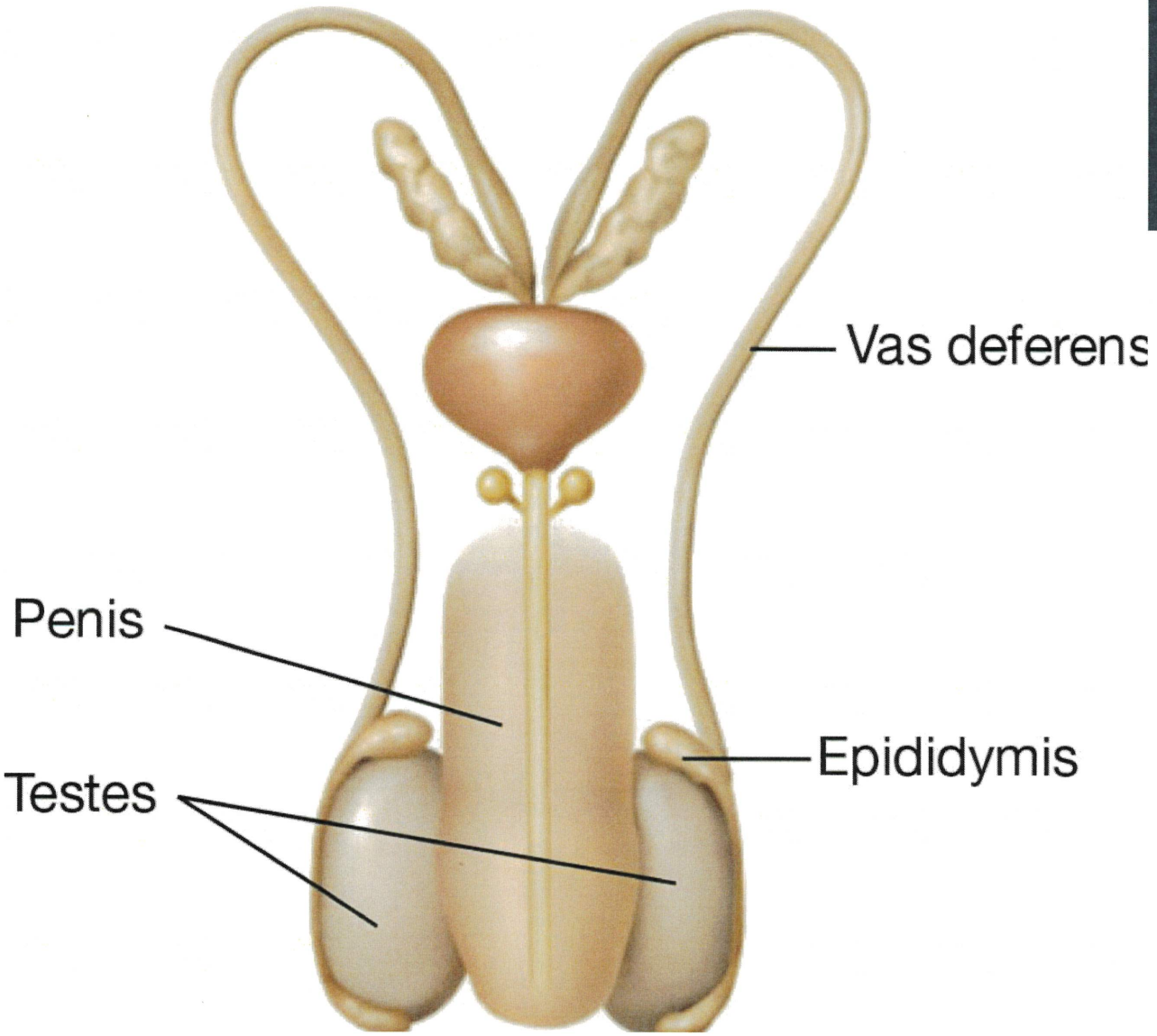
How does your reproductive system work?
U3L6



Male Reproductive System

- Functions:
  - Produce sperm
    - 23 Chromosomes
  - Deliver sperm to the female reproductive system
  - To produce hormone
    - Testosterone makes male characteristics develop (facial hair, deep voice, etc.)

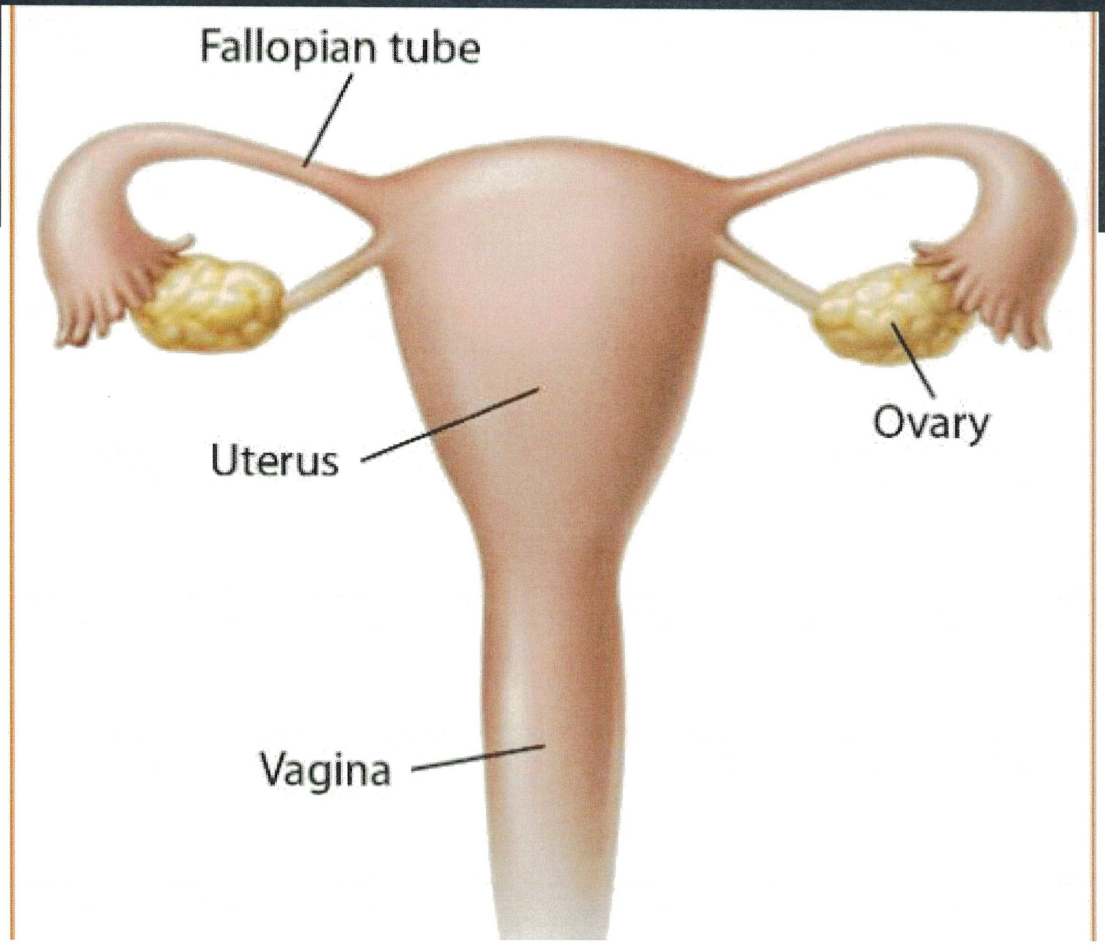
- Structure:
  - **Testes**- where sperm is made and testosterone.
  - **Epididymis**- where mature sperm is stored.
  - **Vas Deferens**- tube that sperm travel through to mix with fluids and make semen.
  - **Urethra-** tube in the penis that sperm travels through to leave the body.
  - **Penis**- organ on the outside of the body that delivers sperm into the female reproductive system.


Vas deferens
Penis
Epididymis
Testes

Female Reproductive System

- Function:
  - Produces Hormones
    - Estrogen
    - Progesterone
  - Produces Egg cells
    - 23 chromosomes
  - Protect and nourish a fertilized egg until birth.

- Structure:
  - **Ovaries**- Produce egg cells
  - **Fallopian Tubes**- carry eggs to uterus
  - **Uterus**- Where fertilized egg develops into a baby
  - **Vagina-** canal that allows sperm to be delivered and is the birth canal.


Fallopian tube
Uterus
Ovary
Vagina

Egg Cells

- How are eggs released?
  - Menstrual Cycle (Period)
  - Takes about 1 month
  - ½ way through an egg is released and goes into the Fallopian tube. If fertilized it goes to the uterus for 9 months.
  - Unfertilized eggs are shed along with the lining of the uterus during menstruation and then the uterus lining thickens and starts over.
- How are eggs fertilized?
  - A few hundred sperm enter the female reproductive system.
  - They get up into the uterus to find the egg.
  - They release an enzyme to dissolve the outer covering of the egg.
  - Once one makes it in the egg blocks other sperm and then travels into the uterus and attaches to the thickened uterus wall.

Human Growth and Development

- Stages of Pregnancy:
  - First Trimester- when placenta , umbilical cord and many organs form. Embryo to Fetus.
  - Second Trimester- joints and bones form, fetus starts moving, can breathe and swallow, rapid brain growth.
  - Third Trimester- responds to light and sound, organs become fully functional, bones grow and harden, can open eyes by week 32, and can also dream.
- Full term Pregnancy lasts about 40 weeks.
- BIrth:
  - Birth begins with uterine muscle contractions.
  - This pushes the baby out through the vagina.
  - Cut the umbilical cord
  - Delivery ends when the delivery of the placenta
- Childhood- lasts from 2 years old to puberty
- Adolescence- lasts from puberty to adulthood usually starting around 9 years old.

Sexually Transmitted Infections (STI's)

- How are they caused?
  - Viruses
  - Bacteria
  - Parasites
- Viruses:
  - Acquired Immunodeficiency Syndrome (AIDS)
  - Herpes- painful sores
  - HPV- often symptomless
- Bacteria: can be treated with antibiotics
  - Chlamydia- burning sensation when peeing
  - Gonorrhea
- Parasites:
  - Trichomoniasis- more common for women pain when peeing
  - Pubic Lice- causes itching

FACT OR MYTH

REPRODUCTIVE SYSTEMS

Drag th
circles ov
for eacl

FERTALIZATION

1. Sperm + Egg = Baby — FACT OR MYTH
2. Your whole body begins as a single cell — FACT OR MYTH
3. A fetus becomes and embryo — FACT OR MYTH
4. All major organs are formed by 6 weeks — FACT OR MYTH
5. Through the umbilical cord, the fetus takes in oxygen and nutrients — FACT OR MYTH

MALE REPRODUCTIVE SYSTEM

1. The bladder holds sperm — FACT OR MYTH
2. Sperm travel through the bladder — FACT OR MYTH
3. The testicles produce sperm — FACT OR MYTH
4. 1,500 sperm are created every second — FACT OR MYTH
5. The seminal vesical makes fluid for sperm — FACT OR MYTH

FEMALE REPRODUCTIVE SYSTEM

1. Fallopian tubes are the pathway for eggs — FACT OR MYTH
2. The fetus grows inside the ovaries — FACT OR MYTH
3. The cervix dilates in labor — FACT OR MYTH
4. The cervix produces the egg — FACT OR MYTH
5. At birth, females have 1 million eggs — FACT OR MYTH

FACT OR MYTH

REPRODUCTIVE SYSTEMS

FERTALIZATION

1. Sperm + Egg = Baby — FACT OR MYTH
2. Your whole body begins as a single cell — FACT OR MYTH
3. A fetus becomes and embryo — An embryo becomes a fetus — FACT OR MYTH
4. All major organs are formed by 6 weeks — 8 weeks — FACT OR MYTH
5. Through the umbilical cord, the fetus takes in oxygen and nutrients — FACT OR MYTH

MALE REPRODUCTIVE SYSTEM

1. The bladder holds sperm — Urine — FACT OR MYTH
2. Sperm travel through the bladder — Epididymis — FACT OR MYTH
3. The testicles produce sperm — FACT OR MYTH
4. 1,500 sperm are created every second — FACT OR MYTH
5. The seminal vesical makes fluid for sperm — FACT OR MYTH

FEMALE REPRODUCTIVE SYSTEM

1. Fallopian tubes are the pathway for eggs — FACT OR MYTH
2. The fetus grows inside the ovaries — Uterus — FACT OR MYTH
3. The cervix dilates in labor — FACT OR MYTH
4. The cervix produces the egg — Ovary — FACT OR MYTH
5. At birth, females have 1 million eggs — FACT OR MYTH

Links to PDF Copies:

Fact or Myth

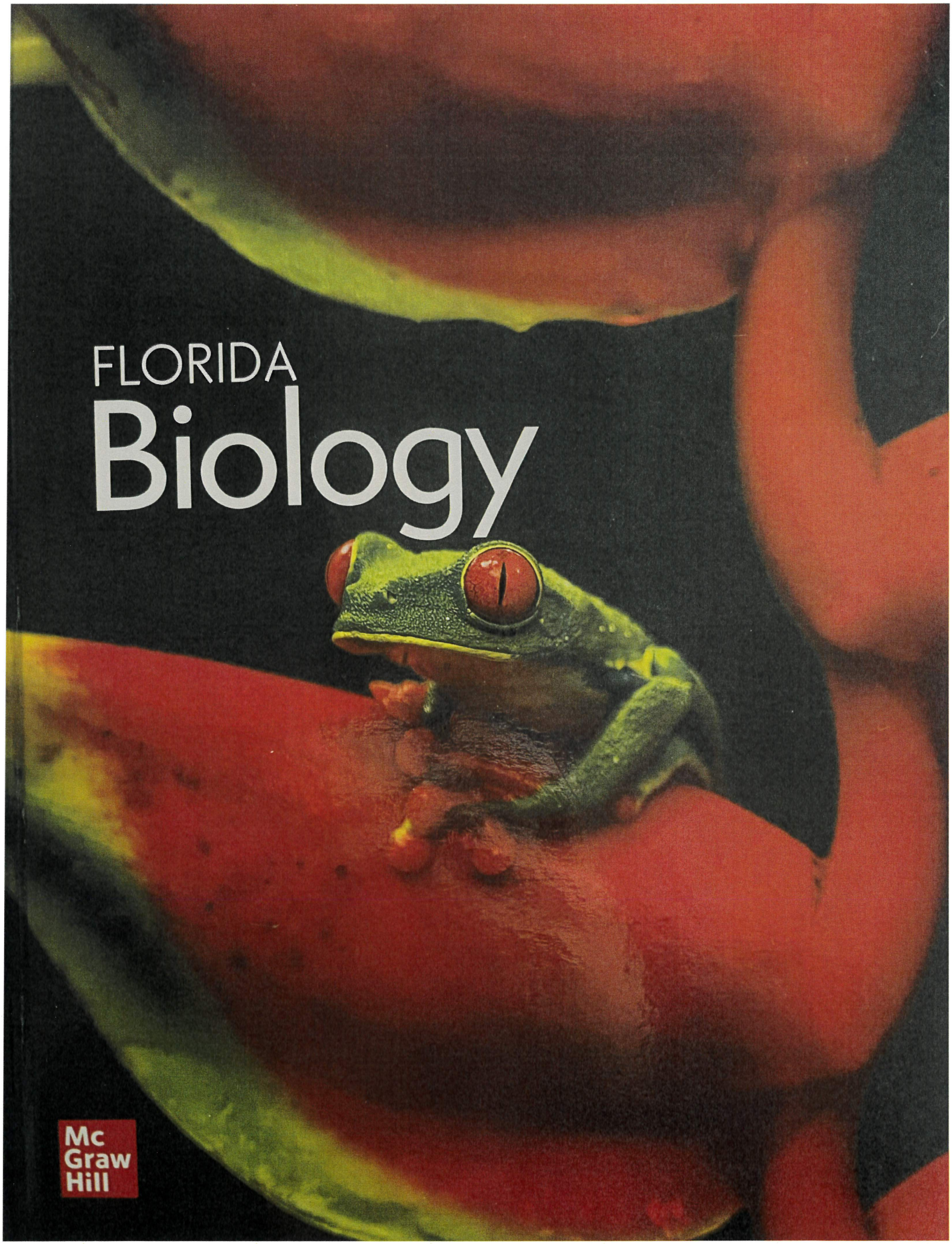
Fact or Myth Answer Sheet

* This Google Slides may be downloaded as a PPT for those who do not have access to Google Suite:
File > Download > PPT

If sharing with students, be sure to delete slide 2 and 3 before you assign. You may copy and paste slides 2 and 3 into a new Google Slides presentation. OR make a copy of this version, delete slides 2 and 3 then assign.

Biology I

Biology 1 (#2000310)


FLORIDA
Biology
Mc
Graw
Hill

LESSON 4

Reproductive System

Looking at the diversity of people in **Figure 18,** it can be difficult to believe that all people that ever lived are products of the same process: reproduction.

Reproduction itself might seem to be pretty straightforward. You've already learned that all living things reproduce, and many of them do so sexually through production of gametes that meet in fertilization to form a new organism. Yet, the process is surprisingly complex, requiring the interaction of multiple body systems at precise times so that humans can reproduce. In this lesson, you will learn about these structures and their interactions.

Figure 18 Despite our remarkable diversity, all people result from the same basic stages of reproduction.

Essential Question

What are the structures and functions of the male and female reproductive systems?

Male Reproductive System

Figure 19 illustrates the male reproductive structures. The male reproductive glands are called the testes (singular, testis) and are located outside of the body cavity in a pouch called the scrotum (SKROH tum). A temperature lower than 37°C—average body temperature—is required for the development of sperm. Because the scrotum is located outside of the body cavity, it is several degrees cooler. This makes the environment suitable for the normal development of sperm.

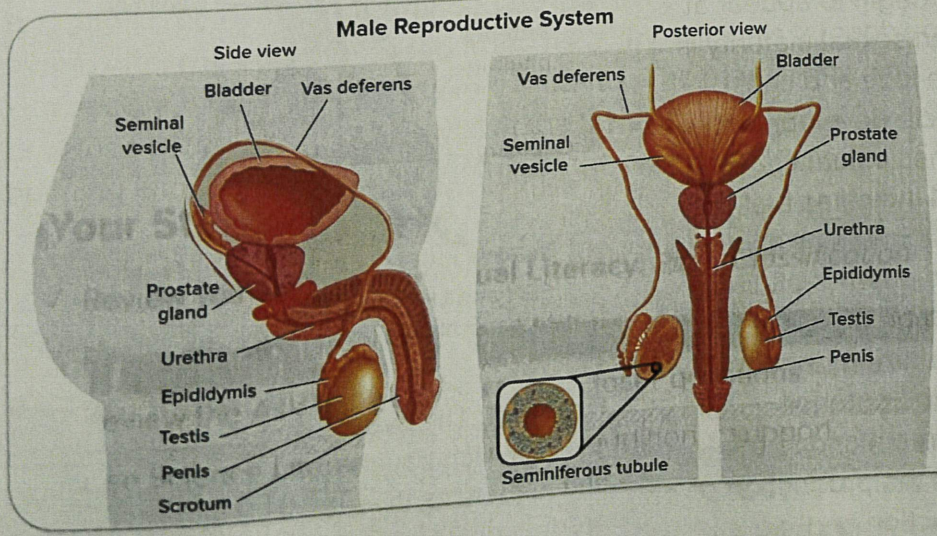


Figure 19 The male reproductive system produces gametes called sperm in the testes.

Look Closer **Identify** the structure that produces sperm.

Rawpixel.com/Shutterstock

FSAS SC.912.L.16.13

Structures and functions of the male reproductive system

The male reproductive cells, called sperm cells, are produced in the testes. You can follow the path that sperm travel in **Figure 19** on the previous page as you read about the structures in the male reproductive system. Sperm, like the one shown in **Figure 20,** develop in the testes in the **seminiferous tubules** (se muh NIHF rus • TEW byulz). These tubules produce 100–200 million sperm each day. Next, sperm travel to the **epididymis** (eh puh DIH duh mus), a structure located on top of each testis where sperm mature and are stored. When the sperm are released from the body, they travel through the **vas deferens** (VAS • DEF uh runz), a duct leading away from the testis. There are two vas deferens, one leading away from each testis. The two vas deferens join together and enter the **urethra** (yoo REE thruh), the tube that carries both semen and urine outside of the body through the penis.

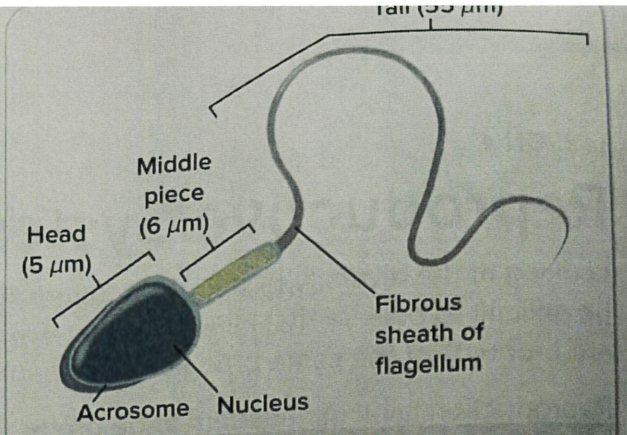


Figure 20 A sperm is a flagellated cell composed of a head, midpiece, and tail.

Ask Yourself **Identify** in sequence the structures that a sperm cell passes through or encounters as it makes its way out of the body.

Sperm require a nourishing fluid to survive long enough to fertilize an egg. **Semen** refers to the fluid that contains sperm and their nourishment, as well as other fluids from the male reproductive glands. The seminal vesicles contribute over half of the semen and secrete the sugar needed for energy. They also provide other nutrients, proteins, and enzymes for the sperm. The prostate gland and bulbourethral glands contribute an alkaline solution to the fluid to neutralize acidic conditions that sperm might encounter in the urethra and the female reproductive tract.

Male hormones Testosterone, a hormone which is made in the testes, is necessary for the production of sperm. It also influences the development of male secondary sex characteristics that begin to appear at **puberty,** the period of growth when sexual maturity is reached. These include hair on the face and chest, broader shoulders, increased muscle development, and a deeper voice. Three hormones influence testosterone production. **Figure 21** indicates that the hypothalamus produces gonadotropin-releasing hormone (GnRH), which acts on the anterior pituitary gland. GnRH stimulates the production of follicle-stimulating hormone (FSH) and luteinizing hormone (LH). Both FSH and LH travel from the anterior pituitary gland through the bloodstream and to the testes. In the testes, FSH promotes the production of sperm and LH stimulates the production and secretion of testosterone.

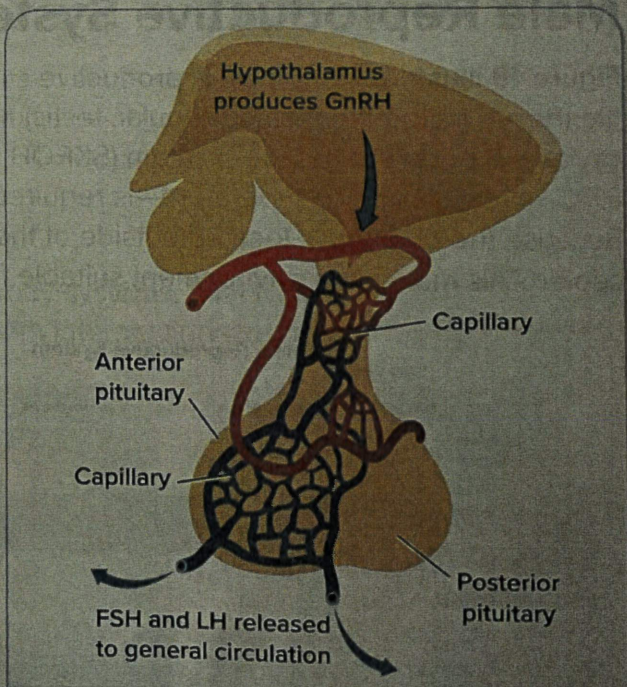


Figure 21 The hypothalamus produces GnRH, which travels to the pituitary gland and influences the rate of LH and FSH production. LH and FSH are regulated by negative feedback.

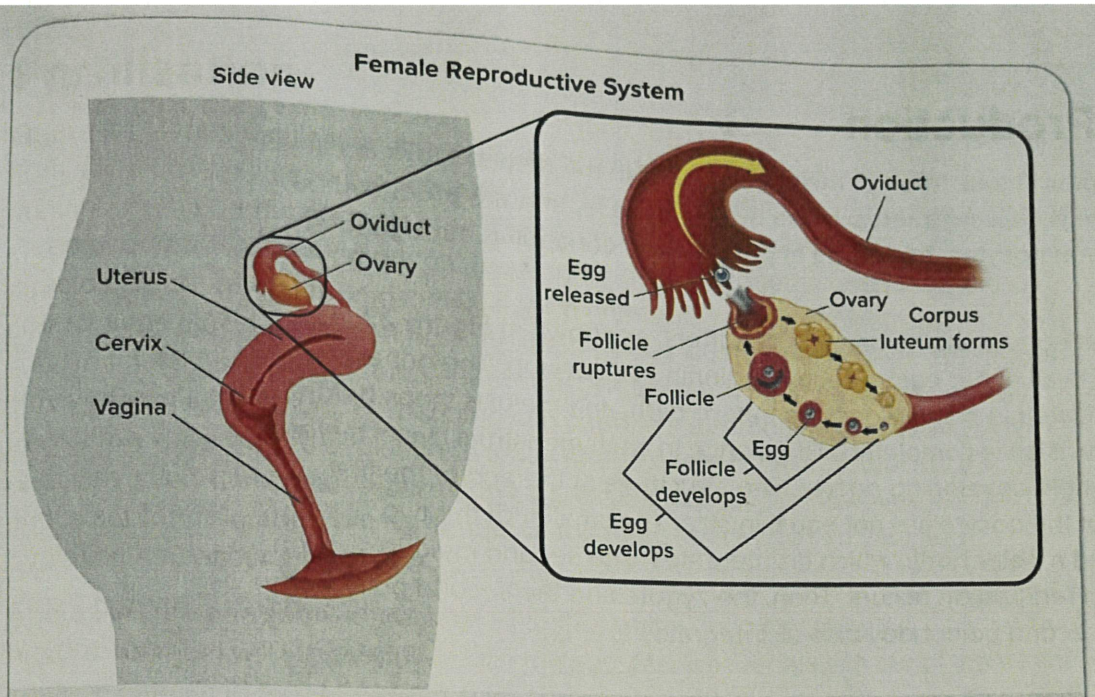


Figure 22 The main structures of the female reproductive system are the vagina, uterus, and ovaries. During every menstrual cycle, one follicle fully matures and releases an egg. The follicle is then called the corpus luteum.

Female Reproductive System

A female's reproductive system produces egg cells, receives sperm, and provides an environment that is right for fertilization of an egg and the development of an embryo. Refer to **Figure 22** as you read about the structures of the female reproductive system.

Structures and functions of the female reproductive system

Female reproductive cells, called egg cells, are produced in the ovaries, shown in **Figure 22.** Inside each ovary are **oocytes,** which are immature eggs. Approximately once every 28 days, oocyte development is stimulated and an egg, called an ovum, is formed. The ovum is surrounded by follicle cells that protect and nourish the ovum. After the egg is released from the ovary, it travels through an **oviduct** (OH vuh duct), a tube that connects to the uterus. The uterus, or womb, is where a baby develops before birth. The cervix, at the lower end of the uterus, has a narrow opening into the vagina, which leads to the outside of the female's body.

Ask Yourself **List** the structures of the female reproductive system and their functions.

Female hormones Estrogen and progesterone are steroid hormones made by cells in the ovaries. A female's anterior pituitary gland also produces LH and FSH. During puberty, an increase in estrogen levels causes a female's breasts to develop and her amount of fat tissue to increase. During puberty, a female will also experience her first **menstrual cycle,** the events that take place each month in the human female to help prepare the female body for pregnancy.

Gamete Production

Recall from Chapter 13 that, through meiosis, one cell in the testes or ovaries gives rise to four sex cells called gametes. In the human male, sperm are produced daily from primary spermatocytes, beginning at puberty and continuing throughout a male's lifetime.

The production of eggs in the human female differs, as shown in **Figure 23.** A female is born with all of her eggs already beginning to develop. The genetic material has replicated in primary oocytes before birth, and meiosis stops before the first meiotic division is completed. Then, once in each menstrual cycle, meiosis continues for a single developing oocyte. The structures at the end of the first meiotic division of the oocyte are not equal in size. The smaller of the two structures is called a **polar body,** which disintegrates. The second meiotic division takes place only if fertilization occurs. Then, the zygote and the second polar body are formed. The second polar body also disintegrates.

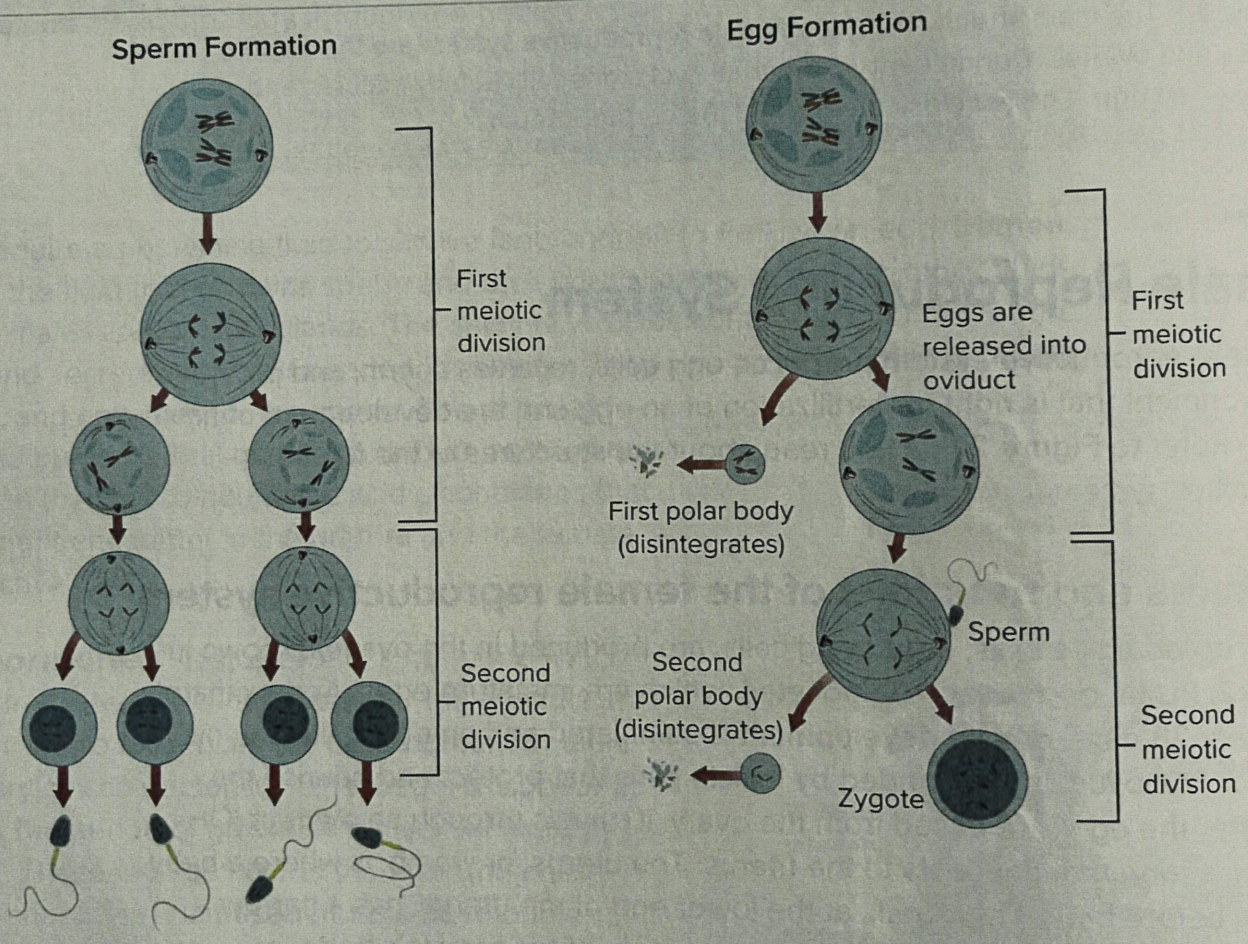


Figure 23 The human male sex cell production follows the general pattern of meiosis and results in many sperm. Meiosis in the human female results in one egg. The second division in meiosis will not be completed in a human female unless the egg is fertilized.

Look Closer **Summarize** the differences between sperm cell and egg cell production.

Fertilization

Figure 24 shows fertilization, the process of a sperm joining with an egg. Fertilization usually occurs in the upper portion of an oviduct near the ovary. In humans, both sperm and eggs are haploid, and each normally has 23 chromosomes. Fertilization brings these chromosomes together, restoring the diploid number of 46 chromosomes. Sperm enter the vagina when strong muscular contractions ejaculate semen from the male's penis during intercourse. Sperm can survive for 48 hours in the female reproductive tract, but an unfertilized egg can survive for only 24 hours. Fertilization can happen if intercourse occurs anytime from a few days before ovulation to a day after ovulation. Overall, there is a relatively short time when fertilization can occur successfully. However, it is important to remember that the length of the menstrual cycle can vary and ovulation can occur at any time.

About 300 million sperm are released into the vagina during intercourse. Only several hundred of them will successfully reach the egg. Many never make it out of the vagina, some are attacked by white blood cells, and many simply die along the way. Only one sperm can fertilize an egg, but it takes several hundred to participate in the process.

CHEMISTRY CONNECTION A single sperm cannot penetrate the plasma membrane of a human egg. Notice in **Figure 24** that the tip of each sperm is a specialized lysosome called an acrosome. As several hundred sperm bombard the egg, the enzymes inside of the acrosomes weaken the plasma membrane of the egg. Eventually the plasma membrane becomes weak enough that one sperm can penetrate the egg. Immediately, the egg forms a barrier to prevent other sperm from entering the now-fertilized egg.

Ask Yourself **Explain** why only one sperm can fertilize an egg.

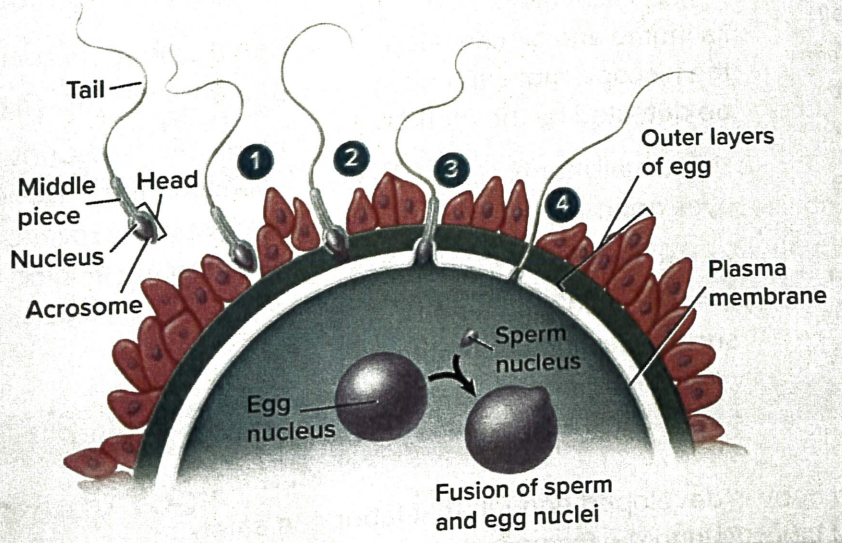


Figure 24 Although many sperm are needed to weaken the barrier that surrounds the egg, only one sperm fertilizes an egg (steps 1–4). Fertilization is complete when the sperm nucleus fuses with the egg nucleus.

HMH

Florida Biology

Stephen Nowicki

CHAPTER 29

Reproduction and Development

29.1 Reproductive Anatomy

29.2 Reproductive Processes

29.3 Fetal Development

Data Analysis
INTERPRETING GRAPHS

29.4 Birth and Development

ONLINE BIOLOGY

HMDScience.com

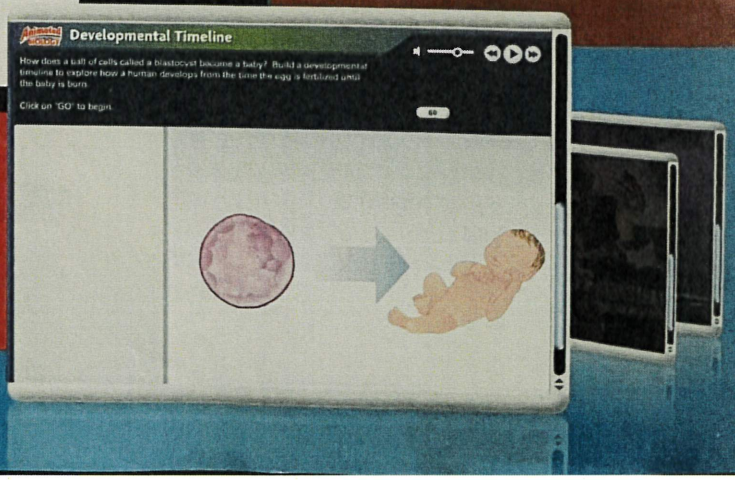
ONLINE Labs

- **QuickLab** Human Sex Cells
- Hormones in the Human Menstrual Cycle
- Development of an Embryo
- Effects of Chemicals on Reproductive Organs
- Stages of Human Development
- **Video Lab** Sonography

Animated BIOLOGY

PREMIUM CONTENT

Developmental Timeline Use an interactive timeline to explore different milestones of fetal development, such as when the heart develops and when fingers form.



What protects this developing baby?

This developing baby, only about four months old, floats in a liquid world, receiving all its oxygen and nutrients from its mother's body. The journey from a single cell to a fully developed human being is guided by genetic instructions, environmental influences, and the complex actions of hormones in both mother and baby.

READING TOOLBOX

This reading tool can help you learn the material in the following pages.

USING LANGUAGE

Recognizing Main Ideas A main idea is a sentence that states the main point of a paragraph. The main idea is often, but not always, one of the first few sentences of a paragraph. All the other sentences of the paragraph give support to the main idea.

YOUR TURN

Find the main idea in the paragraph below.

Disease-causing pathogens are transmitted in many ways. Some pathogens can be passed by drinking contaminated water. Other pathogens are present in body fluids such as semen. These pathogens can be passed from one person to another through sexual contact.

29.1 Reproductive Anatomy

SC.912.L.16.13

KEY CONCEPT **Female and male reproductive organs fully develop during puberty.**

MAIN IDEAS

- The female reproductive system produces ova.
- The male reproductive system produces sperm.

VOCABULARY

- reproductive system
- puberty
- ovum
- ovary
- uterus
- estrogen
- fallopian tube
- testis
- testosterone
- scrotum
- epididymis
- vas deferens
- semen

SC.912.L.16.13 Describe the basic anatomy and physiology of the human reproductive system. Describe the process of human development from fertilization to birth and major changes that occur in each trimester of pregnancy.

CONNECT TO

ENDOCRINE SYSTEM

You read in **Nervous and Endocrine Systems** that the hypothalamus and pituitary glands are part of the endocrine system. These two glands are considered "master" glands because the hormones they secrete affect other glands that play key roles in human reproduction, growth, and development.

Connect to Your World

You have something in common with every person ever born. Like everyone else, you began life as a single cell, produced when one male sex cell joined with one female sex cell. Sexual reproduction is the means by which the human species passes on genetic information to each generation.

MAIN IDEA

The female reproductive system produces ova.

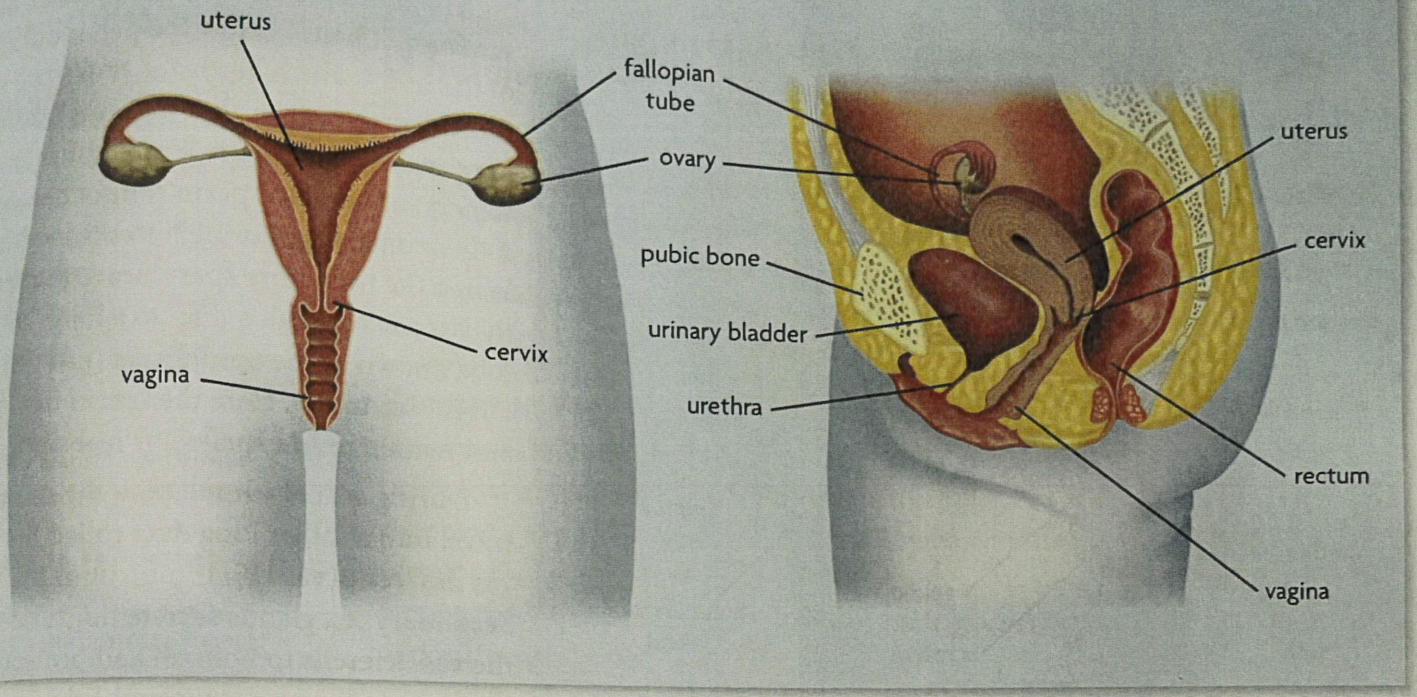
The **reproductive system** is a collection of specialized organs, glands, and hormones that help to produce a new human being. Females and males reach sexual maturity, or the ability to produce offspring, only after puberty. **Puberty** marks a time in your life when your hypothalamus and your pituitary gland release hormones, such as follicle-stimulating hormone (FSH) and luteinizing hormone (LH). Such hormones begin the process of developing your sexual characteristics and reproductive system.

The main functions of the female reproductive system are to produce ova (singular, **ovum**), or egg cells, and to provide a place where a fertilized egg can develop. Unlike males, females have all of their reproductive organs located inside their bodies. This organization helps to protect a fertilized egg while it develops. The egg cells are produced in the ovaries. The **ovaries** are paired organs located on either side of the **uterus,** or womb, as shown in **FIGURE 1.1.** When a female baby is born, she already has about 2 million potential egg cells stored in her ovaries.

In the ovaries, FSH and LH stimulate the release of another important hormone, estrogen. **Estrogen** is a steroid hormone that has three main functions. First, it controls the development of female sexual characteristics, including widening the pelvis, increasing fat deposits and bone mass, and enlarging the breasts. Second, it is needed for egg cells to develop fully before they leave the ovaries. Third, estrogen helps to prepare the uterus for pregnancy every month and helps to maintain a pregnancy when it occurs.

When an egg cell matures each month, it is released from an ovary and enters the fallopian tube. The **fallopian tube** (fuh-LOH-pee-uhn) is an organ about 10 centimeters (4 in.) long that ends in the uterus. An egg takes several days to travel through this tube. During that time, it can be fertilized by sperm

FIGURE 1.1 FEMALE REPRODUCTIVE ANATOMY



that enter the tube. A fertilized egg will attach to the wall of the uterus, but an unfertilized egg will eventually be broken down and discarded.

The uterus is about the size and shape of a pear. It is composed of three layers: a thin inner layer of epithelial cells, a thick middle layer of muscle, and an outer layer of connective tissue. The lower end of the uterus is called the cervix, which opens into the vagina. In a normal birth, a baby is pushed down the canal of the vagina to exit the mother's body. The complex processes of fertilization and human development are described in Sections 2 and 3.

Analyze How does the release of estrogen affect the female reproductive system during puberty?

READING TOOLBOX

TAKING NOTES

Use a two-column chart to list the major parts and functions of the female and male reproductive anatomy.

Female	Male
Ovaries — Paired organs where eggs are produced	Testes — Paired organs that produce sperm cells

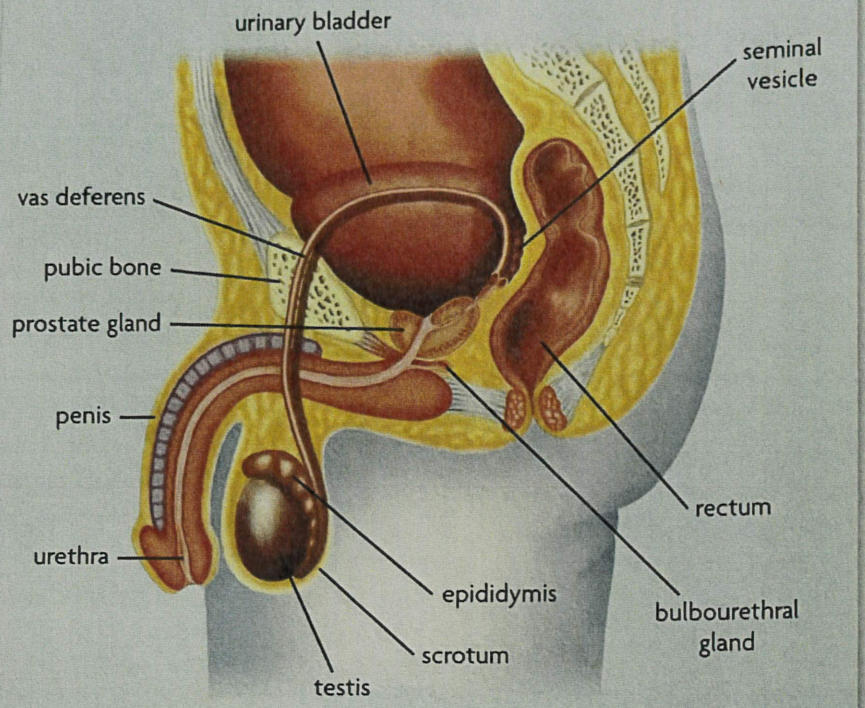
MAIN IDEA

The male reproductive system produces sperm.

The main functions of the male reproductive system are to produce sperm cells and to deliver them to the female reproductive system. The diagram in **FIGURE 1.2**, on the following page, shows the organs in which sperm are produced and stored and the organs that deliver the sperm.

Males do not produce sperm until puberty but afterward can produce sperm all their lives. Sperm production takes place in the testicles, or **testes** (TEHS-teez), which are paired organs. Each testis (singular of *testes*) contains hundreds of tiny tubules where millions of sperm cells are produced. In the testes, LH stimulates the release of testosterone. **Testosterone** (tehs-TAHS-tuh-ROHN) is a steroid hormone that, along with FSH, stimulates the production of sperm cells. Testosterone also controls the development of male sexual characteristics. These include a deeper voice than a female's, more body hair,

FIGURE 1.2 MALE REPRODUCTIVE ANATOMY



greater bone density, and increased muscle mass.

The testes are enclosed in a pouch, the **scrotum.** It hangs below the pelvis outside of the body, which keeps the testes two to three degrees cooler than the core body temperature. The lower temperature is important because sperm cannot develop if the temperature in the testes is too high. When the immature sperm leave the testes, they travel through a duct to a long, coiled tube known as the **epididymis** (EHP-ih-DIHD-uh-mihs). Here the sperm mature and remain until expelled or reabsorbed.

During sexual stimulation, the sperm travel into another long duct called the **vas deferens** (vas DEHF-uhr-uhnz). Secondary sex glands secrete fluids into the vas deferens to nourish and protect the sperm. The prostate gland, which surrounds the urethra, produces a fluid that helps sperm move more easily. The bulbourethral gland (BUHL-boh-yu-REE-thruhl) and the seminal vesicle secrete basic fluids that help to neutralize the acidity in the urethra and in the female's vagina. The fluids from all three glands, together with the sperm, form a milky white substance known as **semen.**

During sexual arousal, blood flows into the penis, making it rigid. Semen moves from the vas deferens into the urethra, which runs the length of the penis. When ejaculation occurs, a muscle closes off the bladder to prevent urine from mixing with the semen in the urethra. Smooth muscle contractions then propel the semen along the urethra and eject it from the penis.

Apply **Why might having a high fever affect sperm production?**

SELF-CHECK Online
HMDScience.com
PREMIUM CONTENT

29.1 Formative Assessment

REVIEWING ▶ MAIN IDEAS

1. Explain the function of the following parts of the female reproductive system: **ovary, fallopian tube, uterus.**
2. Explain the function of the following parts of the male reproductive system: **testes, scrotum, epididymis, vas deferens.**

CRITICAL THINKING

3. **Compare** In what ways are the effects of **testosterone** on males and **estrogen** on females similar?
4. **Infer** Both males and females have paired organs that produce sex cells. What survival advantage for our species might this pairing of organs provide?

CONNECT TO PLANTS

5. Recall that flowering plants reproduce sexually. The stamen produces pollen grains, and the carpel contains an ovary where eggs are produced. How do these structures compare with human reproductive organs?

29.2 Reproductive Processes

SC.912.L.16.13

KEY CONCEPT **Human reproductive processes depend on cycles of hormones.**

MAIN IDEAS

- Eggs mature and are released according to hormonal cycles.
- Sperm production in the testes is controlled by hormones.
- Fertilization occurs when a sperm cell joins an egg cell.
- Sexually transmitted diseases affect fertility and overall health.

VOCABULARY

follicle
ovulation
menstrual cycle
endometrium
corpus luteum
menopause
zygote
infertility
sexually transmitted disease

SC.912.L.16.13 Describe the basic anatomy and physiology of the human reproductive system. Describe the process of human development from fertilization to birth and major changes that occur in each trimester of pregnancy.

Connect to Your World

You may have heard the phrase "Timing is everything." In football, for instance, precise timing between players can mean the difference between catching or dropping a key pass. Likewise, timing is everything for the hormones that regulate the reproductive processes in your body. Numerous feedback loops among these hormones help ensure that each process occurs at the right time and in the right order.

MAIN IDEA

Eggs mature and are released according to hormonal cycles.

A female's reproductive cycle is controlled by hormones released by the hypothalamus, the pituitary gland, and the ovaries. Each month, the levels of these hormones rise and fall in well-timed feedback loops that regulate the development and release of an egg and prepare the uterus to receive it.

Production of Eggs

The production of eggs, or ova, begins before a female is born, as described in Section 1. Recall that meiosis is a type of cell division that produces sex cells, or gametes. After the chromosomes in each of the cells are duplicated, meiosis I can begin. The potential eggs then enter a resting phase that lasts until puberty. At birth, a female has about 2 million of these partially developed eggs in her ovaries. Before puberty begins, many of these cells break down until only about 400,000 are left.

At puberty, a monthly hormone cycle begins the second stage of egg production. Every 28 days or so, an increase in FSH stimulates a potential egg to complete meiosis I, as shown in **FIGURE 2.1**. The potential egg divides unevenly, producing two sex cells. The larger cell receives most of the organelles, cytoplasm, and nutrients an embryo will need when an egg is fertilized. The smaller cell, or polar body, simply breaks down. The larger sex cell completes meiosis II only after a sperm enters it. The cell divides again to produce an ovum, or egg, and a second polar body that also breaks down. Both the ovum and the second polar body contain 23 chromosomes from the mother.

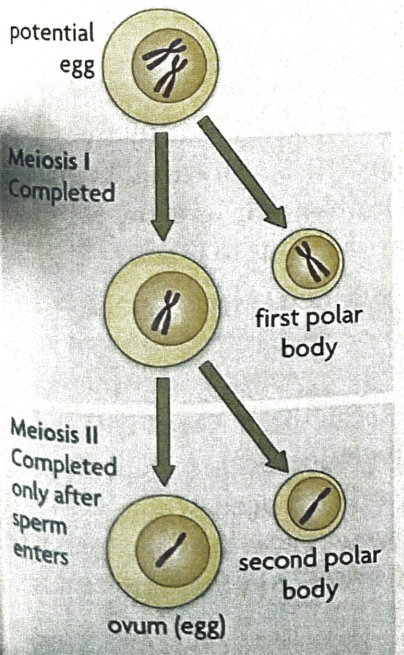
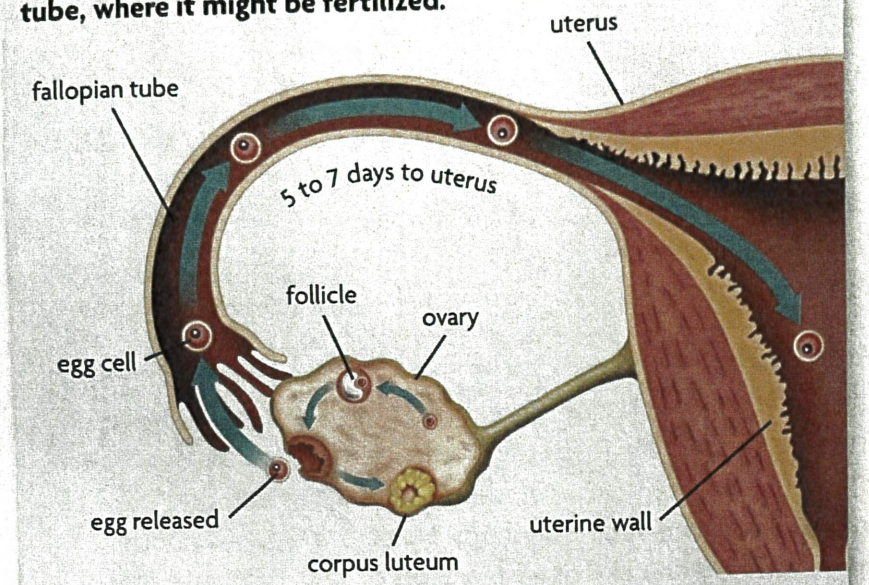


FIGURE 2.1 Potential eggs go through meiosis I and II to produce mature ova, or eggs with 23 chromosomes each.

FIGURE 2.2 Release of Egg

After an egg is released, it travels through the fallopian tube, where it might be fertilized.



Infer **Why might it be an advantage that the egg takes several days to travel through the fallopian tube?**

Release of Egg

Each developing sex cell, which you can think of as an egg, is surrounded by a group of cells called a **follicle** that helps the egg to mature. When an egg is ready to be released, the follicle ruptures, and the egg breaks through the ovary wall, as shown in **FIGURE 2.2**. The release of an egg from the ovary is called **ovulation.** The egg is swept into the fallopian tube, where it can be fertilized by a sperm. Over the next five to seven days, the egg moves through the tube to the uterus. An unfertilized egg is discarded during menstruation.

In most cases, only one egg is released during ovulation. About 400 to 500 eggs are released over a female's reproductive life. Which ovary releases an egg each month is entirely random. If one ovary is damaged, however, the other may take over and release an egg each month.

Biology VIDEO CLIP
HMDScience.com
PREMIUM CONTENT
Ovulation

The Menstrual Cycle

The **menstrual cycle** is a series of monthly changes in the reproductive system that include producing and releasing an egg and preparing the uterus to receive it. The length of the cycle is slightly different for each female, but averages about 28 days. The cycle has three main phases—flow phase, follicular phase, and luteal phase, as **FIGURE 2.3** shows. The timing of each phase is regulated by specific hormones.

CONNECT TO

ANIMAL BEHAVIOR

As you read in **Animal Behavior,** hormone cycles control more than reproduction. Certain glands and proteins in some animals detect seasonal changes in temperature and in the hours of daylight. As a result, the glands secrete hormones that control when an animal will hibernate or migrate.

1. **Flow phase** Day 1 of the menstrual cycle is the first day that the menstrual flow begins. The flow occurs when the lining of the uterus, or **endometrium** (EHN-doh-MEE-tree-uhm), detaches from the uterine wall and passes through the vagina to the outside of the body. Some blood, mucus, and tissue fluid are also expelled. The muscles of the uterus contract to help expel the lining. These contractions, known as "cramps," can be painful for some females. During this phase, the level of FSH starts to rise, and another follicle in the ovaries begins to mature.
2. **Follicular phase** The follicular (fuh-LIHK-yuh-luhr) phase lasts from about day 6 to day 14. At the start of this phase, the level of estrogen in the blood is relatively low. Hormones from the hypothalamus stimulate the pituitary to release more FSH and LH. Recall that a rise in FSH and LH causes the egg and follicle to mature. Ovulation occurs at about day 14. As the egg is developing, the follicle releases estrogen, which steadily increases over the next few days. This hormone causes the endometrium to thicken. Estrogen also stimulates a sharp increase in LH, which causes the follicle to rupture, releasing the egg.

3 Luteal phase In the luteal (LOO-tee-uhl) phase, the release of hormones is now timed to stop egg production and to develop the endometrium to receive a fertilized egg. After ovulation, the empty follicle turns yellow and is called the **corpus luteum** (KAWR-puhs LOO-tee-uhm), or "yellow body." The corpus luteum releases estrogen and another hormone, progesterone, which limits the production of LH. Progesterone and estrogen also increase the number of blood vessels in the endometrium. If the egg is not fertilized, rising levels of estrogen and progesterone cause the hypothalamus to stop releasing FSH and LH. The corpus luteum then breaks down and stops secreting estrogen and progesterone. As a result, the uterus lining begins to shed, and the next flow phase starts.

For most women, the menstrual cycle continues throughout their reproductive years, which may last from preteen years to the late 50s. Eventually, however, the levels of hormones decline with age. This decline disrupts the normal timing of the menstrual cycle. In a process called **menopause,** the cycle gradually becomes more and more irregular and finally stops altogether. Menopause can occur as early as a woman's mid-30s.

READING TOOLBOX

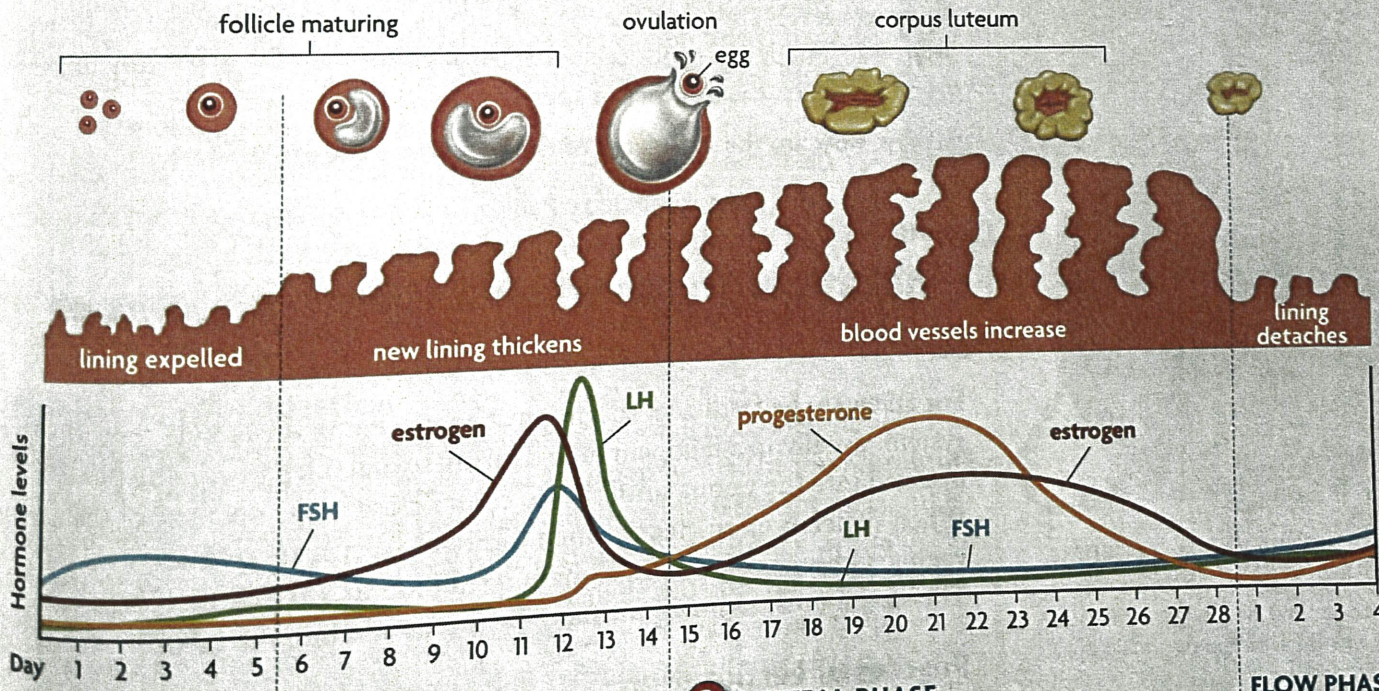
VOCABULARY

Menstruation and *menopause* are based on the Latin word *mensis,* which means "month."

Summarize What are the main functions of estrogen and progesterone during the follicular and luteal phases?

FIGURE 2.3 Menstrual Cycle

Hormones cause changes in the follicle, egg, and lining of the uterus.

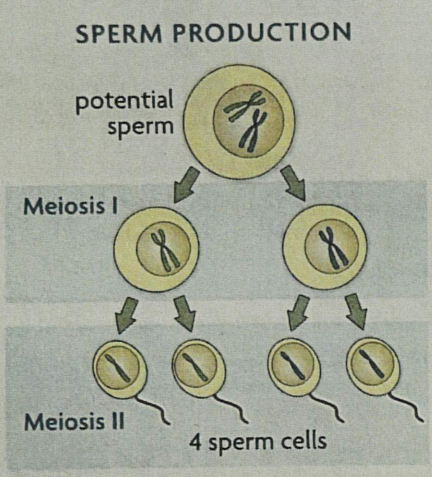


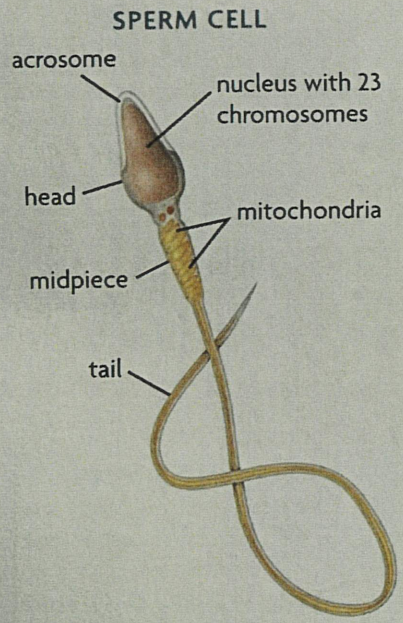
Analyze During which phase does the egg have the greatest chance of being fertilized?

MAIN IDEA

Sperm production in the testes is controlled by hormones.

FIGURE 2.4 Each potential sperm cell that undergoes meiosis produces four mature sperm cells with 23 chromosomes each. A mature sperm has a head, midpiece, and whiplike tail that enables it to move.





The reproductive cycles for males and females are different in two ways. First, females begin to produce eggs before they are born, but males do not produce sperm until they reach puberty. Second, females usually produce only one egg a month to be fertilized, while males produce millions of sperm almost daily.

The production of sperm begins when hormones from the hypothalamus stimulate the pituitary to release FSH and LH, which circulate to the testes. The testes start releasing testosterone, which causes specialized cells to go through meiosis to develop into mature sperm. As the levels of testosterone rise, the levels of FSH and LH begin to decline. This feedback loop among the hormones helps to control the number of sperm that are produced.

Unlike eggs, which produce polar bodies, the developing sperm divide into four equal sperm cells, as shown in **FIGURE 2.4**. Each cell is haploid, with 23 chromosomes. Sperm cells then fully mature in the epididymis. As the diagram shows, each sperm has a head, midpiece, and tail. The head contains a nucleus and a cap region called the acrosome. When a sperm cell contacts an egg, the acrosome releases enzymes that allow the sperm to penetrate the egg's membrane. The midpiece holds the mitochondria that supply the sperm with ATP for the energy it needs. The tail, or flagellum, propels the sperm from the vagina to the fallopian tubes, where fertilization can take place.

After sperm are released through the penis, testosterone levels decline. These low levels stimulate the hypothalamus, and sperm production increases again. Most men can produce sperm throughout their lives, starting in puberty. However, the number of sperm usually declines with age.

Compare **How are the structures of the sperm and the egg similar?**

MAIN IDEA

Fertilization occurs when a sperm cell joins an egg cell.

For an egg to be fertilized, sperm must be present in the female reproductive system, usually in a fallopian tube. During sexual intercourse, the penis is inserted into the vagina until the tip comes close to the opening of the uterus. When semen is ejaculated through the penis, sperm are released into the vagina. One ejaculation can contain 50 million to 500 million sperm cells. The sperm must swim up through the uterus and into the fallopian tubes.

Process of Fertilization

Out of millions of sperm cells released, only one will fertilize an egg. Why only one? The answer has to do with the egg's membrane—a protective layer filled with binding sites where the sperm can attach. When a sperm manages to contact and bind to the egg, the sperm's acrosome releases an enzyme that digests the membrane at that spot. The sperm can then enter the egg, as

QUICK LAB OBSERVING

Human Sex Cells

In this lab, you will examine prepared slides of mammalian male and female sex cells.

PROBLEM How do male and female sex cells differ?

PROCEDURE

1. Examine a slide of sperm cells under low power and high power. Draw a sperm cell and label its structures.
2. Examine a slide of egg cells under low power and high power. Draw an egg cell and label its different structures.

MATERIALS

- slide of mammalian sperm cells
- slide of mammalian egg cells
- microscope

ANALYZE AND CONCLUDE

1. **Analyze** Why is the flagellum an important structure in a sperm cell?
2. **Contrast** How is the egg structurally different from the sperm?

shown in **FIGURE 2.5.** Once the egg is penetrated, its surface changes to form a barrier that stops other sperm from entering. In effect, the egg lets in one sperm, then closes the door on the others. The egg then completes meiosis II. Then the 23 chromosomes of the sperm join with the 23 chromosomes of the egg to form a fertilized egg called a **zygote.** This combination of chromosomes helps preserve genetic diversity because chromosomes in a pair often have different alleles of genes. This is one reason children are never exact genetic copies of their parents.

In rare cases, more than one egg may be released into the fallopian tubes. If two eggs are fertilized, they will develop into fraternal twins. Fraternal twins are not genetically the same. They are just like any other siblings who are born separately.

Genetically identical twins occur only when a single fertilized egg splits into two zygotes, each one with 46 chromosomes. As a result, two identical but separate embryos develop in the uterus. In even rarer cases, a fertilized egg may split into three, four, or more zygotes. If they all develop, the mother will give birth to several genetically identical babies.

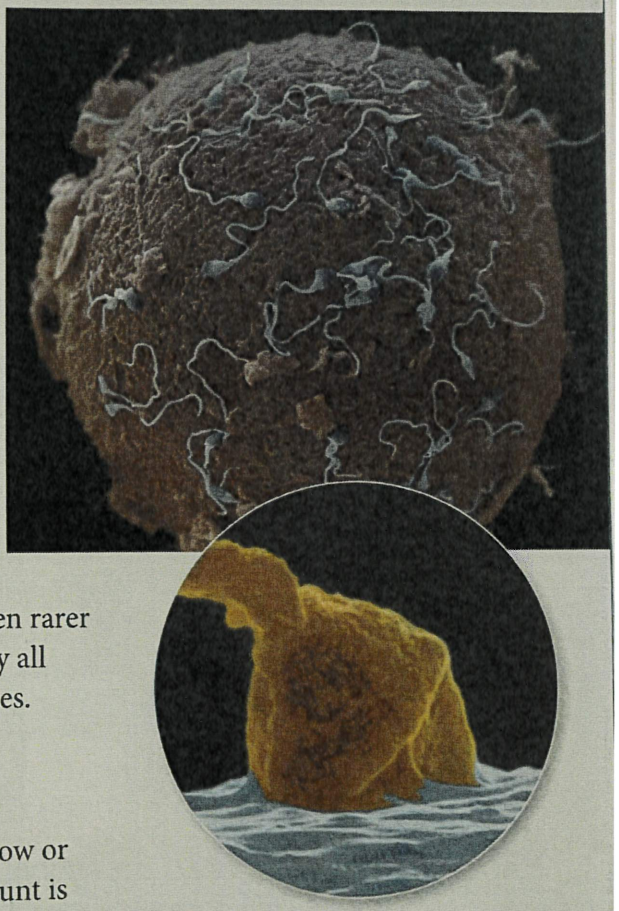


FIGURE 2.5 In the top image, sperm surround an egg. The bottom image shows one sperm penetrating an egg's membrane. (colored SEM)

Problems in Fertilization

Infertility refers to any condition that makes reproduction difficult or impossible. In the male, for instance, the vas deferens may be too narrow or blocked, which prevents sperm from leaving the body. If the sperm count is too low or the sperm are weakened or deformed, fertilization may not occur. Certain illnesses, such as mumps in adults, can destroy the testes' ability to produce sperm. In females, diseases that damage the ovaries or fallopian tubes can prevent eggs from being produced or reaching the uterus. The eggs themselves may have defects that keep the sperm from getting through the membrane. Many infertility problems can be corrected through treatments such as medications, surgery, or even dietary changes.

Apply **If twins are born and one is a boy and one is a girl, are they identical or fraternal siblings? Explain your answer.**

MAIN IDEA

Sexually transmitted diseases affect fertility and overall health.

Diseases passed from one person to another during sexual contact are called **sexually transmitted diseases,** or STDs. These diseases affect millions of people in their peak reproductive years and cause thousands of deaths. Some STDs in the early stages produce few symptoms. People do not realize they are carrying the disease and continue to infect others through sexual contact.

Bacterial STDs include chlamydia, syphilis, and gonorrhea. Chlamydia is the most common infection in the United States. Bacterial STDs attack the reproductive organs, such as the ovaries, and often cause infertility. In the case of syphilis, an untreated infection can even be fatal. Another infection, trichomoniasis, is caused by a parasite, shown in **FIGURE 2.6.** Trichomoniasis and chlamydia mostly affect young women aged 15 to 24 and can cause a serious condition known as pelvic inflammatory disease. People with these infections show few symptoms at first. This may be one reason why rates for trichomoniasis and chlamydia are increasing. Most parasitic and bacterial STDs can be treated with antibiotics.

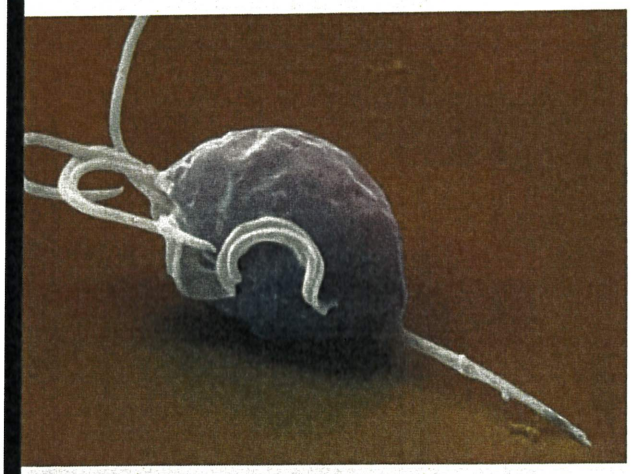


FIGURE 2.6 The parasite *Trichomonas vaginalis* causes a common STD infection, trichomoniasis, that can affect fertility. (colored SEM; magnification 9000×)

Viral STDs include hepatitis B, genital herpes, human papillomavirus (HPV), and human immunodeficiency virus (HIV), which causes AIDS. Although medications can control these diseases, there are no cures. Antibiotics have no effect on viruses. HPV has been linked to cervical cancer, and AIDS has caused millions of deaths worldwide.

People can avoid STDs, just as they avoid other diseases. The surest ways are to abstain from sexual contact before marriage and for partners who do not have STDs to remain faithful in a committed relationship. Using a condom is the next safest choice; however, a condom can break or tear.

Infer **How might a bacterial STD infection affect the reproductive cycle of a male or female?**

29.2 Formative Assessment

SELF-CHECK Online
HMDScience.com
PREMIUM CONTENT

REVIEWING MAIN IDEAS

1. What is the main function of each phase in the **menstrual cycle**?
2. How does the structure of the sperm cell aid its function?
3. Describe how an egg is fertilized.
4. **Sexually transmitted diseases** can affect fertility. Explain why.

CRITICAL THINKING

5. **Contrast** Name two ways that the production of eggs differs from the production of sperm.
6. **Apply** A woman gives birth to quadruplets, or four infants. Two of her children are identical twins. The other two are fraternal twins. How could this have happened?

CONNECT TO

DEVELOPMENTAL BIOLOGY

7. Every egg contains one X chromosome. Each sperm contains either one X or one Y chromosome. Explain why the sperm always determines a baby's gender.