# Chapter 21: Reproduction and Growth

## Section Objectives

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<th>Section</th>
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<td><strong>Chapter Opener</strong></td>
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| **21-1 Human Reproduction** | 1. Explain the function of the reproductive system.  
2. Identify the major structures of the male and female reproductive system.  
3. Explain the stages of the menstrual cycle. |
| **21-2 Fertilization to Birth** | 4. Describe how an egg becomes fertilized.  
5. Identify the major events in the stages of development of an embryo and fetus.  
6. Differentiate between fraternal and identical twins.  
7. State the sequence of events of childbirth. |
| **21-3 Development After Birth** | 8. Compare the stages of infancy and childhood.  

## Activities and Features

### Explore Activity: Observe the Proportion of Boys to Girls, p. 571

| Physics Integration, p. 573 |
| Skill Builder: Sequencing, p. 577 |
| Using Math, p. 577 |
| Activity 21-1: Interpreting Diagrams, p. 578 |

### Using Math, p. 580

**Chemistry Integration, p. 581**

**Problem Solving: When to Test, p. 581**

**MiniLab: Interpreting Embryo Development, p. 585**

**Skill Builder: Interpreting Data, p. 585**

**Science Journal, p. 585**

### Using Math, p. 587

**MiniLab: Investigating What Immunizations Are Required by Your School, p. 588**

**Using Math, p. 590**

**Skill Builder: Concept M apping, p. 591**

**Using Computers, p. 591**

**Science and Society: New View of the Old, p. 592**

**Activity 21-2: Average Growth Rate in Humans, p. 593**

### Using Math, p. 583

**reference materials, pencil, paper, ruler**

**standard immunization procedures, personal immunization record**

### Activity 21-2

**Activity Worksheets, pp. 117–118, 120**

**Enrichment, p. 60**

**Multicultural Connections, pp. 41–42**

**Reinforcement, p. 60**

**Study Guide, pp. 83–84**

## Assessment Resources

### Chapter Review, pp. 41–42

### Assessment, pp. 81–84

### Performance Assessment in the Science Classroom (PASC)

### Mindlogger Videoquiz

### Alternate Assessment in the Science Classroom

### Performance Assessment, p. 21

### Chapter Review Software

### Computer Test Bank

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Need Materials? Contact Science Kit at 1-800-828-7777 or at www.sciencekit.com on the Internet.

For alternate materials, use the activity on the listed page.

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**Key to Teaching Strategies**

The following designations will help you decide which activities are appropriate for your students.

- **Level 1** activities should be appropriate for students with learning difficulties.
- **Level 2** activities should be within the ability range of all students.
- **Level 3** activities are designed for above-average students.

**ELL** ELL activities should be within the ability range of English Language Learners.

**COOP LEARN** Cooperative Learning activities are designed for small group work.

**These strategies represent student products that can be placed into a best-work portfolio.**

W multispe Learning Styles logos, as described on page 631, are used throughout to indicate strategies that address different learning styles.
Menstrual Cycle

Chapter 21

This is a representation of key blackline masters available in the Teacher Classroom Resources. See Resource Manager boxes within the chapter for additional information.

Reproduction and Growth

You know? travel through produces

SEXUAL REPRODUCTION

Embryo

Meeting Different Ability Levels

Study Guide for Content Mastery

Reinforcement

Enrichment Worksheets

Hands-on Activities

Activity Worksheets

Lab Manual

Assessment

Performance Assessment

Chapter Review

Test Practice Workbook

Accessibility

Critical Thinking/ Problem Solving

Spanish Resources

Extending Content

Multicultural Connections

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Chapter 21: Reproduction and Growth

Reproduction (Section 21-1)

To continue the species, animals reproduce and bring forth new individuals of their own kind. In humans, as in other placental mammals, there is direct involvement of hormones in the reproductive cycle. The table below summarizes the effects of various hormones on the reproductive system.

<table>
<thead>
<tr>
<th>Source</th>
<th>Hormone Action</th>
</tr>
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<tbody>
<tr>
<td>Pituitary:</td>
<td>Follicle-stimulating hormone (FSH) promotes growth of ovarian follicles</td>
</tr>
<tr>
<td></td>
<td>and the growth of seminiferous tubules</td>
</tr>
<tr>
<td></td>
<td>Luteinizing hormone (LH) stimulates ovulation and production of estrogen</td>
</tr>
<tr>
<td></td>
<td>Interstitial-cell-stimulating hormone (ICSH) stimulates production of milk in</td>
</tr>
<tr>
<td></td>
<td>mammary glands</td>
</tr>
<tr>
<td></td>
<td>Testes: Testosterone develops secondary sex characteristics</td>
</tr>
<tr>
<td></td>
<td>Ovary: Estrogens develops secondary sex characteristics</td>
</tr>
<tr>
<td></td>
<td>Progesterone regulates menstrual cycle and prepares uterine lining for</td>
</tr>
<tr>
<td></td>
<td>implantation</td>
</tr>
</tbody>
</table>

The male reproductive organ is the penis, which serves both as a conduit for sperm-filled semen and for urine. The urethra carries both fluids to the outside of the body. Suspended between the legs, in a saclike structure called the scrotum, are the testes. This near external position of the testes is designed to keep the sperm producing tissues from the higher temperatures of the abdomen, which can kill sperm.

The ovaries of the female reproductive system are small, almond-shaped bodies approximately 30 mm in length and 15 mm in width. Within each ovary are small groups of specialized cells, the follicles. Each month, one egg, the ovum, develops and matures within a follicle. A mature ovum is about 0.10 mm in diameter.

Fertilization (Section 21-2)

The process of meiosis in the testes and ovaries results in the formation of sperm and eggs having one half the number of chromosomes. How the chromosomes are distributed to a mature cell is by chance. The possible mathematical combinations of the 23 chromosomes appearing in either a mature sperm or egg are in the order of 2^23, or 8,388,608. Considering that a zygote is formed from the union of a sperm and egg, the possible combinations are now 8,388,608^2. For this reason it is unlikely that there are any two individuals having the exact same genetic pattern.

The life of a sperm in the female reproductive tract is usually less than forty-eight hours. Acidity, high temperature, and length of travel kills most of the sperm. During intercourse, the total number of sperm deposited may be more than 300 million. However, only a few thousand reach the oviduct to make contact with the egg. Through an intricate mechanism involving enzymes, one sperm is able to penetrate the ovum. The fusing of the sperm and egg forms a zygote. Within 24 hours, the chromosomes of the two cells have combined and cell division begins. After several cell divisions, the group of cells have the external appearance of a raspberry. Further cell division produces a hollow ball of cells called an embryo. Six days after fertilization, secretions from the embryo prevent the lining of the uterine cavity from being shed.

Development After Birth (Section 21-3)

One signal of the initiation of labor is the expelling of the mucous plug that formed a protective barrier between the vagina and the uterus. An additional signal is the rupturing of the amnion that surrounds the fetus. The fluid within is discharged through the vagina. This event is often referred to as breaking water. The head of the fetus is pushed firmly against the opening of the uterus to the vagina. The walls of the vagina can stretch considerably. Eventually, the contractions of the uterus and the assistance from the mother push the baby out into a new environment. Because the baby is still attached to the placenta, the umbilical cord is clamped and then cut, leaving several inches exposed. There is no pain in this procedure because the cord does not have nerves. The scar that is left is the naval, or belly button.

To order the following products for use with this chapter, call Glencoe at 1-800-334-7344:

- CD-ROM
- NGS PictureShow: Human Body 3
- Curriculum Kit
- Geokit: Human Body 2
- Transparency Set
- NGS PicturePac: Human Body 3
- Videodisc
- STV: Human Body

Teacher’s Corner

Products Available from Glencoe

To order the following products for use with this chapter, call Glencoe at 1-800-334-7344:

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- Transparency Set
- NGS PicturePac: Human Body 3
- Videodisc
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Fertilization

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Membranes that have formed around the egg induce the development of fingerlike projections that penetrate the wall of the uterus and eventually embed the embryo in the wall. Because there is close contact with the blood supply of the mother, the embryo is able to receive the necessary nutrients and oxygen required for growth and development. However, this is only a temporary solution that functions until the umbilical cord and placenta have developed.

Teacher to Teacher

“....”

Edward G. Ezrailson, Ph.D.
Science Consultant
Spring, TX
CHAPTER 21 Reproduction and Growth

and differentiation of cells. and the subsequent growth on energy for cell division productive system is dependent tioning of the human repro-

The unique func-

t. Energy

Theme Connection

Energy The unique func-

looking for new vocabulary

Look for the following logos for strategies that emphasize different learning modalities.

Linguistic Across the Curriculum, p. 574, 580; Using Science Words, p. 580; Science Journal, p. 582; Review, p. 594

Auditory-Musical Out of Time, p. 594

Logical-Mathematical MiniLab, p. 588

Visual-Spatial Activity, pp. 578, 593; M ultilab Learning Styles, pp. 580, 584; Quick Demo, p. 581; MiMiniLab, p. 583; Visual Learning, p. 587; Making a Model, p. 589; Reteach, pp. 589, 594

Interpersonal Discussion, pp. 584, 587; Integrating the Sciences, p. 587; Activity, p. 587; Inclusion Strategies, p. 588; Review, p. 594

Explore Activity

You or some of your friends may come from families with both brothers and sisters. Some may come from families that have only boys or only girls. What do you think are the odds of a small family having all boys or all girls? Do the odds change as the family grows larger? What do you think is the proportion of boys to girls among children born in the general population?

Observe the Proportion of Boys to Girls

1. Take a penny and toss it in the air. The chance is equal that it will land heads or tails.
2. Toss the penny a hundred times.
3. Keep a record of the number of times it lands heads up and the number of times it lands tails up.
4. Keep a record of the order in which the penny lands.

In your Science Journal, record the results of your trials. Analyze your record for any pat-

tens that occurred. Write your observations about sequences of five or more heads before a tails fell. Relate this to families that have five girls or five boys. Infer the chances that a girl would be born if there were a sixth child.

Explore Activity

Purpose Kinesthetic Use the Explore Activity to intro-

duce students to the re-

productive system.

Preparation Collect small foam trays to deaden the sound and catch the tossed pennies.

Materials pennies

Teaching Strategies • Have the student who ob-

serves the side of the coin that lands faceup convey the information quietly to a recorder. This will expedi-

t the process.

• Share the class data to see any long sequence of heads or tails. Combine the totals to determine how close the data are to a 50:50 ratio.

Students should observe that while there is an approxi-

mate 50:50 ratio in a hundred tosses, there may be se-

quences of one side landing faceup repeatedly for several tosses.

Assessment Planner

Performance Have students repeat this activity rolling a numbered cube one hundred times to determine whether each number lands faceup an approximately equal number of times. Use Performance Assessment in the Science Classroom, p. 25.

Content Assessment Section Assessment, pp. 577, 585, 591 Chapter Assessment, pp. 596-597 Proficiency Prep, pp. 576, 585, 590
**The Reproductive System**

Reproduction is the process that continues life on Earth. Organisms that carry out sexual reproduction form eggs and sperm that transfer genetic information from one generation to the next. The number of offspring an organism has varies with the species. Humans and other mammals have fewer offspring than most other animals. If you baby-sit, you know that babies and young children require almost constant attention. For this reason, most humans have only one or two babies at a time. However, in rare cases, mothers have given birth to as many as eight babies. Organisms such as spiders can lay thousands of eggs, which results in thousands of offspring at one time, as shown in Figure 21-1.

**The Male Reproductive System**

Most human body systems are alike in males and females. This is not the case for the reproductive system. Males and females each have structures specialized for their role in reproduction. Figure 21-2 shows the structures of the male reproductive system. The external organs of the male reproductive system are the penis and scrotum. The penis is the male organ for reproduction and urination. The scrotum is a sac-like pouch located behind the penis. Within the scrotum are the two testes. During puberty, the testes begin to produce the male reproductive cells, called sperm, and the male sex hormone, testosterone. Sperm are single cells with a head and tail. The tail moves the sperm, and the head contains genetic information. The external location of the scrotum helps keep the testes at a lower temperature. Sperm production is more efficient at lower temperatures.

**Sperm Production**

Sperm production is a continuous process from puberty throughout the life of a male. Oocytes production in females begins before birth. There is no production after birth. Each ovary may have nearly a million primary oocytes—cells from which eggs form.
Sperm Movement

Many organs help in the production, transport, and storage of sperm inside the male body. After sperm are produced, they travel from the testes through tubes that circle the bladder. Behind the bladder, a gland called the seminal vesicle provides sperm with a fluid that gives them energy and helps them move as shown in Figure 21-3. This mixture of sperm and fluid is called semen. Semen leaves the body through the urethra, the same tube that at other times carries urine from the body. Semen and urine never mix. A muscle at the back of the bladder contracts to prevent urine from entering the urethra as sperm are ejected from the body.

Egg Movement

About once a month, an egg is released from an ovary, as in Figure 21-5. This process is called ovulation (ah yuuh LAY shun). The two ovaries take turns releasing an egg. One month, the first ovary releases an egg. Next month, the other ovary releases an egg and so on. When the egg is released, it enters the oviduct, as shown in Figure 21-6. Sometimes, the egg is fertilized by a sperm. If fertilization occurs, it will happen in an oviduct. Short, hairlike structures called cilia help sweep the egg through the oviduct to the uterus. The uterus is a hollow, pear-shaped, muscular organ with thick walls in which a fertilized egg develops. The lower end of the uterus is connected to the outside of the body by a muscular tube called the vagina. The vagina also is called the birth canal because a baby travels through this passageway during birth.

The Menstrual Cycle

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 certain changes. The menstrual cycle of a human female averages 28 days. However, the cycle can vary in some individuals from 20 to 40 days. The changes include the maturing of an egg.

Caption Answer

Figure 21-4 ovaries

Teacher FYI

In the seventeenth century, some naturalists believed that the sperm contained a miniature, compacted human being that unfolded and developed within the female.

Discussion

What other functions does semen have in addition to carrying the sperm? Chemical substances in semen provide fructose and supplies the energy for sperm movement; the substances also provide a slightly alkaline environment that protects the sperm when they contact acidic conditions.

Ovaries produce the hormone estrogen that controls the development of female secondary sex characteristics. There is a belief that males do not produce this hormone. There is a belief that males do not produce this hormone. There is a belief that males do not produce this hormone. There is a belief that males do not produce this hormone. There is a belief that males do not produce this hormone.

Across the Curriculum

Language Arts

Have students look up the words sperm and ovary and find out why the Latin roots are appropriate to their meanings.
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Reteach

Extension

Proficiency Prep

Check for Understanding Discussion

Use a question box to solicit discussion questions that students may not want to ask in class. Why doesn’t a human female produce thousands of eggs at one time? They are well protected and have a good chance of being fertilized.

Reteach

Use diagrams to illustrate the pathway of the egg as it moves from the ovary to the uterus.

Extension

For students who have mastered this section, use the Reinforcement and Enrichment masters.

4 Close

Proficiency Prep

Use this quiz to check students’ recall of section content.

1. Females produce eggs. What do males produce?
   - sperm

2. What is the normal length of the menstrual cycle? 4 to 6 days

Content Background

During the week before the initiation of the menstrual cycle, a woman may experience depression, fatigue, headache, irritability, nervousness, and lack of concentration. This group of symptoms is referred to as premenstrual syndrome, or PM S. Studies suggest the condition may be due to changes in hormonal levels during the cycle. Diet, exercise, aspirin, and other medicines are used to lessen the severity of the discomfort.

Reinforcement and Enrichment

See Science Web Site at www.glencoe.com/sec/science/ca

Visit the Glencoe Science Web Site at www.glencoe.com/sec/science/ca for more information about the menstrual cycle.

internet CONNECTION

Visit the Glencoe Science Web Site at www.glencoe.com/sec/science/ca for more information about the menstrual cycle.

internet CONNECTION

For Internet tips, see Glencoe’s Using the Internet in the Science Classroom.

Proficiency Prep

Use this quiz to check students’ recall of section content.

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Reading Check

What causes the uterine wall to thicken again after menstruation?

Reading Check

What causes the uterine wall to thicken again after menstruation?

Section Assessment

1. What is the major function of a reproductive system?
   - to produce offspring

2. Explain the movement of sperm through the male reproductive system.
   - The sperm are produced in the testes, travel through the epididymis, vasa deferentia, seminal vesicle, and urethra.

3. List the organs of the female reproductive system and describe their functions.
   - Ovary: produces eggs and hormone; Fallopian tube: transports eggs; Uterus: receives and nourishes the developing embryo; Vagina: gives birth

4. Explain the cause of menstrual flow.
   - Menstruation occurs due to the shedding of the uterine lining.

5. Think Critically: Adolescent females often require the additional amounts of iron in their diet. Explain why.
   - Iron is essential for the production of hemoglobin, which carries oxygen to the body’s cells.

6. Skill Builder Sequencing: Sequence the movement of an egg through the female reproductive system and the movement of a sperm through the male reproductive system. If you need help, refer to Sequencing in the Skill Handbook on page 678.
   - Egg: ovary → ovulated → oviduct → uterus → ovulated → fertilized egg → developed embryo → placenta → birth
   - Sperm: testis → epididymis → vas deferens → seminal vesicle → urethra

Using Math

Usually, one egg is released each month during the reproductive years of a female. For a woman whose first menstruation starts at age 12 and ends at age 50, calculate the number of eggs released. In males, about 300 million sperm are produced in a day. Relate this number to the number of eggs released by a woman during her entire life.

Assessment

Performance Further assess students’ abilities to sequence by having them order the movement of a sperm through the male reproductive system using Figure 21-5. Use Performance Assessment in the Science Classroom, p. 55.
Troubleshooting Stress the Teaching Strategies

Time 40 minutes

Diagrams of the Menstrual Cycle.

Answers to Questions and captions when interpreting importance of examining labels You can see what is happening about 14 days 7 through 28 days 1 to 6 Days Condition of Uterus What Happens

1–6 Days lining begins to thicken egg matures in the ovary

7–12 Days lining is thicker ovulation

13–14 Days ovulation begins

15–28 Days ovulation occurs, sperm enters egg

Figure 21-9 SpERM must travel from the vagina, through the uterus, and into the oviduct to fertilize an egg. Where does fertilization usually occur?

Conclude and Apply

1. How long is the average menstrual cycle?

2. How many days does menstruation usually last?

3. On what days does the lining of the uterus build up?

4. Infer why this process is called a cycle.

5. Calculate how many days before menstruation usually occurs.

6. Interpret the diagram to explain the menstrual cycle.

Starting in adolescence, the hormone estrogen causes changes in the uterus. These changes prepare the uterus to accept a fertilized egg that may embed itself in the uterine wall.

What You’ll Investigate

What happens to the uterus during a female’s monthly cycle?

Goals

• Observe the stages in a diagram of the menstrual cycle.

• Relate the process of ovulation to the cycle.

Procedure

1. The diagram below shows what is explained in Section 21-1 on the menstrual cycle.

2. Study the diagram and labels.

3. Use the information in Section 21-1 and the diagram below to complete a table like the one shown.

4. How are the diagrams different?

5. On approximately what day in a 28-day cycle is the egg released from the ovaries?

6. Interpreting Diagrams

Fertilization

Before the invention of powerful microscopes, some people imagined a sperm to be a miniature person that grew in the uterus of a female. Others thought the egg contained a minia-

ture individual that started to grow when stimulated by semen. In the latter part of the 1700s, experiments using amphibians showed that contact between an egg and sperm is necessary for life to begin development. With the development of the cell theory in 1839, scientists recognized that a human develops from a single egg that has been fertilized by a sperm. The uniting of a sperm with an egg is known as fertilization.

As you see in Figure 21-9, the process begins when sperm, deposited into the vagina, move through the uterus into the oviducts. Whereas only one egg is usually present, nearly 200 to 300 million sperm are deposited. Of that number, only one sperm will fertilize the egg. The nucleus of the sperm and the nucleus of the egg have 23 chromosomes each. When the egg and sperm unite, a zygote with 46 chromosomes is formed. Most fertilization occurs in an oviduct.
GLENOCE TECHNOLOGY
CD-ROM

Glencoe Science Voyages Interactive CD-ROM Explorations

Have students do the interactive exploration. What are the stages of development before birth?

Response of the Egg

Once a sperm has penetrated the egg, another series of chemical actions take place. These actions prevent further penetration by other sperm. Special chemical secretions are released onto the egg's surface. These secretions prevent other sperm from binding. Other chemicals cause changes on the surface of the egg itself that prevent penetration. At this point, the nucleus of the successful sperm fuses with the nucleus of the egg. This fusion creates a new cell, called a zygote, that undergoes mitosis, as shown in Figure 21-11.

Figure 21-10. The sperm releases enzymes that disrupt the membrane on the surface of the egg. The sperm head can now penetrate the egg.

Magnification: 2700X

A Biochemical Event

Several hundred million sperm may be deposited in the vagina, but only several thousand actually reach the egg in the oviduct. During their travels, the sperm come in 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 eggs.

Although many sperm may actually reach the egg, only one will fertilize it, as shown in Figure 21-10. The one sperm that makes successful contact with the egg releases an enzyme from the saclike structure on its head. It is these enzymes that allow the sperm to enter. Once the sperm enters, an electrical response changes the plasma membrane of the egg. Enzymes help speed up chemical reactions. The enzyme has a direct effect on the protective egg-surface membranes. The structure of the membrane is disrupted, and the sperm head is now able to penetrate the egg.

Figure 21-11. Fertilization results from the fusion of an egg nucleus and a sperm (A). The resulting zygote undergoes mitosis as shown in (B) and (C) to form a hollow ball of cells (D).

When to Test?

Expectant mothers want to know, "Will my baby be healthy?" Several tests to check for birth defects can be done before a baby is born. One test is known as amniocentesis (am nee oh sen TEE sus). In this test, the doctor extracts a small amount of fluid from the amniotic sac that surrounds the fetus. Examination of the fluid can reveal certain abnormalities. A similar test takes a tissue sample of the placenta, the tissue that connects mother and child. Analysis of the tissue can show evidence of certain diseases.

One of the most frequently used tests is an ultrasound. A device generates sound waves that are transmitted through the mother’s body. The sound waves produce photographic images of the fetus. Doctors observe the images to detect not only deformities, but also the size, sex, and rate of development of the fetus.

While each procedure has a benefit, each also has a risk. Some risks are to the mother, and some are to the unborn fetus. Some doctors also think that too many tests may have an adverse effect on the development of the fetus.

Think Critically: Under what conditions might parents want to know the sex of their unborn child? Study the ultrasound photo and infer what information parents want to know the sex of their unborn child? Under what conditions might they make use of this information.

Ultrasound image of a 23-week-old fetus

21-2 FERTILIZATION TO BIRTH

Across the Curriculum

History

Have students research and report on early misconceptions of the role of sperm and eggs in the process of fertilization and development.

Multiple Learning Styles

Visual-Spatial

Have students use the diagrams in the text to outline the development of the fertilized egg from a zygote to a blastocyst.

Integrating the Sciences

Physics

Have students research the characteristics of ultrasound. How is ultrasound used in sonar?

Problem Solving

In both amniocentesis and tissue sampling the body must be entered to complete the procedure. The use of ultrasound does not require this.

Quick Demo

Visual-Spatial

Use Styrofoam balls to construct four- and eight-cell models to illustrate the earliest stages of growth of the zygote. Have students infer how these early stages develop into a hollow ball.
Development Before Birth

The zygote moves along the oviduct to the uterus. During this time, the zygote is dividing and forming a ball of cells. After about seven days, the ball of cells is implanted in the wall of the uterus. The uterine wall has been thickening in preparation to receive a fertilized egg. How the fertilized egg will develop for nine months until the birth of the baby. This period of time is known as pregnancy.

The Embryo

During the first two months of pregnancy, the unborn child is known as an embryo. In Figure 21-12, you can see how the embryo receives nutrients and removes wastes. Nutrients from the wall of the uterus are received by the embryo through villi. Blood vessels develop from the villi and form the placenta. The umbilical cord is attached to the embryo’s navel and connects with the placenta. The umbilical cord transports nutrients and oxygen from the mother to the baby through a vein. Carbon dioxide and other wastes are carried through arteries in the umbilical cord back to the mother’s blood. Other substances in the mother’s blood can pass to the embryo, as well. These include drugs, toxins, and disease organisms. Because these substances can harm the embryo, a mother needs to avoid harmful drugs, alcohol, and tobacco during pregnancy.

During the third week of pregnancy, a thin membrane begins to form around the embryo. This is called the amnion or the amniotic (am nee AH tihk) sac. It is filled with a clear liquid called amniotic fluid. The amniotic fluid in the amniotic sac helps cushion the embryo against blows and can store nutrients and wastes. This sac attaches to the placenta.

During the first three months of development, as shown in Figure 21-13, all of an embryo’s major organs form. A heart structure begins to beat and move blood through the embryo’s blood vessels. At five weeks, the embryo is only as large as a single grain of rice, but there is a head with recognizable eyes, nose, and mouth features. During the sixth and seventh weeks, tiny arms and legs develop fingers and toes.

Caption Answer

Figure 21-12 from the mother through arteries in the umbilical cord

Babies Have students write a short paragraph about myths associated with the question, “Where do babies come from?”

Figure 21-13 The photograph shows an enlarged view of a two-month-old embryo. The actual size is approximately 2 cm. You can see the head with eyes and nose. Tiny arms, legs, and toes are developing. The soft-looking tissue behind the embryo is the placenta.
The Fetus
After the first two months of pregnancy, as shown in Figure 21-14, the developing baby is called a fetus. At this time, body organs are present. Around the third month, the fetus is 8 cm to 10 cm long, the heart can be heard beating using a stethoscope, and the mother may feel the baby’s movements within her uterus. The fetus may suck its thumb. By the fourth month, an ultrasound test can determine the sex of the fetus. By the end of the seventh month of pregnancy, the fetus is 30 cm to 38 cm in length. 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. 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 baby is ready for birth.

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 may be two girls, two boys, or a boy and a girl. Fraternal twins do not always look alike. Not all twins are fraternal. Sometimes, a single egg splits apart shortly after it is fertilized. Each part of the egg then develops and forms an embryo. Because both children developed from the same egg and sperm, they are identical twins. Each has the same set of genes. Identical twins must be either two girls or two boys. Figure 21-15 illustrates both identical and fraternal twin development. Triplets and other multiple births may occur when either three or more eggs are produced at one time or an egg or egg splits into three or more parts.

Interpersonal Have students describe how substances are exchanged between the embryo or fetus and the mother. Determine whether they understand that there is no direct exchange of materials. Recall that there is also diffusion of substances other than oxygen, carbon dioxide, and nutrients.

Figure 21-14 The photograph shows the fetus at about three months. The body organs are present, and the heart can be heard beating using a stethoscope. The fetus is 8 cm to 10 cm long.

Figure 21-15 What are the differences between the development of fraternal and identical twins? Fraternal twins develop from two separate eggs that have been fertilized by different sperm. Identical twins are the result of one egg that has been fertilized by one sperm and later the resulting zygote splits.

Multiple Learning Styles
Visual-Spatial Have students prepare a series of actual-size cutouts of the fetus from two months to birth to have a visual demonstration of the size relationships of the developing baby.

Interpersonal Have students describe how substances are exchanged between the embryo or fetus and the mother. Determine whether they understand that there is no direct exchange of materials. Recall that there is also diffusion of substances other than oxygen, carbon dioxide, and nutrients.

Reteach Conduct a diffusion experiment to illustrate the process and reinforce the concept of diffusion through the placenta.

Extension For students who have mastered this section, use the Reinforcement and Enrichment masters.

Proficiency Prep
Use this quiz to check students’ recall of section content.
1. Of the millions of sperms deposited, how many will fertilize the egg? one
2. What attaches the embryo to the placenta? umbilical cord
3. When does the embryo begin to beat? early in the first three months of development
4. When has the fetus usually shifted to a head-down position? by the ninth month

Section Assessment
1. Sperm and egg combine, producing a zygote
2. During the embryo stage, the amniotic sac and placenta develop and all the embryo’s major organs form. During the fetal stage, the fetus continues to grow and develop.
3. The developing baby becomes a fetus after two months of pregnancy
4. Think Critically The exchange is due to diffusion between the capillaries, the umbilical cord, and the placenta.

Section Check
1. What happens when an egg is fertilized?
2. What is one major event that occurs during the embryo and fetal stages?
3. At what stage in the pregnancy does the embryo become a fetus?
4. Think Critically If a mother is taking drugs during pregnancy, how can these harmful substances pass into the blood system of the embryo?
5. Skill Builder Interpreting Data A human fetus grows at different rates during its development. Do the Chapter 21 Skill Activity on page 726 in the Skill Handbook and interpret data about fetal development.
6. Skill Builder From the third month to the fourth month there is a rapid increase in growth rate from 8 cm to 15 cm. Between the fifth and eighth months, there is a gradual increase in the size of the fetus. From the eighth month to the ninth month, there is an 11 cm increase in length.

Performance Assess students’ abilities to interpret data by having them make a statement about how the growth of a fetus compares with the growth rate of an embryo. Use Performance Assessment in the Science Classroom, p. 27.

Fraternal twins are the result of two eggs that are fertilized by two different sperms while identical twins are the result of one egg that has been fertilized by a single sperm cell.
Development After Birth

After developing for nine months within the mother, the baby is ready to be born. Like all newborn, living things, the baby finds itself suddenly pushed out into the world. Within the uterus and amniotic sac, the baby was in a warm, watery, dark, and protected environment. In contrast, the new environment is cooler, dryer, brighter, and not as protective.

Labor
The process of childbirth as shown in Figure 21-16 begins with labor, which is the muscular contractions of the uterus. As the contractions increase in strength and frequency, the amniotic sac usually breaks and releases its fluid. Over a period of hours, the contractions cause the opening of the uterus to widen to allow the baby to pass through. More powerful and frequent contractions push the baby out through the vagina into its new environment.

Sometimes, the mother’s pelvis is too small for the baby to fit through or the baby is in the wrong position for birth. In cases like this, the baby is delivered through an incision in the mother’s uterus and abdomen. This surgery is called cesarean section.

Infancy and Childhood
The first four weeks after birth are known as the neonatal period. Neonatal means “newborn.” During this time, the baby adjusts to life outside of the uterus. Body functions such as respiration, digestion, and excretion are now performed by the baby rather than through the placenta. Unlike some other living things, the human baby depends on others to survive. The human baby needs to be fed and have its diaper changed.

In contrast, a newborn colt begins walking a few hours after its birth. The human baby is ready to be born. Like all newborn, living things, the baby finds itself suddenly pushed out into the world. Within the uterus and amniotic sac, the baby was in a warm, watery, dark, and protected environment. In contrast, the new environment is cooler, dryer, brighter, and not as protective.

Post Labor
At birth, the baby is still attached to the umbilical cord and placenta. The person assisting with the birth of the baby ties the cord and then cuts it. The baby may cry. Crying forces air into its lungs. The scar that later forms where the cord was attached is the navel. Soon after the baby’s delivery, contractions expel the placenta from the mother’s body.

Infancy is a period of rapid growth and development. An early skill is the ability to walk with the child's help. What are some of the developments that occur during infancy?

Using Math
Cotton diapers can be reused up to 100 times before having to be replaced. Calculate how many diapers you would need for a year if an average of six were used each day. If a package of 12 cloth diapers costs $18, how much would be spent on the diapers for one year? Infer what other costs are involved.

Discussion
Interpersonal Discuss how the newborn infant must adjust to the new environment into which he or she has been born. Have students compare and contrast the conditions of the two environments.

Caption Answer
Figure 21-17 rapid mental and physical development, smile, laugh, sit up, simple words

Activity
• Have students bring photos of themselves at various stages (infant, child, adolescent) and describe favorite activities they remember from these stages.
• Have students conduct a survey of parents with young children. Ask questions such as: What do you enjoy most about your children? How difficult is it to care for your children?

Learning
Based on the observations in this photograph, students list some of the stages involved in childbirth.

Health
Arrange a visit to an X-ray lab to view X rays of bones of infants or young children and compare them with X rays of adults to show the differences in cartilage and bone. If a visit is impractical, other sources of X-ray photos may be available.
Infancy
The next stage of development is infancy, the period from the neonatal stage to one year. It is a period of rapid growth and development for both mental and physical skills. At around six weeks of age, babies are able to smile. At four months, most babies can laugh, sit up when propped, and recognize their mother’s face. At eight months, the infant is usually able to say a few simple words. One of the major events within the first year is the ability to stand unsupported for a few seconds. Some children walk before age one.

Childhood
After infancy is childhood, which lasts until age 12. The physical growth rate for height and weight is not as rapid as in infancy. However, muscular coordinations and mental abilities develop. By 18 months, the child is able to walk without help. Between two and three years, the child learns to control his or her bladder and bowel. At age three, the child can speak in simple sentences. By age five, many children can read a limited number of words. Throughout this stage, children develop their abilities to speak, read, write, and reason. At the same time, children also mature emotionally and learn how to get along with other people, as shown in Figure 21-18. Find out how old you were when you began to talk. What were your first words?

Adolescence
The next stage of development is adolescence. You are in this stage. Adolescence begins around ages 12 to 15. A part of adolescence is puberty. As you read earlier, puberty is the time of development when a person becomes physically able to reproduce. For girls, puberty occurs between ages eight and 13. For boys, puberty occurs between ages 13 and 15.

During puberty, hormones that cause changes in the body are produced by the pituitary gland. The hormone FSH helps produce reproductive cells. LH helps with the production of sex hormones. As a result of the secretion of these hormones, secondary sex characteristics, some of which are evident in Figure 21-19, result. 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 the growth of facial, pubic, and underarm hair; a deepened voice; and an increase in muscle size. Many young adults begin to feel sexual attraction, as well.

The Growth Spurt
Adolescence is the time of your final growth spurt. Are you shorter or taller than your classmates? Because of differences in the time hormones begin functioning among individuals

During the period from the neonatal stage to one year, the infant is able to smile. At four months, most babies can laugh, sit up when propped, and recognize their mother’s face.

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The Growth Spurt
Adolescence is the time of your final growth spurt. Are you shorter or taller than your classmates? Because of differences in the time hormones begin functioning among individuals.
At birth, the head of a newborn is about one-quarter of the total body length. Measure the head length and height of at least ten classmates and ten adults. Calculate the ratio of the head length to body length for the adolescents and the adults. Graph your data and compare the results.

Figure 21-21 Adulthood is the final stage of development. This is when the growth of the muscular and skeletal systems stops. What is the approximate age range for a person in middle adulthood?

Adulthood

The final stage of development is that of adulthood. It begins with the end of adolescence and extends to old age. Young adults are people in their twenties. Many young adults are completing an education, finding employment, and possibly marrying and beginning a family. This is when the growth of the muscular and skeletal system stops. You can see in Figure 21-20 how body proportions change as you grow from infancy to adulthood.

People from age 30 to age 60 are in the stage of middle adulthood. During these years, physical strength begins to decline. Blood circulation and respiration become less efficient. Bones become more brittle, and the skin’s elastic tissues are lost, causing the skin to become wrinkled. People in this group are busy with family and work commitments. They often care for aging parents, as well as children.

Senior Citizens

Think about someone you know over age 60. How is that person like or different from you? Around this age, many people retire. They take up hobbies, travel, or volunteer at hospitals and community organizations. Many continue to work. They are an active part of society. People over 75 years are placed in the oldest age group. While many in this group are mentally and physically active, others may need assistance in meeting their needs.

After birth, the stages of development of the human body begin with a baby making adjustments to a new environment. From infancy to adolescence, the body’s systems mature, enabling the person to be physically and mentally ready for adulthood. During the next 50 years or longer, people live their lives making contributions to family, community, and society. Throughout the life cycle, people who care for their health enjoy a higher quality of life.

Section Assessment

1. What are muscular contractions of the uterus during birth? labor
2. At approximately what age does adolescence begin? 12 to 13 years old
3. What is the final stage of development in humans? adulthood

Differential growth causes the head to grow less rapidly after birth, until the length of the head is approximately one eighth of the body length. Student’s data should approximate this ratio.

Proper Health

Health care.

Humans due to improved extension of the life span of health care.

From age 30 to

Figure 21-21

Caption Answers

4 Close

Proficiency Prep

Use this quiz to check students’ recall of section content.

1. What are muscular contractions of the uterus during birth? labor
2. At approximately what age does adolescence begin? 12 to 13 years old
3. What is the final stage of development in humans? adulthood

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 information for all three columns. If you need help, refer to page 702.

D. Adolescence person becomes physically able to reproduce
E. Adulthood several stages
1. early adult—20s
2. middle adult—30s to 50s
3. young-old—65 to 74 years
4. old-old—75 years+
New View of the Old

Imagine that you are 90 years old. How would you describe yourself? Some young people think that the elderly are forgetful and physically impaired. They associate certain conditions with aging—loss of hearing and sight, arthritis, osteoporosis, diabetes, and Alzheimer's disease, for example. They assume that older people have less physical energy and mental ability than younger people.

A New View

This new image of the physical and mental wellness of the very old has had an effect on health care. Traditionally, health care programs have assumed that more and more resources would be needed as a person grows older. However, the overall good health of people over 90 may keep their health maintenance costs lower than predicted.

Teaching Strategies

• Have students conduct a survey of parents, relatives, or friends to find out about elderly persons who are still active and in social activities. If possible, have each student interview at least one active person who is more than 80 years old. Have students look for patterns in the interviews. Do the interviewees share common health and lifestyle habits?

• Based on the results of their interviews, have students make a list of things they can do to live a longer life.

• Have students brainstorm some common daily problems of the elderly.

For More Information

American Society on Aging
633 Market St., Suite 512
San Francisco, CA 94103
415-882-2910
201 HUMAN REPRODUCTION
Reproduction is a means to continue life. The union of an egg and sperm starts the process of development from a zygote to a complete human being. The reproductive system allows new organisms to be created. Tests in males produce sperm. Sperm are single cells with a head and a tail. The tail allows the sperm to move as it travels through the uterus and along the oviduct to the egg. Eggs are produced by the ovaries in females. An egg is released from one of the ovaries on about the fourteenth day of the menstrual cycle. The egg is drawn into the oviduct, where fertilization can occur. The fertilization of an egg by a sperm forms new life. Eggs that are not fertilized disintegrate, and the lining of the uterus is shed. What are the differences in the structure of the egg and sperm?

202 FERTILIZATION TO BIRTH
When fertilized, the egg forms a zygote. The zygote moves through the oviduct and implants in the wall of the uterus. During the first two months of pregnancy, the unborn child is known as an embryo. A placenta forms, and the umbilical cord supplies nutrients and oxygen from the mother to the baby. Wastes are carried away through the umbilical cord. After two months, the body organs have formed and the developing baby is called a fetus. After nine months, the developed baby is pushed out of the mother by contractions of the uterus. Twins occur when two eggs are fertilized or when a single egg splits after fertilization. Why are so many sperm released if only one is needed to fertilize the egg?

203 DEVELOPMENT AFTER BIRTH
Infancy is the stage of development from the neonatal period to one year. This stage is followed by childhood, which lasts to age 12 and is marked by development of muscular coordination and mental abilities. Adolescence is when a person becomes physically able to reproduce. The final stage of development is adulthood. A number of conditions are associated with aging. Certain genes are believed to be responsible for aging and for a person’s adaptive ability and functional reserve. How are the characteristics of the stages of infancy and childhood alike?
Using Vocabulary

- adolescence
- adulthood
- amniotic sac
- atrium
- atery
- embryo
- fetus
- infancy
- testis
- menstrual cycle
- menstruation

Which science term describes each of the following?

1. birth canal
2. egg-producing organ
3. release of egg from the ovary
4. place where a fertilized egg develops into a baby
5. membrane that protects the unborn baby

Checking Concepts

Choose the word or phrase that best answers the question.

6. Where does the embryo develop?
   - a) ovary
   - b) uterus
   - c) ovary
   - d) ovary
   - e) ovary

7. What is the monthly process of egg release called?
   - a) ovulation
   - b) ovulation
   - c) ovulation
   - d) puberty
   - e) puberty

8. What is the union of an egg and sperm?
   - a) fertilization
   - b) fertilization
   - c) fertilization
   - d) ovulation
   - e) ovulation

9. Where is the egg fertilized?
   - a) ovary
   - b) uterus
   - c) ovary
   - d) ovary
   - e) ovary

10. During which period do mental and physical skills rapidly develop?
    - a) the neonatal C) adulthood period
    - b) infancy D) adolescence
    - c) infancy
    - d) puberty

11. During which period does puberty occur?
    - a) adulthood
    - b) adulthood
    - c) adulthood
    - d) infancy

12. What are sex characteristics common to both males and females?
    - a) breasts
    - b) increased fat
    - c) increased fat
    - d) pubic hair

13. During which period does growth stop?
    - a) childhood
    - b) adulthood
    - c) adolescence
    - d) infancy

14. What is the period of development with three stages?
    - a) infancy
    - b) adulthood
    - c) adulthood
    - d) childhood

15. During which period does the ability to reproduce begin?
    - a) adolescence
    - b) adulthood
    - c) childhood
    - d) infancy

Thinking Critically

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

17. Identify the structure in which each process occurs: ovulation, fertilization, and implantation.

18. When does menopause occur?

19. What kind of cell division occurs during mitosis?

20. Describe one major change in each stage of human development.

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

Worksheet: Use the following terms to create a concept map: ovary, ovulation, oviduct, uterus, and ovary.

Hypothesizing: Make a hypothesis about the effects of raising identical twins apart from each other.

Making and Using Graphs: The growth of an embryo does not occur at the same rate throughout development. Use the data below to make a graph showing the week of development versus size of the embryo. When is the fastest period of growth?

<table>
<thead>
<tr>
<th>Week After Fertilization</th>
<th>Size (mm)</th>
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<tbody>
<tr>
<td>3</td>
<td>3</td>
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<tr>
<td>4</td>
<td>6</td>
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<td>5</td>
<td>12</td>
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<td>7</td>
<td>4</td>
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<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Embryo Size During Development

Week After Fertilization

1. If you need help, refer to the Skill Handbook.
2. Classifying: Classify each of the following structures of the male and female reproductive systems as male or female and internal or external: ovary, penis, scrotum, testes, uterus, and vagina.
3. Classifying: Classify each of the following: ovary, penis, scrotum, testes, uterus, and ovary.
4. Hypothesizing: Make a hypothesis about the effects of raising identical twins apart from each other.
5. Making and Using Graphs: The growth of an embryo does not occur at the same rate throughout development. Use the data below to make a graph showing the week of development versus size of the embryo. When is the fastest period of growth?
6. Thinking Critically: Explain the similar functions of the ovaries and testes.
7. Identifying: Identify the structure in which each process occurs: ovulation, fertilization, and implantation.
8. When does menopause occur?
9. What kind of cell division occurs during mitosis?
10. Describe one major change in each stage of human development.

Test-taking Tip

Maximize Your Score: Ask how your test will be scored. In order to do your best, you need to know if there is a penalty for guessing, and if so, how much of one. If there is no penalty at all, you should always fill in what you think is the best answer.

Test Practice

Use these questions to test your Science Proficiency.

1. During the menstrual cycle, the lining of the uterine thickens. Which statement best explains the need for this phase?
   - a) to prepare the uterus for fertilizing an egg
   - b) to prepare the uterus for discharging excess eggs from the body
   - c) to prepare the uterus for supporting and nourishing the developing embryo
   - d) to prepare the uterus for hormones that fight infections

2. Sperm travel a long pathway before being discharged from the body. Which statement explains the correct sequence of structures through which the sperm pass?
   - a) testes—sperm duct—seminal vesicles—urethra
   - b) testes—sperm duct—urethra
   - c) seminal vesicles—urethra
   - d) testes—seminal vesicles—urethra

3. Students should make line or bar graphs with the headings Weeks After Fertilization on the x-axis and Size (in mm) on the y-axis. The most rapid period of growth occurs between weeks seven and eight.

4. Labor—amniotic sac breaks—baby moves out of uterus and vagina

5. The Test-Taking Tip was written by The Princeton Review, the nation’s leader in test preparation.

6. A

Developing Skills

1. Neonatal: adjusts to life outside the uterus; Infancy: rapid growth and development of mental and physical skills—speak, stand; Childhood: development of mental and muscle coordination—walk, talk, read, reason; Adolescence: puberty—ability to reproduce, secondary sex characteristics and growth, increased reasoning; Adult—three stages—growth of muscular and skeletal system stops.

2. Neonatal: adjusts to life outside the uterus; Infancy: rapid growth and development of mental and physical skills—speak, stand; Childhood: development of mental and muscle coordination—walk, talk, read, reason; Adolescence: puberty—ability to reproduce, secondary sex characteristics and growth, increased reasoning; Adult—three stages—growth of muscular and skeletal system stops.

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