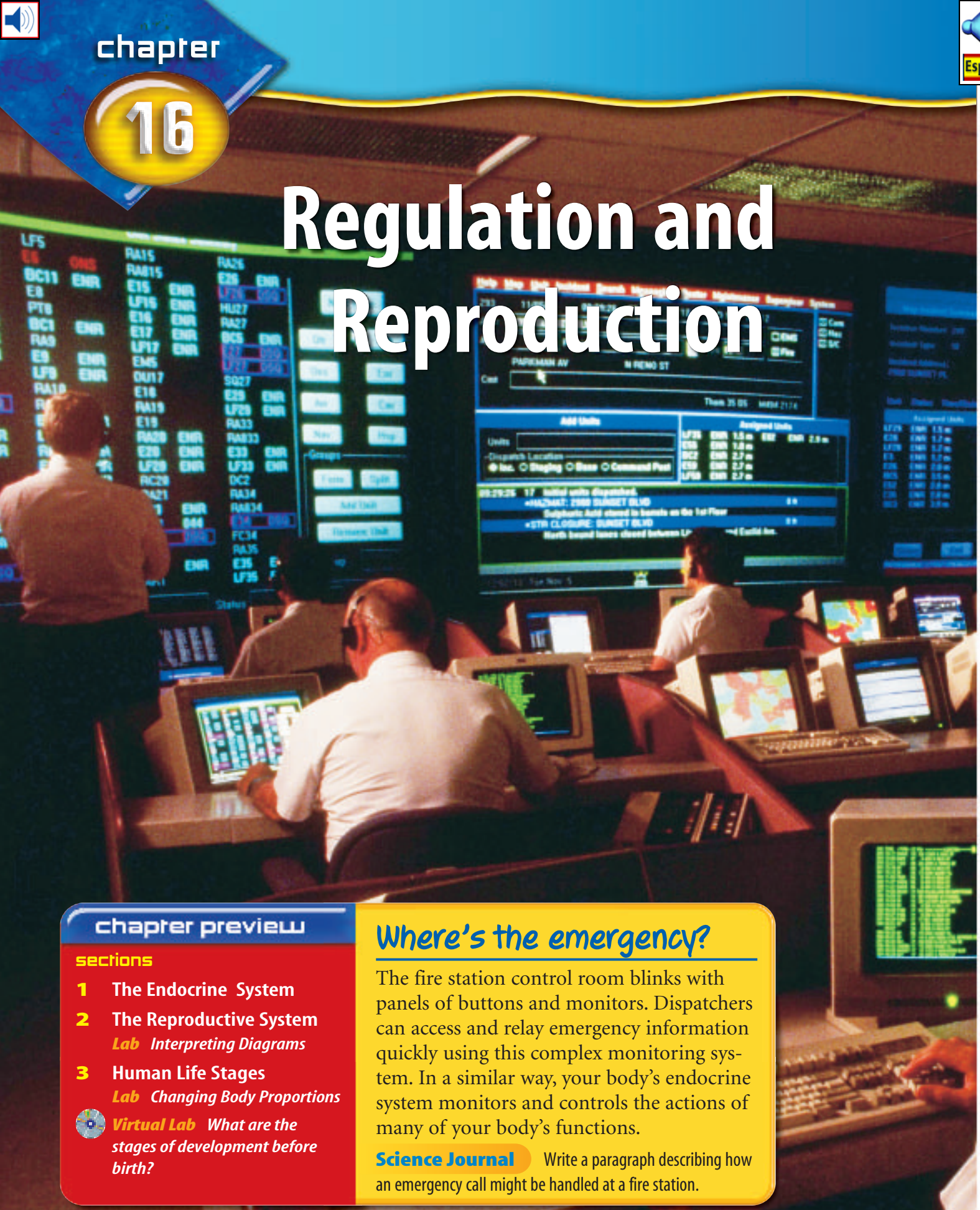
chapter 16

Regulation and Reproduction



chapter preview

sections

Where's the emergency?

The fire station control room blinks with panels of buttons and monitors. Dispatchers can access and relay emergency information quickly using this complex monitoring system. In a similar way, your body's endocrine system monitors and controls the actions of many of your body's functions.

Science Journal Write a paragraph describing how an emergency call might be handled at a fire station.

Lawerence Manning/CORBIS

CONTENTS

Start-Up Activities

Launch Lab

Model a Chemical Message

Your body has systems that work together to coordinate your body's activities. One of these systems sends chemical messages through your blood to certain tissues, which, in turn, respond. Do the lab below to see how a chemical signal can be sent.

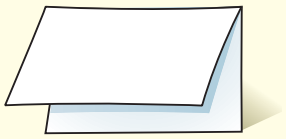
1. Cut a 10-cm-tall *Y* shape from filter paper and place it on a plastic, ceramic, or glass plate.
2. Sprinkle baking soda on one arm of the *Y* and salt on the other arm.
3. Using a dropper, place five or six drops of vinegar halfway up the leg of the *Y*.
4. **Think Critically** Describe in your Science Journal how the chemical moves along the paper and the reaction(s) it causes.

ScienceOnline
Preview this chapter's content and activities at green.msscience.com

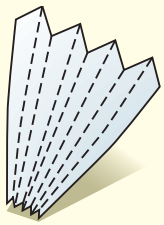
Foldables Study Organizer

Stages of Life Make the following Foldable to help you predict the stages of life.

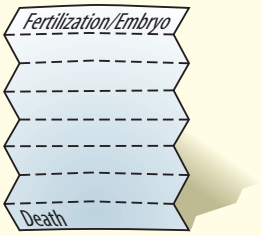
STEP 1 **Fold** a vertical sheet of paper in half from top to bottom. Then fold it in half again top to bottom two more times. Unfold all the folds.



STEP 2 **Refold** the paper into a fan, using the folds as a guide. Unfold all the folds again.



STEP 3 **Label** as shown.



Read and Write Before you read the chapter, list as many stages of life as you can on your Foldable. Add to your list as you read the chapter.

section 1

The Endocrine System

David Young-Wolff/PhotoEdit, Inc.

as you read

What You'll Learn

- **Define** how hormones function.
- **Identify** different endocrine glands and the effects of the hormones they produce.
- **Describe** how a feedback system works in your body.

Why It's Important

The endocrine system uses chemicals to control many systems in your body.

Review Vocabulary

tissue: groups of cells that work together to perform a specific function

New Vocabulary

- hormone

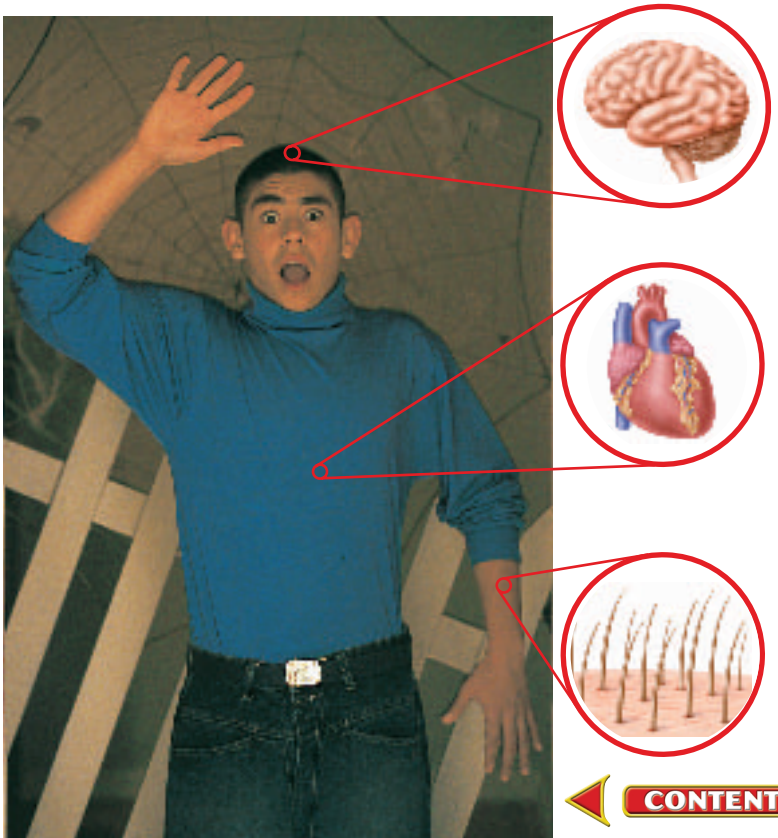
Functions of the Endocrine System

You go through the dark hallways of a haunted house. You can't see a thing. Your heart is pounding. Suddenly, a monster steps out in front of you. You scream and jump backwards. Your body is prepared to defend itself or get away. Preparing the body for fight or flight in times of emergency, as shown in **Figure 1,** is one of the functions of the body's control systems.

Control Systems All of your body's systems work together, but the endocrine (EN duh krun) and the nervous systems are your body's control systems. The endocrine system sends chemical messages in your blood that affect specific tissues called target tissues. The nervous system sends rapid impulses to and from your brain, then throughout your body. Your body does not respond as quickly to chemical messages as it does to impulses.

Endocrine Glands

Tissues found throughout your body called endocrine glands produce the chemical messages called **hormones** (HOR mohnz). Hormones can speed up or slow down certain cellular processes. Some glands in your body release their products through small tubes called ducts. Endocrine glands are ductless and each endocrine gland releases its hormone directly into the blood. Then, the blood transports the hormone to the target tissue. A target tissue usually is located in the body far from the location of the endocrine gland that produced the hormone to which it responds.



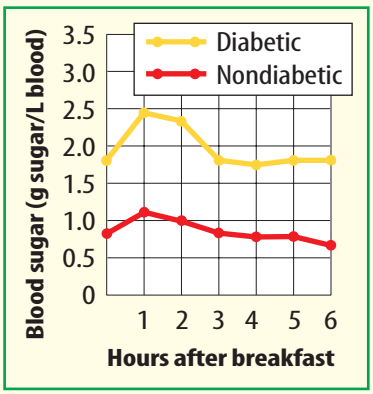
Reading Check *What is the function of hormones?*

Figure 1 Your endocrine system enables many parts of your body to respond immediately in a fearful situation.

Gland Functions Endocrine glands have many functions in the body. The functions include the regulation of its internal environment, adaptation to stressful situations, promotion of growth and development, and the coordination of circulation, digestion, and the absorption of food. **Figure 2** on the next two pages shows some of the body's endocrine glands.

Applying Math — Use Percentages

GLUCOSE LEVELS Calculate how much higher the blood sugar (glucose) level of a diabetic is before breakfast when compared to a nondiabetic before breakfast. Express this number as a percentage of the nondiabetic sugar level before breakfast.



Solution

1 *This is what you know:*

- nondiabetic blood sugar at 0 h = 0.85 g sugar/L blood
- diabetic blood sugar at 0 h = 1.8 g sugar/L blood

2 *This is what you need to find out:*

How much higher is the glucose level of a diabetic person than that of a nondiabetic person before breakfast?

3 *This is the procedure you need to use:*

- Find the difference in glucose levels:
  1.8 g/L − 0.85 g/L = 0.95 g/L
- Use this equation:

$$\frac{\text{difference between values}}{\text{nondiabetic value}} \times 100\% = \text{percent difference}$$

- Substitute in the known values:

$$\frac{0.95}{0.85} \times 100\% = 112\%$$

- Before breakfast, a diabetic's blood sugar is about 112 percent higher than that of a nondiabetic.

4 *Check your answer:*

Change 112% to a decimal then multiply it by 0.85. You should get 0.95.

Practice Problems

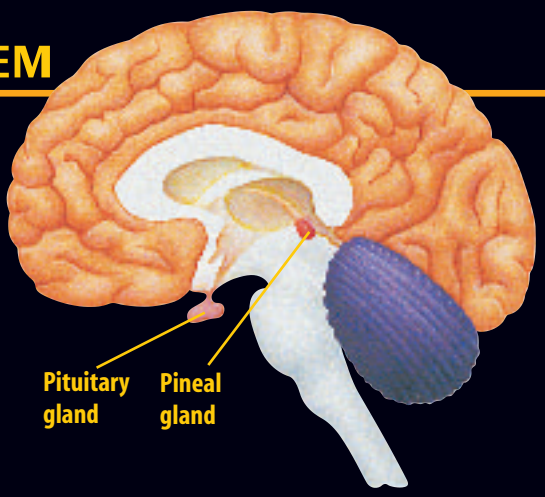
1. Express as a percentage how much higher the blood sugar value is for a diabetic person compared to a nondiabetic person 1 h after breakfast.
2. Express as a percentage how much higher the blood sugar value is for a diabetic person compared to a nondiabetic person 3 h and 6 h after breakfast.

NATIONAL GEOGRAPHIC

VISUALIZING THE ENDOCRINE SYSTEM

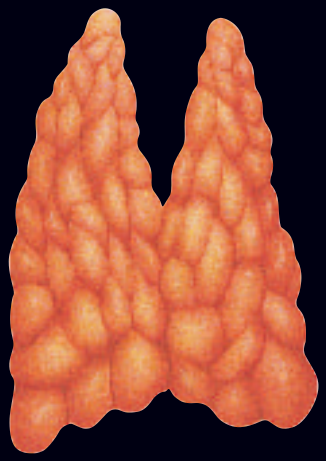
Figure 2

Your endocrine system is involved in regulating and coordinating many body functions, from growth and development to reproduction. This complex system consists of many diverse glands and organs, including the nine shown here. Endocrine glands produce chemical messenger molecules, called hormones, that circulate in the bloodstream. Hormones exert their influence only on the specific target cells to which they bind.

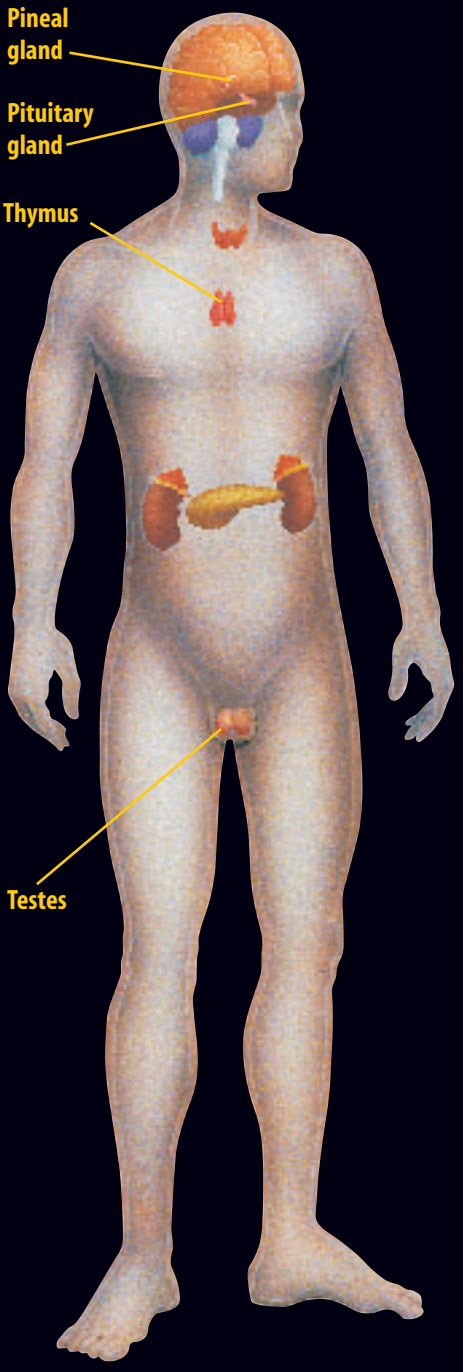


PINEAL GLAND Shaped like a tiny pinecone, the pineal gland lies deep in the brain. It produces melatonin, a hormone that may function as a sort of body clock by regulating wake/sleep patterns.

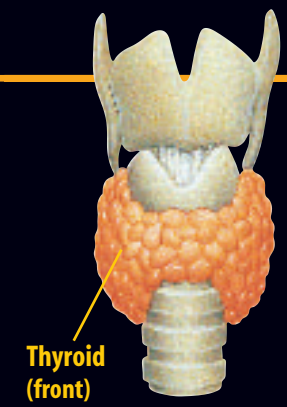
PITUITARY GLAND A pea-size structure attached to the hypothalamus of the brain, the pituitary gland produces hormones that affect a wide range of body activities, from growth to reproduction.



THYMUS The thymus is located in the upper chest, just behind the sternum. Hormones produced by this organ stimulate the production of certain infection-fighting cells.

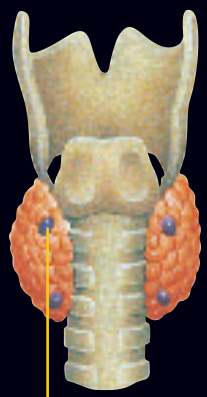


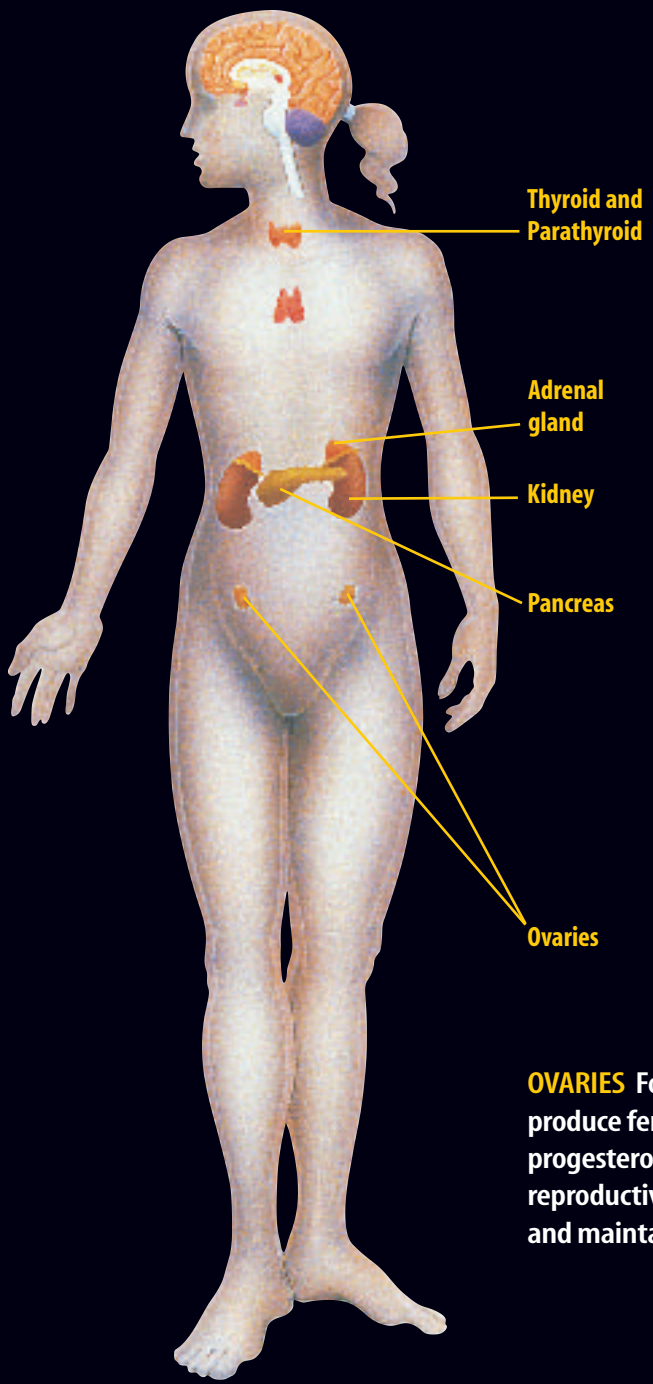
TESTES These paired male reproductive organs primarily produce testosterone, a hormone that controls the development and maintenance of male sexual traits. Testosterone also plays an important role in the production of sperm.

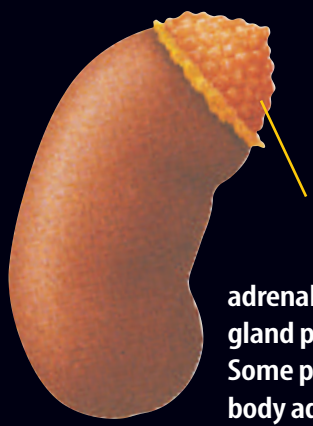


THYROID GLAND Located below the larynx, the bi-lobed thyroid gland is richly supplied with blood vessels. It produces hormones that regulate metabolic rate, control the uptake of calcium by bones, and promote normal nervous system development.

PARATHYROID GLANDS Attached to the back surface of the thyroid are tiny parathyroids, which help regulate calcium levels in the body. Calcium is important for bone growth and maintenance, as well as for muscle contraction and nerve impulse transmission.







ADRENAL GLANDS On top of each of your kidneys is an adrenal gland. This complex endocrine gland produces a variety of hormones. Some play a critical role in helping your body adapt to physical and emotional stress. Others help stabilize blood sugar levels.

PANCREAS Scattered throughout the pancreas are millions of tiny clusters of endocrine tissue called the islets of Langerhans. Cells that make up the islets produce hormones that help control sugar levels in the bloodstream.

OVARIES Found deep in the pelvic cavity, ovaries produce female sex hormones known as estrogen and progesterone. These hormones regulate the female reproductive cycle and are responsible for producing and maintaining female sex characteristics.

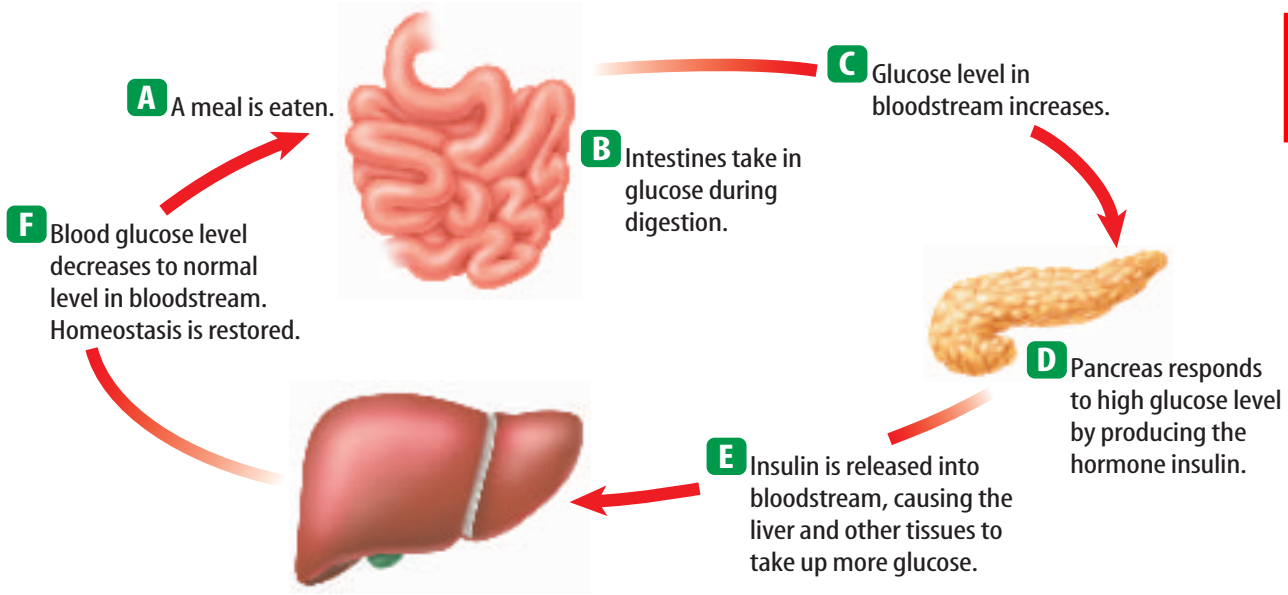


Figure 3 Many internal body conditions, such as hormone level, blood sugar level, and body temperature, are controlled by negative-feedback systems.

A Negative-Feedback System

To control the amount of hormones that are in your body, the endocrine system sends chemical messages back and forth within itself. This is called a negative-feedback system. It works much the way a thermostat works. When the temperature in a room drops below a set level, the thermostat signals the furnace to turn on. Once the furnace has raised the temperature in the room to the set level, the thermostat signals the furnace to shut off. It will continue to stay off until the thermostat signals that the temperature has dropped again. **Figure 3** shows how a negative-feedback system controls the level of glucose in your bloodstream.

section 1 review

Summary

Functions of the Endocrine System

- The nervous system and the endocrine system are the control systems of your body.
- The endocrine system uses hormones to deliver messages to the body.

Endocrine Glands

- Endocrine glands release hormones directly into the bloodstream.

A Negative-Feedback System

- The endocrine system uses a negative-feedback system to control the amount of hormones in your body.

Self Check

1. **Explain** the function of hormones.
2. **Choose** one endocrine gland. How does it work?
3. **Describe** a negative-feedback system.
4. **Think Critically** Glucose is required for cellular respiration, the process that releases energy within cells. How would a lack of insulin affect this process?

Applying Skills

5. **Predict** why the circulatory system is a good mechanism for delivering hormones throughout the body.
6. **Research** recent treatments for growth disorders involving the pituitary gland. Write a brief paragraph of your results in your Science Journal.

section 2

The Reproductive System

Reproduction and the Endocrine System

Reproduction is the process that continues life on Earth. Most human body systems, such as the digestive system and the nervous system, are the same in males and females, but this is not true for the reproductive system. Males and females each have structures specialized for their roles in reproduction. Although structurally different, both the male and female reproductive systems are adapted to allow for a series of events that can lead to the birth of a baby.

Hormones are the key to how the human reproductive system functions, as shown in **Figure 4.** Sex hormones are necessary for the development of sexual characteristics, such as breast development in females and facial hair growth in males. Hormones from the pituitary gland also begin the production of eggs in females and sperm in males. Eggs and sperm transfer hereditary information from one generation to the next.

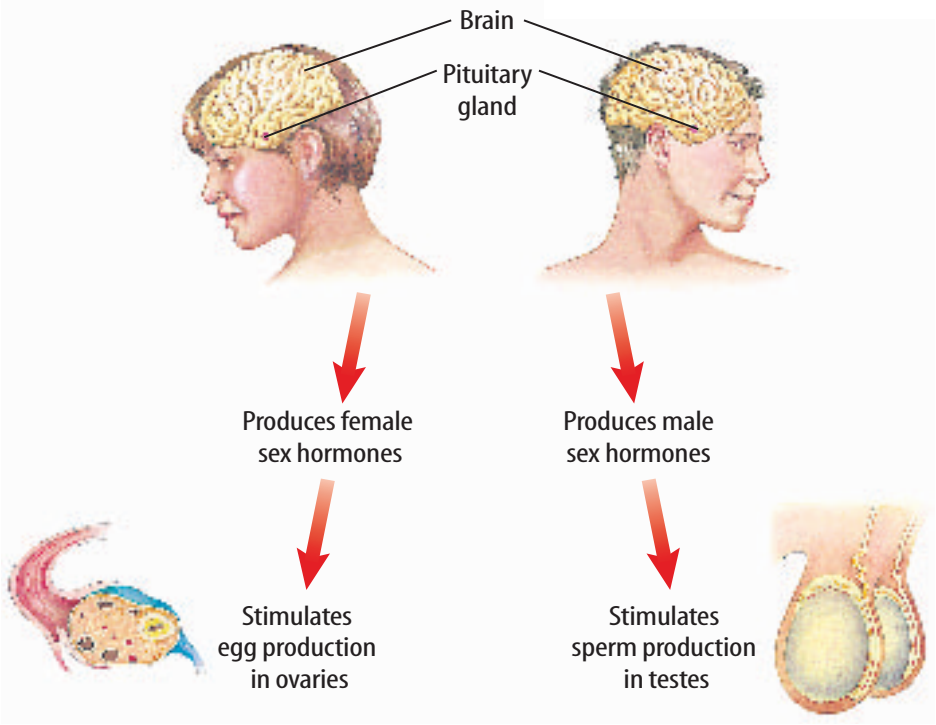


Figure 4 The pituitary gland produces hormones that control the male and female reproductive systems.

as you read

What You'll Learn

- **Identify** the function of the reproductive system.
- **Compare and contrast** the major structures of the male and female reproductive systems.
- **Sequence** the stages of the menstrual cycle.

Why It's Important

Human reproductive systems help ensure that human life continues on Earth.

Review Vocabulary

cilia: short, hairlike structures that extend from a cell

New Vocabulary

- testes
- sperm
- semen
- ovary
- ovulation
- uterus
- vagina
- menstrual cycle
- menstruation

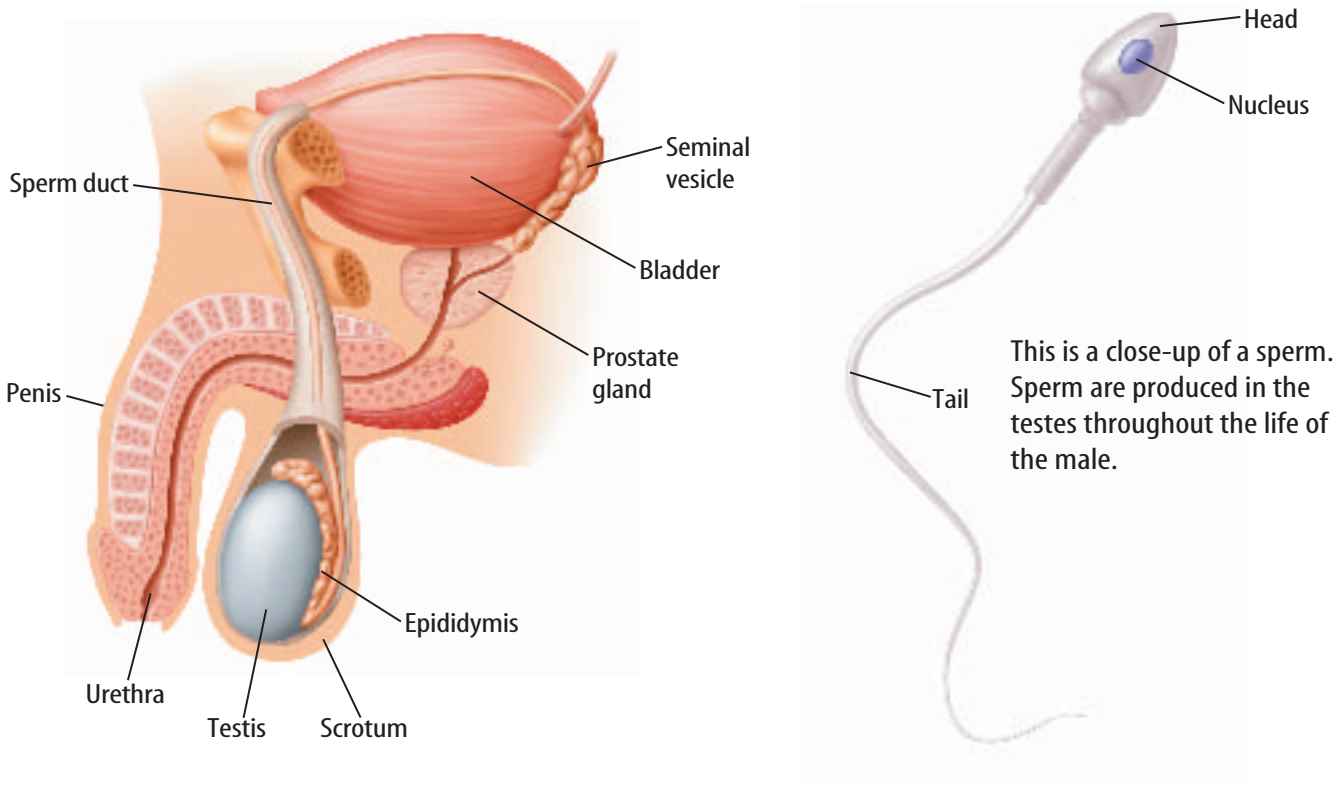


Figure 5 The structures of the male reproductive system are shown from the side of the body.

The Male Reproductive System

The male reproductive system is made up of external and internal organs. The external organs of the male reproductive system are the penis and scrotum, shown in **Figure 5.** The scrotum contains two organs called testes (TES teez). As males mature sexually, the **testes** begin to produce testosterone, the male hormone, and **sperm,** which are male reproductive cells.

Sperm Each sperm cell has a head and tail. The head contains hereditary information, and the tail moves the sperm. Because the scrotum is located outside the body cavity, the testes, where sperm are produced, are kept at a lower temperature than the rest of the body. Sperm are produced in greater numbers at lower temperatures.

Many organs help in the production, transportation, and storage of sperm. After sperm are produced, they travel from the testes through sperm ducts that circle the bladder. Behind the bladder, a gland called the seminal vesicle provides sperm with a fluid. This fluid supplies the sperm with an energy source and helps them move. This mixture of sperm and fluid is called **semen** (SEE mun). Semen leaves the body through the urethra, which is the same tube that carries urine from the body. However, semen and urine never mix. A muscle at the back of the bladder contracts to prevent urine from entering the urethra as sperm leave the body.

The Female Reproductive System

Unlike male reproductive organs, most of the reproductive organs of the female are inside the body. The **ovaries**—the female sex organs—are located in the lower part of the body cavity. Each of the two ovaries is about the size and shape of an almond. **Figure 6** shows the different organs of the female reproductive system.

The Egg When a female is born, she already has all of the cells in her ovaries that eventually will develop into eggs—the female reproductive cells. At puberty, eggs start to develop in her ovaries because of specific sex hormones.

About once a month, an egg is released from an ovary in a hormone-controlled process called **ovulation** (ahv yuh LAY shun). The two ovaries release eggs on alternating months. One month, an egg is released from an ovary. The next month, the other ovary releases an egg, and so on. After the egg is released, it enters the oviduct. If a sperm fertilizes the egg, it usually happens in an oviduct. Short, hairlike structures called cilia help sweep the egg through the oviduct toward the uterus (YEW tuh rus).

Reading Check *When are eggs released by the ovaries?*

The **uterus** is a hollow, pear-shaped, muscular organ with thick walls in which a fertilized egg develops. The lower end of the uterus, the cervix, narrows and is connected to the outside of the body by a muscular tube called the **vagina** (vuh JI nuh). The vagina also is called the birth canal because during birth, a baby travels through this tube from the uterus to the outside of the mother's body.

Science Online

Topic: Ovarian Cysts

Visit green.msscience.com for Web links to information about ovarian cysts.

Activity Make a small pamphlet explaining what cysts are and how they can be treated.

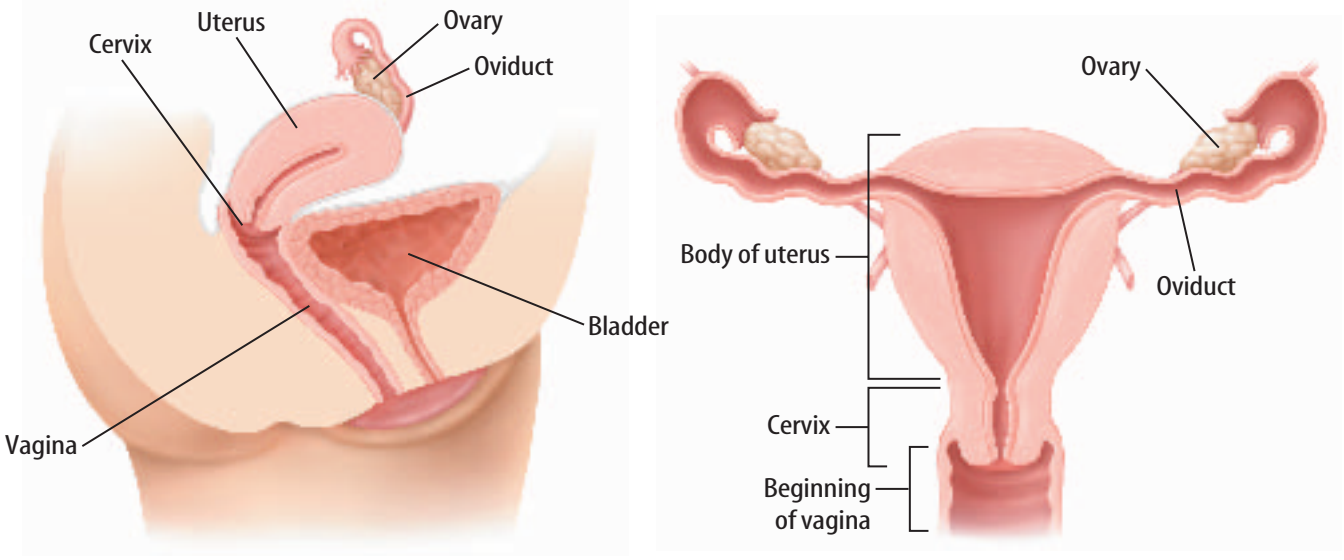


Figure 6 The structures of the female reproductive system are internal.
Name *where eggs develop in the female reproductive system.*

Mini LAB

Graphing Hormone Levels

Procedure

Make a line graph of this table.

Hormone Changes

Day	Level of Hormone
1	12
5	14
9	15
13	70
17	13
21	12
25	8

Analysis

1. On what day is the highest level of hormone present?
2. What event takes place around the time of the highest hormone level?

The Menstrual Cycle

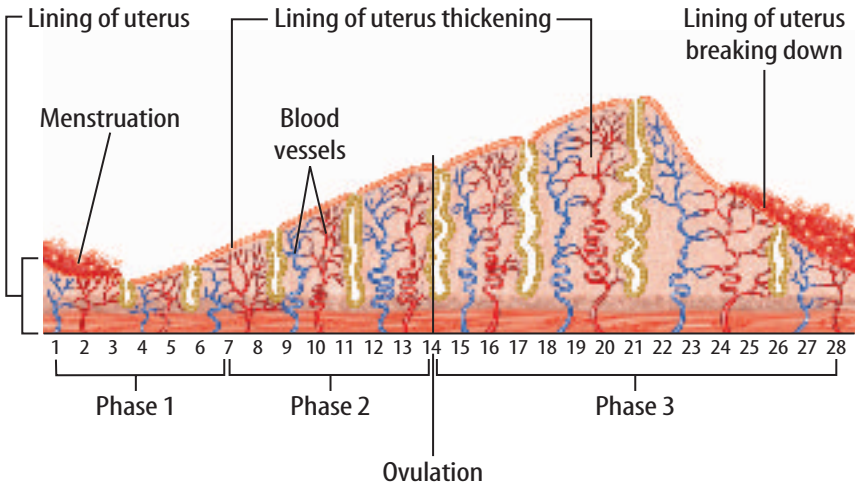
How is the female body prepared for having a baby? The **menstrual cycle** is the monthly cycle of changes in the female reproductive system. Before and after an egg is released from an ovary, the uterus undergoes changes. The menstrual cycle of a human female averages 28 days. However, the cycle can vary in some individuals from 20 to 40 days. Changes include the maturing of an egg, the production of female sex hormones, the preparation of the uterus to receive a fertilized egg, and menstrual flow.

Reading Check *What is the menstrual cycle?*

Endocrine Control Hormones control the entire menstrual cycle. The pituitary gland responds to chemical messages from the hypothalamus by releasing several hormones. These hormones start the development of eggs in the ovary. They also start the production of other hormones in the ovary, including estrogen (ES truh jun) and progesterone (proh JES tuh rohn). The interaction of all these hormones results in the physical processes of the menstrual cycle.

Phase One As shown in **Figure 7,** the first day of phase 1 starts when menstrual flow begins. Menstrual flow consists of blood and tissue cells released from the thickened lining of the uterus. This flow usually continues for four to six days and is called **menstruation** (men STRAY shun).

Figure 7 The three phases of the menstrual cycle make up the monthly changes in the female reproductive system.
Explain *why the uterine lining thickens.*



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Phase Two Hormones cause the lining of the uterus to thicken in phase 2. Hormones also control the development of an egg in the ovary. Ovulation occurs about 14 days before menstruation begins. Once the egg is released, it must be fertilized within 24 h or it usually begins to break down. Because sperm can survive in a female's body for up to three days, fertilization can occur soon after ovulation.

Phase Three Hormones produced by the ovaries continue to cause an increase in the thickness of the uterine lining during phase 3. If a fertilized egg does arrive, the uterus is ready to support and nourish the developing embryo. If the egg is not fertilized, the lining of the uterus breaks down as the hormone levels decrease. Menstruation begins and the cycle repeats itself.

Menopause For most females, the first menstrual period happens between ages nine years and 13 years and continues until 45 years of age to 60 years of age. Then, a gradual reduction of menstruation takes place as hormone production by the ovaries begins to shut down. Menopause occurs when both ovulation and menstrual periods end. It can take several years for the completion of menopause. As **Figure 8** indicates, menopause does not inhibit a woman's ability to enjoy an active life.

Figure 8 This older woman enjoys exercising with her granddaughter.

section 2 review

Summary

Reproduction and the Endocrine System

- Reproduction is the process that continues life.
- The human reproductive system needs hormones to function.

The Male Reproductive System

- Sperm are produced in the testes and leave the male through the penis.

The Female Reproductive System

- Eggs are produced in the ovaries and, if fertilized, can develop in the uterus.

The Menstrual Cycle

- A female's menstrual cycle occurs approximately every 28 days.
- If an egg is not fertilized, the lining of the uterus breaks down and is shed in a process called menstruation.

Self Check

1. **Identify** the major function of male and female reproductive systems in humans.
2. **Explain** the movement of sperm through the male reproductive system.
3. **Compare and contrast** the major organs and structures of the male and female reproductive systems.
4. **Sequence** the stages of the menstrual cycle in a human female using diagrams and captions.
5. **Think Critically** Adolescent females often require additional amounts of iron in their diet. Explain.

Applying Math

6. **Order of Operations** Usually, one egg is released each month during a female's reproductive years. If menstruation begins at 12 years of age and ends at 50 years of age, calculate the number of eggs her body can release during her reproductive years.

LAB

Interpreting Diagrams

Starting in adolescence, hormones cause the development of eggs in the ovary and changes in the uterus. These changes prepare the uterus to accept a fertilized egg that can attach itself in the wall of the uterus. What happens to an unfertilized egg?

Real-World Question

What changes occur to the uterus during a female's monthly menstrual cycle?

Goals

- **Observe** the stages of the menstrual cycle in the diagram.
- **Relate** the process of ovulation to the cycle.

Materials

paper pencil

Procedure

1. The diagrams below illustrate the menstrual cycle.
2. Copy and complete the data table using information in this chapter and diagrams below.
3. On approximately what day in a 28-day cycle is the egg released from the ovary?

Menstruation Cycle

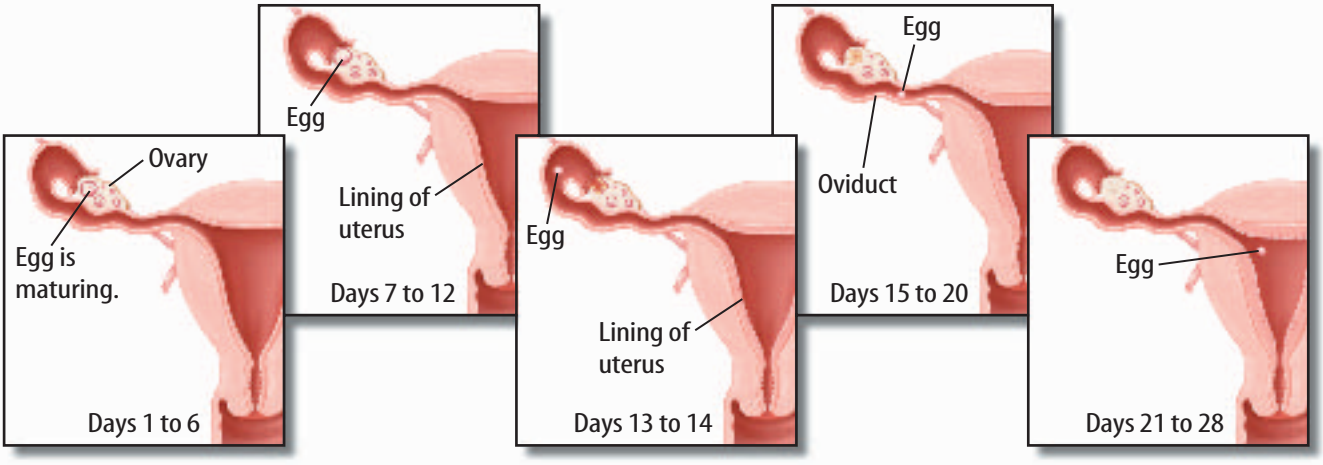
Days	Condition of Uterus	What Happens
1–6		
7–12		
13–14		
15–18		

Conclude and Apply

1. **Infer** how many days the average menstrual cycle lasts.
2. **State** on what days the lining of the uterus builds up.
3. **Infer** why this process is called a cycle.
4. **Calculate** how many days before menstruation ovulation usually occurs.

Communicating Your Data

Compare your data table with those of other students in your class. **For more help, refer to the Science Skill Handbook.**



section 3

Human Life Stages

The Function of the Reproductive System

Before the invention of powerful microscopes, some people imagined an egg or a sperm to be a tiny person that grew inside a female. In the latter part of the 1700s, experiments using amphibians showed that contact between an egg and sperm is necessary for the development of life. With the development of the cell theory in the 1800s, scientists recognized that a human develops from an egg that has been fertilized by a sperm. The uniting of a sperm and an egg is known as fertilization. Fertilization, as shown in **Figure 9,** usually takes place in the oviduct.

Fertilization

INTEGRATE Chemistry

Although 200 million to 300 million sperm can be deposited in the vagina, only several thousand reach an egg in the oviduct. As they enter the female, the sperm come into contact with chemical secretions in the vagina. It appears that this contact causes a change in the membrane of the sperm. The sperm then become capable of fertilizing the egg. The one sperm that makes successful contact with the egg releases an enzyme from the saclike structure on its head. Enzymes help speed up chemical reactions that have a direct effect on the protective membranes on the egg's surface. The structure of the egg's membrane is disrupted, and the sperm head can enter the egg.

Zygote Formation Once a sperm has entered the egg, changes in the electric charge of the egg's membrane prevent other sperm from entering the egg. At this point, the nucleus of the successful sperm joins with the nucleus of the egg. This joining of nuclei creates a fertilized cell called the zygote. It begins to undergo many cell divisions.

as you read

What You'll Learn

- **Describe** the fertilization of a human egg.
- **List** the major events in the development of an embryo and fetus.
- **Describe** the developmental stages of infancy, childhood, adolescence, and adulthood.

Why It's Important

Fertilization begins the entire process of human growth and development.

Review Vocabulary

nutrient: substance in food that provides energy and materials for cell development, growth, and repair

New Vocabulary

- pregnancy
- embryo
- amniotic sac
- fetus
- fetal stress

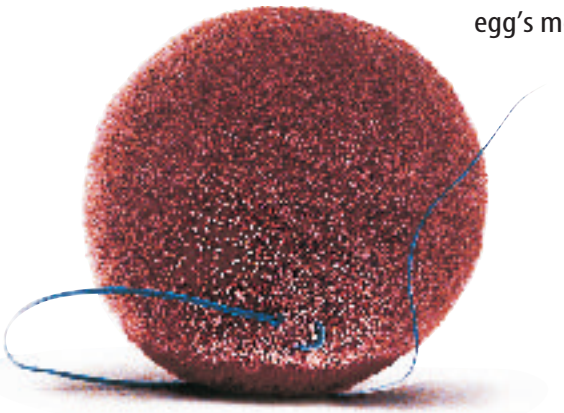


Figure 9 After the sperm releases enzymes that disrupt the egg's membrane, it penetrates the egg.

Color-enhanced SEM Magnification: 340×

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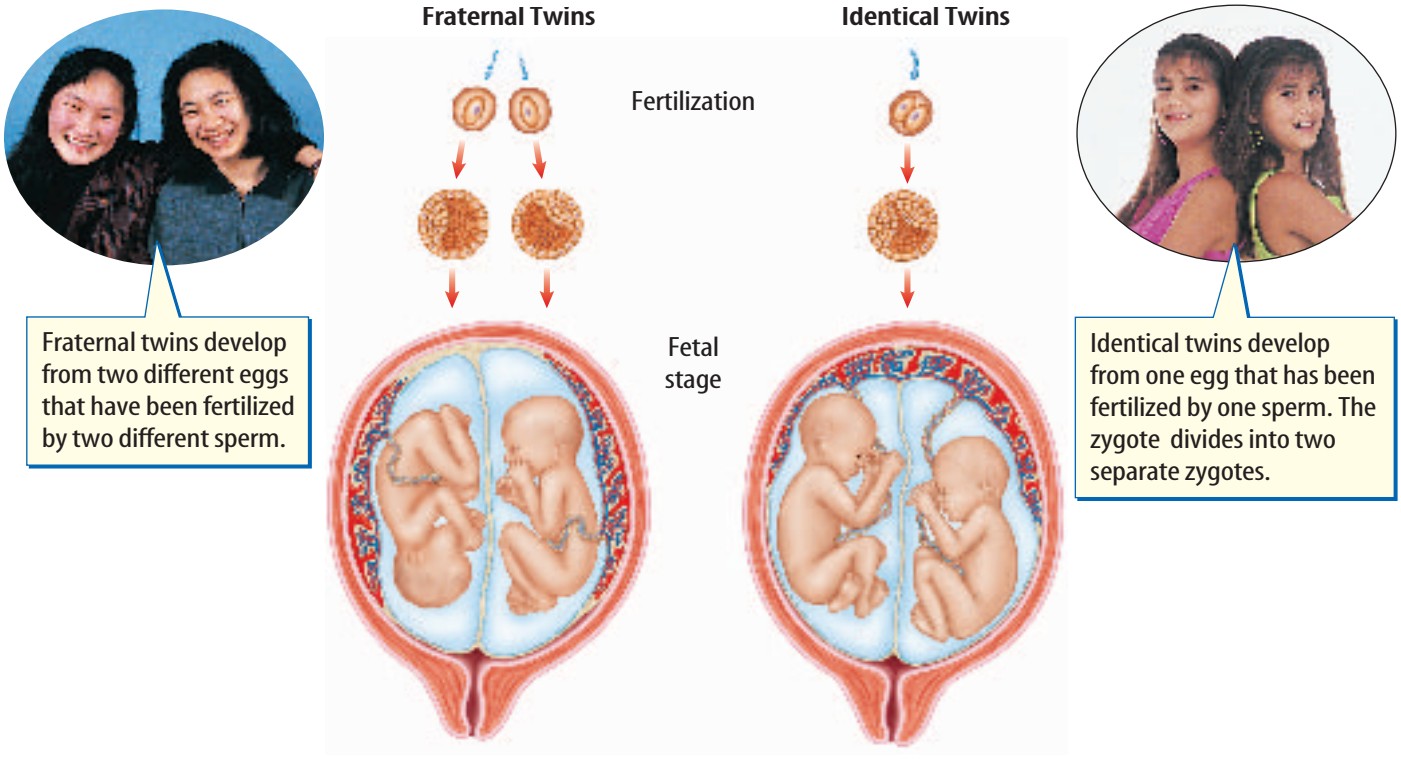
Figure 10 The development of fraternal and identical twins is different.



INTEGRATE Career

Midwives Some women choose to deliver their babies at home rather than at a hospital. An at-home birth can be attended by a certified nurse-midwife. Research to find the educational and skill requirements of a nurse-midwife.

Multiple Births

Sometimes two eggs leave the ovary at the same time. If both eggs are fertilized and both develop, fraternal twins are born. Fraternal twins, as shown in **Figure 10,** can be two girls, two boys, or a boy and a girl. Because fraternal twins come from two eggs, they only resemble each other.

Because identical twin zygotes develop from the same egg and sperm, as explained in **Figure 10,** they have the same hereditary information. These identical zygotes develop into identical twins, which are either two girls or two boys. Multiple births also can occur when three or more eggs are produced at one time or when the zygote separates into three or more parts.

Development Before Birth

After fertilization, the zygote moves along the oviduct to the uterus. During this time, the zygote is dividing and forming into a ball of cells. After about seven days, the zygote attaches to the wall of the uterus, which has been thickening in preparation to receive a zygote, as shown in **Figure 11.** If attached to the wall of the uterus, the zygote will develop into a baby in about nine months. This period of development from fertilized egg to birth is known as **pregnancy.**

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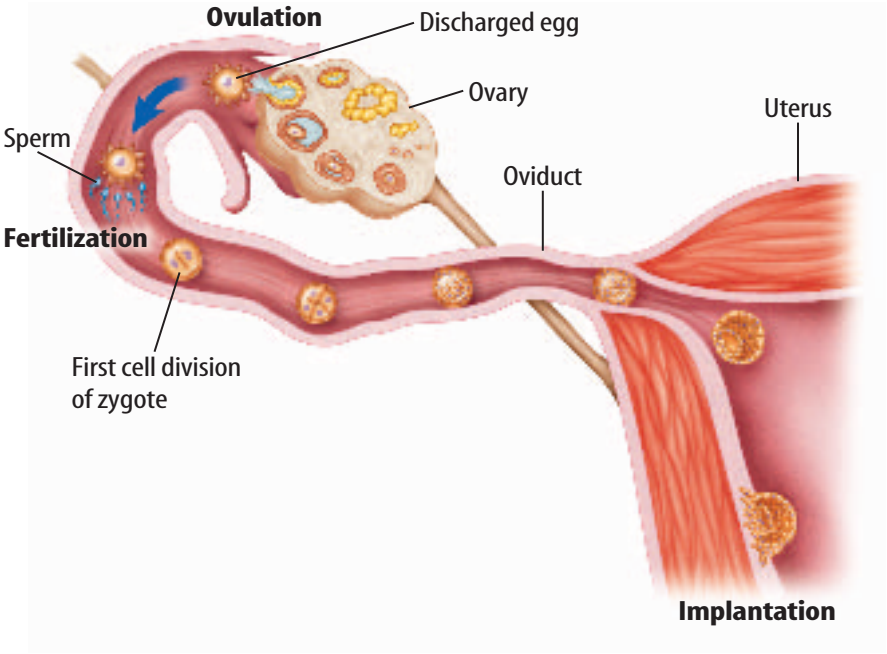

Figure 11 After a few days of rapid cell division, the zygote, now a ball of cells, reaches the lining of the uterus, where it attaches itself to the lining for development.

The Embryo After the zygote attaches to the wall of the uterus, it is known as an **embryo,** illustrated in **Figure 12.** It receives nutrients from fluids in the uterus until the placenta (plu SEN tuh) develops from tissues of the uterus and the embryo. An umbilical cord develops that connects the embryo to the placenta. In the placenta, materials diffuse between the mother's blood and the embryo's blood, but their bloods do not mix. Blood vessels in the umbilical cord carry nutrients and oxygen from the mother's blood through the placenta to the embryo. Other substances in the mother's blood can move into the embryo, including drugs, toxins, and disease organisms. Wastes from the embryo are carried in other blood vessels in the umbilical cord through the placenta to the mother's blood.

Reading Check ***Why must a pregnant woman avoid alcohol, tobacco, and harmful drugs?***

Figure 12 By two months, the developing embryo is about 2.5 cm long and is beginning to develop recognizable features.

Pregnancy in humans lasts about 38 to 39 weeks. During the third week, a thin membrane called the **amniotic** (am nee AH tihk) **sac** begins to form around the embryo. The amniotic sac is filled with a clear liquid called amniotic fluid, which acts as a cushion for the embryo and stores nutrients and wastes.

During the first two months of development, the embryo's major organs form and the heart structure begins to beat. At five weeks, the embryo has a head with eyes, nose, and mouth features. During the sixth and seventh weeks, fingers and toes develop.

Figure 13 A fetus at about 16 weeks is approximately 15 cm long and weighs 140 g. **Describe** *the changes that take place in a fetus by the end of the seventh month.*

The Fetus After the first two months of pregnancy, the developing embryo is called a **fetus,** shown in **Figure 13.** At this time, body organs are present. Around the third month, the fetus is 8 cm to 9 cm long. The mother may feel the fetus move. The fetus can even suck its thumb. By the fourth month, an ultrasound test can determine the sex of the fetus. The fetus is 30 cm to 38 cm in length by the end of the seventh month of pregnancy. Fatty tissue builds up under the skin, and the fetus looks less wrinkled. By the ninth month, the fetus usually has shifted to a head-down position within the uterus, a position beneficial for delivery. The head usually is in contact with the opening of the uterus to the vagina. The fetus is about 50 cm in length and weighs from 2.5 kg to 3.5 kg.

The Birthing Process

The process of childbirth, as shown in **Figure 14,** begins with labor, the muscular contractions of the uterus. As the contractions increase in strength and number, the amniotic sac usually breaks and releases its fluid. Over a period of hours, the contractions cause the opening of the uterus to widen. More powerful and more frequent contractions push the baby out through the vagina into its new environment.

Delivery Often a mother is given assistance by a doctor during the delivery of the baby. As the baby emerges from the birth canal, a check is made to determine if the umbilical cord is wrapped around the baby's neck or any body part. When the head is free, any fluid in the baby's nose and mouth is removed by suction. After the head and shoulders appear, contractions force the baby out completely. Up to an hour after delivery, contractions occur that push the placenta out of the mother's body.

Mini LAB

Interpreting Fetal Development

Procedure

Make a bar graph of the following data.

Fetal Development

End of Month	Length (cm)
3	8
4	15
5	25
6	30
7	35
8	40
9	51

Analysis

1. During which month does the greatest increase in length occur?
2. On average, how many centimeters does the baby grow per month?

Try at Home

Petit Format/Nestle/Science Source/Photo Researchers

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Cesarean Section Sometimes a baby must be delivered before labor begins or before it is completed. At other times, a baby cannot be delivered through the birth canal because the mother's pelvis might be too small or the baby might be in the wrong birthing position. In cases like these, surgery called a cesarean (suh SEER ee uhn) section is performed. An incision is made through the mother's abdominal wall, then through the wall of the uterus. The baby is delivered through this opening.

Reading Check *What is a cesarean section?*

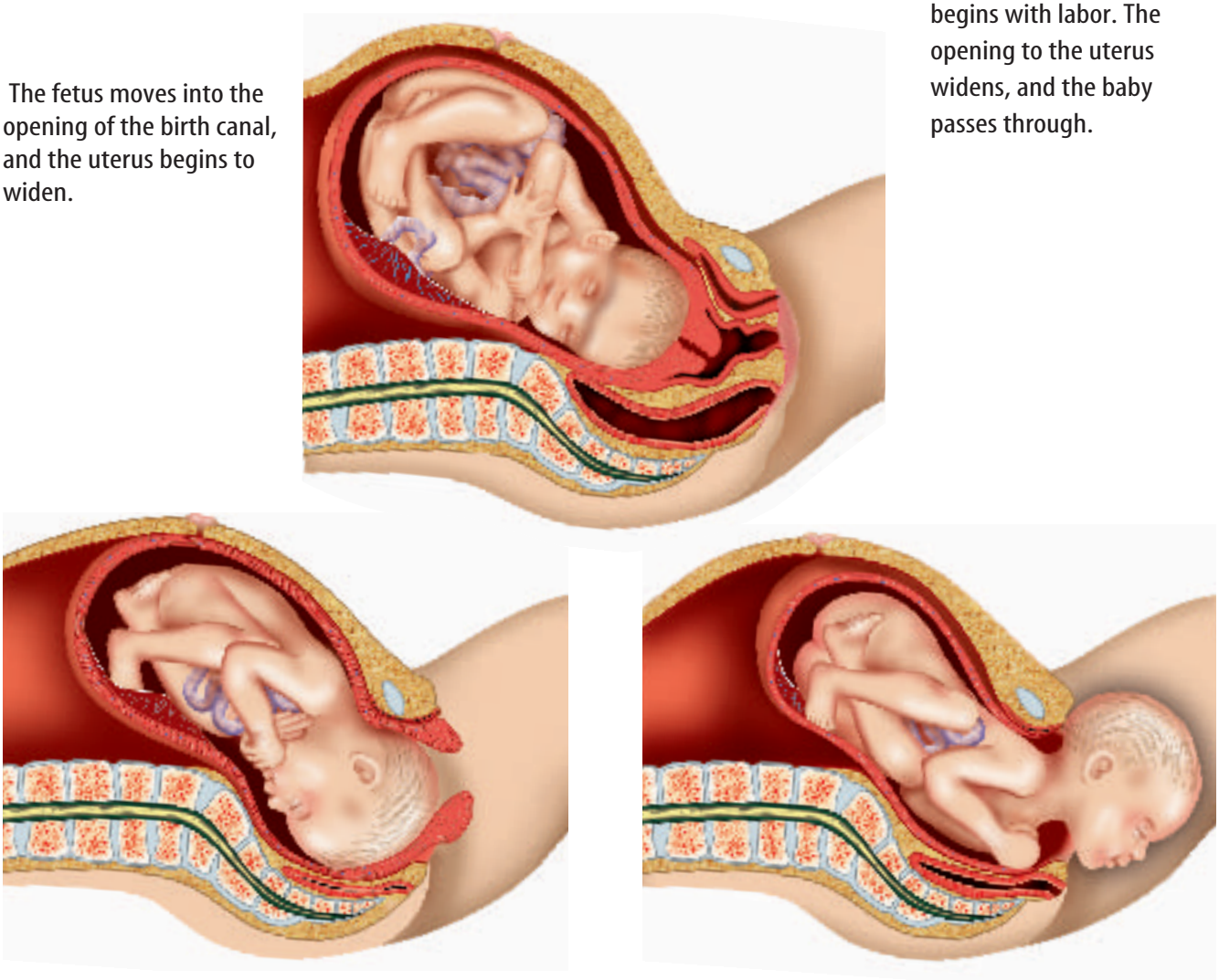
After Birth When the baby is born, it is attached to the umbilical cord. The person assisting with the birth clamps the cord in two places and cuts it between the clamps. The baby does not feel any pain from this procedure. The baby might cry, which is the result of air being forced into its lungs. The scar that forms where the cord was attached is called the navel.

Science Online

Topic: Cesarean Sections

Visit green.msscience.com for Web links to information about cesarean section delivery.

Activity Make a chart listing the advantages and disadvantages of a cesarean section delivery.



The fetus moves into the opening of the birth canal, and the uterus begins to widen.

The base of the uterus is completely dilated.

The fetus is pushed out through the birth canal.

Figure 14 Childbirth begins with labor. The opening to the uterus widens, and the baby passes through.

Stages After Birth

Defined stages of development occur after birth, based on the major developments that take place during those specific years. Infancy lasts from birth to around 18 months of age. Childhood extends from the end of infancy to sexual maturity, or puberty. The years of adolescence vary, but they usually are considered to be the teen years. Adulthood covers the years of age from the early 20s until life ends, with older adulthood considered to be over 60. The age spans of these different stages are not set, and scientists differ in their opinions regarding them.

Infancy What type of environment must the infant adjust to after birth? The experiences the fetus goes through during birth cause **fetal stress.** The fetus has emerged from an environment that was dark, watery, a constant temperature, and nearly soundless. In addition, the fetus might have been forced through the constricted birth canal. However, in a short period of time, the infant's body becomes adapted to its new world.

The first four weeks after birth are known as the neonatal (nee oh NAY tul) period. The term *neonatal* means "newborn." During this time, the baby's body begins to function normally. Unlike the newborn of some other animals, human babies, such as the one shown in **Figure 15,** depend on other humans for their survival. In contrast, many other animals, such as the young horse also shown in **Figure 15,** begin walking a few hours after they are born.

Figure 15 Human babies are more dependent upon their caregivers than many other mammals are.

Infants and toddlers are completely dependent upon caregivers for all their needs.

Other young mammals are more self-sufficient. This colt is able to stand within an hour after birth.

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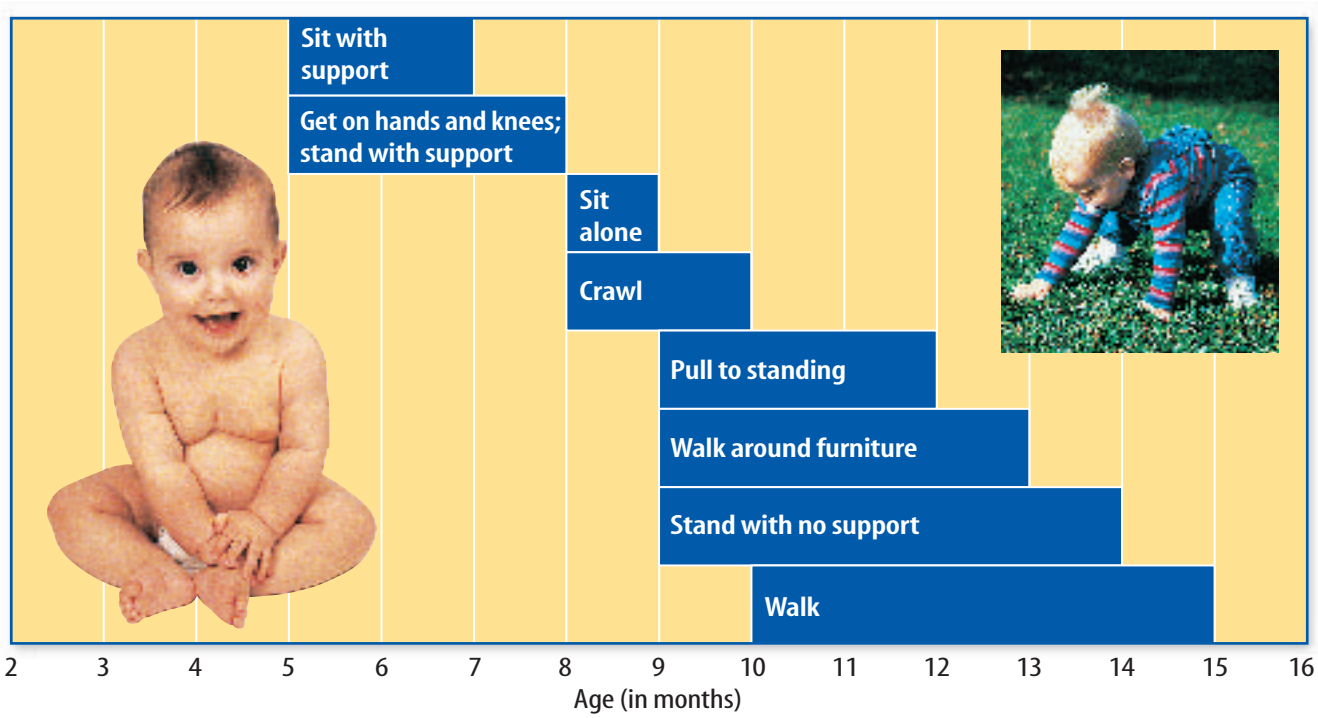

Figure 16 Infants show rapid development in their nervous and muscular systems through 18 months of age.

During these first 18 months, infants show increased physical coordination, mental development, and rapid growth. Many infants will triple their weight in the first year. **Figure 16** shows the extremely rapid development of the nervous and muscular systems during this stage, which enables infants to start interacting with the world around them.

Childhood After infancy is childhood, which lasts until about puberty, or sexual maturity. Sexual maturity occurs around 12 years of age. Overall, growth during early childhood is rather rapid, although the physical growth rate for height and weight is not as rapid as it is in infancy. Between two and three years of age, the child learns to control his or her bladder and bowels. At age two to three, most children can speak in simple sentences. Around age four, the child is able to get dressed and undressed with some help. By age five, many children can read a limited number of words. By age six, children usually have lost their chubby baby appearance, as seen in **Figure 17.** However, muscular coordination and mental abilities continue to develop. Throughout this stage, children develop their abilities to speak, read, write, and reason. These ages of development are only guidelines because each child develops at a different rate.

Figure 17 Children, like these kindergartners, grow and develop at different rates.

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Figure 18 The proportions of body parts change over time as the body develops.
Describe *how the head changes proportion.*

INTEGRATE Physics

Adolescent Growth During adolescence, body parts do not all grow at the same rate. Legs grow longer before the upper body lengthens. This changes the body's center of gravity, the point at which the body maintains its balance. This is one cause of teenager clumsiness. In your Science Journal, write a paragraph about how this might affect playing sports.

Adolescence Adolescence usually begins around age 12 or 13. A part of adolescence is puberty—the time of development when a person becomes physically able to reproduce. For girls, puberty occurs between ages nine and 13. For boys, puberty occurs between ages 13 and 16. During puberty, hormones produced by the pituitary gland cause changes in the body. These hormones produce reproductive cells and sex hormones. Secondary sex characteristics also develop. In females, the breasts develop, pubic and underarm hair appears, and fatty tissue is added to the buttocks and thighs. In males, the hormones cause a deepened voice, an increase in muscle size, and the growth of facial, pubic, and underarm hair.

Adolescence usually is when the final growth spurt occurs. Because the time when hormones begin working varies among individuals and between males and females, growth rates differ. Girls often begin their final growth phase at about age 11 and end around age 16. Boys usually start their growth spurt at age 13 and end around 18 years of age.

Adulthood The final stage of development, adulthood, begins with the end of adolescence and continues through old age. This is when the growth of the muscular and skeletal system stops. **Figure 18** shows how body proportions change as you age.

People from age 45 to age 60 are sometimes considered middle-aged adults. During these years, physical strength begins to decline. Blood circulation and respiration become less efficient. Bones become more brittle, and the skin becomes wrinkled.

Older Adulthood People over the age of 60 may experience an overall decline in their physical body systems. The cells that make up these systems no longer function as well as they did at a younger age. Connective tissues lose their elasticity, causing muscles and joints to be less flexible. Bones become thinner and more brittle. Hearing and vision are less sensitive. The lungs and heart work less efficiently. However, exercise and eating well over a lifetime can help extend the health of one's body systems. Many healthy older adults enjoy full lives and embrace challenges, as shown in **Figure 19.**

Figure 19 Astronaut and Senator John Glenn traveled into space twice. In 1962, at age 40, he was the first U.S. citizen to orbit Earth. He was part of the space shuttle crew in 1998 at age 77. Senator Glenn has helped change people's views of what many older adults are capable of doing.

Reading Check ***What physical changes occur during late adulthood?***

Human Life Spans Seventy-seven years is the average life span—from birth to death—of humans in the United States, although an increasing number of people live much longer. However, body systems break down with age, resulting in eventual death. Death can occur earlier than old age for many reasons, including diseases, accidents, and bad health choices.

section 3 review

Summary

Fertilization

- Fertilization is the uniting of a sperm and an egg.

Development Before Birth

- Pregnancy begins when an egg is fertilized and lasts until birth.

The Birthing Process

- Birth begins with labor. Contractions force the baby out of the mother's body.

Stages After Birth

- Infancy (birth to 18 months) and childhood (until age 12) are periods of physical and mental growth.
- A person becomes physically able to reproduce during adolescence. Adulthood is the final stage of development.

Self Check

1. **Describe** what happens when an egg is fertilized in a female.
2. **Explain** what happens to an embryo during the first two months of pregnancy.
3. **Describe** the major events that occur during childbirth.
4. **Name** the stage of development that you are in. What physical changes have occurred or will occur during this stage of human development?
5. **Think Critically** Why is it hard to compare the growth and development of different adolescents?

Applying Skills

6. **Use a Spreadsheet** Using your text and other resources, make a spreadsheet for the stages of human development from a zygote to a fetus. Title one column *Zygote,* another *Embryo*, and a third *Fetus.* Complete the spreadsheet.

LAB

Changing Body Proportions

Goals

- **Measure** specific body proportions of adolescents.
- **Infer** how body proportions differ between adolescent males and females.

Materials

tape measure
erasable pencil
graph paper

Real-World Question

The ancient Greeks believed that the perfect body was completely balanced. Arms and legs should not be too long or short. A person's head should not be too large or small. The extra-large muscles of a body builder would have been ugly to the Greeks. How do you think they viewed the bodies of infants and children? Infants and young children have much different body proportions than adults, and teenagers often go through growth spurts that quickly change their body proportions. How do the body proportions differ between adolescent males and females?

Procedure

1. Copy the data table in your Science Journal and record the gender of each person that you measure.
2. Measure each person's head circumference by starting in the middle of the forehead and wrapping the tape measure once around the head. Record these measurements.

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3. Measure each person's arm length from the top of the shoulder to the tip of the middle finger while the arm is held straight out to the side of the body. Record these measurements.
4. Ask each person to remove his or her shoes and stand next to a wall. Mark their height with an erasable pencil and measure their height from the floor to the mark. Record these measurements in the data table.

Age and Body Measurements

Gender of Person	Head Circumference (cm)	Arm Length (cm)	Height (cm)

5. **Combine** your data with that of your classmates. Find the averages of head circumference, arm length, and height. Then, find these averages for males and females.
6. Make a bar graph of your calculations in step 5. Plot the measurements on the *y*-axis and plot all of the averages along the *x*-axis.
7. **Calculate** the proportion of average head circumference to average height for everyone in your class by dividing the average head circumference by the average height. Repeat this calculation for males and females.
8. **Calculate** the proportion of average arm length to average height for everyone in your class by dividing the average arm length by the average height. Repeat this calculation for males and females.

Analyze Your Data

Analyze whether adolescent males or females have larger head circumferences or longer arms. Which group has the larger proportion of head circumference or arm length to height?

Conclude and Apply

Explain if this lab supports the information in this chapter about the differences between growth rates of adolescent males and females.

Communicating Your Data

Construct data tables on poster board showing your results and those of your classmates. Discuss with your classmates why these results might be different.

Matt Meadows

SCIENCE Stats

Facts About Infants

Did you know...

...Humans and chimpanzees share about 99 percent of their genes. Although humans look different than chimps, reproduction is similar and gestation is the same—about nine months. Youngsters of both species lose their baby teeth at about six years of age.

Mammal Facts

Mammal	Average Gestation	Average Birth Weight	Average Adult Weight	Average Life Span (years)
African elephant	22 months	136 kg	4,989.5 kg	35
Blue whale	12 months	1,800 kg	135,000 kg	60
Human	**9 months**	**3.3 kg**	**59–76 kg**	**77***
Brown bear	7 months	0.23–0.5 kg	350 kg	22.5
Cat	2 months	99 g	2.7–7 kg	13.5
Kangaroo	1 month	0.75 –1.0 g	45 kg	5
Golden hamster	2.5 weeks	0.3 g	112 g	2

*In the United States

Applying Math Assume that a female of each mammal listed in the table above is pregnant once during her life. Which mammal is pregnant for the greatest proportion of her life?

Echidna

...Of about 4,000 species of mammals, only three lay eggs: the platypus, the short-beaked echidna (ih KIHD nuh), and the long-beaked echidna.

Find Out About It

Visit green.msscience.com/science_stats to research which species of vertebrate animals has the longest life span and which has the shortest. Present your findings in a table that also shows the life span of humans.

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Reviewing Main Ideas

Section 1 The Endocrine System

1. Endocrine glands secrete hormones directly into the bloodstream. They affect specific tissues in the body.
2. A change in the body causes an endocrine gland to function. Hormone production slows or stops when homeostasis is reached.

Section 2 The Reproductive System

1. Reproductive systems allow new organisms to be formed.
2. The testes produce sperm, which leave the male body through the penis.
3. The female ovaries produce eggs. If fertilized, an egg develops into a fetus within the uterus.
4. An unfertilized egg and the built-up lining of the uterus are shed in menstruation.

Section 3 Human Life Stages

1. After fertilization, the zygote becomes an embryo, then a fetus. Twins occur when two eggs are fertilized or when a zygote divides after fertilization.
2. Birth begins with labor. The amniotic sac breaks. Then, usually after several hours, contractions force the baby out of the mother's body.
3. Infancy, from birth to 18 months of age, is a period of rapid growth of mental and physical skills. Childhood lasts until age 12 and involves further physical and mental development.
4. Adolescence is when a person becomes physically able to reproduce. In adulthood, physical development is complete and body systems become less efficient. Death occurs at the end of life.

Visualizing Main Ideas

Copy and complete the following table on life stages.

Human Development

Stages of Life	Age Range	Physical Development
Infant		sits, stands, words spoken
		wa ks, speaks, writes, reads
Adolescent		
		end of muscular and skeletal growth

chapter 16 Review

Using Vocabulary

amniotic sac p. 481
embryo p. 481
fetal stress p. 484
fetus p. 482
hormone p. 468
menstrual cycle p. 476
menstruation p. 476
ovary p. 475
ovulation p. 475
pregnancy p. 480
semen p. 474
sperm p. 474
testes p. 474
uterus p. 475
vagina p. 475

Fill in the blank with the correct vocabulary word or words.

1. _____ is a mixture of sperm and fluid.

2. The time of the development until the birth of a baby is known as _____.

3. During the first two months of pregnancy, the unborn child is known as a(n) _____.

4. The _____ is a hollow, pear-shaped muscular organ.

5. The _____ is the membrane that protects the unborn child.

6. The _____ is the organ that produces eggs.

Checking Concepts

Choose the word or phrase that best answers the question.

7. Where is the egg usually fertilized?
A) oviduct **C)** vagina
B) uterus **D)** ovary

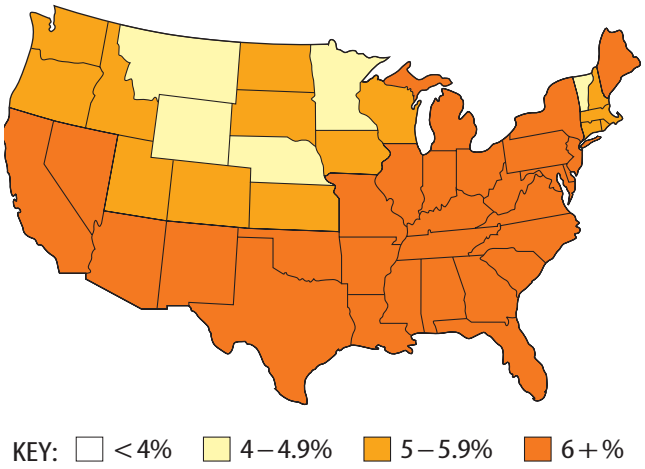
8. What are the chemicals produced by the endocrine system?
A) enzymes **C)** hormones
B) target tissues **D)** saliva

9. Which gland produces melatonin?
A) adrenal **C)** pancreas
B) thyroid **D)** pineal

10. Where does the embryo develop?
A) oviduct **C)** uterus
B) ovary **D)** vagina

Use the figure below to answer question 11.

Prevalence of Diabetes per 100 Adults, United States, 2001



11. Using the figure above, which state has the lowest incidence of diabetes?
A) Wyoming **C)** Michigan
B) Florida **D)** Washington

12. What is the monthly process that releases an egg called?
A) fertilization **C)** menstruation
B) ovulation **D)** puberty

13. What is the union of an egg and a sperm?
A) fertilization **C)** menstruation
B) ovulation **D)** puberty

14. During what stage of development does the amniotic sac form?
A) zygote **C)** fetus
B) embryo **D)** newborn

15. When does puberty occur?
A) childhood **C)** adolescence
B) adulthood **D)** infancy

16. During which period does growth stop?
A) childhood **C)** adolescence
B) adulthood **D)** infancy

Thinking Critically

17. List the effects that adrenal gland hormones can have on your body as you prepare to run a race.

18. Explain the similar functions of the ovaries and testes.

Use the diagram below to answer question 19.

19. Identify the structure in the above diagram in which each process occurs: ovulation, fertilization, and implantation.

20. Compare and contrast your endocrine system with the thermostat in your home.

21. Explain if quadruplets—four babies born at one birth—are always identical or always fraternal, or if they can be either.

22. Predict During the ninth month of pregnancy, the fetus develops a white, greasy coating. Predict what the function of this coating might be.

23. Form a hypothesis about the effect of raising identical twins apart from each other.

24. Classify each of the following structures as female or male and internal or external: ovary, penis, scrotum, testes, uterus, and vagina.

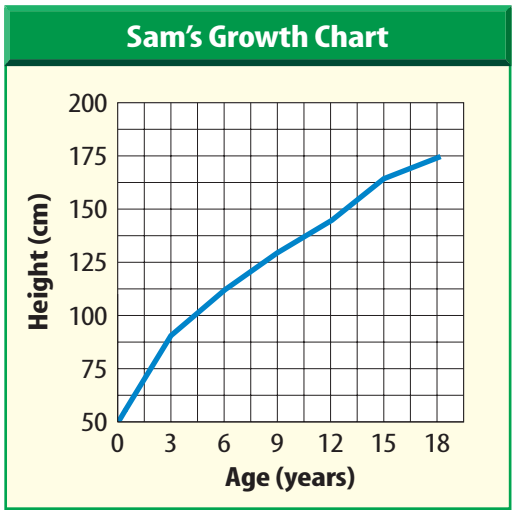
Performance Activities

25. Letter Find newspaper or magazine articles on the effects of smoking on the health of the developing embryo and newborn. Write a letter to the editor about why a mother's smoking is damaging to her unborn baby's health.

Applying Math

26. Blood Sugar Levels Carol is diabetic and has a fasting blood sugar level of 180 mg/dL. Luisa does not have diabetes and has a fasting blood sugar level of 90 mg/dL. Express as a percentage how much higher the fasting blood sugar level is for Carol as compared to that for Luisa.

Use the graph below to answer questions 27 and 28.



27. Early Childhood Growth The graph above charts Sam's growth from birth to 18 years of age. According to the graph, how much taller was Sam at 12 years of age than he was at 3 years of age?

28. Adolescent Growth According to the graph, how much did Sam grow between 12 and 18 years of age?

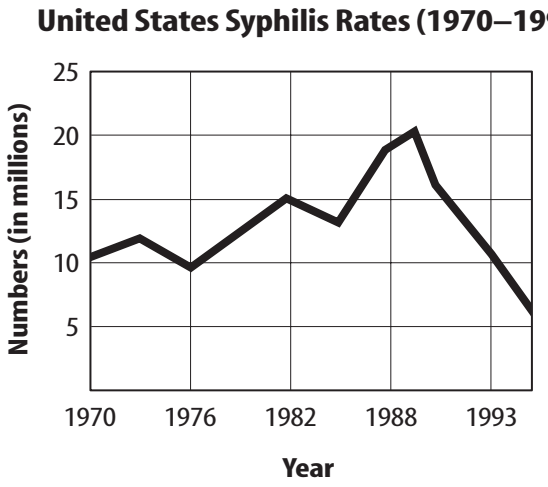
Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

1. When do eggs start to develop in the ovaries?

A. before birth **C.** during childhood
B. at puberty **D.** during infancy

Use the graph below to answers questions 2 and 3.



2. According to the information in the graph, in which year was the syphilis rate the lowest?

A. 1976 **C.** 1988
B. 1982 **D.** 1993

3. According to the information in the graph, during which years was there a decrease in the syphilis rate?

A. 1970–1972 **C.** 1988–1990
B. 1976–1982 **D.** 1990–1993

4. Which of the following glands is found in the neck?

A. pineal **C.** thyroid
B. adrenal **D.** pancreas

Test-Taking Tip

Bar Graphs On a bar graph, line up each bar with its corresponding value by laying your pencil between the two points.

5. What is the mixture of sperm and fluid called?

A. semen **C.** seminal vesicle
B. testes **D.** epididymis

Use the table below to answer questions 6–8.

Results of Folic Acid on Development of Neural Tube Defect

Group	Babies with Neural Tube Defect	Babies without Neural Tube Defect
Group I—Folic Acid	6	497
Group II—No Folic Acid	21	581

(From CDC)

6. Researchers have found that the B-vitamin folic acid can prevent neural tube defects. In a study done in Europe in 1991, one group of pregnant women was given extra folic acid, and the other group did not receive extra folic acid. What percentage of babies were born with a neural tube defect in Group II?

A. 1.0% **C.** 3.0%
B. 2.5% **D.** 4.0%

7. What percentage of babies were born with a neural tube defect in Group I?

A. 1.0% **C.** 3.0%
B. 2.5% **D.** 4.0%

8. Which of the following statements is true regarding the data in this table?

A. Folic acid had no effect on the percentage of babies with a neural tube defect.
B. Extra folic acid decreased the percentage of babies with a neural tube defect.
C. Extra folic acid increased the percentage of babies with a neural tube defect.
D. Group I and Group II had the same percentage of babies born with a neural tube defect.

Part 2 Short Response/Grid In

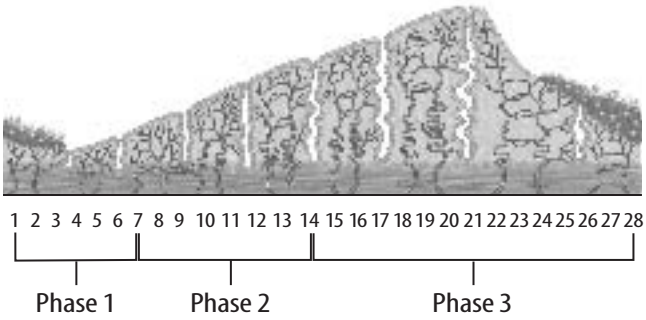
Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

9. How are endocrine glands different from salivary glands?

10. What does parathyroid hormone do for the body?

11. What is the function of the cilia in the oviduct?

Use the illustration below to answer questions 12 and 13.



12. According to the illustration, what percentage of the menstrual cycle is phase 3?

13. According to the illustration, what percentage of the menstrual cycle is phase 2?

14. According to the illustration, on which day does ovulation occur?

15. During which stage of development before birth does amniotic fluid develop? What is the purpose of amniotic fluid?

16. During which stage of development after birth is physical growth and development the most rapid?

17. Rubella, also know as German measles, is caused by a virus. If a pregnant woman is infected with rubella, the virus can affect the formation of major organs, such as the heart, in the fetus. During which stage of development before birth would a rubella infection be most dangerous?

Part 3 Open Ended

Record your answers on a sheet of paper.

18. Predict how each of the following factors may affect sperm production: hot environment, illness with fever, testes located inside the body cavity, and injury to the testes. Explain your answer.

19. Sexually transmitted diseases can cause infection of the female reproductive organs, including the oviduct. Infection of the oviduct can result in scarring. What might happen to an egg that enters a scarred oviduct?

Use the table below to answer question 20.

Pre-eclampsia Risk in Pregnancy	
Risk Factors	**Risk Ratio**
First pregnancy	3:1
Over 40 years of age	3:1
Family history	5:1
Chronic hypertension	10:1
Chronic renal disease	20:1
Antiphospholipid syndrome	10:1
Diabetes mellitus	2:1
Twin birth	4:1
Angiotensinogen gene T235	
Homozygous	20:1
Heterozygous	4:1

20. Pre-eclampsia is a condition that can develop in a woman after 20 weeks of pregnancy. It involves the development of hypertension or high blood pressure, an abnormal amount of protein in urine, and swelling. Infer why a woman with chronic hypertension has a higher risk of developing pre-eclampsia than a woman without hypertension.