LESSON 1

Prenatal Development

HEALTH TERMS

fertilization
zygote
blastocyst
embryo
amnion
placenta
umbilical cord
fetus
genes
genetic counseling

HEALTH CONCEPTS

- Pregnancy begins with the union of an ovum and a sperm cell.
- A baby develops during many stages of cell division.
- A dominant gene will usually mask the trait carried by a recessive gene.

The majority of couples who marry will choose to have children. There are many responsibilities to consider before becoming a parent. Parents need to be prepared to provide for the physical, mental, and social well-being of a child.

As soon as a male begins to produce sperm, he becomes capable of fathering a child. As soon as a female begins to ovulate, she becomes capable of becoming pregnant. A female can actually become pregnant before she starts to menstruate. Remember that menstruation occurs because the ovum is not fertilized. **Fertilization** is *the union of a sperm cell with an ovum.* If an ovum is fertilized, a female becomes pregnant and there is no menstrual period.

Fertilization

Pregnancy begins with the joining of an ovum from the mother and a sperm cell from the father. During sexual intercourse, the erect penis is inserted into the vagina. Hundreds of millions of sperm are released during ejaculation and immediately begin swimming through the cervix into the uterus and then into each fallopian tube. If an ovum is present in one of the fallopian tubes, one of the sperm can fertilize the ovum. *A fertilized ovum* is called a **zygote.** A film immediately surrounds the zygote, preventing any other sperm from penetrating it. The remaining sperm cells die. Fertilization usually takes place in the upper one-third of a fallopian tube.

After fertilization, the zygote divides into two cells, then four, then eight, and so on. It also begins its journey to the uterus. This takes about three to four days. The process of cell division has begun. By the end of the pregnancy, the fertilized ovum will have divided millions of times.

The zygote changes from a small mass of cells into *a ball of cells with a cavity in the center.* These cells are called a **blastocyst.** The blastocyst spends another few days in the uterus, preparing to implant in the uterine lining. This lining is called the endometrium. During this time, the blastocyst receives nourishment from the secretions of the endometrium. Since the beginning of the menstrual cycle, the lining of the uterus has been preparing to receive the fertilized ovum. It becomes thick and spongy to prepare for implantation of the fertilized ovum.

An ectopic pregnancy occurs when the zygote implants outside the uterus. Although the zygote may implant at various places in the reproductive system of the female, the most common site of ectopic pregnancy is in one of the fallopian tubes. After it implants, the cells continue to divide and develop. An ectopic pregnancy, if not diagnosed early and treated, could be fatal to the mother.

Did You Know?

On July 25, 1978, the birth of a 5-pound, 12-ounce healthy baby girl in an English hospital made medical history. Louise Brown became the first baby ever to be born as a result of in vitro fertilization. The term *in vitro* literally means "in glass." In vitro fertilization refers to fertilization of an egg by a sperm outside of the body or in an artificial environment. After fertilization, the developing embryo is implanted in the female's uterus.

Embryonic Development

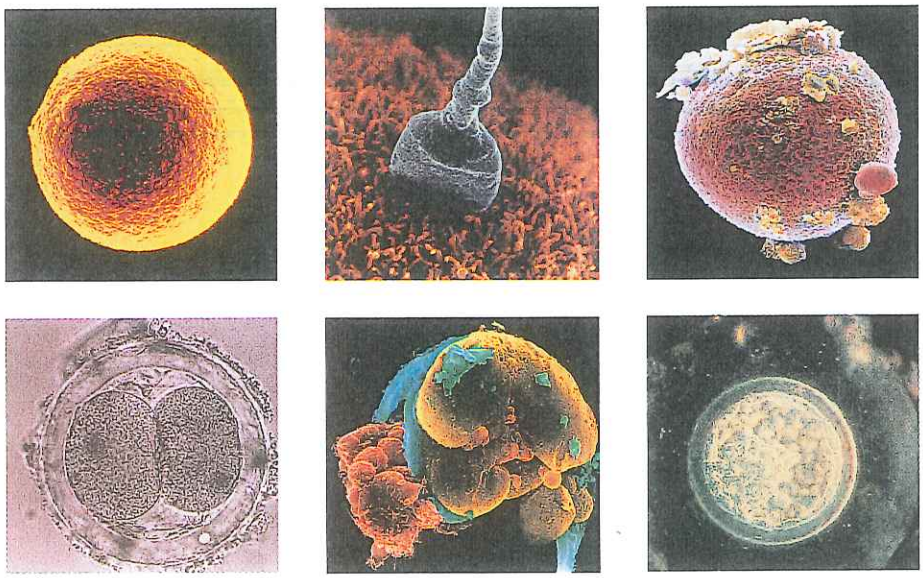
About seven to eight days after fertilization, the blastocyst attaches to the inner wall of the uterus. Now it produces special enzymes, complex proteins that cause chemical reactions, to aid the blastocyst in dissolving some of the uterine lining. Gradually, the blastocyst becomes buried within the lining. This process is called implantation. *The implanted blastocyst* is now called an **embryo.** At this point, the embryo is in the first stages of development.

During the next five weeks of pregnancy, the embryo grows rapidly. At the start of the sixth week, it is 1 millimeter long, or about 10,000 times the size of the original ovum. The cells of the embryo align into three layers that will form the baby's organs and systems. One layer becomes the respiratory and digestive systems. One layer develops into muscles, bones, blood vessels, and skin. The third layer becomes the nervous system, sense organs, and mouth.

The brain is one of the first organs to develop. Neurons appear around the eighteenth day after fertilization. Three weeks later, the rapidly growing central nervous system causes the head to take shape. Drugs and alcohol taken by the mother will effect the development of the embryo's nervous system. This can cause mental retardation and learning disabilities.

NOTE. Doctors calculate the day of conception to be about two weeks from the beginning of the mother's last menstrual period.

- **Amnion.** Special membranes also form around the developing embryo. One of these membranes forms *a fluid-filled sac around the embryo* called the **amnion,** or bag of waters. This developing sac acts like a shock absorber, providing a moist cushion that protects the embryo.
- **Placenta.** The **placenta** is *a structure that forms along the lining of the uterus as the embryo implants.* It is made of blood-rich tissue that transfers oxygen and nutrients from the mother's blood to the embryo's blood. The placenta has several jobs, serving the purpose of the lungs, liver, kidneys, endocrine glands, and digestive system for the developing embryo.
- **Umbilical Cord.** *The tube that connects the embryo to the placenta* is called the **umbilical cord.** The umbilical cord grows to a length



Beginning at the top left corner, these photos show the unfertilized ovum; a sperm penetrating an ovum; the zygote within a protective shield. Bottom row, left to right: a two-cell zygote; an eight-cell zygote; and a blastocyst.

of about 20 inches. Blood vessels from the embryo connect to blood vessels that go through the umbilical cord and into the placenta. The mother's blood vessels also extend into the placenta.

The blood of the mother and that of the embryo never mix. However, the blood vessels come close enough to allow oxygen and nutrients to enter the embryo's bloodstream. In the same manner, waste products leave the embryo's blood and are removed through the mother's body. About three-fourths of a quart of the mother's blood travels through the placenta each minute.

STRESS. Substances harmful to a developing fetus such as alcohol, nicotine, and other drugs are passed from mother to baby the same way that nutrients and oxygen cross the placenta.

Fetal Development

When the embryo is 56 days old and measures about 1 inch (2.5 cm) in length, it enters the second phase of its development. *The developing baby from the eighth week until birth* is known as a **fetus.** Beneath its transparent, hairless skin—which is covered by a waxy, protective coating—the fetus has all of its major organs and tissues, although they are very tiny and are far from fully formed. During the remaining 32 weeks, until birth, the fetus will increase in length 12½ times, and its organs will increase 120 times in weight. The chart on page 68 lists the month-to-month development of the fetus.

Determining a Pregnancy

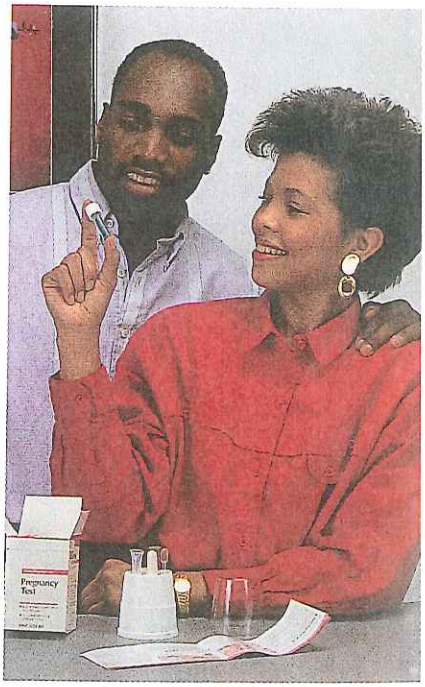
A new hormone, human chorionic gonadotropin (HCG), is secreted by the placenta beginning in the embryo stage. This hormone stimulates the production and release of greater amounts of estrogen and progesterone, which help maintain the lining of the uterus, keeping it suitable for pregnancy. These hormones also prevent the ovaries from releasing any more ova. Thus, another ovum cannot be fertilized once a pregnancy has begun.

Pregnancy tests are based on testing the urine for the presence of HCG. Small amounts of HCG are cleansed from the blood through the mother's kidneys. So HCG can be detected in the urine as early as the first week after a missed menstrual period. Doctors can also perform a test known as a radioimmunoassay. It can detect HCG in urine or blood as early as a week before the menstrual period is to begin. The doctor will also do an internal examination to further confirm pregnancy. Changes in the cervix and size of the uterus are observed when a female is pregnant.

Home Pregnancy Tests

There are several home pregnancy tests on the market today. These test urine for the presence of HCG in a way similar to how a doctor would conduct the test. However, in one study of these tests, negative results were found to be less reliable than positive test results. In other words, if the test is positive it's very likely the person is pregnant; if the test is negative, the person may actually be pregnant. This happens because the test may have been taken too soon or taken incorrectly. A person who uses a home test and has a negative result might not take time to confirm the results at a doctor's office or clinic. If the home test was not accurate, the female may miss early prenatal care and may be making choices that are not good for her baby's health.

Home pregnancy tests should be confirmed by a doctor.



Stages of development before birth (a) 5 weeks; (b) 3 months; (c) 5–6 months; (d) 7–8 months inside the uterus

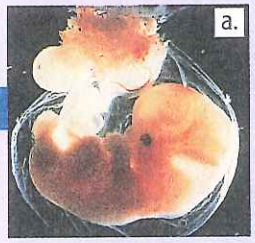
A Girl or a Boy?

Will a baby be a girl or a boy? Recall from Chapter 2 that sperm and ova each contain only one set of the 23 different chromosomes. When a sperm cell and egg cell combine, the fertilized ovum then has two sets of chromosomes, or 23 pairs. Half the pair comes from the sperm cell and half the pair from the egg cell.

DEVELOPMENT IN THE WOMB BEFORE BIRTH

END OF FIRST MONTH

- One-quarter inch (6 mm long)
- Heart, brain, and lungs begin to form

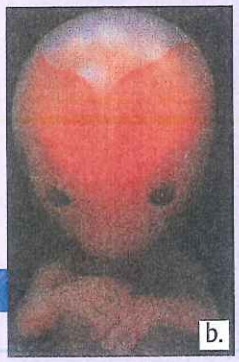


END OF SECOND MONTH

- About 1.5 inches (3.8 cm long)
- Muscles, skin developing
- Arms, hands, eyes, and ears forming
- Legs beginning to form, along with knees and ankles
- All vital organs starting to develop

END OF THIRD MONTH

- About 3 inches (7.5 cm) long
- Weighs about 1 ounce (28.3 g)
- Movement can be felt
- Heart fully formed and beating
- Toes and fingers formed
- Can open and close mouth



END OF FOURTH MONTH

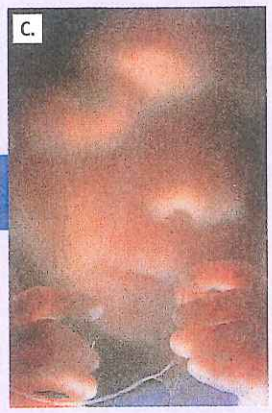
- 4 inches (10.2 cm)
- Weighs 6 ounces (169.8 g)
- Lanugo (fine hair) forming all over body
- Swallowing and sucking reflexes developing
- Tooth buds appear
- Sex identifiable
- Mother may feel fetus moving

END OF FIFTH MONTH

- 8 to 10 inches (20 to 25 cm) long
- Weighs 1 pound (453.6 g)
- Eyelashes appear
- Nails and scalp hair begin to grow
- Heartbeat can be heard with stethoscope

END OF SIXTH MONTH

- About 12 inches (30 cm) long
- Weighs 1¾ pounds (.79 kg)
- Can kick
- Can hear sounds
- Has fingernails, fingerprints, and footprints



END OF SEVENTH MONTH

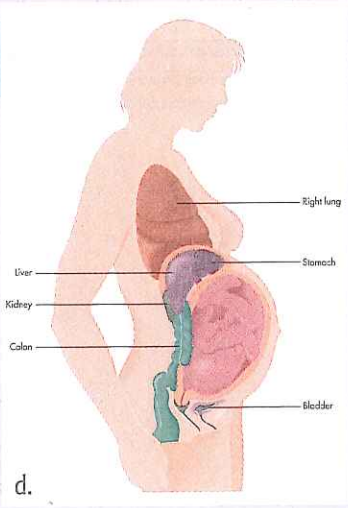
- Weighs 3 pounds (1.36 g)
- Fat layer forming
- Might even hiccup, cry, and/or suck thumb
- Can move arms and legs freely
- Eyes are open

END OF EIGHTH MONTH

- About 18 inches (46 cm) long
- Weighs about 5 pounds (2.27 kg)
- Extensive brain growth
- Hair grows
- Skin gets smoother as thicker fat layer develops
- Kidneys are mature

END OF NINTH MONTH

- 18 to 20 inches (46 to 50 cm) long
- Weighs 7 to 9 pounds (3.2 to 4.1 kg)
- Lungs are mature
- All other organs have developed enough to function on their own



One pair is made up of specialized sex chromosomes. There are two kinds of sex chromosomes, X and Y. Sperm cells may carry either an X or a Y chromosome. Ova carry only an X chromosome. If an ovum is fertilized by a sperm cell carrying an X chromosome, the combination is XX and results in the formation of a girl. If the sperm cell is carrying a Y chromosome, the pairing forms an XY combination, resulting in a boy. So the determination of the sex of a child is based on the father's sperm cell.

NOTE. Not all inherited traits are either dominant or recessive. Some traits can be expressed as hybrids —a combination of the trait inherited from the mother and from the father. For example, the hair texture of a child with a curly-haired parent and straight-haired parent can be wavy—a combination of the two.

Genes and Heredity

Chromosomes are made up genes. **Genes** are *units of heredity that determine which traits, or characteristics, we inherit from our parents.* Our genes control mostly all our traits—from the color and texture of our hair to the shape of our toes. For some traits, there are two kinds of genes—dominant and recessive. The dominant gene will usually mask, or hide, the trait of the recessive gene.

STRESS. Explain that 46 chromosomes making up normal human cells actually consist of 23 pairs of chromosomes.

Recall that most people have two sets of chromosomes, one set from each parent. When a child inherits one recessive and one dominant gene for a trait, the dominant trait will be seen. When there are two recessive genes for a trait, then the recessive trait is seen. For example, the gene for brown eyes is dominant and the gene for blue eyes is recessive. If either parent of a child has two brown-eye genes, the child will have brown eyes. This occurs because no matter what other eye-color gene the child receives, it will be masked by the brown-eye gene from the one parent. If a child has two blue-eyed parents, he or she will have blue eyes. Blue-eyed parents have genes for only blue eyes. Two brown-eyed parents can also have a blue-eyed child. Because brown is dominant, brown-eyed parents can have one brown-eye gene and one blue-eye gene. If a child receives brown-eye genes from both parents or a blue-eye gene from one parent and a brown-eye gene from the other, then the child will have brown eyes. However, if the child receives the recessive blue-eye gene from both parents, that child will have blue eyes.

Hereditary Diseases

The gene for some hereditary diseases is dominant. This means that only one parent needs to contribute the gene to their child for that child to have the disease. Huntington's Chorea is such a disease. The disease causes the progressive loss of mental functions. Symptoms generally don't appear until a person is in their thirties or forties. Death occurs 10 to 20 years after symptoms appear.

Other genetic diseases result when both parents carry the recessive gene for the disease. The parents do not have the disease themselves because they have a dominant gene that masks the recessive one. However, if both parents pass on the recessive gene to their child, the child will have that disease. Sickle-cell anemia is a recessive gene disorder. Sickle-cell anemia results from sickle-shaped (rather than round-shaped) red blood cells that clog small blood vessels and deprive vital organs of their blood supply. This can result in enlargement of the heart, swelling of the hands and feet, susceptibility to infections, skin ulcers, delayed sexual maturation, and shortened life span.

For certain diseases, the recessive gene for the disease is carried only on the X chromosome. The Y chromosome, in general, carries less

genetic information because it is smaller than the X chromosome. Because females have two X chromosomes, a woman can have one dominant and one recessive gene and will not have the disease. However, males have only one X chromosome. If they inherit the recessive gene for a disease, there is no other gene to mask it. Therefore, the male will have the disease. Examples of this type of genetic disease are hemophilia and red-green color blindness.

Genetic Counseling

Genetics is the study of the process of heredity. **Genetic counseling** is *a process in which the genetic histories of the male and female are studied to predict or determine the presence of certain inherited diseases.* Certain tests help prospective parents know of the possibility of passing inherited diseases on to their child. For example, if both parents have either sickle cell anemia or carry the recessive trait, the disease can be passed onto their child. If the couple has genetic testing prior to pregnancy, they can make an informed decision about having children.

Tay-Sachs disease is another example of a genetic disease whose presence can be detected. Tay-Sachs results in severe brain dysfunction, paralysis, blindness, and death, usually before the age of five. Though rare in the general population, Tay-Sachs is present in 1 in 28 Jewish people of Eastern European origin. People of this origin may wish to be tested for the trait prior to deciding whether to have children.

Just recently, a genetic test for Huntington's Chorea has been developed. Most people don't realize they have the disease because symptoms don't develop until they are in their thirties or forties. By that age, most people have already had children. People with this disease in their family can be tested earlier. Then they can have all the facts before they decide whether to have children.

Did You Know?

In most cases of twins, the female's ovaries release two mature eggs instead of one. When separate sperm cells fertilize each egg cell, two embryos develop. The two embryos, called fraternal twins, have different genetic makeup and, therefore, do not look any more alike than brothers and sisters normally do.

In other cases, after one egg cell has been fertilized, it divides and two embryos develop. These embryos have the same genetic information and, therefore, are identical twins.

NOTE. Though many hereditary disorders can be detected with prenatal testing, few are curable even after birth.

LESSON 1 Review

LESSON 1 REVIEW ANSWERS ARE FOUND ON PAGE TM33.

Reviewing Facts and Vocabulary

1. Define *zygote* and tell what happens to the zygote within the first four days after fertilization.
2. Describe the important function of the amnion.
3. Which of the following statements is true of the placenta?
   a. The placenta serves as the lungs and digestive system for the developing embryo.
   b. The umbilical cord connects the sperm to the placenta.
   c. The placenta forms along the lining of the fallopian tubes.
4. What two things will a doctor do to determine if a female is pregnant?
5. Does the father's sperm or the mother's ova determine the sex of the baby?

Thinking Critically

6. ***Synthesizing.*** Explain why a woman who thinks she is pregnant but tested negative on a home pregnancy test may want to be tested at a doctor's office.
7. ***Synthesizing.*** What might be some of the positive consequences of genetic testing?

Applying Health Skills

8. ***In Your School.*** Find out which genetic diseases people can be tested for prior to having children. Explain the symptoms and who is most prone to carry the disease.