39–4 (continued)

1 FOCUS

Objectives

39.4.1 ***Describe*** fertilization.
39.4.2 ***Identify*** the stages of early development.
39.4.3 ***Describe*** the function of the placenta.
39.4.4 ***Outline*** the life cycle after birth.

Guide for Reading

Vocabulary Preview

Challenge students to predict what the Vocabulary words mean by writing a definition for each word. As they read the section, students should check their predictions and revise their definitions as needed.

Reading Strategy

Before they read the section, have students use the headings and subheadings to make an outline. Then, as they read, they should fill in phrases under the headings and subheadings to provide key information.

2 INSTRUCT

Fertilization

Use Community Resources

Invite a medical professional from the community to address the class about fertility problems. Good choices of speakers include specialists in obstetrics or endocrinology. Suggest that the speaker address both causes and treatments of infertility. Other relevant topics might include the emotional and financial costs of infertility problems and treatments. Urge students to ask questions after the presentation. L2

39–4 Fertilization and Development

Guide for Reading

Key Concepts
- What is fertilization?
- What are the stages of early development?
- What is the function of the placenta?

Vocabulary
zygote
implantation
differentiation
gastrulation
neurulation
placenta
fetus

Reading Strategy: Using Graphic Organizers
As you read, draw a flowchart that shows the steps from fertilized egg to newborn baby.

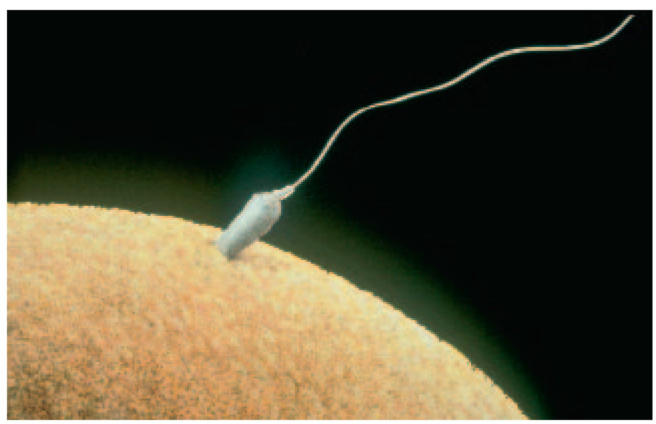
When an egg is fertilized, the remarkable process of human development begins. In this process, a single cell no larger than the period at the end of this sentence undergoes a series of cell divisions that results in the formation of a new human being.

Fertilization

If an egg is to become fertilized, sperm must be present in the female reproductive tract—usually, in a Fallopian tube. During sexual intercourse, sperm are released when semen is ejaculated through the penis into the vagina. The penis generally enters the vagina to a point just below the cervix, which is the opening that connects the vagina to the uterus. Sperm swim actively through the uterus into the Fallopian tubes. Hundreds of millions of sperm are released during an ejaculation, so that if an egg is present in one of the Fallopian tubes, its chances of being fertilized are good.

The egg is surrounded by a protective layer that contains binding sites to which sperm can attach. When a sperm attaches to a binding site, a sac in the sperm head releases powerful enzymes that break down the protective layer of the egg. The sperm nucleus then enters the egg, and chromosomes from the sperm and egg are brought together. **The process of a sperm joining an egg is called fertilization.** After the two haploid (N) nuclei (one from the sperm and one from the egg) fuse, a single diploid (2N) nucleus is formed. A diploid cell contains a set of chromosomes from each parent cell. The fertilized egg is called a **zygote.**

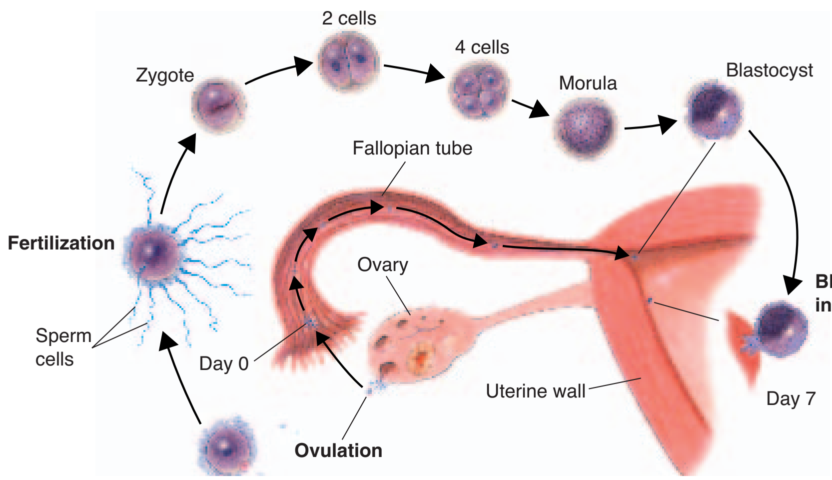
Figure 39–18 **The process by which a sperm joins an egg is called fertilization.** Ernest Everett Just (left) discovered that once the sperm nucleus enters the egg, the egg's cell membrane changes, preventing other sperm from entering.



SECTION RESOURCES

Print:
- ***Teaching Resources,*** Lesson Plan 39–4, Adapted Section Summary 39–4, Adapted Worksheets 39–4, Section Summary 39–4, Worksheets 39–4, Section Review 39–4, Enrichment
- ***Reading and Study Workbook A,*** Section 39–4
- ***Adapted Reading and Study Workbook B,*** Section 39–4
- ***Issues and Decision Making,*** Issues and Decisions 6, 45

Technology:
- ***iText,*** Section 39–4
- ***Transparencies Plus,*** Section 39–4



What prevents more than one sperm from fertilizing an egg? Early in the twentieth century, cell biologist Ernest Everett Just, shown in **Figure 39–18,** found the answer. The egg cell contains a series of granules just beneath its outer surface. When a single sperm enters the egg, the egg reacts by releasing the contents of these granules outside the cell. The material in the granules coats the surface of the egg, forming a barrier that prevents other sperm from attaching to and entering the egg.

▲ **Figure 39–19** If an egg is fertilized, a zygote forms and begins to undergo cell division (mitosis) as it travels to the uterus. (The egg in this illustration has been greatly enlarged.) **Interpreting Graphics** ***How much time passes before the blastocyst is attached to the uterine wall?***

Early Development

While still in the Fallopian tube, the zygote begins to undergo mitosis, as shown in **Figure 39–19.** Cell division continues. As each cell divides, the number of cells doubles. Four days after fertilization, the embryo is a solid ball of about 64 cells called a morula (MAWR-yoo-luh). **The stages of early development include implantation, gastrulation, and neurulation.**

Implantation As the morula grows, a cavity forms in the center. This transforms the morula into a hollow structure with an inner cavity called a blastocyst. About six or seven days after fertilization, the blastocyst attaches itself to the wall of the uterus. The embryo secretes enzymes that digest a path into the soft tissue. This process is known as **implantation.**

At this point, cells in the blastocyst begin to specialize as a result of the activation of genes. This specialization process, called **differentiation,** is responsible for the development of the various types of tissue in the body. A cluster of cells, known as the inner cell mass, develops within the inner cavity of the blastocyst. The embryo itself will develop from these cells, while the other cells of the blastocyst will differentiate into the tissues that surround the embryo.

Early Development

Build Science Skills

Using Models Challenge students to use illustrations in reference books to create three-dimensional clay models of the zygote, morula, and blastocyst stages. Have students show their models to the class. Ask: **What changes have occurred at each stage?** *(From the single-celled zygote to the morula stage, cell divisions have produced a solid mass of cells. By the blastocyst stage, the mass of cells has become a hollow, fluid-filled ball.)* L1 L2

Use Visuals

Figure 39–19 Ask: **Where does fertilization usually occur?** *(In the Fallopian tube)* **How does the zygote differ from the egg that has just been released from the ovary?** *(It has been fertilized by a sperm, making it a diploid cell.)* **What happens to the zygote before it reaches the uterus?** *(It undergoes many cell divisions.)* **At what stage does implantation occur?** *(At the blastocyst stage)* L1 L2

Make Connections

Health Science Tell students that in about one percent of pregnancies, the blastocyst implants in the Fallopian tube or abdominal cavity instead of in the wall of the uterus. When this occurs, it is called ectopic pregnancy. It poses serious risks for both fetus and mother. Diagnosis of an ectopic pregnancy can be made with an ultrasound examination. L2

UNIVERSAL ACCESS

English Language Learners
The technical terms in this section may be difficult for students to master. Give them extra practice by having them write each word and its definition on opposite sides of an index card. They should write the definitions in both English and their native language. For more reinforcement, have pairs of students use the cards to quiz each other on the spelling, pronunciation, and meaning of each term. L1 L2

Advanced Learners
Give students an extra challenge by having them research dangers to the embryo during weeks four through nine of gestation. Students should find out which substances are toxic and how they affect the embryo during each week of development. *(Students may find out, for example, that infectious agents can cause heart defects in week five and blindness in week six.)* L3

Answer to . . .

Figure 39–19 *7 days*

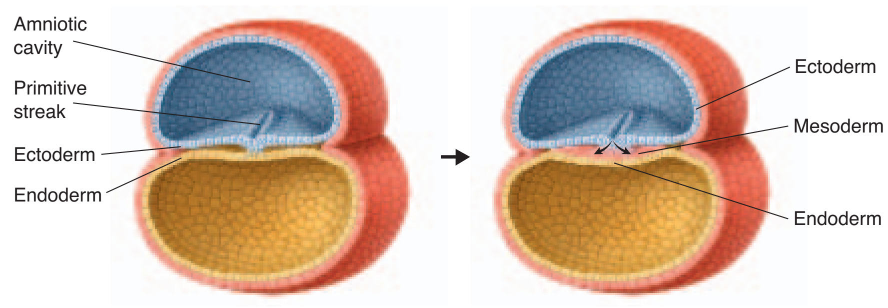
39–4 (continued)

Build Science Skills

Classifying Have students classify organs of the body according to the primary germ layers from which they originate. This will help them appreciate the significance of the germ layers. First, write the terms *Ectoderm, Mesoderm,* and *Endoderm* on the board. Then, name several different organs—for example, uterus, small intestine, skin, heart, stomach, and brain—and challenge students to list each organ under the correct germ layer. *(For the examples given, students should list uterus and heart under* Mesoderm, *skin and brain under* Ectoderm, *and stomach and small intestine under* Endoderm.*)* L1 L2

Use Visuals

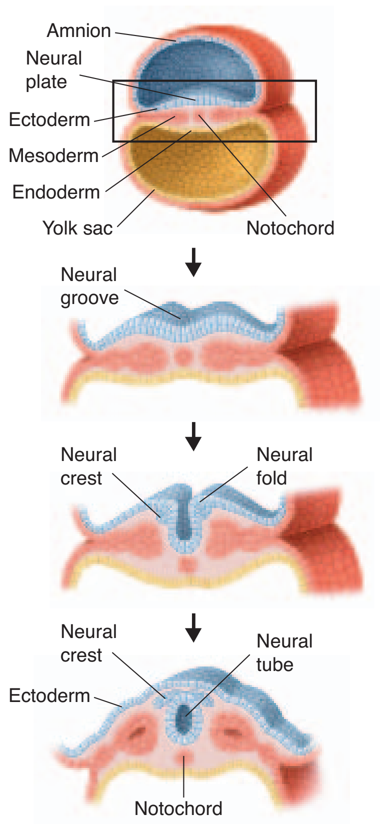
Figure 39–21 Help students appreciate the details of the central nervous system formation shown in the figure by challenging them to find everything that differs from one drawing to the next in the sequence. Also, call on students to identify the three cell layers—ectoderm, mesoderm, and endoderm—in each drawing. L1 L2



▲ **Figure 39–20** **Gastrulation results in the formation of three cell layers.** The diagram on the left shows the primitive streak, a line that forms in the center of the blastocyst. The movement of cells away from the primitive streak, shown in the diagram on the right, forms the mesoderm.

Gastrulation The inner cell mass of the blastocyst gradually sorts itself into two layers, which then give rise to a third layer. The third layer is produced by a process of cell migration known as **gastrulation** (gas-troo-LAY-shun), shown in **Figure 39–20.** The result of gastrulation is the formation of three cell layers: ectoderm, mesoderm, and endoderm. These three layers are referred to as the primary germ layers, because all of the organs and tissues of the embryo will be formed from them. The ectoderm will develop into the skin and the nervous system. The endoderm forms the lining of the digestive system and many of the digestive organs. Mesoderm cells differentiate to form many of the body's internal tissues and organs.

Neurulation Gastrulation is followed by an important step in human development, neurulation (NUR-uh-lay-shun). **Neurulation** is the development of the nervous system. Shortly after gastrulation is complete, a block of mesodermal tissue begins to differentiate into the notochord. Recall that all chordates possess a notochord at some stage of development. As the notochord develops, the neural groove changes shape, producing a pair of ridges, or neural folds, as shown in **Figure 39–21.** Gradually, these folds move together to create a neural tube from which the spinal cord and the rest of the nervous system, including the brain, develop.



◀ **Figure 39–21** **Neurulation is the formation of the central nervous system.** The ectoderm near the notochord thickens and forms the neural plate. The raised edges of the neural plate form neural folds. The neural folds gradually move together and fuse to form the neural tube. One end of the neural tube will develop into the brain; the other end develops into the spinal cord. Cells of the neural crest migrate to other locations and develop into nerves.

BIO INSIGHTS

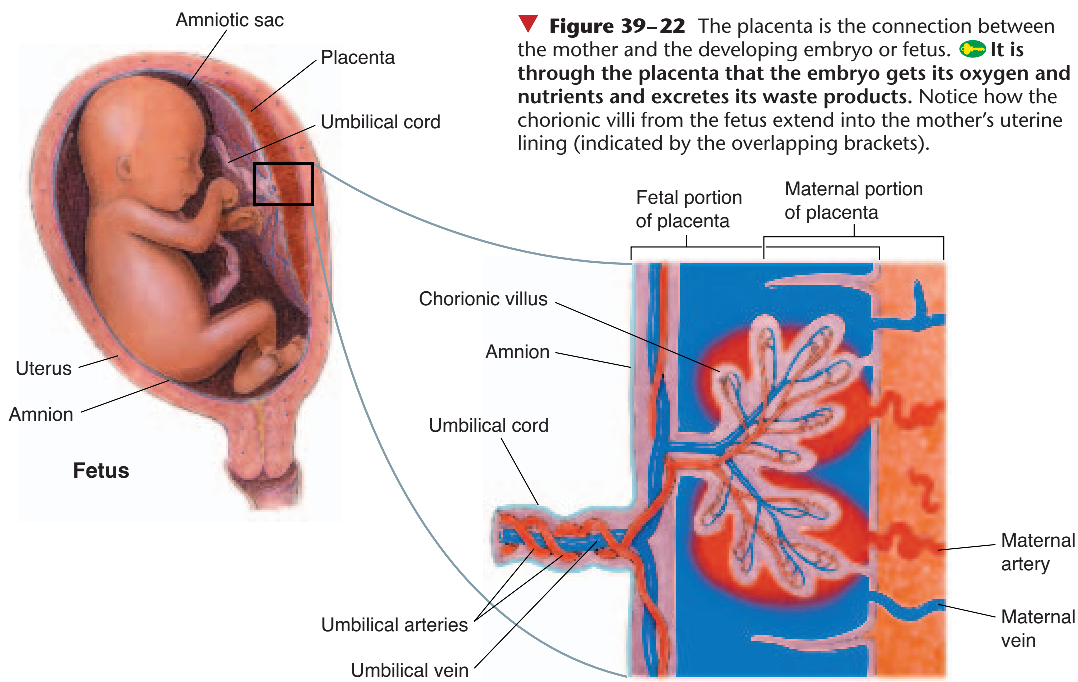
HISTORY OF SCIENCE

Observing fertilization
Scientists of antiquity could not observe fertilization, so they had no direct evidence for how it occurs. Aristotle thought that semen was a seed that gave rise to a new individual and that the female body was simply the place where the seed was nourished. In the mid-1600s, when microscopes were invented, scientists were able to see human sperm for the first time. Even then, however, some claimed they saw a tiny human, which they named homunculus, within each sperm. Scientists of the 1700s and 1800s studied frog eggs, because amphibian eggs are large enough to be seen with a magnifying glass. They were able to see how fertilized eggs developed from zygote to morula and blastocyst stages. Human eggs were first viewed in the early 1900s, but it was not until the 1940s that the fertilization of human eggs was observed directly.

Extraembryonic Membranes As the embryo develops, membranes form to protect and nourish the embryo. Two of these membranes are the amnion and the chorion. The amnion develops into a fluid-filled amniotic sac, which cushions and protects the developing embryo within the uterus. By the end of the third week of development, the chorion—the outermost of the extraembryonic membranes—has formed. Small, fingerlike projections called chorionic villi form on the outer surface of the chorion and extend into the uterine lining.

The chorionic villi and uterine lining form a vital organ called the **placenta.** The placenta is the connection between mother and developing embryo. The developing embryo needs a supply of nutrients and oxygen. It also needs a means of eliminating carbon dioxide and metabolic wastes. Nutrients and oxygen in the blood of the mother diffuse into the embryo's blood in the chorionic villi. Wastes diffuse from the embryo's blood into the mother's blood.

In actuality, the blood of the mother and that of the embryo flow past each other, but they do not mix. They are separated by the placenta. Across this thin barrier, gases exchange, and food and waste products diffuse. **The placenta is the embryo's organ of respiration, nourishment, and excretion.** The placenta allows the embryo to make use of the mother's organ systems while its own are developing. **Figure 39–22** shows a portion of the placenta.



▼ **Figure 39–22** The placenta is the connection between the mother and the developing embryo or fetus. **It is through the placenta that the embryo gets its oxygen and nutrients and excretes its waste products.** Notice how the chorionic villi from the fetus extend into the mother's uterine lining (indicated by the overlapping brackets).

Demonstration

Demonstrate the important role played by the amnion. Put a raw egg inside a gallon-size resealable plastic storage bag, fill the bag with water, and seal it shut. Challenge one or more students to try to break the egg without removing the egg or water from the bag. Then, ask: **If the amnion is like the storage bag, what role does it play in fetal development?** *(It cushions the developing fetus from outside injuries.)* **When might this be important?** *(Possible answers might include in case the mother falls or is in an automobile accident.)* L1 L2

Make Connections

Health Science Point out that the mother's antibodies may cross the placenta, which helps protect the child if the antibodies are specific to foreign invaders, such as viruses and bacteria. However, if the antibodies are specific to the child's own blood cells, it can lead to fatal complications for the fetus. This can occur if the mother is Rh negative and the fetus is Rh positive, meaning that the fetal blood cells carry the Rh antigen. Explain that the presence of the Rh antigen in the fetal blood stimulates the mother to produce antibodies against it. Conclude by saying that drugs to suppress the formation of antibodies against the Rh antigen can be given to the mother to prevent problems for the Rh-positive fetus. L2

BIO INSIGHTS

BIOLOGY UPDATE

Fetal surgery for spina bifida
About 1 in every 1000 children is born with spina bifida, a condition in which some of the vertebrae do not develop normally, leaving part of the spinal cord exposed to damage from amniotic fluid before birth and from infection and injury during and after birth. Symptoms of spina bifida depend on the extent to which the spinal cord is exposed and damaged. In severe cases, the condition may cause hydrocephalus (water on the brain), mental retardation, abnormalities of the kidneys and bladder, and physical deformities. In the mid-1990s, doctors performed the first successful human fetal surgery to help correct spina bifida in utero. Since then, many more fetal surgeries for spina bifida have been performed with good results. Spina bifida babies who have fetal surgery require fewer postnatal shunt procedures to control hydrocephalus, and they are less likely to develop malformations of the hindbrain.

39–4 (continued)

Go Online NSTA SciLinks

Download a worksheet on human growth and development for students to complete, and find additional teacher support from NSTA SciLinks.

Use Community Resources

Ask a physician's assistant, nurse, or technician who assists with or performs pregnancy ultrasound scans to speak to the class about the procedure. Suggest that the speaker address such topics as why and when ultrasound scans are performed during pregnancy and what can be learned from them. If possible, have the speaker bring sample ultrasound scans of fetuses at different stages of development to show the class. Ask students to write a brief summary of what they learn. L2

Control of Development

Build Science Skills

Making Judgments After students have read about the role of stem cells in fetal development, have them go online to find information on the use of stem cells in scientific research. Encourage students to make a judgment, based on what they learn, about whether the advantages of stem cell research outweigh any potential disadvantages. Call on volunteers to share their judgments with the class. L2 L3

Go Online NSTA SciLinks

For: Links on human growth and development
Visit: www.SciLinks.org
Web Code: cbn-0394

Importance of Development This early period of development is particularly important because a number of external factors can disrupt development at this time. The placenta acts as a barrier to some harmful or disease-causing agents. Other disease-causing agents, including the ones that cause AIDS and German measles, can penetrate the placenta and affect development. So can drugs—including alcohol, medications, and addictive substances.

After eight weeks of development, the embryo is called a **fetus.** By the end of three months of development, most of the major organs and tissues of the fetus are fully formed. During this time, the umbilical cord also forms. The umbilical cord, which contains two arteries and one vein, connects the fetus to the placenta. The muscular system of the fetus is by now well developed, and the fetus may begin to move and show signs of reflexes. The fetus is about 8 centimeters long and has a mass of about 28 grams.

CHECKPOINT *What is the function of the umbilical cord?*

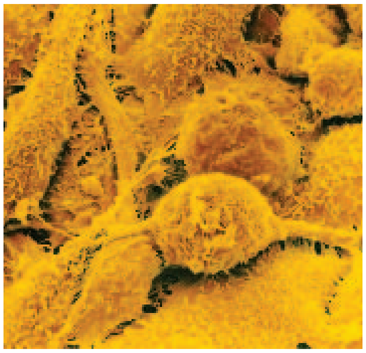
Control of Development

As you have read, over just a few weeks of development, a single zygote cell differentiates into the many complex cells and tissues of a human fetus. How does this happen? Is the fate of each cell in the embryo predetermined? Is there a master control switch that decides whether a cell will become skin, muscle, blood, or bone?

These are the kinds of questions that fascinate developmental biologists, who study the processes by which organisms grow and develop. Although many of the most important questions about development are still unanswered, researchers have made remarkable progress in the last few years. One of their most surprising findings is that the fates of many cells in the early embryo are not fixed. In mice, for example, researchers can mix cells from the inner cell mass of two different embryos. Rather than growing into a jumble of disorganized tissues, a perfectly normal mouse develops. This suggests that embryonic cells communicate with one another to regulate development and differentiation.

This finding is confirmed by experiments showing that the inner cell mass contains embryonic stem cells, unspecialized cells like those in **Figure 39–23**, which are capable of differentiating into nearly any specialized cell type. Researchers are now working to learn the mechanisms that control stem cell differentiation, hoping eventually to grow new tissue to repair the damage caused by injury or disease to individuals after birth.

Stem cells are also found in adult tissues, including the blood-forming tissues of the bone marrow, and even in the brain. The developmental potential of adult stem cells is only beginning to be understood, but it is already clear that they also have the ability to differentiate into a wide variety of cell types.



▲ **Figure 39–23** This artificially colored SEM shows embryonic stem cells. Stem cells differentiate into cells that form the endoderm, ectoderm, and mesoderm. These cells then undergo further differentiation to form all of the body's specialized cells.

Later Development

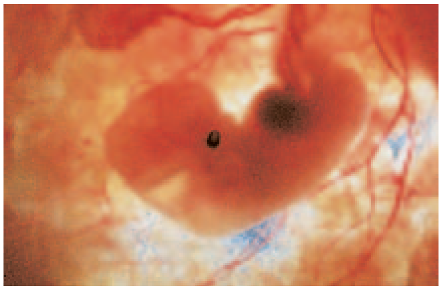
During the fourth, fifth, and sixth months after fertilization, the tissues of the fetus become more complex and specialized, and begin to function. The fetal heart becomes large enough so that it can be heard with a stethoscope. Bone continues to replace the cartilage that forms the early skeleton. A layer of soft hair grows over the fetus's skin. As the fetus increases in size, the mother's abdomen swells to accommodate it. The mother can begin to feel the fetus moving.

During the last three months, the organ systems mature, and the fetus grows in size and mass. The fetus doubles in mass, and the lungs and other organs undergo a series of changes that prepare them for life outside the uterus. The fetus is now able to regulate its body temperature. In addition, the central nervous system and lungs complete their development. **Figure 39–24** shows an embryo and a fetus at different stages of development.

On average, it takes nine months for a fetus to fully develop. Babies born before eight months of development, called premature babies, often have severe breathing problems because of incomplete lung development.

CHECKPOINT *What happens in a fetus during the last three months of development?*

Figure 39–24 At 7 weeks, most of the organs have begun to form. The heart—the large, dark rounded structure—is beating. By 14 weeks, the hands, feet, and legs have reached their birth proportions. The eyes, ears, and nose are well developed. When the fetus is full-term, it is fully developed and capable of living on its own. **Interpreting Graphics** *What significant changes do you see from 7 weeks to 14 weeks?*



Embryo at 7 Weeks

Fetus at 14 Weeks

Fetus at Full Term

Later Development

Make Connections

Mathematics Guide students in using mathematics to appreciate how quickly a fetus grows. Draw a small dot on the chalkboard, and tell students that the dot represents a fertilized egg. Point out that an actual human egg is smaller, about 0.1 mm in diameter and barely visible with the unaided eye. Then, show students a baby doll that is about the same size as a newborn, or about 50 cm in length. Ask: **How fast must the fetus grow to change from the size of an egg to the size of a newborn in nine months of gestation?** *(About 56 mm per month)* Ask: **How tall would the individual be by age 15 if growth continued at that rate?** *(About 10 meters tall)* L2

Answers to . . .

CHECKPOINT *The umbilical cord connects the fetus to the placenta.*

CHECKPOINT *During the last three months of development, the organ systems mature and the fetus grows in size and mass.*

Figure 39–24 *The hands, feet, and legs have reached their birth proportions, and the eyes, ears, and nose are visible.*

39–4 (continued)

Quick Lab

Objective Students will be able to observe at which stage frog embryos start to show developmental changes.

Skills Focus **Observing, Drawing Conclusions**

Materials dropper pipette, early-stage frog embryos, depression slide, dissecting microscope, prepared slides of frog embryos

Time 20 minutes

Advance Prep Order frog eggs so that they arrive just before you need them, because they develop into tadpoles within a week.

Safety Remind students to handle microscope slides carefully.

Strategy Guide students in looking for visible differences such as cell size and shape.

Expected Outcome
After observing cells, students should conclude that frog embryos start to show developmental changes in the late gastrula or early neurula stage.

Analyze and Conclude

1. Differences in cell size are visible at the gastrula stage.

2. The body plan becomes visible after neurulation, as the embryo elongates and the head and tail become recognizable.

3. Organ formation is first visible at the neurula stage, as the neural tube takes shape.

Childbirth

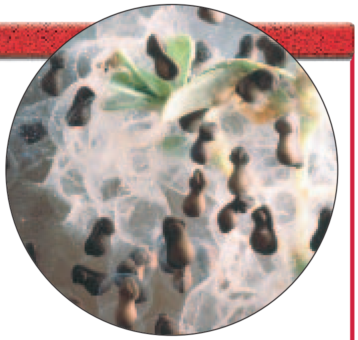
Make Connections

Health Science Tell students that the health status of a newborn is assessed at one minute after birth with a procedure called the Apgar test. The infant is given a score of 0, 1, or 2 on each of the following five items: heart rate, respiration, muscle tone, response to stimuli, and color. The maximum score is 10, and a score of 7 to 10 is generally considered normal. Infants with lower scores need immediate medical attention. Ask: **Which body systems are assessed with the Apgar test?** *(Cardiovascular, respiratory, muscular, and nervous systems)* L2

Quick Lab

How do embryos develop?

Frog Embryos



Materials dropper pipette, early-stage frog embryos, depression slide, dissecting microscope, prepared slides of frog embryos

Procedure

1. Use a dropper pipette to transfer several early-stage frog embryos in water to a depression slide. **CAUTION:** *Microscopes and slides are fragile. Handle them carefully. Tell your teacher if you break any glass.*
2. Look at the embryos under the dissecting microscope at low power. Sketch what you see.
3. Look at prepared slides of the early embryonic stages of a frog. Make sketches of what you see.

Analyze and Conclude

1. **Observing** Describe any differences you saw among the cells. At what stage is cell differentiation visible?
2. **Observing** Were you able to see a distinct body plan? At what stage did the body plan become visible?
3. **Drawing Conclusions** Describe any organs you saw. At what stage did specific organs form?

Childbirth

About nine months after fertilization, the fetus is ready for birth. A complex set of factors affects the onset of childbirth. One factor is the release of the hormone oxytocin from the mother's posterior pituitary gland. Oxytocin affects a group of large involuntary muscles in the uterine wall. As these muscles are stimulated, they begin a series of rhythmic contractions known as labor. The contractions become more frequent and more powerful. The opening of the cervix expands until it is large enough for the head of the baby to pass through it. At some point, the amniotic sac breaks, and the fluid it contains rushes out of the vagina. Contractions of the uterus force the baby, usually head first, out through the vagina.

As the baby meets the outside world, he or she may begin to cough or cry, a process that rids the lungs of fluid. Breathing starts almost immediately, and the blood supply to the placenta begins to dry up. The umbilical cord is clamped and cut, leaving a small piece attached to the baby. This piece will soon dry and fall off, leaving a scar known as the navel—or in its more familiar term, the belly button. In a final series of uterine contractions, the placenta itself and the now-empty amniotic sac are expelled from the uterus as the afterbirth.

The baby now begins an independent existence. Most newborn babies are remarkably hardy. Their systems quickly switch over to life outside the uterus, supplying their own oxygen, excreting wastes on their own, and maintaining their own body temperatures.

▼ **Figure 39–25** A newborn baby takes its first breath of air.

BIO INSIGHTS — HISTORY OF SCIENCE

Caesarean section
Caesarean section is an operation in which a baby is removed from a mother's body through incisions in her abdominal wall and uterus. It is a procedure that is referred to in folklore from around the world. The name may have come from a Roman law, under Julius Caesar, that required all women dying in childbirth to undergo the procedure in order to save their offspring. The law may have been part of an imperialistic effort to increase the Roman population. Until the development of anesthetics, antibiotics, and modern surgical procedures over the past two centuries, caesarean sections were extremely painful and had a high risk of death for both mother and infant. Therefore, a caesarean section was almost always a last resort, performed only when the mother was dead or dying and for the sole purpose of trying to save her infant's life.

The interaction of the mother's reproductive and endocrine systems does not end at childbirth. Within a few hours after birth, the pituitary hormone prolactin stimulates the production of milk in the breast tissues of the mother. The nutrients present in that milk contain everything the baby needs for growth and development during the first few months of life.

Multiple Births

Sometimes more than one baby develops during a pregnancy. For example, if two eggs are released during the same cycle and fertilized by two different sperm, fraternal twins result. Fraternal twins are not identical in appearance because each has been formed by the fusion of a different sperm and egg cell. Fraternal twins may or may not be the same sex.

Sometimes a single zygote splits apart to produce two embryos. These two embryos are called identical twins. Identical siblings are formed by the fusion of the same sperm and egg cell; therefore, they are genetically identical. Identical twins are always the same sex.

CHECKPOINT *What are the differences between identical twins and fraternal twins?*

Early Years

Although the most spectacular changes of the human body occur before birth, development is a continuing process—it lasts throughout the life of an individual. In the first weeks of a baby's life, the systems that developed before birth now move into high gear, supporting rapid growth that generally triples a baby's birth weight within 12 months.

Infancy The first two years of life are known as infancy. Infancy is a period of rapid growth and development. The nervous system develops coordinated body movements as the infant begins to crawl and then to walk. A baby's first teeth appear, and the baby begins to understand and use language. Growth in the skeletal and muscular systems is especially rapid, demanding good nutrition to support proper development.

Childhood Childhood lasts from infancy until the onset of puberty, typically at an age of 12 or 13. Children become more active and independent. Language is acquired, motor coordination is perfected, permanent teeth begin to appear, and the long bones of the skeletal system reach 80 percent of their adult length. The key elements of personality and human social skills are developed, and reasoning skills are developed to a high level.

Figure 39–26 During infancy, an infant learns to stand, walk, speak a few words, and imitate others. From ages 5 to 12, children grow to about 70 percent of their adult height and weight.

Use Community Resources

Arrange for a Lamaze instructor to visit the class to demonstrate the Lamaze method for helping women cope with the pain of childbirth. Have the instructor explain the philosophy behind the Lamaze method and describe what else is taught in Lamaze classes. After the visit, ask students: **Under what other circumstances might the Lamaze method be useful?** *(Whenever a person has to cope with severe stress or pain)* L2

Multiple Births

Build Science Skills

Applying Concepts Tell students that some fertility treatments increase the chances of multiple births by causing more than one egg to be released during ovulation. Ask: **Which type of twins, identical or fraternal, would be produced in such cases?** *(Fraternal twins, because they result from the fertilization of two eggs)* L1 L2

Early Years

Demonstration

Have students bring in photographs of themselves when they were less than two years of age. Display the unlabeled photos in the classroom, and challenge students to identify as many of their classmates as they can. Then, ask: **In what ways do people change physically between infancy and adolescence?** *(People change in body size and proportions. Their facial features also become larger and more mature looking.)* **What are some of the features that remain constant enough that we can use them for identification?** *(Students might mention skin or eye color or the shape of certain distinctive facial features, such as the nose, chin, or eyes.)* Point out that features such as eye color and skin tone can change during infancy. L1

BIO INSIGHTS

FACTS AND FIGURES

Multiple births

Multiple births occur normally in many species of mammals, but they are relatively uncommon in humans. Human twins are born in one out of about 90 births, triplets in one out of about 8000 births, and quadruplets in one out of about 750,000 births. Approximately 70 percent of twins are dizygotic, or two-egg, twins. The chances of having dizygotic twins are greater in women who take the fertility drug clomiphene, which stimulates the ovaries to produce eggs. The chances are also greater in women who have a family history of multiple births, are in their later childbearing years, or are of African ancestry. The chances of having monozygotic, or one-egg, twins, in contrast, appear to be the same in most women, regardless of family history, age, or race.

Answer to . . .

CHECKPOINT *Identical twins are genetically identical; fraternal twins are not.*

39–4 (continued)

Adulthood

Use Community Resources

Suggest that students consult local libraries, senior centers, and government agencies to find out what services are available in their area for seniors. (Services might include meal delivery, social programs, transportation, and nursing care.) Ask: **What needs of seniors are met by these services?** *(Students might mention help for people with disabling health problems or physical limitations and the need for social interaction.)* L2

3 ASSESS

Evaluate Understanding

Call on students at random to name the stages of development of the embryo and fetus. Call on other students to describe the features of the embryo or fetus at each stage.

Reteach

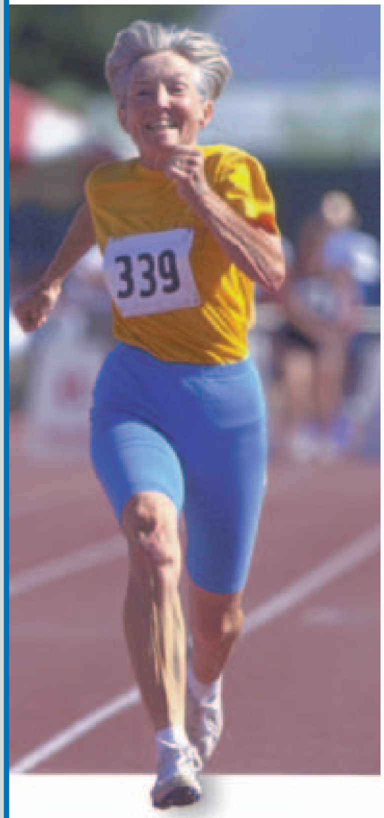
Using the chalkboard, work with students to develop a timeline of important events from fertilization to birth.

Thinking Visually

The timelines should show that students can recognize important developmental milestones, such as walking, talking, learning to read, first permanent tooth, learning to share, and the first signs of puberty.

Interactive Textbook

If your class subscribes to the iText, use it to review the Key Concepts in Section 39–4.



▲ **Figure 39–27** By maintaining a healthy lifestyle, you may be able to slow the aging process. **Applying Concepts** ***What factors contribute to a healthy lifestyle?***

Adolescence Adolescence begins with puberty and ends with adulthood. The surge in sex hormones that starts at puberty produces a growth spurt that will conclude in mid-adolescence as the long bones of the arms and legs stop growing and complete their ossification. The continuing development of intellectual skills combines with personality changes that are associated with adult maturity.

Adulthood

Development continues during adulthood. By most measures, adults reach their highest levels of physical strength and development between the ages of 25 and 35. During these years most individuals assume the responsibilities of adulthood.

In most individuals, the first signs of physiological aging appear in their thirties. Joints begin to lose some of their flexibility, muscle strength starts to decrease, and several body systems show slight declines in efficiency. By age 50, these changes, although generally still minor, are apparent to most individuals. In women, menopause greatly reduces estrogen levels. After menopause, follicle development no longer occurs and ovulation stops. At around age 65, most systems of the body become less efficient, making homeostasis more difficult to maintain.

Although there are some changes in mental functioning during older adulthood, these changes usually have little effect on thinking, learning, or long-term memory. The brain remains open to change and to learning. In fact, evidence suggests that the aging process can be slowed by keeping the mind active and challenged. Most older adults are fully capable of continuing stimulating intellectual work. By practicing the habits of good health and regular exercise, as the woman in **Figure 39–27** is doing, every person can hope to be happy and productive at every stage of human development.

39–4 Section Assessment

1. **Key Concept** Describe the process of fertilization.
2. **Key Concept** Describe the role of the placenta.
3. **Key Concept** Describe the three stages of early development.
4. What are the three germ layers that result from gastrulation?
5. What is oxytocin, and what is its role in childbirth?
6. **Critical Thinking Applying Concepts** Why do you think doctors recommend that women avoid most medications and alcohol during pregnancy?

Thinking Visually

Creating a Timeline
Starting with your birth date, create a timeline of physical and social developmental milestones. As resources, you can use interviews, photographs, and memories.

39–4 Section Assessment

1. Sperm attaches to a binding site and releases enzymes that attack the egg's protective layer; egg and sperm nuclei merge.
2. The placenta is the embryo's organ of respiration, nourishment, and excretion.
3. Implantation: blastocyst attaches itself to the wall of the uterus; gastrulation: three cell layers form; neurulation: the nervous system develops
4. Ectoderm, mesoderm, and endoderm
5. Oxytocin is a hormone that stimulates labor.
6. Because these substances may cross the placenta and harm the embryo or fetus

Answer to . . .

Figure 39–27 *Factors include a well-balanced, low-fat diet, and regular exercise.*