AOHS Foundations of Anatomy and Physiology II

Lesson 20

The Reproductive System

Student Resources

Resource	Description
Student Resource 20.1	Terms: The Reproductive System
Student Resource 20.2	Notes: Reproductive Anatomy and Physiology
Student Resource 20.3	Reading: Anatomy and Physiology of the Male Reproductive System
Student Resource 20.4	Reading: Anatomy and Physiology of the Female Reproductive System
Student Resource 20.5	Reading: The Menstrual Cycle
Student Resource 20.6	Graphs: The Menstrual Cycle
Student Resource 20.7	Reading: Contraceptives
Student Resource 20.8	Posters Summary: Reproductive Health and Conditions
Student Resource 20.9	Lab: ELISA Test
Student Resource 20.10	Notes: Genes and Reproduction
Student Resource 20.11	Reading: Genes and Reproduction

Student Resource 20.12	Reading: Stages of Human Growth and Development
Student Resource 20.13	Glossary: The Reproductive System (separate Word file)
Student Resource 20.14	Guide: Reproduction Expert Blog Post
Student Resource 20.15	Peer Review Chart: Reproduction Blog Post

Student Resource 20.1

Terms: The Reproductive System

Student Name:____Date:__________

Directions: Write down three medical or common terms for parts of the reproductive system. When your teacher tells you to begin, mingle with your classmates and collect as many other medical and common terms as you can.

Terms I thought of		
Terms I collected from classmates		

Student Resource 20.2

Notes: Reproductive Anatomy and Physiology

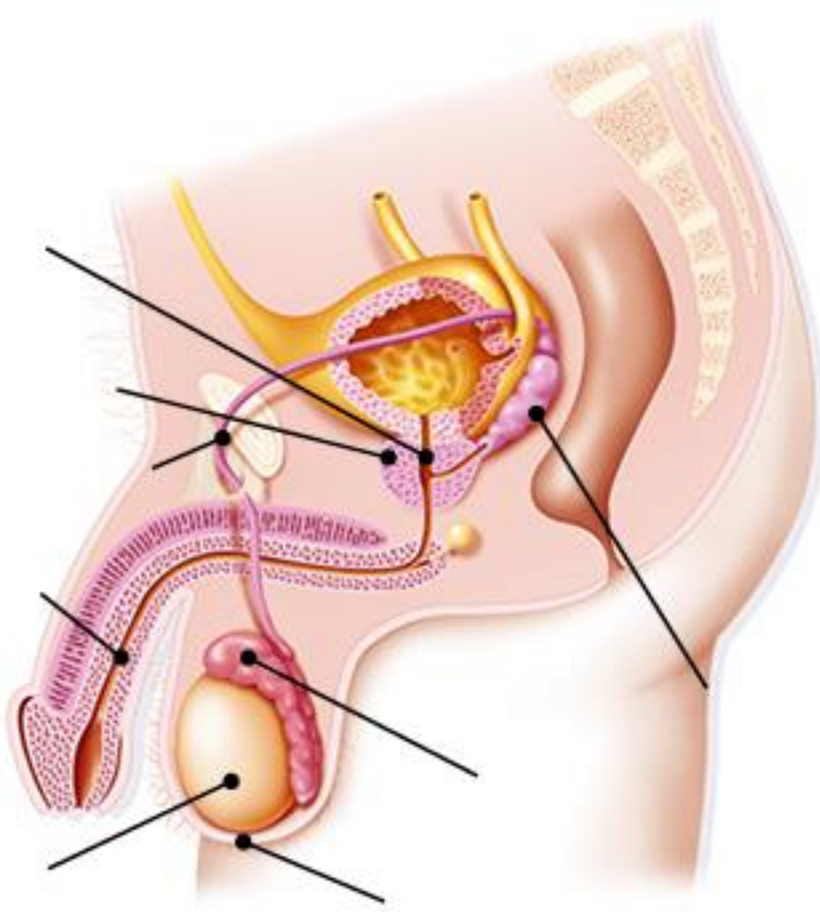
Student Name:____ Date:____________

Directions: Complete the charts and label the diagrams as you watch the presentations on the anatomy and physiology of the male and female reproductive systems.

Part 1: The Male Reproductive System

1. What are the male and female gametes and what is special about them?

2. Label the diagram (lateral view):



Lateral view

3. Describe the path sperm follow through the male reproductive organs.

4. What organs contribute secretions that become part of semen?

5. What is the purpose of semen?

6. Why doesn't a man have to worry about urinating while he is having sex?

7. Complete the chart describing hormonal changes a male goes through during puberty.

Hormone	What it does

8. List four secondary male sex characteristics

a)

b)

c)

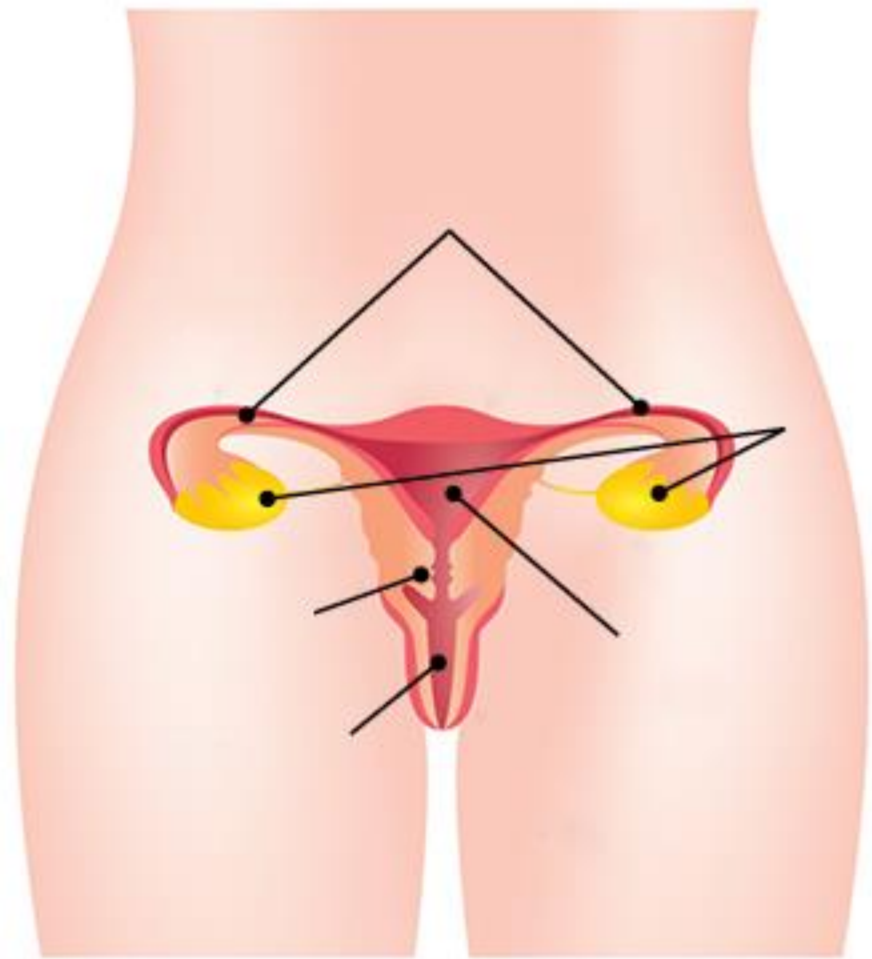
d)

Part 2: The Female Reproductive System

9. What female organ produces gametes?

10. What are these gametes called when they mature?

11. Label the diagram:



Anterior view

12. Describe the path each gamete follows from the point at which the gamete is made to fertilization. Describe the paths for both the female and male gametes. Include where and when the gamete cell is made, the organs it passes through, and where the gametes meet.

13. Why do oocytes sometimes miss the fallopian tube?

14. What is notable about the pH of the vagina and why is it beneficial?

15. How does the clitoris resemble the penis?

16. Where is milk produced in the breast?

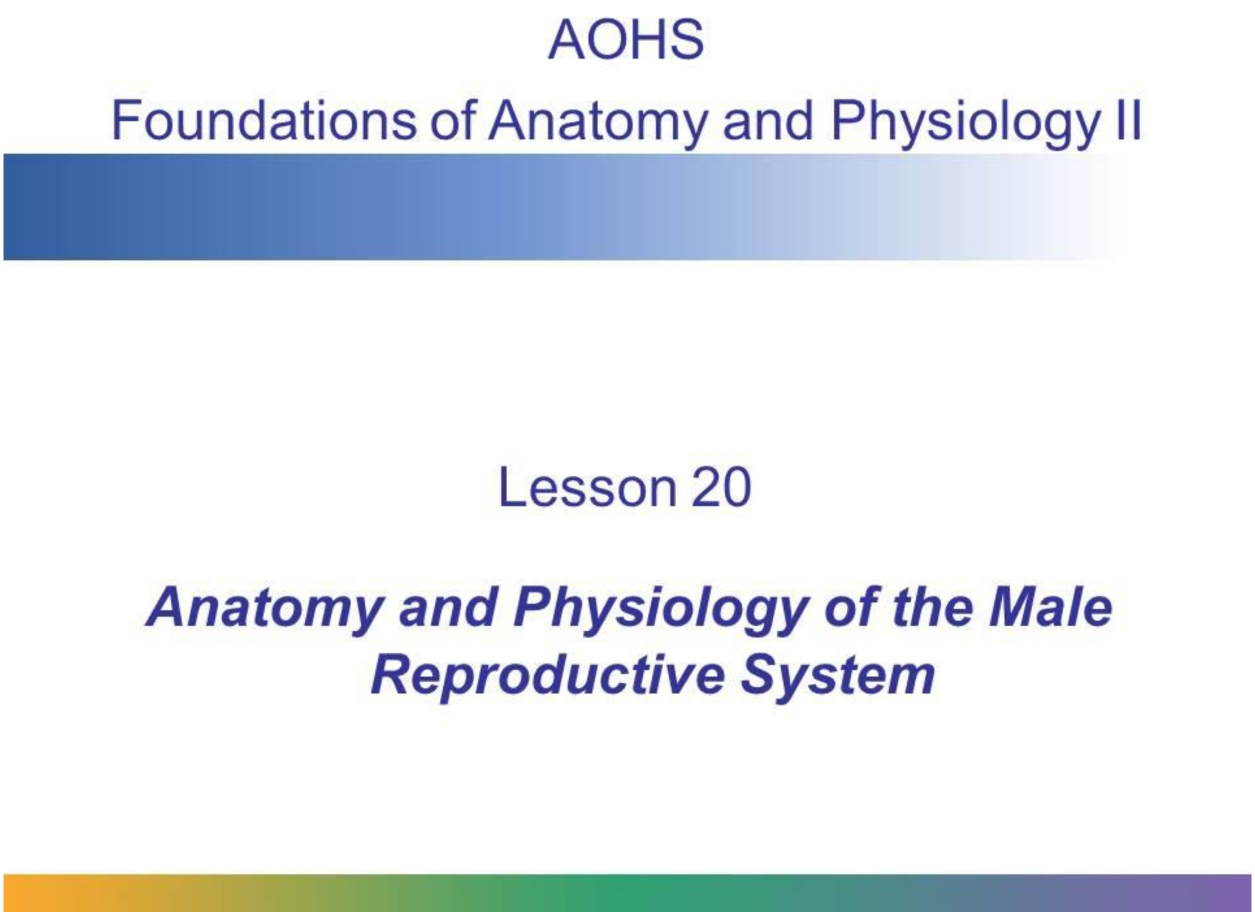
17. What is a zygote?

18. Complete the following chart about hormones involved in pregnancy and childbirth:

Hormone/substance	By what organ	When secreted	Effect
Prolactin			
hCG			
Oxytocin (first)			
Oxytocin (second)			

Student Resource 20.3

Reading: Anatomy and Physiology of the Male Reproductive System



By the end of this presentation, you will know the:

- The function of the reproductive system
- Ways in which the reproductive system is different from other body systems
- The anatomy and physiology of the male reproductive system
- The development of the male reproductive system over a lifetime
- Male hormonal cycles

The reproductive system is unique in two important ways

The reproductive system's function is not related to keeping you alive but to keeping your family's unique genetic traits within the gene pool.

The reproductive system is not at work 24/7 as other systems are.

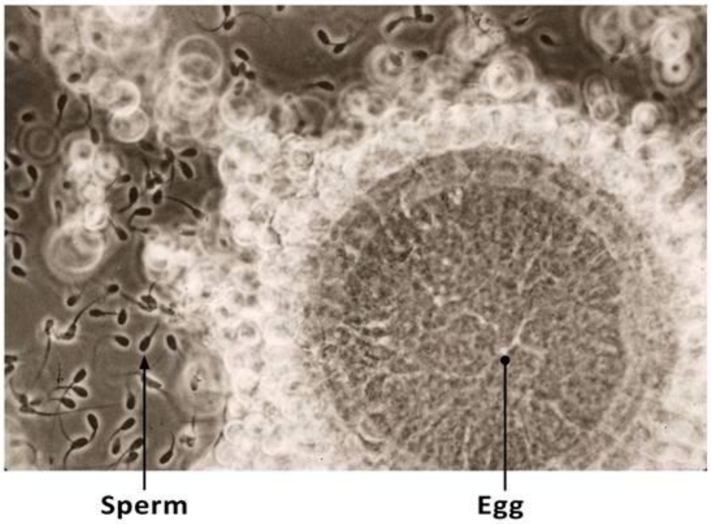
What have you heard or learned about human genetics and the gene pool?

Each of the body systems you've studied so far plays a role in keeping you alive. As you know, if something goes wrong with any of these systems, the whole body can be affected. In stark contrast, you can live without your reproductive system. In fact, the reproductive system can even put some women in life-threatening situations. In colonial America, for example, each time a woman was pregnant, she had about a 1.5% chance of dying from giving birth. Many women had five or six children, raising their chances of dying to nearly 10%. That is a higher rate of death than we see now from many forms of cancer.

While the reproductive system might not keep you alive, it keeps our species alive. Without reproduction, it wouldn't take long before humans disappeared from the earth. On a smaller scale, your personal reproductive system exists for the purpose of making sure that part of you—your genes—continues to exist after you do.

That's a task that takes a lot of energy (especially if you're female), and so your body devotes itself to reproduction on a more punctuated basis than your other body systems operate.

Both male and female reproductive systems produce gametes



Gametes are cells that contain half the DNA of a regular cell.

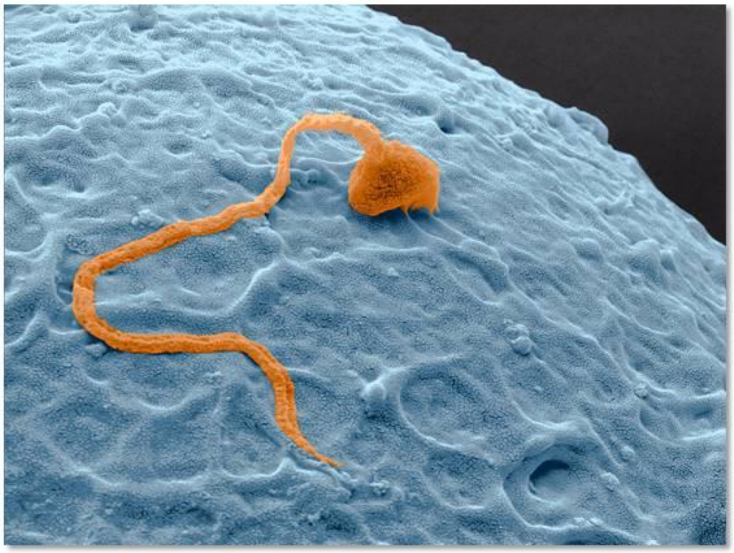
Male gametes are sperm.

Female gametes are eggs, also called ova.

Why do you think the egg is so much larger than the sperm?

Another unique factor of the reproductive system is that it's the only system in your body that produces cells with the mission of being part of the creation of another member of your species. Such cells are called gametes. They contain only half the DNA of an ordinary cell. Female gametes are eggs, also called ova (singular, ovum). You may recall that a chicken egg is a single cell. A human egg isn't so different, except for its smaller size. Still, the egg cell is the largest cell (in diameter) in the human body, measuring about a tenth of a millimeter. They're so big that you don't even need a microscope to see them. Sperm, the male gametes, are about 25 times smaller. They have a powerful tail that propels them through the female reproductive tract. Sperm are expert swimmers—tiny cells carrying little baggage. They have few organelles and don't store much energy.

Fertilization occurs when male and female gametes meet and fuse into a single cell



A single sperm fertilizing an egg cell

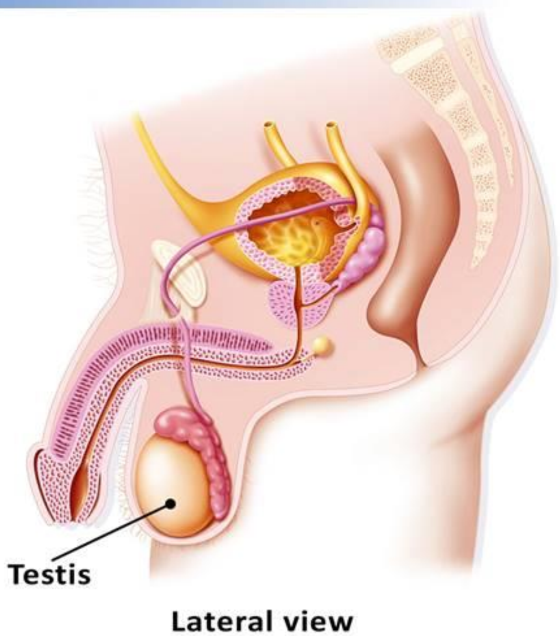
The cell that results from fertilization contains the DNA from both gametes.

Gametes need only half as much DNA as a normal cell because of the task they are called to: to become one with another gamete of the opposite sex. When a sperm meets an egg, the meeting sets in motion a sequence of events that ultimately results in the nucleus of the sperm making its way into the egg. After several hours, the two nuclei fuse and become one, with a full complement of DNA. From there, the fertilized cell begins dividing, eventually producing all the different types of cells needed for a new organism—skin cells, nerves, muscle, brain, and the rest.

Male gametes are produced in the testes

Each testis (also called a testicle) contains a set of long tubules that produce immature sperm.

Organs that produce gametes are called gonads.



What organ is the female gonad?

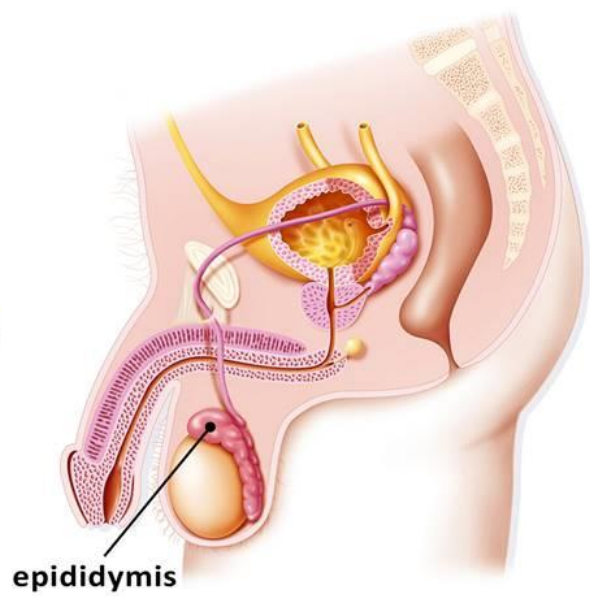
Most of the male reproductive anatomy is devoted to creating and nurturing sperm and getting them to where they might encounter an egg. The process begins in the testes, also called testicles, where special cells produce thousands of sperm. Each testicle is about the size and shape of a plum, and contains a network of tiny tubules where immature sperm are made and shipped out to continue their maturation.

The testes are located outside of the pelvic cavity because the lower temperature is better for sperm production.

The epididymis sits on top of the testes

When sperm enter the epididymis, they are immature.

The sperm mature as they make their way through the thin, coiled tube. The tube is about 20 feet long, and the journey takes about 20 days.



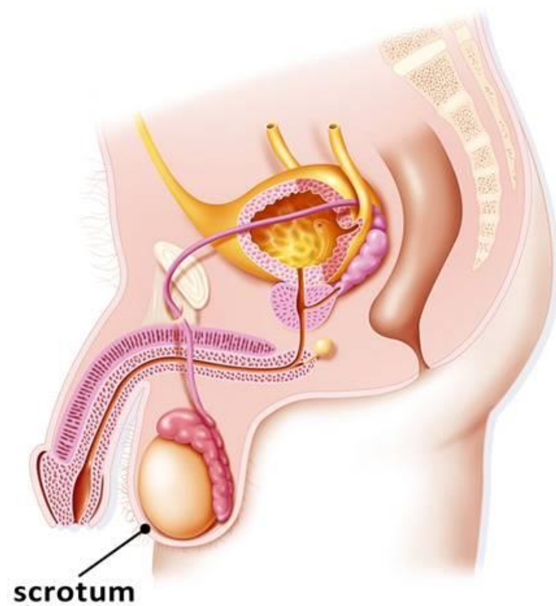
From the testes, sperm move into the epididymis, which covers the top and posterior side of each testicle. The epididymis is the first of a set of ducts that transport sperm. In the average human male, the epididymis is 20 feet long. Immature sperm make their way through this long tube, traveling about a foot a day. By the time they reach the end, they have become mature sperm.

The epididymis acts as a storage space for this mature sperm until the man is engaged in sexual activity. Sperm live only for a few days inside the testes, and then are dissolved. But the testes produce a consistent stream of sperm to keep the supply ample.

The walls of the epididymis contain smooth muscle. When a man is aroused and ejaculates, this smooth muscle contracts, sending sperm on its way.

The testes and epididymis are held in a sac of tissue and skin called the scrotum

The scrotum keeps the testes at a temperature slightly below body temperature.

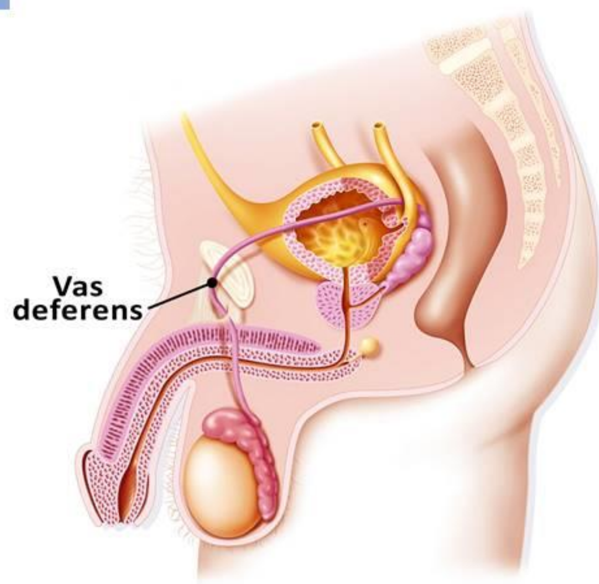


The scrotum is a protective sac made of skin and muscle that keeps the testes in place, just outside, but near the body. The machinery for making sperm functions best at a degree or two below body temperature. Cooler temperatures also slow down sperm production. When cold sensors in the skin of the scrotum sense that it's chilly, a signal goes to the smooth muscle of the scrotum, telling it to contract. When this happens, the testes are pulled inward, closer to the body. This keeps the sperm from being exposed to temperatures that are too cold. When the temperature warms up again, the muscle relaxes, and the testes return to their usual place a little more distant from the body.

A duct called the vas deferens carries mature sperm to the penis

The vas deferens has walls of smooth muscle.

During ejaculation, peristaltic waves in the vas deferens propel the sperm forward.



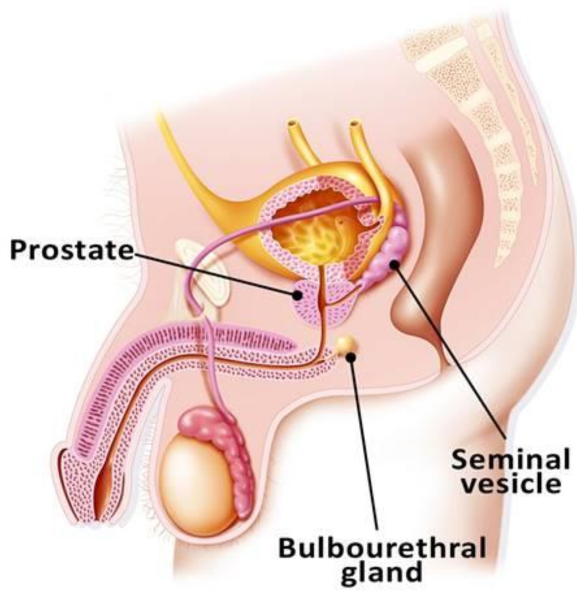
What do you remember about smooth muscle? What is a peristaltic wave?

The next part of a sperm's travels takes it to another, larger duct called the vas deferens. The vas deferens leads from the epididymis to the urethra, though in a somewhat roundabout way. It extends upward and through the opening in the pelvis between the legs and over the top of the urinary bladder. The primary role of the vas deferens is to move sperm along their route out of the body. The walls of the vas deferens are made of smooth muscle, which contracts in waves of peristalsis, propelling sperm toward the urethra.

A man who no longer wants children can decide to have a vasectomy. A vasectomy is a simple surgery where a portion of the vas deferens is tied off, preventing sperm from leaving the body. A man who's had a vasectomy retains full sexual function but can't get a woman pregnant.

Sperm combines with fluids produced by three different glands to form semen

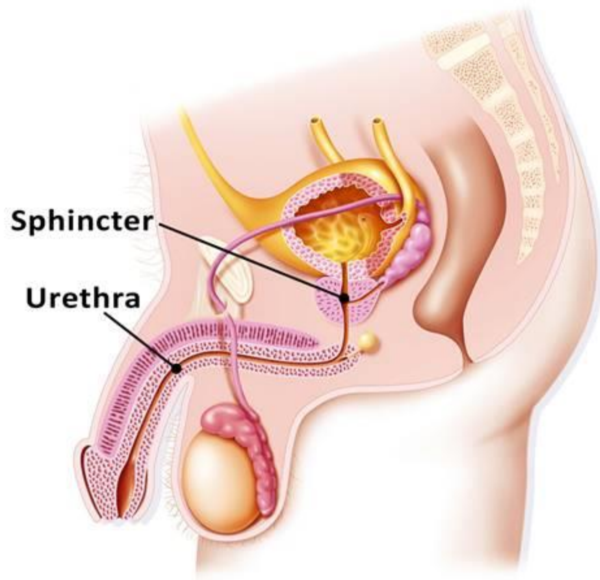
The prostate, seminal vesicles, and bulbourethral glands contribute secretions that provide nutrients and affect the environment in the female's vagina and uterus.



Sperm are great swimmers, but only when they have something to swim through. Three glands located near the end of the vas deferens provide fluid, nutrients, and hormones that sperm need in order to leave the body through ejaculation. The prostate contributes substances that play a role in the fluidity of semen. The seminal vesicles provide a yellowish liquid rich with nutrients, especially sugars, that the sperm will need as they travel on their way. Because there's very little to a sperm cell, it can't store much energy, and needs to be bathed in sugars that it can draw on for energy. The bulbourethral glands produce a mucus that neutralizes pH. Together, these fluids combine with sperm to form semen, the liquid that helps transport sperm out of the body and through the female reproductive tract. Semen is slightly alkaline, to counter the slightly acidic environment in the vagina and uterus.

Semen and urine never mix

When the semen enters the urethra, the bladder sphincter closes. This keeps urine and sperm from mixing.

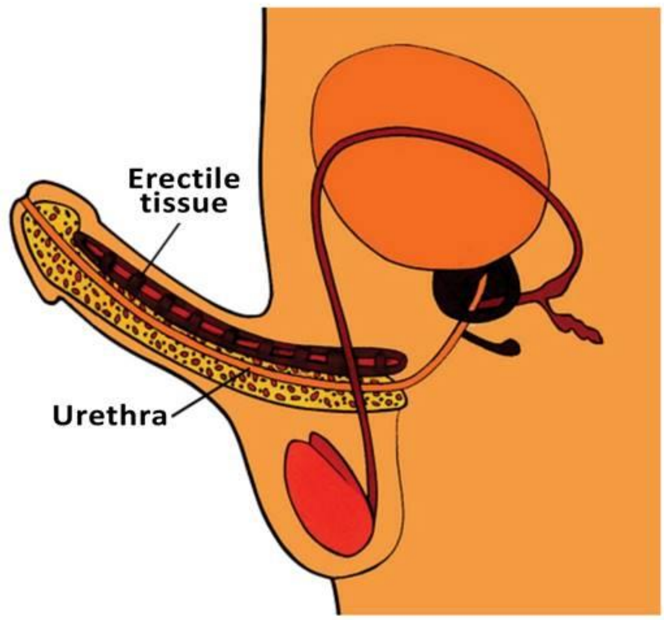


The male urethra is a dual-purpose tube; it's the escape hatch for both urine and semen. But the two never mix in the urethra. When semen enters the tube, the sphincter between the bladder and urethra constricts. This keeps urine out of the semen, and it keeps sperm from mixing with urine.

Semen leaves through the urethra during ejaculation

When a man is sexually aroused, the parasympathetic nervous system widens arteries in the penis.

The erectile tissue fills with blood, enlarging the penis and giving the man an erection.

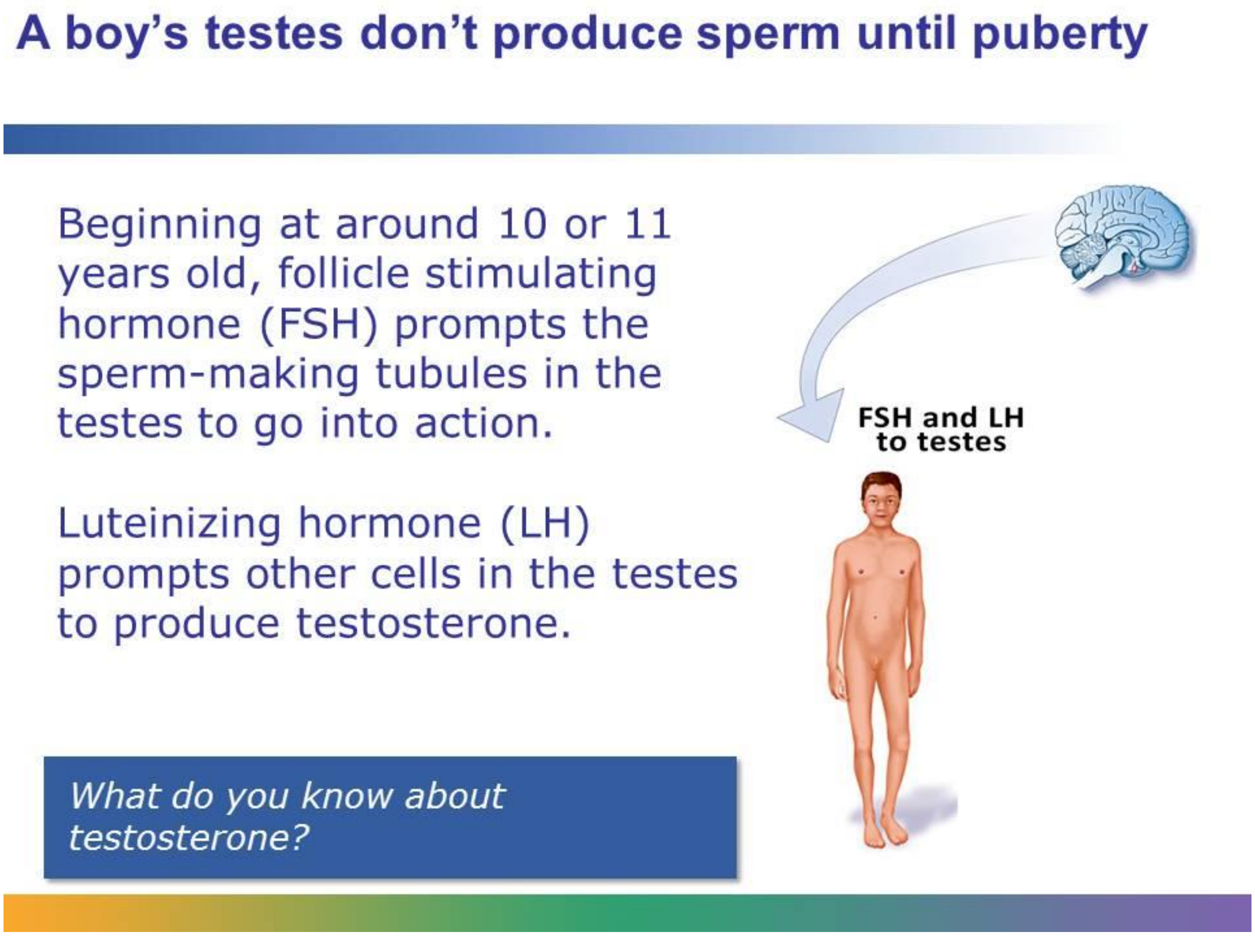


The shaft of the penis is mostly made of erectile tissue, spongy tissue that surrounds the urethra. When a man is sexually excited, his parasympathetic nervous system sends the message to relax the arteries in the penis and let more blood flow. The spongy tissue fills with blood, making the penis rigid. The penis needs to be rigid to deposit sperm as deeply into the female's reproductive tract as possible.

The tip of the penis is covered with a foreskin that becomes less apparent when the penis is erect. In the United States, the foreskin of newborn males is often removed in a procedure called circumcision.

When arousal is at its peak, the three glands that produce components of semen secrete their fluids into the vas deferens. This extra fluid creates a pressure inside the vas deferens that is relieved when the man ejaculates. During ejaculation, smooth muscle tissue in the vas deferens and prostate gland squeeze sperm forward and out through the urethra in spurts. Ejaculation, also called orgasm, or "coming," is usually accompanied by sexual pleasure.

Contrary to popular belief, the shaft of the penis itself doesn't contain any voluntary muscles. But there are muscles at the base of penis that also play a role during ejaculation. They produce strong, rhythmic contractions that contribute to the feeling of pleasure during male orgasm.



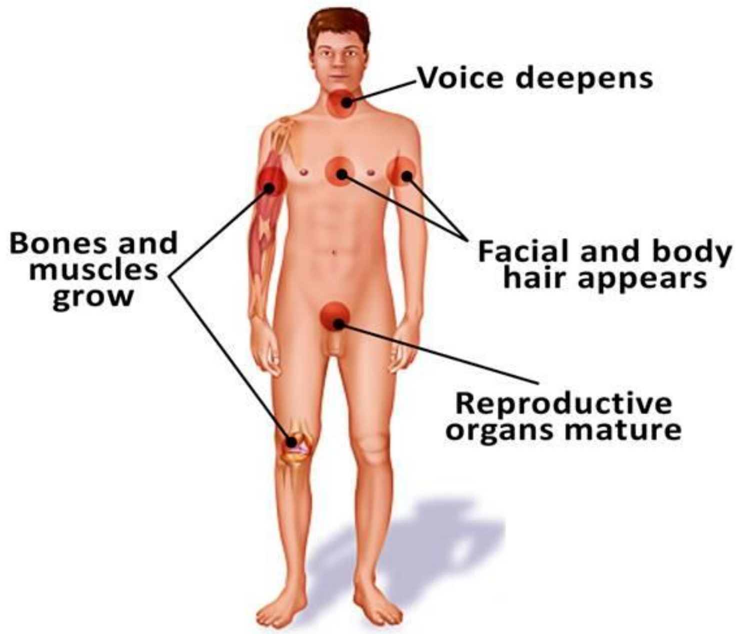
Young boys have all the anatomy in place for sexual reproduction, but their reproductive systems won't mature until the endocrine system starts sending signals. When puberty sets in, the anterior pituitary begins releasing two hormones, follicle stimulating hormone (FSH) and luteinizing hormone (LH). These hormones bring about changes that result in masculinity and male reproductive capacity. FSH heads to the testes and prompts the sperm-producing cells to begin production. LH goes to other cells in the testes and directs them to begin producing testosterone.

Puberty is the beginning of these cycles of activity, and they will continue throughout a man's lifetime. FSH and LH play important roles in the female reproductive cycle as well.

Testosterone maintains sex drive and secondary male sex characteristics

Secondary sex characteristics include facial hair, bone and muscle development, and growth of the larynx.

These characteristics also develop during puberty.

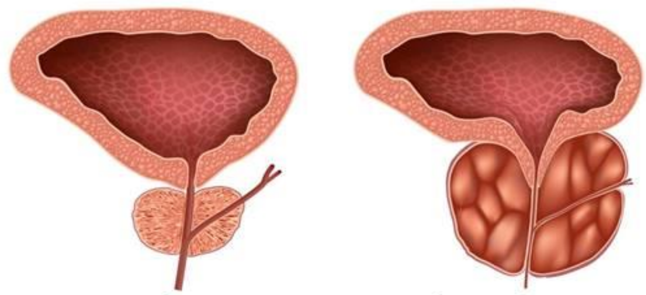


Testosterone plays many roles for both sexes but is particularly important for men. The initial production of testosterone is the driver behind the growth spurt that many boys experience during puberty. It accounts for the way a boy's voice deepens, his bones and muscles fill out, and he finds himself needing to shave. It also directs the development of his reproductive organs to their adult size and function. Testosterone fuels sex drive throughout a man's life. Levels of the hormone decrease as a man ages, but they remain present into old age.

The male reproductive system changes throughout a man’s lifetime

Testosterone production begins to slow down at around age 30.

Many men also experience an enlarged prostate, which can make urination more difficult.



Normal prostate **Enlarged prostate**

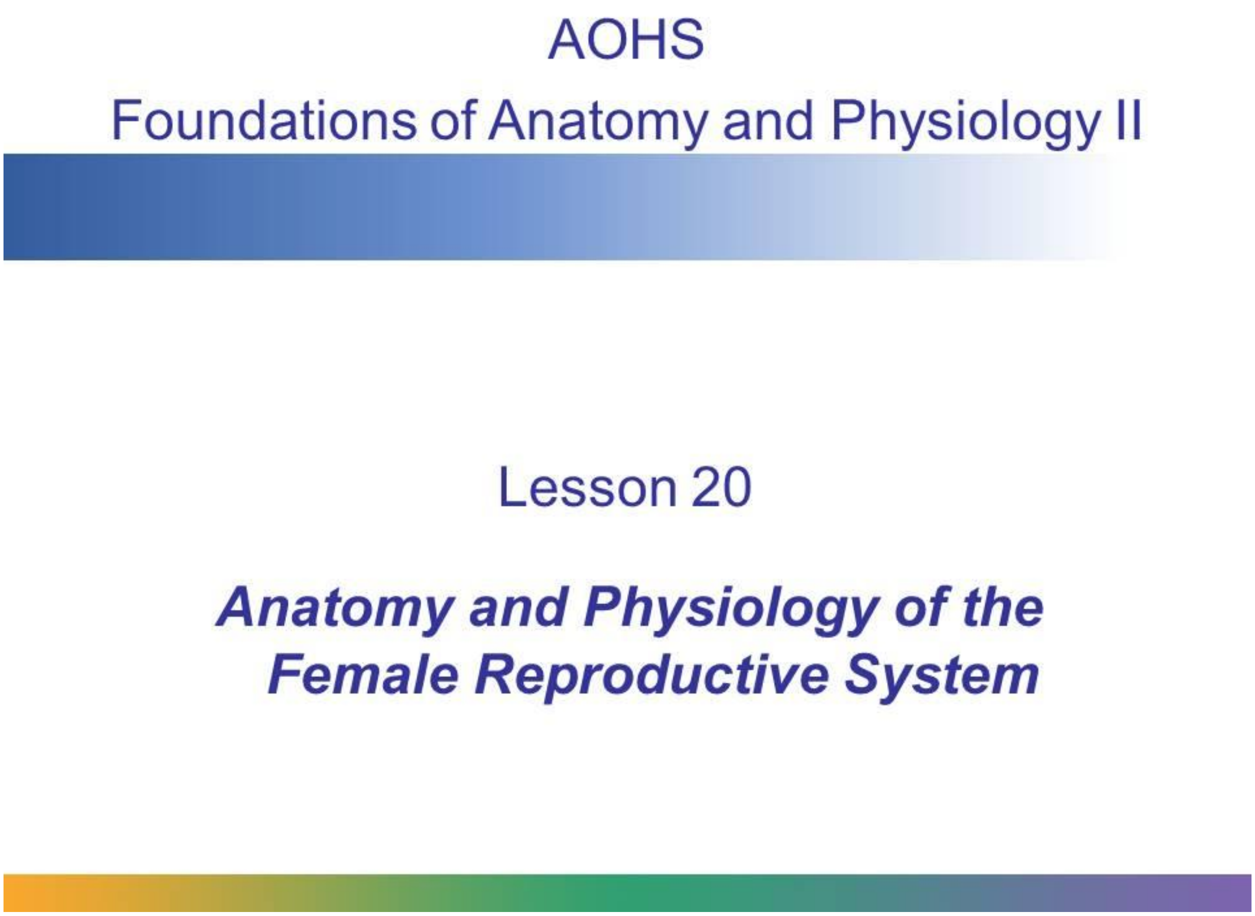
How can men slow the onset of age-related symptoms in their reproductive system?

Both boys and girls are born with reproductive systems that aren’t mature, which means they aren’t able to reproduce. Puberty begins as the reproductive organs start to mature. Men are most fertile in their teens and 20s, when they produce the most sperm, and sperm that are strong swimmers. At around age 30, a man’s testosterone production begins to decline, and therefore so does his sperm production. In his later years, a man may produce sperm that aren’t shaped as well or aren’t as strong as those he produced when he was younger. Older men can usually still reproduce, and many men have children when they are older. Several recent studies have shown, however, that children of older men are more likely to have a range of disorders such as autism and Down syndrome.

A very common condition among older men is an enlarged prostate. Many men have mild enough cases that there’s no need to treatment. But because the prostate surrounds the urethra, when the prostate becomes too enlarged, it can make it hard for the man to urinate. There are many kinds of treatment for an enlarged prostate, and most men are able to resolve the problem. Keeping your weight under control and getting physical activity can help prevent an enlarged prostate.

Student Resource 20.4

Reading: Anatomy and Physiology of the Female Reproductive System



By the end of this presentation, you will know:

- The organs of the female reproductive system
- Changes that occur during puberty
- The processes of fertilization and pregnancy
- The anatomical and physiological changes that occur during pregnancy
- The hormones involved in labor and childbirth
- How the process of menopause occurs

The female reproductive system has many tasks

- Produce gametes in preparation for fertilization
- Gestate and give birth
- Feed a newborn

How are these tasks different from those of the male reproductive system?

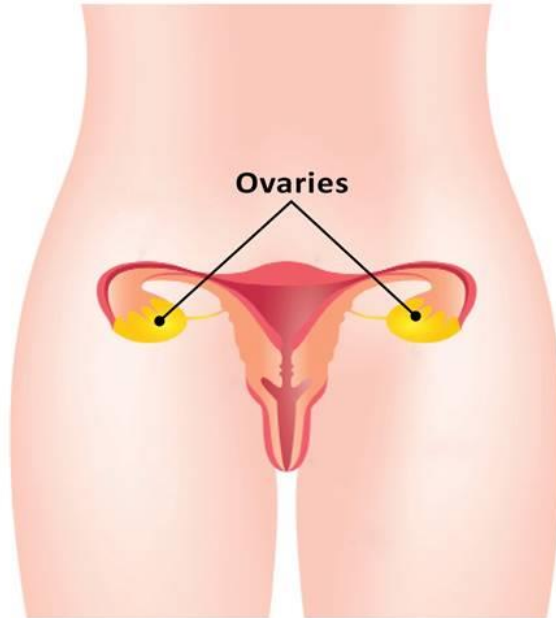
The only task the male reproductive system is faced with is delivering sperm successfully to the female reproductive tract. The female reproductive system has much more work to do: it provides space for a fetus to grow and receive nourishment (a process called gestation). This system enables the female body to give birth and feed the newborn. Because these functions are much more complicated than those of the male reproductive system, the female hormonal cycles and physiology are much more complicated as well.

Ovaries are almond-shaped organs located on either side of the pelvic cavity

The ovaries of a baby girl contain the precursors to her egg cells.

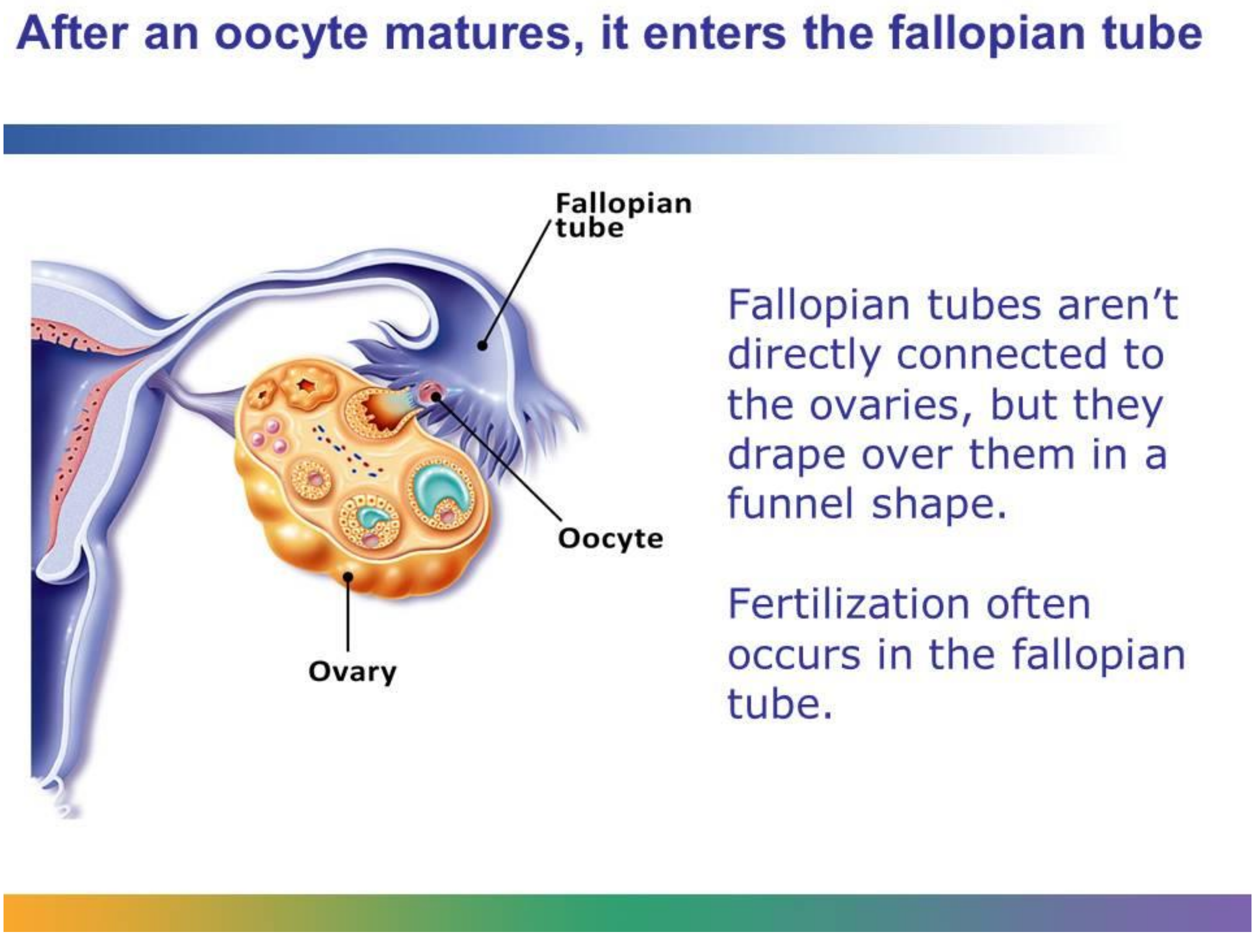
When a girl reaches puberty, her precursor egg cells begin to mature, one each month, in the ovaries.

The mature cell is called an oocyte.



Anterior view

The ovaries are considered the primary sexual organ of the female because they produce the gametes. They're about 2 inches across and anchored to the pelvis and the uterus with ligaments. The cells that will eventually become egg cells develop in the ovaries during fetal development. When a girl begins puberty, her brain begins sending hormonal signals to her ovaries once a month. Those signals prompt an egg cell precursor to mature into a cell called an oocyte and enter the reproductive tract.

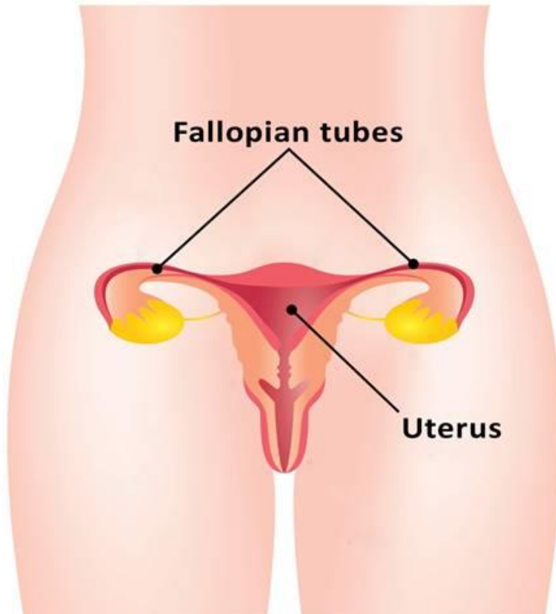


The ovaries aren't connected directly to the reproductive tract. Instead, when a mature oocyte is released from the ovary, it floats through a small space and into the nearby fallopian tube. As you might expect, not every egg makes it; plenty of them miss the mark. When the oocyte does make it to the fallopian tube (which happens frequently enough that our species has had little difficulty reproducing), it has about 4 inches of tube to make it through to reach the uterus. This journey takes three to four days, but the oocyte is only fresh enough for fertilization for about 24 hours. This limited time window means that the best chance for fertilization is when the oocyte is still in the fallopian tube, before it's reached the uterus. Therefore, sperm need to make their way not only into the female reproductive tract but almost all the way through it, to reach the egg while it's in the distant end of the fallopian tube.

The fallopian tubes connect to the uterus

The uterus is a hollow, muscular organ in the pelvis.

When a fertilized egg cell arrives in the uterus, it attaches itself to the inner wall, where it stays and develops into a fetus.



The uterus—also sometimes called the womb—is about the size of a fist, shaped like an upside-down pear, except during pregnancy. The fallopian tubes are lined with cilia that help usher the fertilized egg (or unfertilized oocyte) into the uterus. If the cell is fertilized, it will implant on the inner lining of the uterus and remain there through all of its fetal development. If the cell isn't fertilized, it just passes out of the woman's reproductive tract through menstruation.

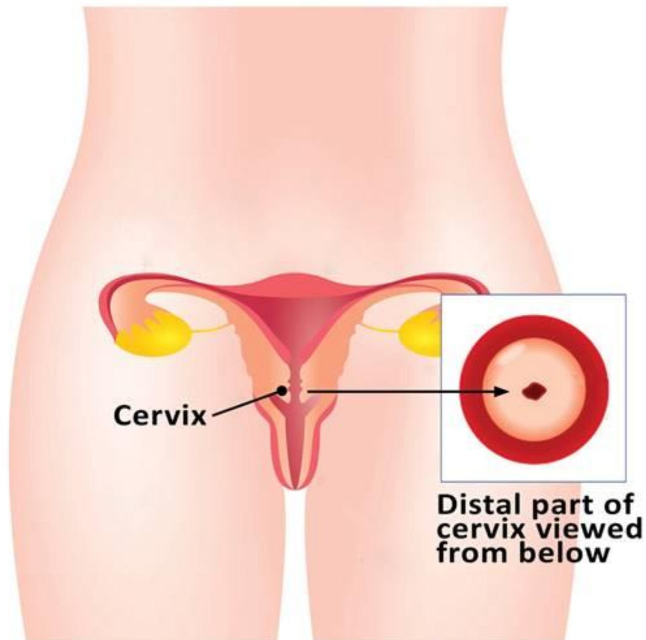
The walls of the uterus are composed of three layers that can stretch to a great degree. Imagine how large a pear is. Not so big, right? Now imagine that you put that pear in, say, a pair of nylons. Then imagine that, in the same nylons, you have to fit a newborn baby. That would have to be some stretchy nylon! You can see how stretchy the walls of the uterus must be.

Along with being stretchy, the uterine walls also need to be muscular, because the most rigorous task in reproduction—giving birth—requires some real force. During birth, hormones make the uterus go through intense contractions that ultimately push the baby out of the womb and into the world.

The cervix is at the base of the uterus

The cervix is a cylinder of muscle. The opening at the center of the cervix widens or dilates as a woman is about to give birth.

A test called a pap smear is commonly given to check for cervical cancer as a routine part of female health care.



At the base of the uterus, where the top of the upside-down pear would be, is a cylinder of muscle called the cervix. Normally, there's a small space in the center of the cervix that allows body fluids out of the uterus and lets sperm in. But when a pregnant woman is about to give birth, the cervix dilates, making the opening much wider. Often the person assisting a birth will look at how far the cervix has dilated to estimate how close the woman is to delivering the baby. Many times, the top of the baby's head can be seen pushing against the opening of the cervix before it's born.

Cancer of the cervix, and precancerous cells, aren't uncommon. It's recommended that once a woman is about 21, she should start being screened for cervical cancer using a test called a pap smear. Many cervical cancers in young, sexually active women arise from infection with the human papilloma virus (HPV). There is now a vaccine available that protects against several forms of the virus. Many school health programs suggest that both boys and girls 11 to 12 years old get vaccinated.

The vagina is a passageway for sperm to enter and an infant being born to exit

The environment in the vagina is slightly acidic, inviting some helpful bacteria and discouraging some harmful ones.

Why is it important to keep harmful bacteria out of the vagina?

The vagina, also sometimes called the birth canal, is a tube about 3–4 inches long. The vagina is where the penis enters the female reproductive system during intercourse and is the canal a fetus must pass through to exit the mother's body. The walls of the vagina have lots of folds. Think back to the pear in the nylons, followed by the baby in the nylons. The same need for stretchiness is true for the vagina. A tube that's usually only slightly open must expand to accommodate the passage of a whole infant, head, shoulders and all. The vagina possesses the ability to stretch this much because of the many folds that allow it to unfold and expand.

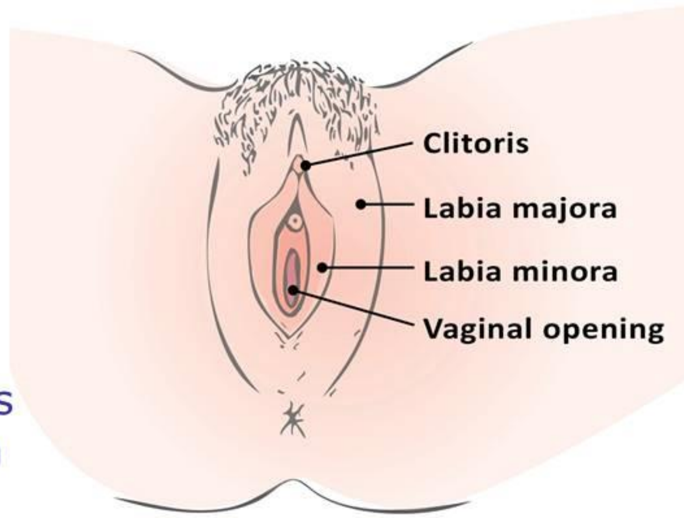
As in the digestive tract, there are also microorganisms in the vagina, and they help maintain balance in the environment. The inside of the vagina is slightly acidic, which is an environment that many harmful bacteria can't tolerate. A common beneficial bacterium in the vagina is lactobacillus, which is also found in fermented milk products like yogurt.

Toward the distal end of the vagina is a thin fold of tissue called the hymen. The hymen contains a lot of blood vessels, and in many women, the hymen is ruptured the first time they have intercourse, releasing some blood. For many women in the United States, the hymen is ruptured while inserting a tampon, playing sports, or getting a first pelvic exam.

The exterior genitalia, called the vulva, consist of two pairs of labia and the clitoris

The labia cover and protect the vagina. Glands near the labia secrete a lubricating fluid.

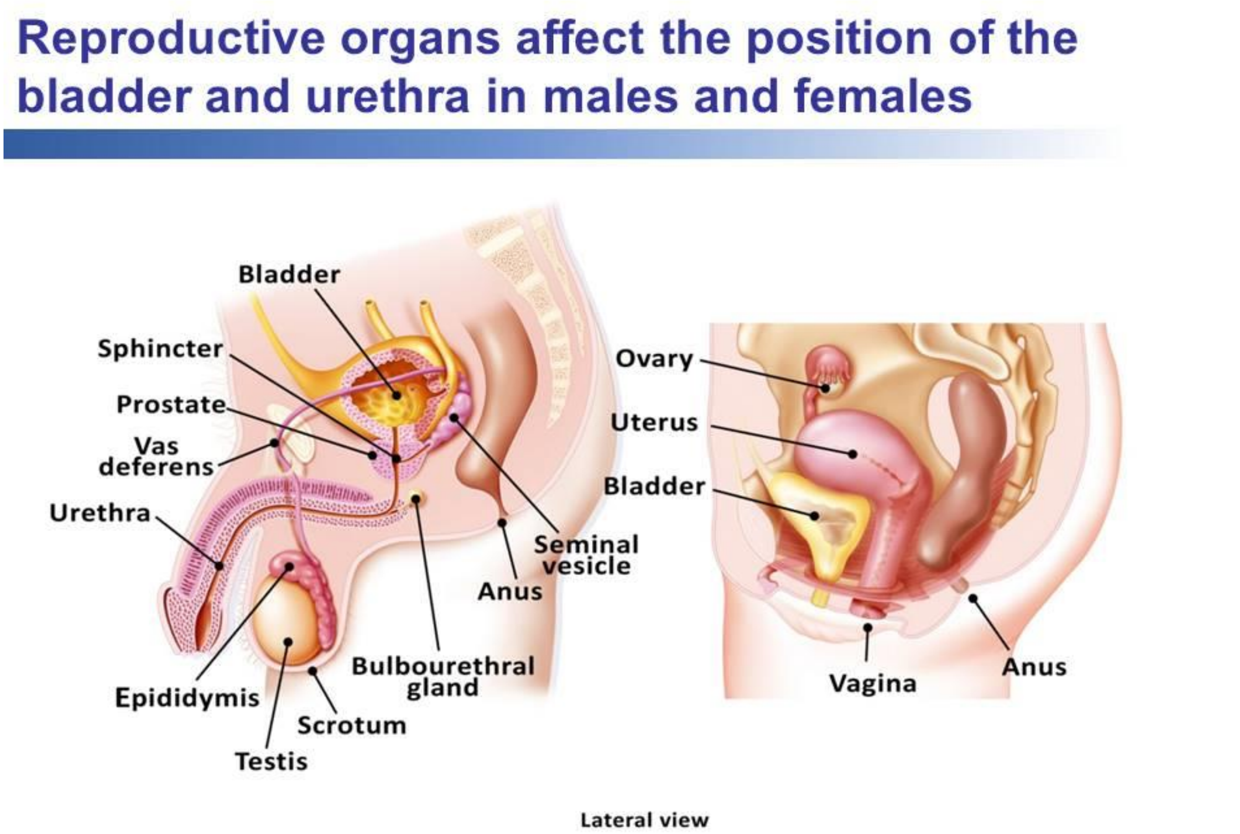
As with the penis, the clitoris responds to stimulation and becomes swollen with blood when the woman is sexually excited.



While most of the reproductive plumbing in females is inside the body, organs outside serve to protect the vaginal opening and to make sex physically pleasurable. Outside the vagina are two separate folds of flesh, the labia majora and the labia minora. The larger outer folds, the majora, have hair on them. Their fleshiness helps cushion and protect the bony parts of the pelvis underneath. The more delicate inner folds, the labia minora, cover the vaginal opening, the urethra, and the clitoris. Near the posterior end of the labia majora are small glands that secrete a fluid that helps provide lubrication during intercourse.

The clitoris is similar to a penis in that it has a shaft and a tip that is highly sensitive to sexual stimulation. The clitoris also contains erectile tissues that swell when filled with blood. A woman can achieve orgasm through stimulating the clitoris, just as a man can reach orgasm through stimulating the penis. Though women don’t emit sperm, they do have waves of muscular contractions in the vagina and sometimes in the uterus as well. These contractions may help usher sperm through the cervix and into the reproductive tract.

Reproductive organs affect the position of the bladder and urethra in males and females

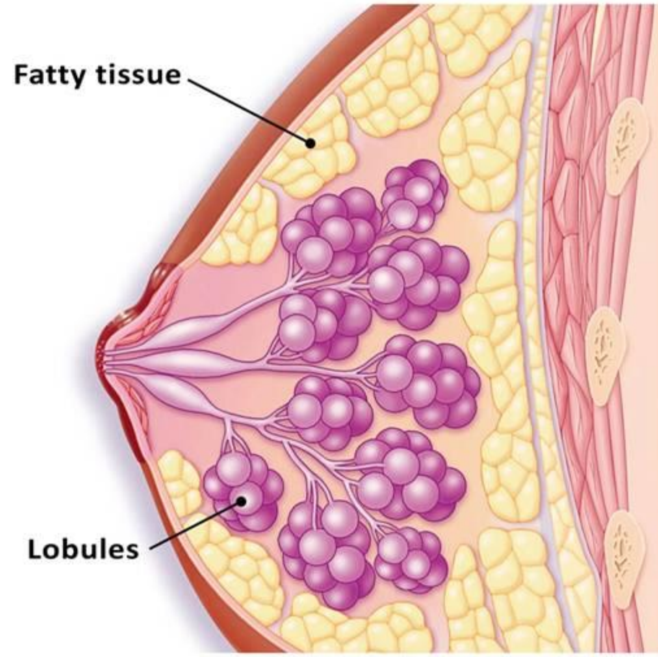


Although males and females have the same urinary organs, they are situated in the pelvic cavity in different ways to make room for the differing reproductive organs. The male bladder is located posterior to the vas differens and superior to the prostate and other glands. In females, the bladder is right up front and against the inferior wall of the cavity, allowing the larger uterus to fit behind it. The male urethra, as you've learned, carries both sperm and urine and is quite a bit longer than the female urethra, which carries only urine. In both sexes, the anus and rectum are posterior to the reproductive organs.

The breasts are secondary sex organs that provide nourishing milk after the baby is born

Breasts contain lobules that house special milk-producing cells. The lobules develop during puberty, as do protective fatty tissues that surround them.

What nutrients would you expect to find in milk?



Lateral view

Breasts, also called mammary glands, provide an infant with nourishment until it's old enough to digest solid food. Breasts begin to develop during puberty. Girls' breasts contain special cells that, when mature, can produce milk after pregnancy. At the start of puberty, hormones signal to these cells that it's time to mature. As the milk-producing cells develop, so do fatty tissues around them, to protect the future infant food supply. It's these protective fatty tissues that give breasts their size and shape.

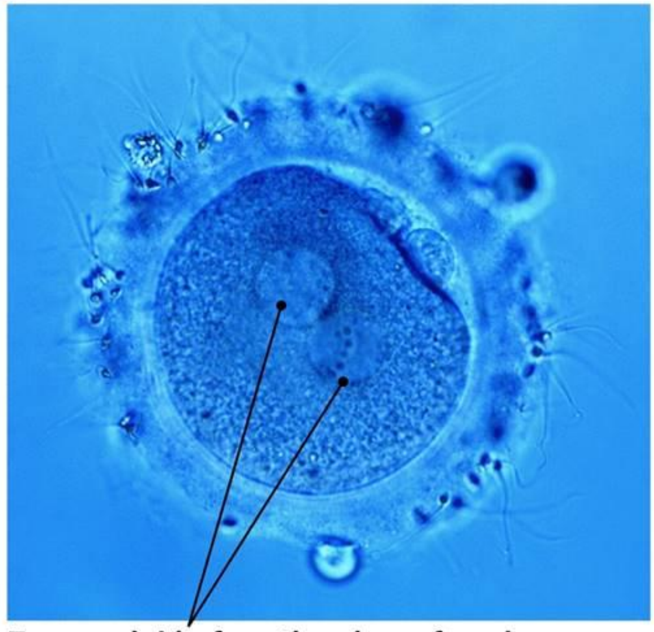
After a woman has a baby, her pituitary gland secretes a hormone called prolactin. Prolactin stimulates milk production in the breast. A baby's suckling the breast to get milk stimulates the mother's pituitary to release oxytocin. The hormone causes contractions in the breast lobules that help them expel milk, similar to how the hormone causes uterine contractions during birth.

Pregnancy occurs when a sperm penetrates the cell membrane of an oocyte

When a sperm enters the oocyte, the nuclei of the two cells fuse. The fertilized egg cell is called a zygote.

Only one sperm can fertilize an egg.

How are fraternal (nonidentical) twins conceived?

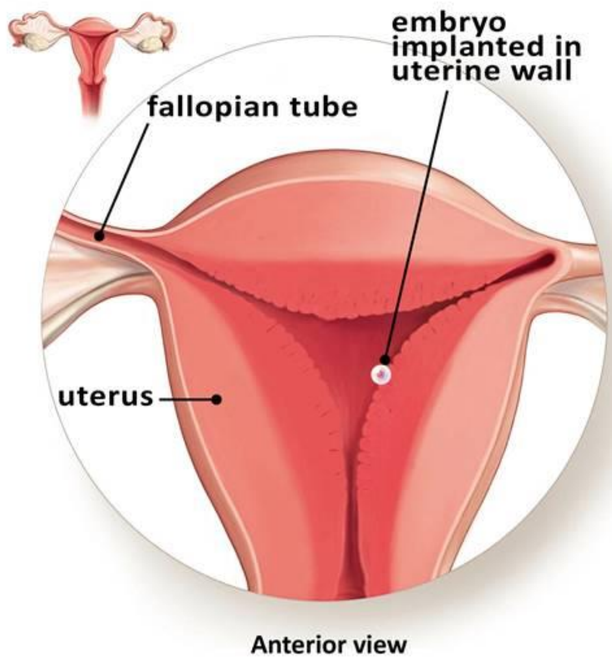


Two nuclei before they have fused.

It's harder than you might think for a sperm to get a crack at fertilizing an egg cell. And the privilege goes to only a single sperm out of the millions that will be ejaculated into the woman's vagina. The oocyte has a casing of other cells around it, and this casing has to be broken down by enzymes carried on the sperm. It actually takes the work of many sperm to break this casing down enough so a sperm might make its way through the cell membrane. The sperm that is the first to make this connection wins. The oocyte absorbs the sperm's nucleus and its half-set of DNA. In several hours, the cell will begin to divide.

The cell is no longer an egg; it is now called a zygote. Its cells continue to divide until it has gone through a certain number of divisions and is considered an embryo. All the while, it is traveling through the fallopian tube to the uterus.

The embryo travels to the uterus and attaches to the inner uterine wall



Once the embryo is implanted in the uterus, a flurry of changes begin in the mother's body.

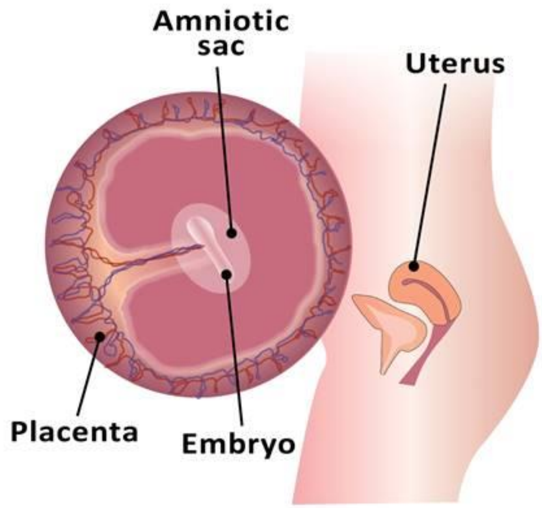
One important change is that the implanted embryo stimulates the production of a hormone known as hCG. This is the substance being tested for in a home pregnancy test.

When the embryo reaches the uterus, around three days after fertilization, it attaches to the inner lining of the uterus. This attachment sets a whole cycle of hormone-driven changes in motion as the mother's body takes on the task of pregnancy. The ovaries shut down and won't release any eggs until the mother is no longer pregnant. In fact, the menstrual cycle is put completely on hold, and the lining that was building up in the uterus remains. That's thanks to a hormone called human chorionic gonadotropin, or hCG. The embryo produces hCG, and the hormone is detectable in the mother's blood as early as 10 to 14 days after the embryo implants in the uterus. It's those early levels of hCG that allow a woman to do a home pregnancy test not long after the first time she misses a period.

The placenta forms from the uterine wall and produces hormones

The amniotic sac forms around the embryo. The placenta forms on one side of the amniotic sac.

The placenta allows for the exchange of oxygen and wastes between mother and fetus.



What happens when the Rh factor of the mother's blood is negative and the baby's is positive?

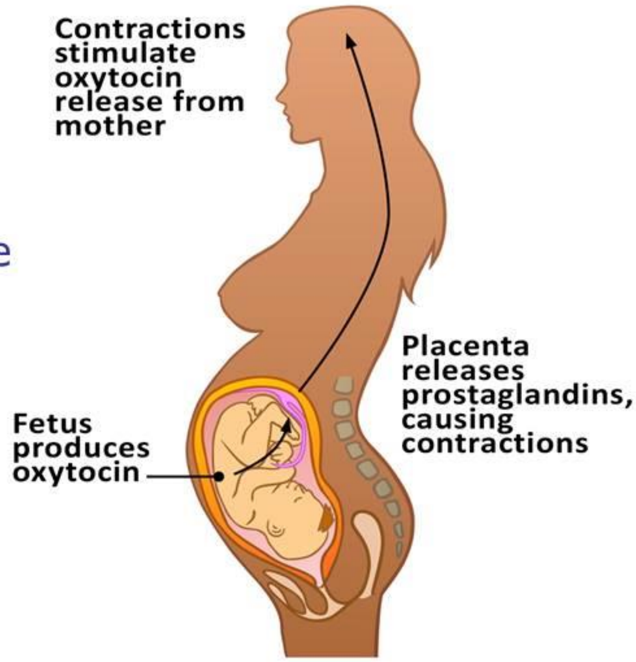
The amniotic sac forms around the embryo (and fetus). It is filled with fluid that protects and bathes the fetus during development. The fluid cushions the fetus and keeps it lubricated so that its developing fingers and limbs don't grow together.

The placenta is a layer of tissue that forms from the walls of the uterus and separates the fetus from the uterine wall. In the first trimester of pregnancy, the placenta actually becomes an endocrine organ, producing lots of estrogen and progesterone. The umbilical cord is the fetus' lifeline and connects to one side of the placenta. The circulatory and respiratory systems aren't functional. The lungs, even once they've developed, are completely collapsed and contain no oxygen. Because the fetus is in a fluid environment, there is no air to breathe into the lungs. All nutrient and gas exchange takes place across the placenta, but the blood supplies do not mix, which allows the fetus to have a different blood type from the mother. The mother does have to send quite a bit of blood to the placenta. A pregnant woman gets winded more easily than usual because she's sending blood to bring oxygen to someone else's cells besides her own.

Before birth, the fetus produces the hormone oxytocin

Oxytocin stimulates the placenta to release hormones called prostaglandins. Together, these hormones cause the uterus to contract.

Contractions cause the mother's pituitary to release oxytocin as well, bumping up the strength and frequency of contractions.



You may have heard mothers joke that the baby makes the decision about when it will be born. Although a pregnant woman doesn't go into labor because her baby thought, "It's time!," recent research suggests that labor is brought about by hormones produced by the fetus, namely the hormone oxytocin. Oxytocin from the fetus triggers a cycle of oxytocin release from the mother's pituitary gland that result in the often-painful uterine contractions known as labor. When the uterus contracts, it signals the mother's pituitary to produce additional oxytocin. More oxytocin means more frequent and stronger contractions.

Stronger and more frequent uterine contractions stimulate more oxytocin

Increasing oxytocin creates a positive feedback cycle that continues to make contractions stronger and more frequent until the baby is born.

How is this positive feedback loop different from the negative feedback loops of homeostasis?

The more often the uterus contracts, the more oxytocin is released. The result is a positive feedback loop in which the levels of oxytocin continue to rise and uterine contractions come more often and with more force. During this time, the mother’s cervix is also dilating. Eventually, the contractions are strong enough to push the fetus out of the uterus, through the dilated cervical opening and through the birth canal. This is no small effort—remember that sock analogy? Getting the fetus along its exit path requires considerable force. Sometimes the force isn’t enough and labor continues so long that it endangers either the fetus or the mother. In these cases, doctors will deliver the baby surgically by a cesarean section, of C-section, which involves cutting the abdominal and uterine walls.

Oxytocin also stimulates maternal feelings and feelings of affection

Oxytocin initiates the desire of a mother to care for her baby. It also plays a role in the emotional attachments we feel in romantic relationships.

Oxytocin has lots of effects in the body beyond those during childbirth. Men have oxytocin too, though often lower levels of it. Oxytocin brings on feelings of care, affection, and bonding, particularly for a mother who just gave birth or who is nursing. Oxytocin is also released by the brains of both men and women during sex, playing a role in romantic attachment.

Oxytocin affects many other behaviors, such as generosity toward others, trust, and empathy. Researchers are studying these many behavioral effects of the hormone, seeking possible ways to address certain kinds of antisocial behaviors. In the meantime, what is known for certain is that, from birth onward, the hormone plays an important and varied role in the relationship between mother and child.

The female reproductive system changes through a woman's lifetime

Women are most fertile in their 20s.

Beginning in their late 30s or early 40s, estrogen and progesterone levels begin to fluctuate. Ovulation gradually becomes less frequent, stopping completely around age 45–55.

Over the course of her lifetime, a woman will ovulate between 300 and 400 eggs. As she approaches her late 30s or early 40s, the cycles of estrogen and progesterone start to fluctuate. In turn, that means levels of LH and FSH also fluctuate in ways they hadn't before. This hormonal roller coaster can produce some disruptive systems, like night sweats, hot flashes, insomnia, and mood swings. It also produces irregular periods, and eventually the woman stops ovulating altogether. This process of reproductive winding down is called menopause. Once a woman has gone through menopause, she's not able to conceive anymore.

The way women experience menopause varies widely. For some, it happens over the course of a few months, and for others it can take five years or more. Some women have symptoms bad enough to disrupt their lives; for others it's much easier.

The lack of hormones, particularly estrogen, also causes changes in the body. The skin, muscles, and bones of both men and women weaken with age, but the effect can be more pronounced in women. (Remember, men also produce estrogen, but much less, so hormonal changes as men age are not as drastic.) Estrogen aids bone function, which means that postmenopausal women are at risk for osteoporosis. Older women can protect their bones by making sure to get enough calcium and do weight-bearing exercise, but the best insurance is to strengthen bones while you're young, because there will be more to make up for the bone loss that happens when you're older.

Student Resource 20.5

Reading: The Menstrual Cycle

Student Name:____ Date:___________

Directions: Complete the reading and answer the questions at the end.

Everyone has heard of "that time of the month." That particular time is part of a cycle that repeats itself about every 28 days, and the cycle is the continual rise and fall of a woman's fertility.

The 28-day menstrual cycle occurs because two separate cycles affect each other, and these two cycles have to occur in a synchronized way in order for a woman to be fertile.

- The ovarian cycle involves hormones secreted by the anterior pituitary that affect the development of the egg in the ovary.
- The uterine cycle involves hormones released by the ovary that affect the state of the uterine lining and of the maturing oocyte.

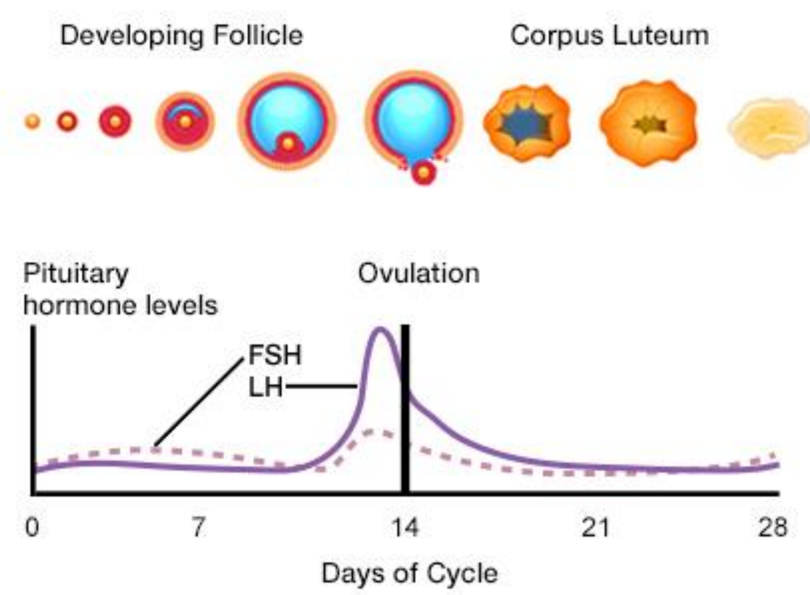
The first day of a woman's period is considered to be the first day of the menstrual cycle.

The ovarian cycle

At the start of menstruation, the ovaries are fairly quiet. Oocytes await the signal from pituitary hormones that it's time to move on to the next stage of maturity. Usually, only one oocyte at a time gets the signal, which comes in the form of the follicle stimulating hormone (FSH).

In the ovary, each egg cell sits in a tiny sac called a follicle. As the pituitary continues to send FSH over the course of about 10 days, the egg matures inside the follicle. At around day 14, the anterior pituitary sends out a surge of luteinizing hormone (LH) that makes the oocyte mature further and then burst out of the follicle. This process is called ovulation. After its escape, the oocyte is swept into the nearest fallopian tube, where it will remain alive for a day at most, unless it is fertilized. The levels of both LH and FSH plummet, and the empty follicle becomes a temporary structure called the corpus luteum (literally "yellow body"). FSH levels begin to rise again during the last few days of the cycle.

Below is a graph showing FSH and LH levels during the 28-day cycle:



During the ovarian cycle, the follicle (and the resulting corpus luteum) act as an endocrine gland, secreting hormones that set the uterine cycle in motion.

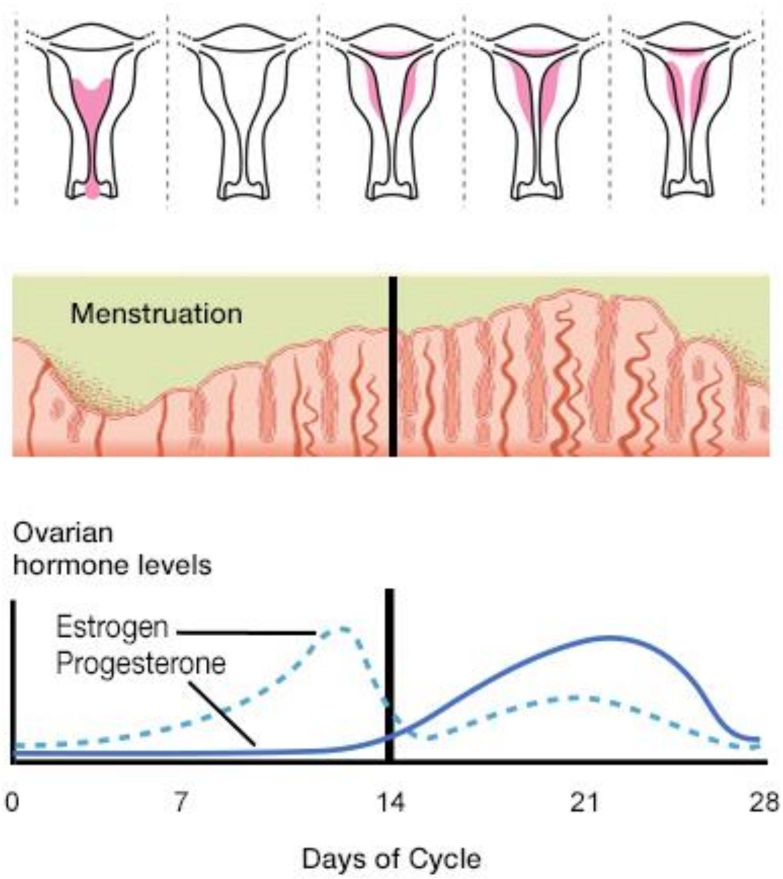
The uterine cycle

Estrogen and progesterone are two important sex hormones that play a significant role in the fertility cycle. In the days prior to the first day of menstruation, their amounts in the system are declining, which can cause mood swings, bloating, and appetite surges in some women. These symptoms, and others, are collectively known as premenstrual syndrome, or PMS. During the first days of menstruation, the ovaries remain quiet not only in terms of egg production but also in terms of hormone production. Rising FSH levels in the follicle prompt it to begin secreting estrogen around day 6 of the cycle, when menstruation is almost over. Estrogen makes the inner wall of the uterus, called the endometrium, grow and develop a rich blood supply. This thickening is the uterus getting prepared to provide a nourishing site for an embryo should the oocyte that will be released into the fallopian tube become fertilized. When blood levels of estrogen are high, the pituitary senses it and slows the production of FSH.

After ovulation occurs, levels of estrogen begin to fall, and the corpus luteum secretes progesterone. Progesterone causes the lining that's developed in the uterus to remain for several days. This is important, because if the oocyte is fertilized, it will take several days to travel through the fallopian tube to the uterus. The embryo will only implant in the wall of the uterus if the thick, nourishing uterine lining is present.

If the egg cell isn't fertilized, the corpus luteum shrinks and stops producing estrogen and progesterone. The oocyte will deteriorate and the body will shed both the egg cell and the uterine lining. This shedding of the lining is what's known as menstruation.

The diagram below shows how levels of hormones from the ovaries affect the lining of the uterus during the cycle.



If the oocyte is fertilized, the corpus luteum remains, and it secretes estrogen and progesterone until the fetus is developed enough to secrete its own hormones.

Negative and positive feedback loops

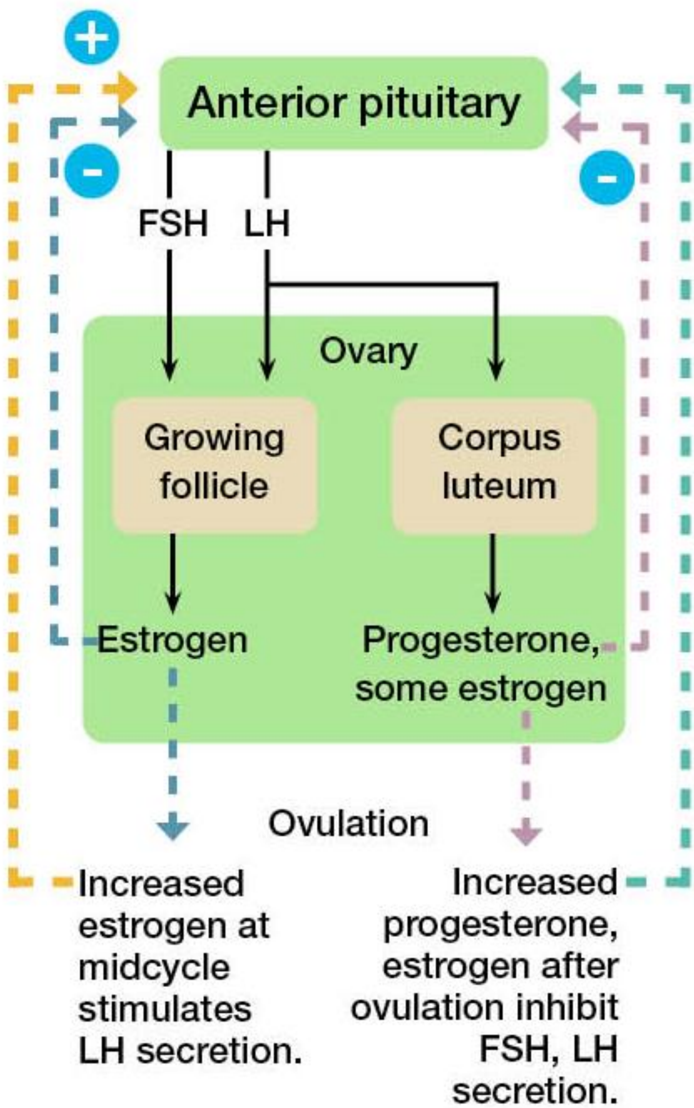
The hormones involved in the menstrual cycle interact in a complex set of feedback loops. You already know that hormones in the ovarian cycle—FSH and LH—set in motion events that stimulate the production of the hormones involved in the uterine cycle. In turn, the hormones of the uterine cycle—estrogen and progesterone—also have an impact on the levels of hormones involved in the ovarian cycle.

Estrogen exerts an effect on both hormones of the ovarian cycle, and the effects are opposite.

- Estrogen is part of a negative feedback loop with FSH. In a negative feedback loop, high levels of one substance in the blood—in this case, estrogen—produce a reduction in levels of another substance, in this case, FSH. Negative feedback loops serve the purpose of keeping levels of the hormones involved in check.
- Estrogen is also part of a positive feedback loop with LH. In a positive feedback loop, elevated levels of one substance—in this case, estrogen—stimulate greater production of another substance—in this case, LH. In this loop, higher estrogen levels result in higher LH levels, and higher LH levels stimulate more production of estrogen. The cycle continues until it results in the LH spike that triggers ovulation. Positive feedback loops are much less common.

Progesterone is involved only in a negative feedback loop that occurs after ovulation. Progesterone inhibits the production of both FSH and LH. Progesterone levels fall at the end of the cycle, and, as a result, production of FSH and LH begins again, setting the cycle in motion once more.

On the following page is a diagram that describes the major feedback loops in the menstrual cycle.



Questions

1) What are the major events in the ovarian cycle?

2) What are the major events in the uterine cycle?

3) Which hormones are part of the ovarian cycle, and what do each of them do?

4) Which hormones are part of the uterine cycle, and what do they do?

Student Resource 20.6

Graphs: The Menstrual Cycle

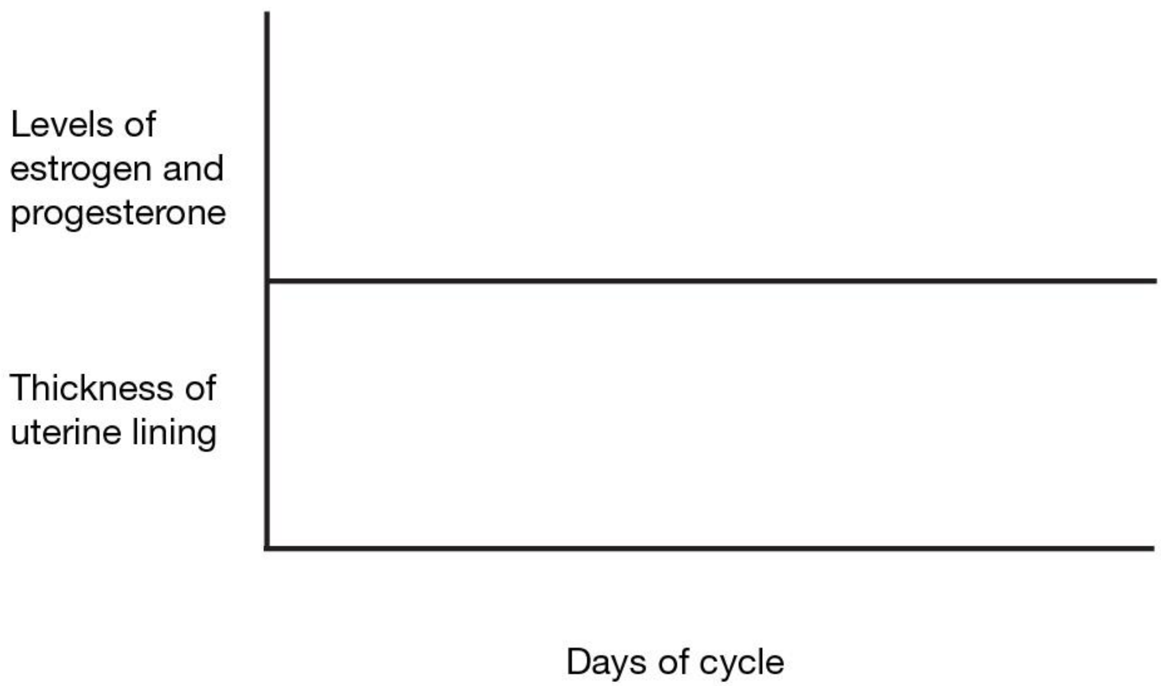
Student Name:____ Date:___________

Directions: Below are several scenarios. For each one, create a graph that starts on the day of the cycle described in the scenario. The graphs should look similar to those in Student Resource 20.5, Reading: The Menstrual Cycle.

1. The level of LH and FSH are at their peak and ovulation is occurring.

Draw a graph for the 28-day cycle, beginning on this day. The graph should show:

- Levels of estrogen and progesterone
- Thickness of the uterine lining
- When menstruation occurs



Questions:

a) On approximately what day of the cycle does this graph begin?

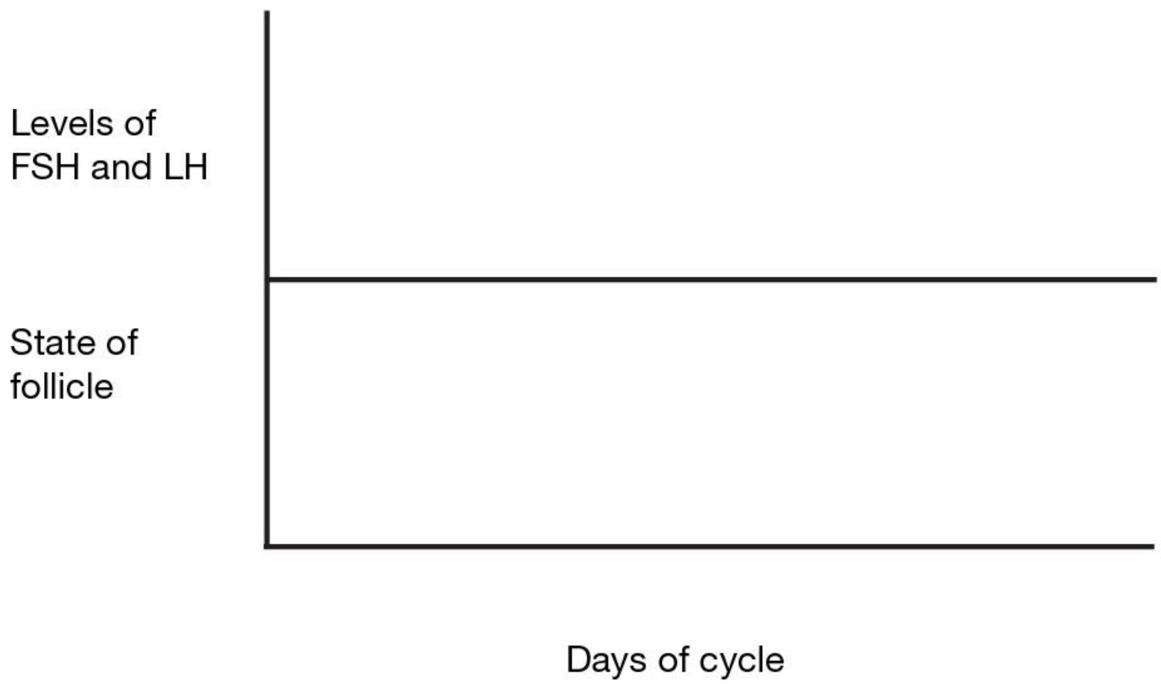
b) What is causing the peak in production of LH?

c) What event makes the level of LH start going down after its peak and why?

2. Levels of progesterone are quite high, and the uterine lining is quite thick.

Draw a graph for the 28-day cycle that begins on this day. The graph should show:

- Levels of FSH and LH
- When ovulation occurred
- What state the follicle is in



Questions:

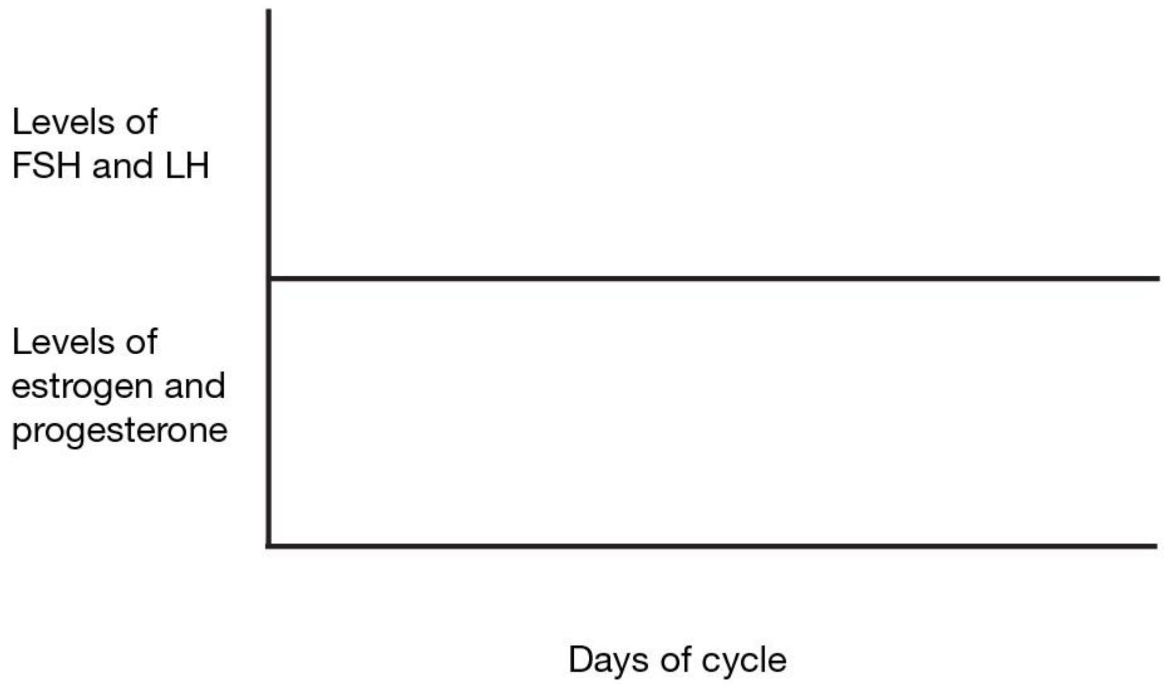
a) On approximately what day of the cycle does this graph begin?

b) Where is the progesterone coming from?

3. The follicle is still maturing and the uterine lining is at its thinnest.

Draw a graph for the 28-day cycle that begins on this day. The graph should show:

- Levels of FSH and LH
- Levels of estrogen and progesterone
- When ovulation occurs
- When menstruation occurs



Questions:

a) On approximately what day of the cycle does this graph begin?

b) Explain why the level of progesterone is what it is at this time in the cycle.

Student Resource 20.7

Reading: Contraceptives

Student Name:____ Date:___________

Directions: Complete the reading and fill in the chart at the end of the reading.

Since antiquity, humans have sought ways to engage in sex while avoiding the consequence of pregnancy. Men around the ancient world tried animal intestines and bladders as condoms. In ancient Egypt, women mixed honey and dates with a bit of acacia bush, smeared it on cloth, and inserted it into their vaginas. The warmth of their bodies caused the mix to form a chemical now used in modern spermicides.

Today's contraceptives are somewhat more refined and much more effective. The word *contraception* comes from *contra*, meaning against, and *conception*. Methods of contraception currently available in the United States fall into five broad categories:

- Barriers: Block sperm from entering the uterus
  Examples: Condoms, diaphragm
- Hormonal: Involve hormones that regulate the ovarian or uterine cycle
  Examples: Birth control pills, contraceptive patch
- Chemical: Spermicide that slows or stops the movement of sperm toward an egg
  Examples: Suppositories. Some barrier methods, such as the sponge and diaphragm, are used with spermicides.
- Intrauterine: Device placed in the uterus that affects the intrauterine environment
  Example: Copper or progesterone IUD
- Sterilization: Surgical or mechanical procedures that block the release of the sperm or egg
  Examples: Vasectomy, tubal ligation ("getting tubes tied")
- Natural: Keeping sperm from entering the vagina or tracking body changes to predict when a woman is fertile
  Examples: Withdrawal, rhythm method

Each of the methods listed above works in a different way to protect from pregnancy. All are reversible, except sterilization.

Barrier methods

Barrier methods all consist of some kind of physical barrier that prevents sperm from entering the vagina. Condoms are the most widely used barrier method, and one of the few birth control options that men as well as women can use. There are condoms for men that fit over the penis, and condoms for women that fit inside the vagina. The male condom is more common. Condoms are available from many grocery and drug stores, and many health clinics and AIDS awareness organizations give out condoms for free. Condoms help prevent the spread of sexually transmitted infections by providing a protective layer of latex between the genital skin of the man and the woman.

Other barrier methods can be effective forms of birth control, but they don't provide protection against infection. The diaphragm and cervical cap are similar options; both fit over the cervix and block the entry of sperm into the uterus. Both also need to be fitted by a physician.

Two other barrier methods, the contraceptive sponge and the cervical shield, are available over the counter at pharmacies. Both are inserted into the vagina before sex; the shield fits over the cervix, and the sponge fits up against it. All four of these vaginal barriers should be used with spermicide to be effective. For typical users of barrier methods, about 18%–20% of women become pregnant each year, though the diaphragm is slightly more effective, with about a 12% rate of accidental pregnancy. These numbers are accurate provided the barrier is used correctly 100% of the time.

Hormonal methods

Hormonal methods of birth control are among the most effective. While they come in a variety of delivery devices—pills, patches, implants, injections, and a vaginal ring—the vast majority of them work on the same principle. They employ synthetic forms of estrogen and progesterone to prevent ovulation and control the environment in the uterus. These birth control methods all require a prescription, and a health care provider can help a woman or a couple decide which is right for them.

You've learned that the estrogen levels in the blood peak as ovulation occurs and that the elevated level of estrogen makes the pituitary slow down the production of FSH. Elevated estrogen levels also stimulate the production of LH, the hormone that triggers ovulation. Progesterone levels also play a role in LH production. Hormonal contraceptives supply steady amounts of both of these hormones, overriding the body's natural cycle and keeping estrogen and progesterone at constant levels. Without the hormonal peaks of a regular menstrual cycle, the pituitary misses the signals that prompt it to secrete LH and initiate ovulation. If no egg leaves the ovary, no pregnancy is going to occur.

Progesterone in hormonal birth control pills also affects the lining of the uterus, making it inhospitable for an embryo to implant. The hormone also causes the mucus covering the cervix to thicken, which makes it more difficult for sperm to swim through.

Most forms of hormonal birth control contain both hormones. With pills, the hormones are taken each day, and then the woman has a few days "off," during which she gets a period. The patch and the ring supply the hormones by having contact with the body surface, and then they are removed after three weeks to allow the woman to menstruate. There are also implants and injections of these hormones that are much longer lasting. The injections prevent pregnancy for about three months and the implants for up to two years.

Some women find that estrogen has side effects they don't like, such as weight gain or moodiness. Women on the pill sometimes find that a different brand or strength of pill can help. Others prefer not to take estrogen at all. In those cases, a woman might opt for what's called the mini-pill that contains only progesterone. Because progesterone also inhibits the production of LH, women on the mini-pill also don't ovulate. But because there isn't any estrogen involved, the mini-pill isn't quite as reliable as the combination pill: about 8% of women taking the mini-pill will get pregnant, and only about 1% of women using methods that combine both hormones will.

Another kind of contraceptive pill that uses these hormones can be used after sex, if a woman thinks she might get pregnant. This emergency contraceptive pill can be purchased over the counter at a pharmacy. The pills contain large doses of hormone, either progesterone alone, or in combination with estrogen. These morning-after pills prevent a fertilized egg from attaching to the wall of the uterus. Some can also prevent ovulation or slow down sperm. Because they are strong doses of hormone, though, they come with side effects. Doctors suggest that these pills be used only in emergencies and that women rely more regularly on other methods of birth control that aren't as disruptive to the body.

Chemical methods

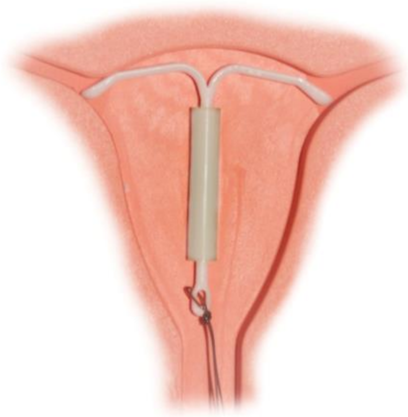
Spermicide contains chemicals that kill or slow sperm so that they don't get through the cervix. Most spermicides available in the United States contain a chemical called nonoxynol-9. As with hormonal contraceptives, the same substance is available in many forms. There are gels, foam, and suppositories that liquefy from a woman's body heat after being inserted. You can also buy spermicidal film. This comes in thin square sheets, and a woman inserts one sheet in her vagina so that it covers her cervix.

Spermicides are most effective when used in combination with a barrier method of birth control, such as a condom or diaphragm. Without an additional barrier method, spermicide is about 75% effective, meaning 1 in 4 woman who use spermicide will get pregnant. Spermicide also enhances the effectiveness of barrier methods. The two together, if consistently used properly, can provide effective protection.

Intrauterine devices

Intrauterine devices, also called IUDs, are a long-term form of contraception. An IUD must be fitted and inserted by a health care provider, and it sometimes needs adjustments. But once it is properly placed, it is the most reliable nonsurgical form of contraception and can prevent pregnancy for many years. It is 99.9% effective, making it the most reliable form of contraception.

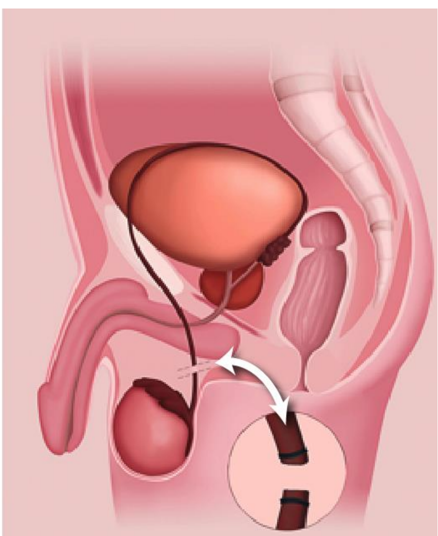
There are two types of IUDs available in the United States. Both are shaped like a T and are about an inch long. Each is inserted directly into the uterus and can remain there for several years. They both work by affecting the uterine environment and the ability for sperm to reach an egg.



The copper IUD releases a small amount of copper into the uterus. The copper creates an inflammatory response in the uterus that keeps sperm from reaching an egg. The copper also affects the lining of the uterus, so that if a sperm does get through to an egg, the embryo is unlikely to implant on the wall of the uterus. This type of IUD can be left in the uterus for up to 10 years. It can also be inserted as a form of emergency contraception, though because inserting the IUD requires a health care provider, it can be expensive.

The second type of IUD available is a hormonal IUD, which releases a synthetic form of progesterone into the uterus. The hormonal IUD thickens cervical mucus, making it harder for sperm to enter the uterus. It also thins the uterine lining so that a fertilized egg is unlikely to implant and maybe keep the follicles from maturing and releasing eggs. A hormonal IUD can be left in for about five years and can't be used as emergency contraception.

Sterilization



Sterilization involves procedures that prevent a man from releasing sperm or a woman from getting pregnant. The procedure for men is called a vasectomy, which involves cutting or sealing the vas deferens so that sperm can't leave the body. Currently, a vasectomy is permanent, though researchers are trying to develop a reversible vasectomy.

Sterilization for women involves blocking the fallopian tubes so that eggs can't descend to the uterus. This can be done surgically, by making an incision in the abdomen to reach the fallopian tubes and cut or tie them. Another option, called essure, doesn't require surgery. To perform an essure, a health care provider threads a tiny tube through the cervix and uterus and into the fallopian tube. Once in place, a tiny spring-shaped device is released into the fallopian tube. Over the course of about three months, scar tissue forms over the spring, blocking off the fallopian tube. Sterilization for both sexes is usually 100% effective, provided there are no complications and the surgery has been done correctly.

Natural methods

Some couples use purely natural methods of birth control. These include withdrawal, when the man pulls his penis out from the woman's vagina before he has an orgasm. Another method, known as the rhythm method or fertility awareness, involves tracking the cyclical body changes involved with fertility in order to predict the days when a woman would be fertile. On fertile days, the couple abstains or uses birth control. Tracking cyclical changes includes noting dips and rises in a woman's body temperature and changes in her cervical mucus. By recognizing a particular woman's patterns of change, it's possible to be fairly accurate about which days are fertile ones. While these methods are safe and don't have side effects, they are the most difficult to consistently do correctly and are the least effective at preventing pregnancy. Between 20% and 25% of couples who use them will get pregnant each year.

Contraceptive Method and Examples	**How It Works**	**Where to Get It**	**Success Rate (if used correctly)**
Barrier Examples:			
Hormonal Examples:			
Chemical Examples:			
Intrauterine Examples:			

Sterilization Examples:			
Natural methods Examples:			

Student Resource 20.8

Posters Summary: Reproductive Health and Conditions

Student Name:____ Date:___________

Directions: After looking at each poster, answer the questions and complete the charts.

1. Explain what endometriosis is and why is it so painful.

2. Fill in the chart with information about the three types of reproductive cancers of most concern to women.

Type of cancer	How is it detected and treated	What helps or hinders survival rates?

3. Fill in the chart with information about the two types of reproductive cancers of most concern to men.

Type of cancer	**How is it detected and treated**	**What helps or hinders detection and treatment**

4. Describe at least three factors that can make it difficult for a man and woman to conceive.

5. Why would a woman's monthly cycle or being stressed and tired make her more likely to get a yeast infection?

6. What types of health care providers do men and women see for problems associated with their reproductive systems?

7. What practices do you do now to protect your reproductive health? Which ones will you start using?

Breast cancer self exam:

- http://www.breastcancer.org/symptoms/testing/types/self_exam/bse_steps

Testicular cancer self exam:

- http://kidshealth.org/teen/sexual_health/guys/tse.html

Student Resource 20.9

Lab: ELISA Test

Student Name:____ Date:___________

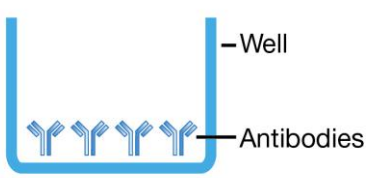
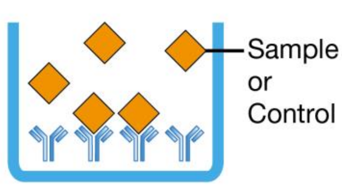
Directions: Read through the information about how ELISA testing works. Then, with your partner, work your way through the lab and determine which patient is pregnant. Once you have your results, answer the questions.

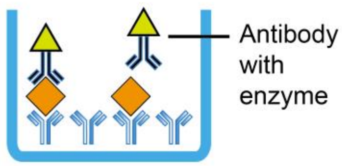
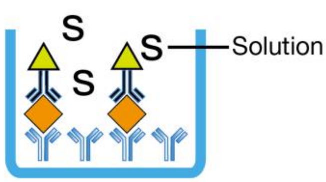
What is ELISA?

An ELISA test is used to screen for all kinds of conditions. It works by using antibodies, which you learned about in the immune system lesson, to detect antigens in a person's body fluid. Antigens can be nearly any molecule of appropriate size, and in the case of a pregnancy test, the antigen is a hormone produced by the embryo. In an ELISA, antibodies are used to detect an antigen, and these antibodies are connected to an enzyme that will cause a color change when a solution containing molecules that interact with the enzyme is added. A change in color indicates the presence of the antigen in the body fluid being tested.

Recall that shortly after a woman becomes pregnant the embryo begins producing a hormone called hCG. In pregnancy testing, hCG represents the antigen. An over-the-counter pregnancy test is an ELISA test that detects hCG.

For this ELISA test, you'll be using a plate with small wells in it. You'll be putting different simulated urine samples in the wells and seeing whether they change color. Here's what will be happening in the well during each step of your testing:

 The inside of each well is coated with antibodies.	The antibodies in the well will bind with the antigen you want to test for, if it is present. In a pregnancy test, the antibodies will bind with hCG. In this lab, you will be using artificial antibodies, antigen, and simulated urine samples.
 A sample is added to the well.	When a sample is added to the well, any molecules of its specific antigen in it will bind to the antibodies in the well. In this lab, an artificial hCG is the antigen.
The wells are emptied and rinsed.	Rinsing the wells removes any leftover sample solution and unbound antigens. Any antigen that is bound to the antibodies in the well will remain bound to the antibodies and thus will be in the well.

 More antibody is added. The antibody has an enzyme that can change the color of the solution.	A second round of antibodies is added to the rinsed well. These antibodies also bind to the antigen. They also contain an enzyme that will change the color of a special solution when it is added to the well.
The wells are emptied and rinsed again.	This rinsing gets rid of any unbound antibody/enzyme particles. There are enough of these particles in the solution that they can bind to all the antigens and still have some left over. Once these leftover particles are rinsed away, what remains in the well is a little tower of molecules. The foundation is the antibody that was originally in the well. The middle is the antigen (if it was present) and the top of the tower is the second antibody with the color-changing enzyme.
 A solution containing molecules that interact with the enzyme is added to the well. If the enzyme is present, the molecules in the solution will change color.	A solution is added to the well that contains molecules that will interact with the enzyme. If the enzyme is present (which only occurs if there was antigen in the sample), the molecules in the solution will change color. If the urine sample didn't contain the antigen, there won't be any enzyme present and the substrate will not change. In this scenario, the solution does not change color.

Collect your lab materials

Your lab kit should contain:

- One microtiter plate with four wells that are numbered
- One tube of bromthymol blue, labeled "Substrate"
- Five tubes with liquid, one each labeled "P1," "P2," "Antigen," "Control," and "Wash"
- Six plastic pipets
- Seven or eight toothpicks
- Safety goggles
- Gloves

You will also need three or four clean paper towels.

Perform the test

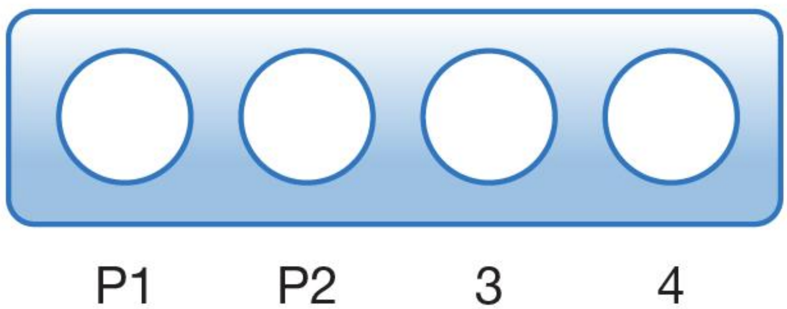
Find the two tubes labeled P1 and P2. These represent urine from two different women. Both women were having difficulty becoming pregnant and so sought fertility counseling. This test will determine whether either of them has managed to become pregnant.

You will also need to conduct two control tests at the same time.

- A positive control will show that the test is working properly when antigen is present.
- A negative control will show that no reaction occurs when antigen isn't present.

The labels on your microtiter plate correspond to the following:

- P1 = urine from Patient 1
- P2 = urine from Patient 2
- 3 = positive control
- 4 = negative control



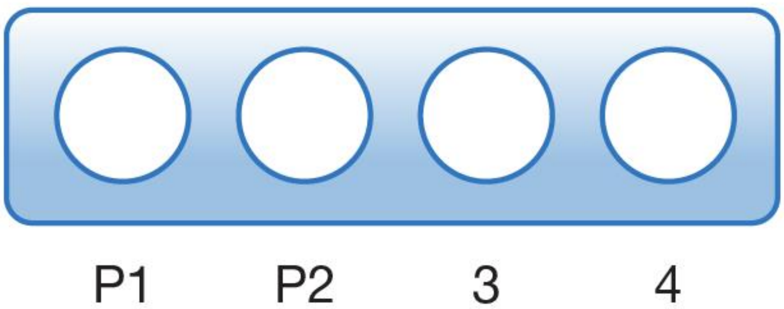
Be sure to use a clean pipet each time you add a new liquid to a well. Don't touch the sides or bottom of the well, just hover over it and let each drop drip in. Set aside your used pipets.

1. Using a clean pipet, add two drops of P1 to the P1 well.
2. Using another clean pipet, add two drops of P2 to the P2 well.
3. Using a third clean pipet, add two drops of antigen to well 3.
4. Using a fourth clean pipet, add two drops of control to well 4.
5. Let the liquid sit in the wells for one minute. Pop any bubbles using a clean toothpick for each well.
6. Flip the plate over onto a paper towel, being careful that the liquid from one well doesn't get mixed with liquid from another well. Let the paper towel absorb the liquid from the wells. Turn the plate back upright and use a clean paper towel to blot up any liquid on the plate around the wells. Do not wipe out the wells themselves, just wipe around them.
7. Using a clean pipet, rinse each well with several drops of wash. Fill each well about half way and then flip the plate over onto a clean portion of paper towel. Again, use clean toothpicks to blot bubbles if any form while you're rinsing and a clean portion of paper towel to blot excess liquid around the wells.
8. Using a clean pipet, put two drops of antibody solution in each well. Be careful not to touch the sides or bottoms of the wells.

9. Let the plate sit for one minute.
10. Again, flip the plate over onto a paper towel, taking care that the fluid from the wells doesn't mix. Blot around the wells with a clean portion of paper towel. Rinse the wells as you did in Step 6.
11. Using a clean pipet, transfer two drops of substrate to each well. Hold the plate with the wells facing up and gently tap it against the surface it's sitting on to mix the substrate with the substances stuck to the wells.
12. After 30 or 45 seconds, note any color changes.

Analyze your data

1. Put an *X* in the microtiter wells where you saw a color change.



2. Was either of the two patients pregnant? How do you know?

3. Fill out the chart below, putting an *X* in front of each substance that is (or was) in each well.

Well P1		**Well P2**		**Well 3**		**Well 4**	
	Antigen		Antigen		Antigen		Antigen
	Antibody + enzyme		Antibody + enzyme		Antibody + enzyme		Antibody + enzyme
	Substrate		Substrate		Substrate		Substrate

4. Explain your results in well 3, the positive control.

5. Explain your results in well 4, the negative control.

6. What do wells 3 and 4 tell us that's important? How do they confirm that we can trust the results of the tests for P1 and P2?

Student Resource 20.10

Notes: Genes and Reproduction

Student Name:____ Date:___________

Directions: Answer the questions and complete the charts as you watch the presentation on genes and reproduction.

1. Label the following three features on the diagram below:

- DNA
- Gene
- Chromosome

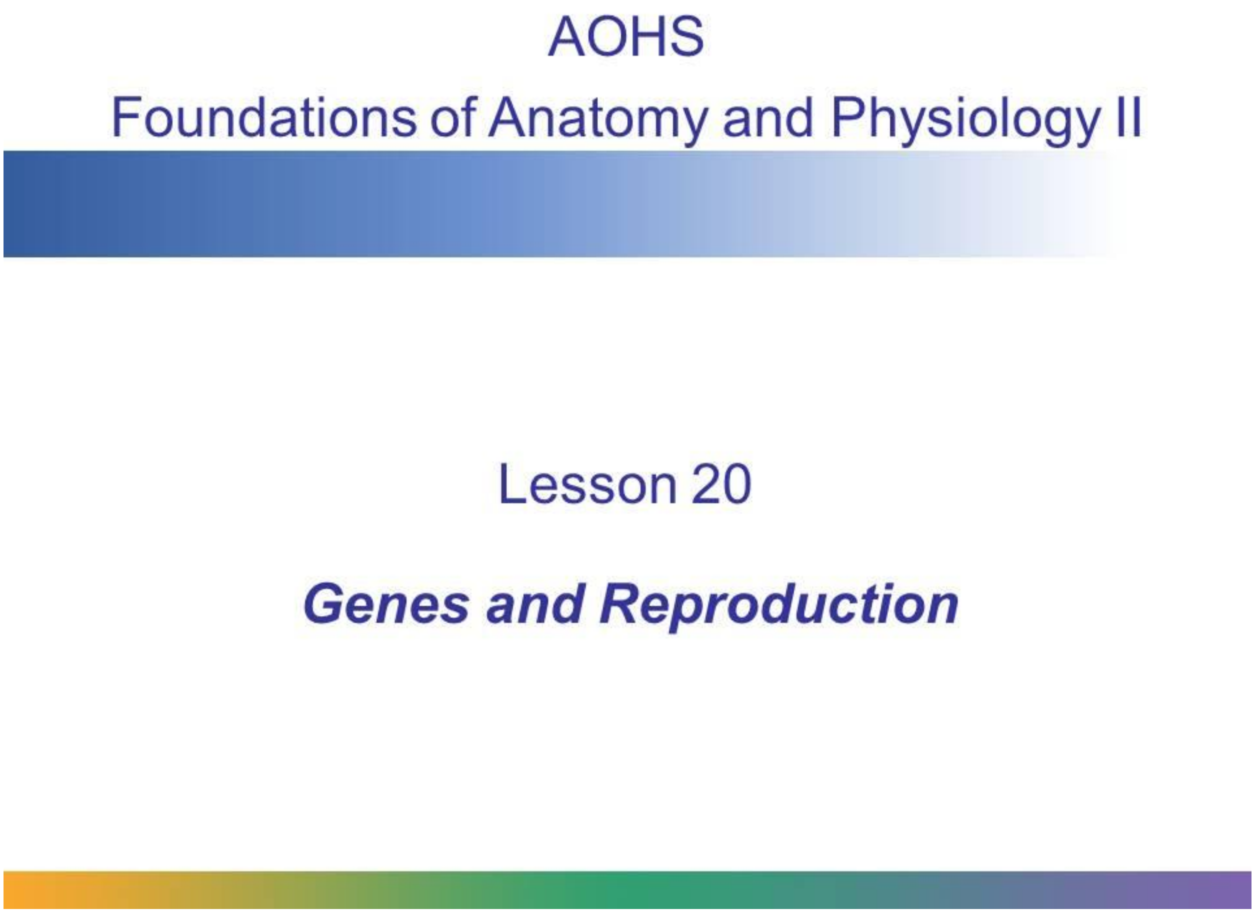
2. Explain how it is true that both genes and chromosomes are made of DNA.

3. Explain why we can say that we have two sets of 23 chromosomes.

4. Explain what alleles are and how they contribute to a diversity in how traits appear.

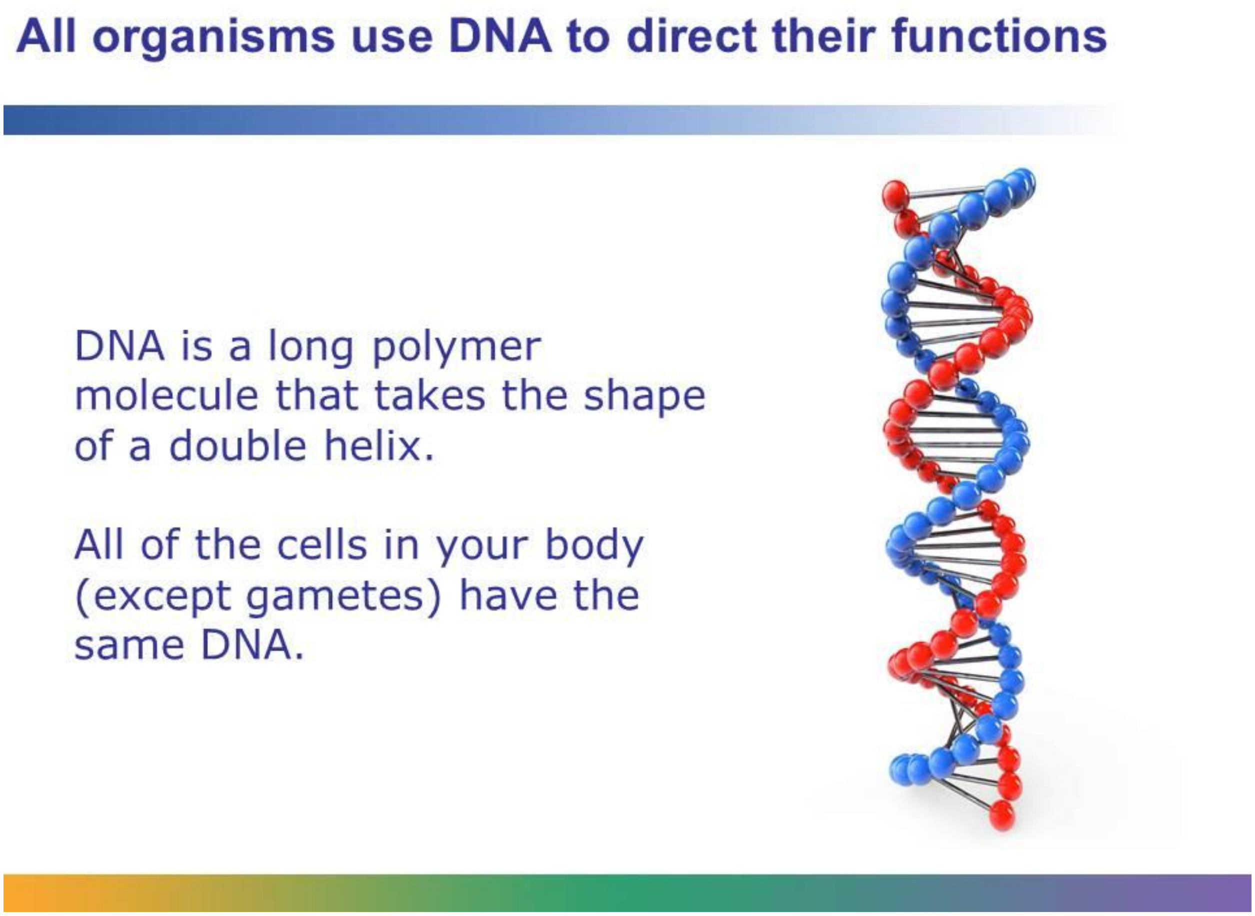
Student Resource 20.11

Reading: Genes and Reproduction



By the end of this presentation, you will know:

- What DNA does
- The difference between DNA, chromosomes, and genes
- How gametes differ from other cells
- What happens to the DNA of gametes during fertilization



Every organism that has ever lived—people, dogs, fish, insects, fungi, amoebas, even bacteria—uses DNA as the control manual for all of its functions. DNA stands for deoxyribonucleic acid (you can see why we call it DNA for short). The code in your DNA holds instructions that your body follows throughout your life. These instructions order the materials that make you produce hair rather than feathers, eggs or sperm rather than seeds, and eyes, nose, ears, and muscles all connected to your brain by neurons.

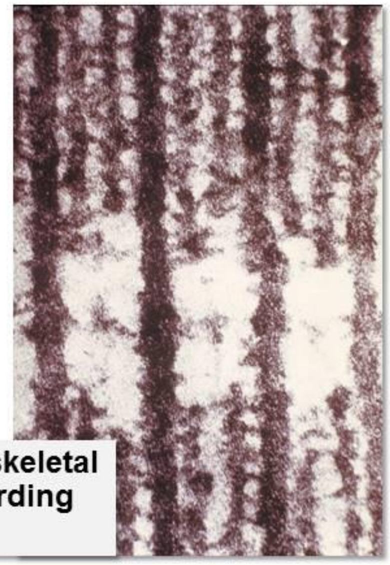
While DNA does very complex things, it's actually not such a complex molecule. Its instructions are written using just four different molecules. A strand of DNA contains two very long chains of these molecules. The chains come together in a shape called a double helix, which is sort of like a spiral staircase with sugar phosphate handrails on either side.

The total DNA found in the nucleus of a single cell in your body includes around 6 billion base pairs. All the cells in your body have the same DNA. Different cells use different parts of the DNA to produce things they need. Together, all of the DNA in each cell is called your genome.

DNA contains the “recipes” for proteins that serve many functions

Some parts of your DNA have recipes for physical characteristics, such as melanin proteins, which give your skin color.

Others parts have recipes for structural proteins such as actin and myosin.



Actin and myosin in skeletal muscle, created according to a “recipe” in DNA.

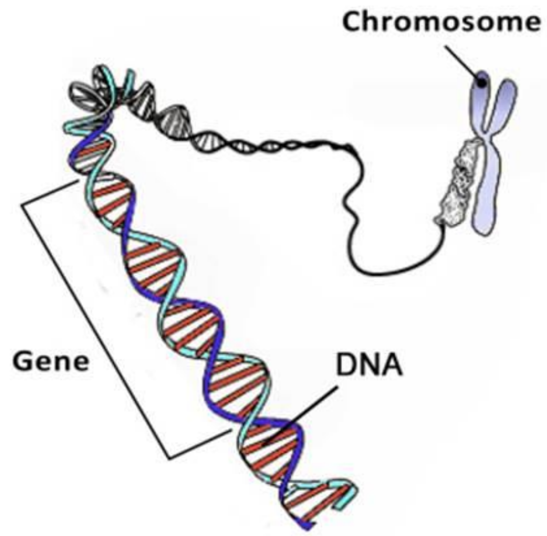
Do you think DNA is the foundation of your personality? Why or why not?

DNA’s main job is to provide the instructions for making proteins. Some of the proteins become structures in your body, such as actin and myosin in your muscles. Other proteins become enzymes that make the necessary chemical reactions happen in your body. Still others are found in cell membranes and control what enters and leaves the cell. Some proteins contribute to traits that make you look like you do—proteins that are pigments for eye color, the shape of hair follicles, the length and strength of your bones.

These recipes are written in the same language for all organisms. In other words, a recipe written with 100 letters will be read the same way by the cells of a human, a fish, a dandelion, even a single-celled yeast. All these organisms will use those letters to make the same protein. Many of the reactions that happen in our bodies, particularly those that enable us to derive energy from nutrients, happen the same way in many other organisms. We share more genes than you might think with things that seem entirely unlike us. Yeast cells and people have about 25% of the same genes. When it comes to a mammal like a mouse, we have over 90% of our genes in common.

The section of DNA that contains the recipe for a specific protein is called a gene

You have about 21,000 genes in your DNA. Many genes can code for more than one protein.

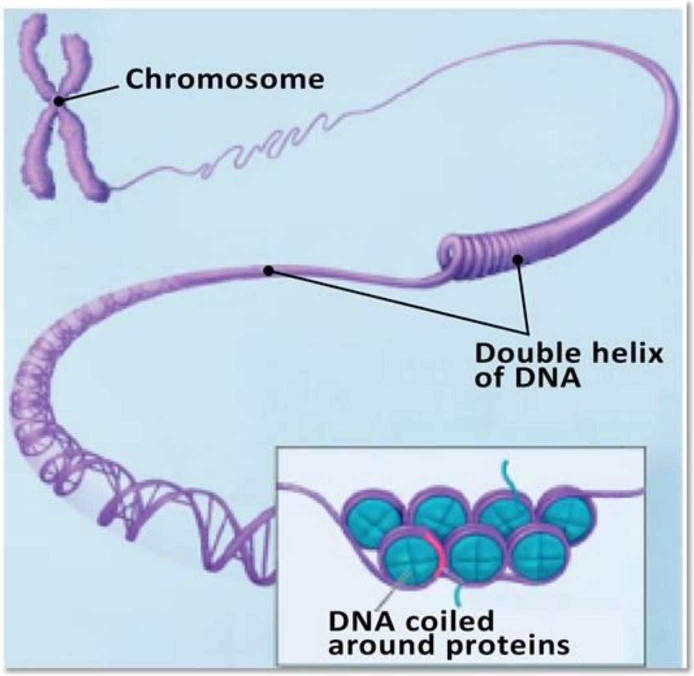


What is the advantage of being able to use one gene to produce many different proteins?

Amid the long strands of DNA in your cells are smaller sections that provide the actual recipes for the proteins. These sections are genes. Before scientists were able to see the whole human genome, they thought there was one gene for every protein that has a function in the body. Instead, they found far fewer genes—around 21,000—and learned that a single gene can be used to produce many different proteins. The exact number of genes is still a matter of debate. The number may change as we learn more about how DNA does its job. Most of your DNA does things besides providing recipes for proteins, and scientists are still learning what all those functions are.

The number of genes an organism has varies greatly from species to species and doesn't always relate to how complex the organism is. The animal that wins the award for the most genes is a water flea. The living thing with the most DNA is a flowering plant native to Japan. It has about 300 feet of DNA in each cell.

DNA is coiled into tightly packed structures called chromosomes



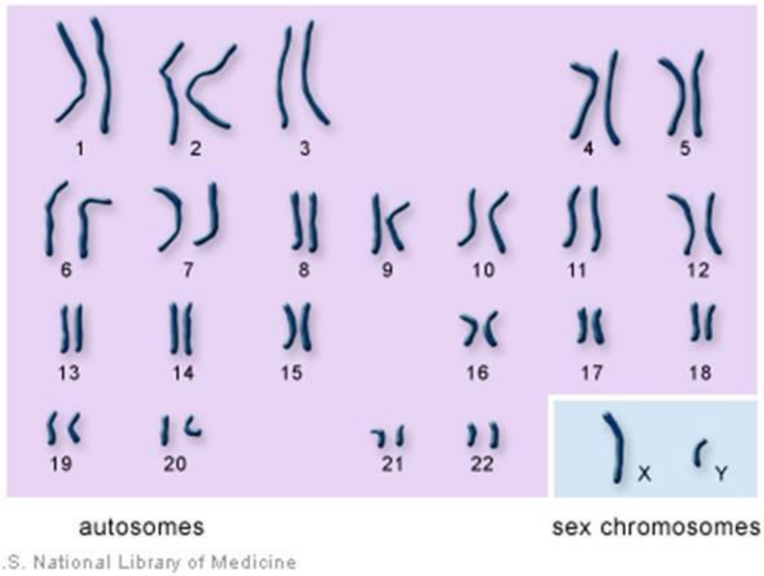
If you could pull all the DNA out of the nucleus of just one of your cells and straighten it out, it would be about 6 feet long. And you have about 50 trillion cells. All that DNA added together, laid end to end, would circle the earth 2.5 million times.

How does all that DNA fit into one person? It's packed into structures called chromosomes. In your chromosomes, DNA is wound around proteins, which are then again wound into more coils. Most of the time, the DNA isn't coiled as tightly as it can be, and it's not visible under a microscope. Just before a cell goes through mitosis (cell division), it makes a copy of all the DNA in each chromosome. When there are two full copies of each chromosome, the cell splits into two, with each daughter cell getting a full complement of DNA. During this splitting process, the chromosomes take on another level of coiling, becoming what's called "supercoiled." It's these supercoiled chromosomes that can be seen under a microscope.

Humans have two sets of 23 chromosomes, for a total of 46

One set comes from your mom, the other from your dad.

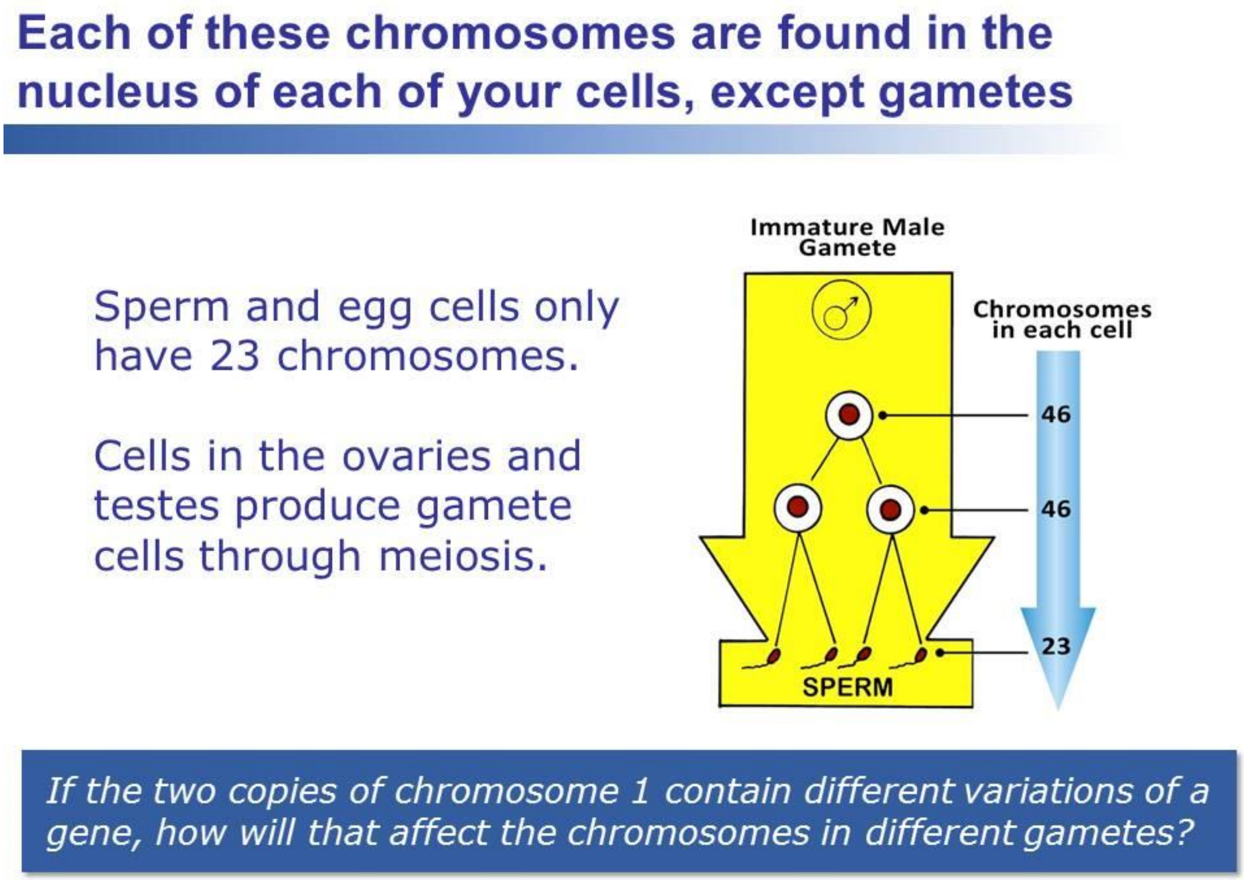
You have two copies of each chromosome (except sex chromosomes), which means you have two copies of each gene.



In a boy, which parent is the Y chromosome from?

Each of us has two sets of 23 chromosomes, one set from each parent. To make them easier to refer to, scientists have numbered the chromosomes in an order that roughly follows size. Chromosome 1 is the biggest, chromosome 2 is slightly smaller, and they decrease in size from there. The two copies of chromosome 1, as with all other chromosome pairs, contain the same genes—in other words, you have two copies of all of your genes. The exception to this is the sex chromosomes X and Y. These are the smallest chromosomes, and they determine which sex you are. This is the only pair of chromosomes that may not have the same genes on each one. Females have an XX pair and males have an XY pair. The X and Y chromosomes contain different genes.

The number of chromosomes an organism has varies from species to species. Bacteria only have one chromosome, a circular ring of DNA inside their single cell. A dog has 78. Corn has 20.



Each cell nucleus in your body contains all 46 chromosomes, except for gamete cells (blood cells are a slight exception because they lose their nuclei, but they begin with 46 chromosomes). Therefore, each of your cells contains all of your genes. But although all cells need to produce certain proteins for their functions, cells also specialize. In doing this, cells of one tissue or organ will make use of some genes that aren't used by other cells. A pancreas cell uses genes that produce insulin, a skin cell uses genes that produce melanin, and a neuron in your brain may mostly use genes to produce proteins it needs to keep its activity flowing.

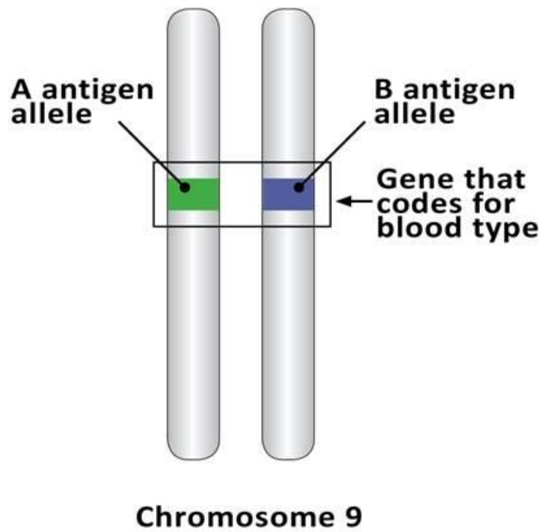
Your gametes are unique in that they only contain one copy of each chromosome. And for each chromosome, the copy could be the one from your mom or the one from your dad. The result is that, in most gametes, the chromosomes are a mix of both of your parents.

In all other cells, when a cell divides to create two cells, each one gets a full set of 46 chromosomes. But certain cells in the ovaries and testes are able to go through a special kind cell division, called meiosis, in which each new cell ends up with half of the original set of chromosomes. They are the only cells in your body that are made this way.

Different people may have different forms of the same gene

Different forms of the same gene are called alleles.

Alleles code for proteins that perform the same function but have a different appearance.



What alleles must be present among the genes of one's parents for their child to have an AB blood type?

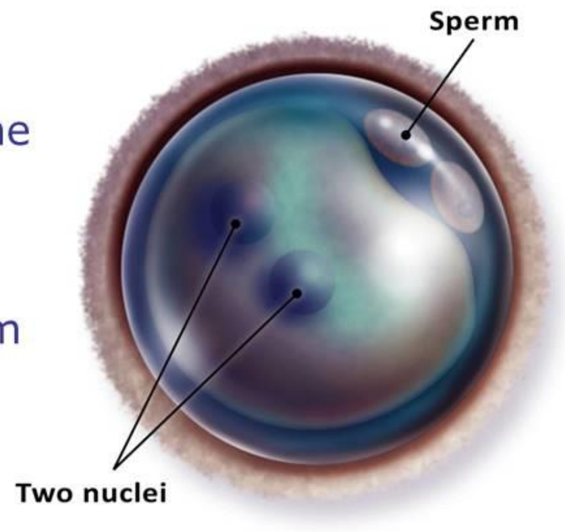
One of the biggest genetic factors in what makes you you is that many genes occur in more than one form. That means they code for proteins that carry out their job but may produce traits that look different or that make a function happen at a slower or faster rate. A good example of this is blood type. You already know that people have different blood types because of antigens (which are proteins) present on the surface of blood cells. There is only one gene, sometimes called the ABO gene, that is responsible for these proteins. This gene is found on chromosome 9. The gene has six different forms, or alleles (pronounced ah-LEELs). Some alleles produce the protein for the A antigen, others the protein for the B antigen, and others the protein for O. Your blood type is determined by which alleles you got from your parents.

People once thought that many traits related to our appearance, such as eye color, dimples, or the shape of your earlobes, are coded for by just one gene. We now know that most of our physical traits are determined by multiple genes, some of which have multiple alleles. All this variation results in a spectrum across traits. Take eye color, for example: a person can have light blue eyes, dark blue, brownish blue, greenish brown, and so forth. The many different possibilities come together as many different shades of eye color. All this variation in so many of your physical traits is the main reason why each of us looks and is unique.

During fertilization, the two gametes bring their 23 chromosomes together

The zygote will inherit gene alleles from each parent.

Some combinations that result will be different from those that either parent has.



What blood factor do you know of that the mother might not have but the baby might?

When a sperm cell fertilizes an egg cell, the egg cell absorbs its nucleus. For a brief time, the egg cell has two nuclei, each with 23 chromosomes. Then the two nuclei fuse and the fertilized egg has a full complement of 46 chromosomes. The egg begins to divide, making copies of all its DNA with each division, so that both new cells get all the chromosomes.

The zygote will have combinations of genes that result from what both the father and mother have contributed.

Advances in genetics make it a rapidly growing health career field

Examples of careers focusing on human genetics:

- Genetic counselor
- Forensic scientist
- Genetic data analyst
- Genetics laboratory researcher or assistant

Does a career in human genetics appeal to you? Why or why not?

In 2003, the Human Genome Project completed its mission of sequencing and mapping the human genome, all the DNA present in a human's chromosomes. It was an international effort that taught us a great deal about what genes exist in our DNA and how genes work.

That knowledge created an explosion of new research into human genetics, which is certain to grow. Knowing the genome is helping us understand inherited diseases, the mechanisms of cancer, how to more accurately diagnose some health conditions, and how to create treatments that can be tailored to a patient's genetic makeup. It is also helping us understand how genes and the environment interact to cause diseases such as cancer, diabetes, and Alzheimer's. Forensic scientists use increasingly sensitive DNA fingerprinting and other methods of looking at DNA to help them identify samples from a crime scene. Software engineers and data analysts have their hands full writing computer programs and crunching the huge amounts of data being compiled. And we also need ethicists and social scientists who understand genetics and can help hospitals, health care workers, and the government craft regulations around privacy and research.

Genetic research is having a profound impact on our understanding of the role of genetics in every phase of human life. It is one of the most exciting fields of medicine today—and we have only just begun to understand it.

Student Resource 20.12

Reading: Stages of Human Growth and Development

Among the many things written into your DNA is the program of growth and development your body will follow over your lifetime. Of course, there are many factors that can influence the details, such as your diet, activity, and environment. But you have a few milestones preprogrammed through the arc of a lifetime and will go through a series of stages and changes that are part of being human.

These stages are something of a guideline: you don't just suddenly wake up and find yourself in a new stage of life one day. Your body is changing and moving through this arc all the time. But certain changes in the nervous and reproductive systems are good markers for measuring the passage of time in a human body. Each person grows into the next stage differently, usually somewhere within a certain age range.

As we've been able to understand more about genetics, researchers have been able to explore growth, development, and aging in new ways. These are all very active fields of research, involving questions of metabolism, brain function, immunity, and the life stages of individual cells. While we can describe some of the changes that happen during different life stages, others are still not understood. The process of aging, in particular, is one that researchers are working at mightily, trying to get a clearer picture of.

Infancy

When a human baby is born, she has a lot of developing left to do before all body systems are in full working order. Even the moment of birth brings about a lot of changes. In the womb, the baby hasn't had to breathe for herself, so her lungs aren't inflated. That's why a baby's first breath is such an event—it's the first time she's filled them with air.

The baby has also been kept cozily at body temperature by her mother, and at birth, the baby has to start regulating her own body temperature. The first workings of the baby's immune system are in place and the baby has some of her mother's antibodies. These help to protect the baby from the new environment, which is full of pathogens.

Over the course of the first year, several of an infant's body systems change dramatically. A baby's skin, usually very thin at birth, develops a more robust thickness. Muscles that control the hands and face take shape, allowing the infant to grasp objects and make facial expressions. Over the year, the baby develops reflexes, an ability to roll over onto the belly, and then to sit up and crawl. Eyesight and hearing will mature, and the baby will begin to hear bits of language and try to mimic some sounds.

Toddler

The toddler stage is so named because this is when the child begins to "toddle," or learn to walk. Between the ages of 1 and 3, the child begins to grow strong enough to move without any help. The toddler starts to understand what others are saying and begins to communicate back. Toddlers start to recognize people and take actions that show personal will, like handing you a book if they want you to read to them. During this stage, children do a lot of physical exploration, picking things up and studying texture, shape, and color. By the time toddlers reach three years, they will display the full range of emotions, build towers out of blocks, digest all types of food, and be able to run.

Children at this age are also old enough to learn sphincter control—importantly, the bladder and anal sphincters. Toilet training is a particularly important stage for many parents as well as for their toddlers.

Childhood

Humans are unique among animal species in having a childhood that spans a decade. Researchers believe that human childhood is long because there is so much brain development that happens during this stage. Between the ages of 3 and 13, children will master their native language (and maybe another language as well, depending on their circumstances). They'll develop the facial motor skills to speak that language and the manual dexterity to write it. And they'll use that language to help understand and absorb culture. All humans participate in the culture that surrounds them, and our human childhood is likely as long as it is to allow for us to grow into our culture. Some researchers believe that aspects of our culture, such as foods, physical activities, and rituals can have an impact on our anatomy as we grow through childhood. Culture clearly has an impact on brain development. During childhood, children will learn to draw, but what they'll draw and how they'll imagine it will be shaped in part by their culture. By the time they reach the end of childhood, all their motor skills will have developed, their immune system will have tuned itself to their environment, and they will have matured emotionally so that they can make friends and take on responsibilities.

Adolescence

In a human body up to this point in life, all the body systems have been maturing except one: the reproductive system. Somewhere around 13 (give or take a few years), puberty sets in as the reproductive organs emerge from the state of suspended animation they've been in. In later adolescence, these hormonal changes combine with a whirlwind of brain development.

For girls, who often enter adolescence before boys do, puberty sets in when breasts begin to develop and body shape begins to change. Slowly, fat is redistributed to the breasts, thighs, and hips, filling out the typical female shape. Inside the body, ovulation begins, and the girl starts getting periods. When that happens, she is able to become pregnant. She'll also grow hair in her underarms and her pubic area, and the hair on her legs may also become thicker.

For boys, puberty means their testes get the signal to begin testosterone production. The penis and testicles will get larger, and the testes will start to produce sperm. The shape of a boy's body also changes during puberty. Muscles get stronger, and hair grows in the underarms, pubic area, and on the chest and face. The boy's vocal chords get longer, and his voice deepens. As with females, the male body begins to take shape, with broader shoulders and narrower hips.

For both sexes, adolescence brings with it lots of physical and emotional shifts. Skin changes produce acne, which in itself is enough to make many teenagers yearn for adulthood. As their bones and muscles lengthen, adolescents may go through growth spurts that make last month's clothes too small. More bone and muscle means more cells, which translates to more energy. Adolescents are famous for being able to stay up all night. And they're also famous for having unusual sleep schedules, affected by the cocktail of surging hormones.

As you've learned, the brain is also undergoing lots of changes, growing and pruning neurons, solidifying pathways of thought, and developing areas that control judgment, reasoning, and empathy. By the time individuals emerge from adolescence, they are remarkably different from a decade earlier, and they are no longer children.

Young adulthood

After adolescence, young adults go through a transition to young adulthood, which will last until they are 40 or 45. During this time, they are entering their healthiest and most stable physical period. Without lots of body changes to distract them, they mature in terms of their thought processes, exploring who they are and their role in the world. It's during young adulthood that many people think about getting married or having children. And this makes sense, because this stage is when both sexes are at their reproductive height.

It's also the stage where some body functions actually begin the slow decline that will continue through the rest of life. Young adults begin to produce slightly less bone than they lose and slightly fewer keratins in their skin. Metabolism stabilizes, and a young adult can't eat as much as an adolescent without gaining weight. And depending on genetics and environment, damage to the arteries can begin during these years.

The most dramatic physical changes of young adulthood take place in the brain, which is not yet on a downhill trajectory. Memory and learning are at their prime during this stage of life, and a person is able to think about things in a more complex way, incorporating abstractions, moral reasoning, and empathy broadly, and developing intuition.

Middle adulthood

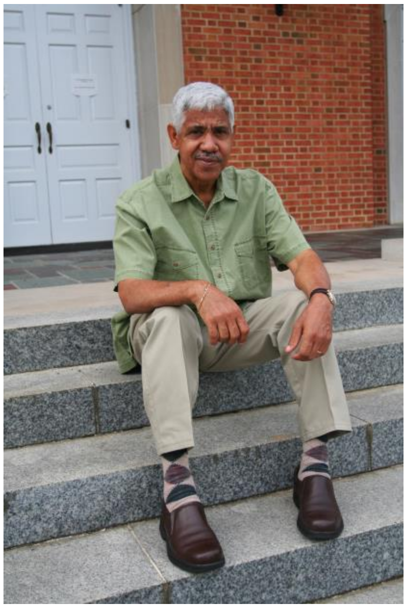
The common American experience of living through middle age is actually relatively new in human history (and still uncommon in some parts of the world). Since antibiotics and other feats of modern medicine, many more people live to middle age and beyond than did 100 years ago. Humans are the only animals known to live up to a third of their lifespan after their fertile years.

As adulthood moves forward, the 40s, 50s and 60s see a lot of physical processes slowing down but some important brain processes picking up. Damaged tissues aren't repaired as quickly, and replacement of lost cells slows down. Bones and muscles can lose mass, though the loss can be minimized by exercise and a healthy diet. Reproductive systems in both sexes also go into decline. Usually in the late 40s or early 50s, a woman enters menopause. Her periods may become irregular and she may have heavy bleeding or very little. The changing balance of hormones can cause hot flashes, mood swings, and night sweats. Eventually, the woman stops ovulating and menstruation ends altogether.

Men continue to produce sperm throughout their lives, but their fertility also declines. Around age 30, a man begins to produce less testosterone, and it continues to diminish each year. By around age 70, a man's testosterone production is about half of what it was at age 30. This phenomenon has been dubbed by some as "male menopause" or "andropause," and some describe it as similar to female menopause, with mood swings, fatigue, and diminished strength. Some men also lose some sexual function. Though they can still produce sperm, they may have trouble getting an erection. Their sperm are also less likely to be in tip-top shape. Recent studies have concluded that the sperm of older men has a higher chance of having genetic deviations that can result in autism, mental disorders, and Down syndrome. The sperm of older men might have a harder time reaching their targets, though, as it's more common for them to be weaker swimmers.

On the flip side, people's brains continue to develop through middle age. Scientists have only recently begun to see how the brain changes and matures during this time. Middle age seems to be the height of thinking that involves judgment and intuition, financial decisions, and following a train of logic. So while people in this stage of life may (or may not) be slower at figuring out a new cell phone, they're more adept at figuring out how to resolve a difficult problem with someone.

Old age



The brain continues to develop, as long as it's exercised, right up through old age. That offers some solace to people lucky enough to reach this stage and experience the less pleasant effects that age can bring to the rest of their organs. Bodies that have gone through decades of wear and tear feel the effects of prior damage and mistreatment most during their later years.

By the end of the 60s, a person's immune system isn't as effective. The most obvious consequence is that minor infections, like a cold, may last longer. More seriously, though, is the fact that immune cells become less efficient at finding and destroying cells gone awry, and thus cancer is more likely to develop. In addition, autoimmune disorders, such as arthritis, allergies, and skin conditions, can become more common.

All other systems are affected by age, too. Digestion slows down. The bladder shrinks. The capacity of the lungs and the heart may decrease. Bone and muscle mass are lost, skin becomes fragile. The list of changes could fill a medical dictionary. But these changes take place in a unique way for each person. Some people lose a lot of function of one body system, but others remain healthy. Some people lose the ability to digest certain foods, and others continue eating whatever they like. Many people who smoke or rarely exercise will find themselves facing circulatory problems that may be their undoing. Others, through the luck of genetics and the effort of taking care of themselves, may live well and healthily into old age.

Student Resource 20.14

Guide: Reproduction Expert Blog Post

Student Name:____ Date:__________

Directions: Fill in the charts to help you outline and craft your blog post.

Your blog post question:

Your task is to create a blog post that answers this question, being as informative and as accurate as possible. Writing a blog post lets you do much more than just write. You can link to videos, include images, link to and quote from other authors, and even respond to comments you get on your posts. Here are some good blog examples that you can browse for inspiration:

- http://www.huffingtonpost.com/teen/the-blog/
- http://www.rookiemag.com/
- http://www.thestranger.com/seattle/SavageLove?show=blog

Guidelines

Follow these guidelines when thinking about how to write and what you will say.

- Use proper anatomical language. If you want to use more common language, ask your teacher about what words are acceptable.
- You're free to include whatever media or links you'd like to (provided they are appropriate), but you must also include text that describes the anatomy and physiology behind the answer to the question.
- Text should be around 300 words, written as a direct response to the person who posed the question.
- If you quote someone from another source, whether it's another blog, web page, article, song, anything, you need to add quotation marks and add specific reference about where the quote is from. If you're quoting from something online, it's best to also add a link.
- Encourage readers to add their thoughts in the comments after the blog post. You could even leave them with a question to get their thoughts about or experiences with the topic.

Content guide

Use this guide to help you organize content and sources for your blog post. You might use some sources only for information and others you might link to. Refer to the example below.

Source:

Type of media	**Link to my post?**
Online article	*no*
What I learned *Gonorrhea is adept at developing resistance to different antibiotics. In the 1990s and 2000s, the bacterium has developed resistance to several antibiotics. The CDC considers it a potential public health threat.*	
Citation *Example: Dan Savage. "We're Running Out of Drugs to Treat Gonorrhea." Savage Love Blog, http://slog.thestranger.com/slog/archives/2014/03/17/we-are-running-out-of-drugs-to-treat-gonorrhea (accessed Apr. 10, 2014).*	

Source #1	
Type of media	**Link to in my post?**
What I learned	
Citation	

Source #2

Type of media	**Link to in my post?**
What I learned	
Citation	

Source #3	
Type of media	**Link to in my post?**
What I learned	
Citation	

Source #4	
Type of media	**Link to in my post?**
What I learned	
Citation	

Source #5	
Type of media	**Link to in my post?**
What I learned	
Citation	

Assessment criteria

Make sure your assignment meets or exceeds the following assessment criteria:

- The blog post provides a clear and accurate response to the question.
- The blog post includes relevant aspects of the anatomy and physiology of the reproductive system in its response.
- The blog post is interesting and appropriate for a teen readership.
- The article includes information on how to prevent, manage, or cure the disease or condition.
- The article concludes with a list of three to five properly formatted references.
- The blog post is neat and uses proper spelling and grammar.

Student Resource 20.15

Peer Review Chart: Reproduction Expert Blog Post

Student Name:____ Date:___________

Directions: You and a partner will review each others' blog post. Put your name at the top of this sheet and then exchange resources with your partner. On your partner's resource, fill in your name as reviewer and each section of the chart. Return the resource to your partner when you're done.

Name of reviewer:

Three things that are done well in the writing of this blog post:

1)

2)

3)

Two suggestions I have about this blog post to improve it are:

1)

2)

The questions I have about this blog post are: