

# chapter 3

# PRENATAL DEVELOPMENT AND BIRTH

## chapter outline

### 1 Prenatal Development

**Learning Goal 1** Describe prenatal development.

- The Course of Prenatal Development
- Teratology and Hazards to Prenatal Development
- Prenatal Care
- Normal Prenatal Development

### 2 Birth

**Learning Goal 2** Discuss the birth process.

- The Birth Process
- Assessing the Newborn
- Preterm and Low Birth Weight Infants

### 3 The Postpartum Period

**Learning Goal 3** Explain the changes that take place in the postpartum period.

- Physical Adjustments
- Emotional and Psychological Adjustments
- Bonding



**D**iana and Roger married when he was 38 and she was 34. Both worked full-time and were excited when Diana became pregnant. Two months later, Diana began to have some unusual pains and bleeding. Just two months into her pregnancy she had lost the baby. Diana thought deeply about why she was unable to carry the baby to full term. It was about the time she became pregnant that the federal government began to warn that eating certain types of fish with a high mercury content during pregnancy on a regular basis can cause a miscarriage. Now she eliminated these fish from her diet.

Six months later, Diana became pregnant again. She and Roger read about pregnancy and signed up for birth preparation classes. Each Friday night for eight weeks they practiced simulated contractions. They talked about what kind of parents they wanted to be and discussed how their lives would change after the baby was born. When they found out that their offspring was going to be a boy, they gave him a nickname: Mr. Littles.

This time, Diana's pregnancy went well, and Alex, also known as Mr. Littles, was born. During the birth, however, Diana's heart rate dropped precipitously, and she was given a stimulant to raise it. Apparently the stimulant also increased Alex's heart rate and breathing to a dangerous point, and he had to be placed in a neonatal intensive care unit (NICU).

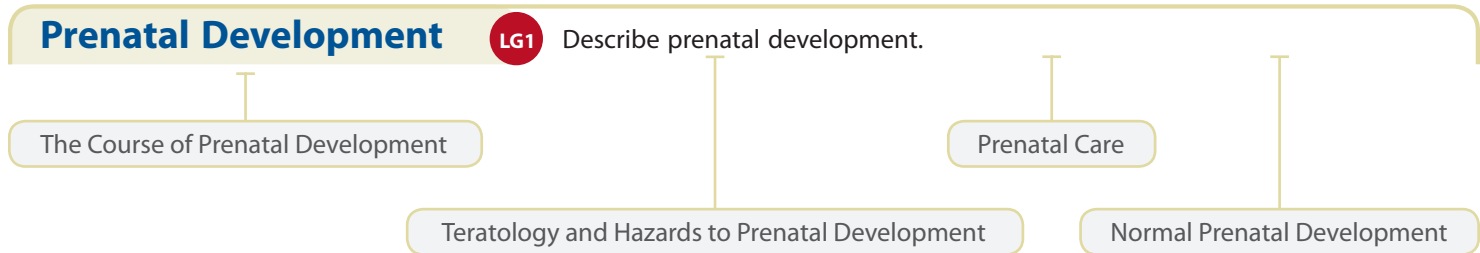
Several times a day, Diana and Roger visited Alex in the NICU. A number of babies in the NICU who had a very low birth weight had been in intensive care for weeks, and some of these babies were not doing well. Fortunately, Alex was in better health. After several days in the NICU, his parents were permitted to take home a very healthy Alex.



Alex, also known as "Mr. Littles."

# preview

This chapter chronicles the truly remarkable developments from conception through birth. We will look at normal development as well as hazards to normal development (such as mercury, mentioned in the preceding story). We will outline the birth process and the tests used to assess the newborn. We will examine the physical, emotional, and psychological adjustments that a mother goes through during the time following birth, the postpartum period. And we will end by comparing theories on parent-infant bonding.



Imagine how Alex (“Mr. Littles”) came to be. Out of thousands of eggs and millions of sperm, one egg and one sperm united to produce him. Had the union of sperm and egg come a day or even an hour earlier or later, he might have been very different—maybe even of the opposite sex. *Conception* occurs when a single sperm cell from the male unites with an ovum (egg) in the female’s fallopian tube in a process called fertilization. Over the next few months, the genetic code discussed in Chapter 2 directs a series of changes in the fertilized egg, but many events and hazards will influence how that egg develops and becomes tiny Alex.

## THE COURSE OF PRENATAL DEVELOPMENT

Typical prenatal development begins with fertilization and ends with birth, lasting between 266 and 280 days (from 38 to 40 weeks). It can be divided into three periods: germinal, embryonic, and fetal.

**The Germinal Period** The **germinal period** is the period of prenatal development that takes place in the first two weeks after conception. It includes the creation of the fertilized egg, called a *zygote*, followed by cell division and attachment of the zygote to the uterine wall.

Rapid cell division by the zygote continues throughout the germinal period (recall from Chapter 2 that this cell division occurs through a process called *mitosis*). By approximately one week after conception, the differentiation of these cells—their specialization for different tasks—has already begun. At this stage, the group of cells, now called the **blastocyst**, consists of an inner mass of cells that will eventually develop into the embryo, and the **trophoblast**, an outer layer of cells that later provides nutrition and support for the embryo. *Implantation*, the attachment of the zygote to the uterine wall, takes place about 11 to 15 days after conception. Figure 3.1 illustrates some of the most significant developments during the germinal period.

**The Embryonic Period** The **embryonic period** is the period of prenatal development that occurs from two to eight weeks after conception. During the embryonic period, the rate of cell differentiation intensifies, support systems for cells form, and organs appear.

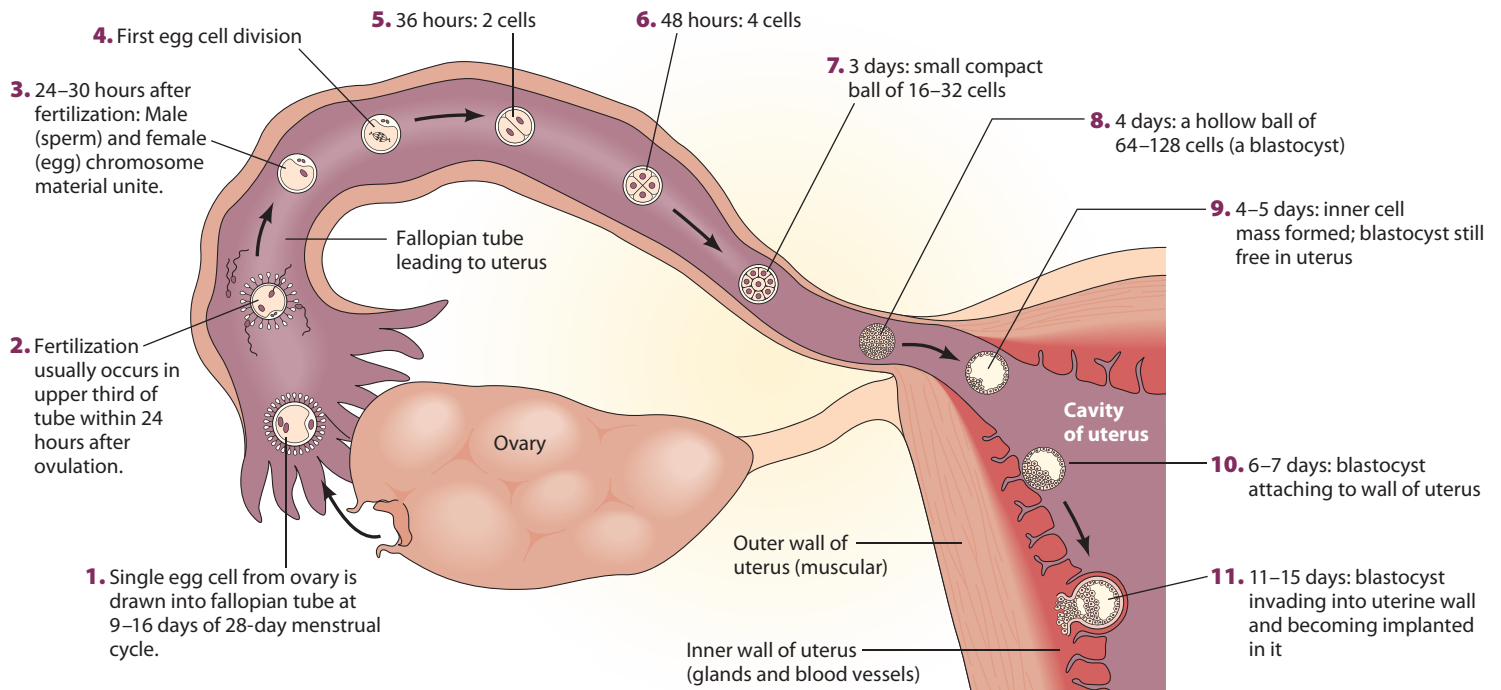
This period begins as the blastocyst attaches to the uterine wall. The mass of cells is now called an *embryo*, and three layers of cells form. The embryo’s *endoderm* is the inner layer of cells, which will develop into the digestive and respiratory systems.

**germinal period** The period of prenatal development that takes place in the first two weeks after conception. It includes the creation of the zygote, continued cell division, and the attachment of the zygote to the uterine wall.

**blastocyst** The inner layer of cells that develops during the germinal period. These cells later develop into the embryo.

**trophoblast** The outer layer of cells that develops in the germinal period. These cells provide nutrition and support for the embryo.

**embryonic period** The period of prenatal development that occurs two to eight weeks after conception. During the embryonic period, the rate of cell differentiation intensifies, support systems for the cells form, and organs appear.



**FIGURE 3.1**

**SIGNIFICANT DEVELOPMENTS IN THE GERMINAL PERIOD.**

Just one week after conception, cells of the blastocyst have already begun specializing. The germination period ends when the blastocyst attaches to the uterine wall. Which of the steps shown in the drawing occur in the laboratory when IVF (described in Chapter 2) is used?

The *mesoderm* is the middle layer, which will become the circulatory system, bones, muscles, excretory system, and reproductive system. The *ectoderm* is the outermost layer, which will become the nervous system and brain, sensory receptors (ears, nose, and eyes, for example), and skin parts (hair and nails, for example). Every body part eventually develops from these three layers. The endoderm primarily produces internal body parts, the mesoderm primarily produces parts that surround the internal areas, and the ectoderm primarily produces surface parts.

As the embryo's three layers form, life-support systems for the embryo develop rapidly. These life-support systems include the amnion, the umbilical cord (both of which develop from the fertilized egg, not the mother's body), and the placenta. The **amnion** is like a bag or an envelope and contains a clear fluid in which the developing embryo floats. The amniotic fluid provides an environment that is temperature and humidity controlled, as well as shockproof. The **umbilical cord** contains two arteries and one vein, and connects the baby to the placenta. The **placenta** consists of a disk-shaped group of tissues in which small blood vessels from the mother and the offspring intertwine but do not join.

Figure 3.2 illustrates the placenta, the umbilical cord, and the blood flow in the expectant mother and developing organism. Very small molecules—oxygen, water, salt, food from the mother's blood, as well as carbon dioxide and digestive wastes from the offspring's blood—pass back and forth between the mother and embryo or fetus (Wick & others, 2010). Large molecules cannot pass through the placental wall; these include red blood cells and harmful substances, such as most bacteria and maternal wastes. The mechanisms that govern the transfer of substances across the placental barrier are complex and are still not entirely understood (Barta & Drugan, 2010; Cetin & Alvino, 2009).

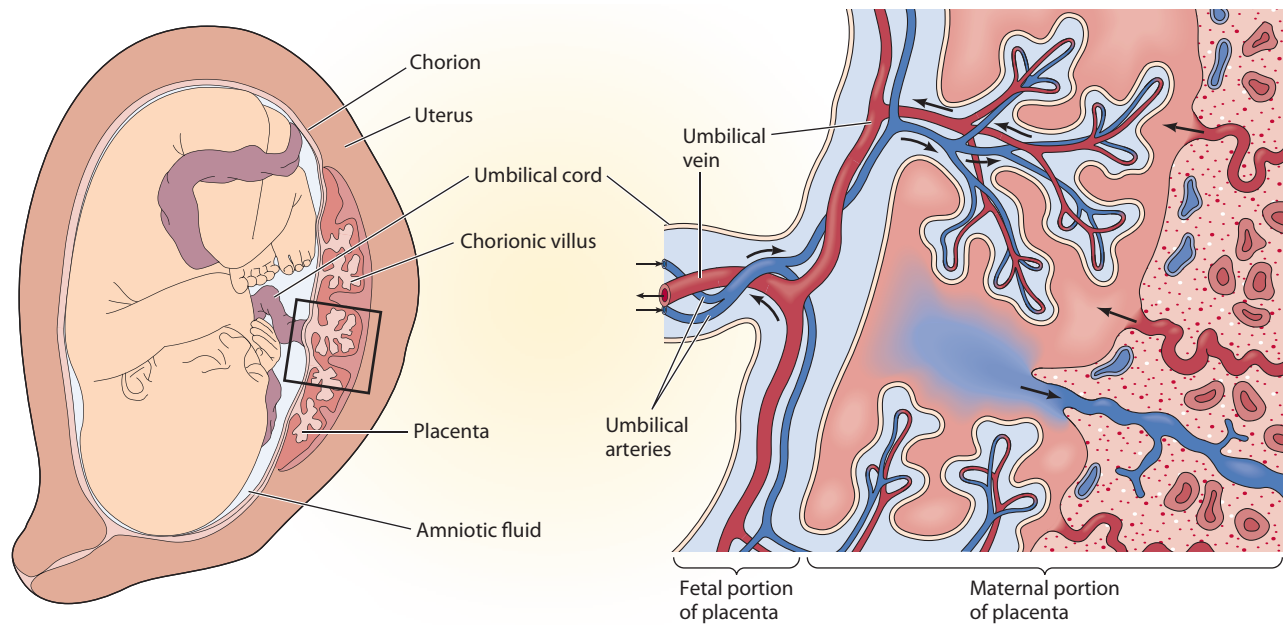
By the time most women know they are pregnant, the major organs have begun to form. **Organogenesis** is the name given to the process of organ formation during the first two months of prenatal development. While they are being formed, the organs are especially vulnerable to environmental changes (Rojas & others, 2010; Torchinsky & Toder, 2010). In the third week after conception, the neural tube that eventually becomes the spinal cord forms. At about 21 days, eyes begin to appear, and at 24 days the cells for the heart begin to differentiate. During the fourth week, the urogenital system becomes apparent, and arm and leg buds emerge. Four chambers of the heart take shape, and blood vessels appear. From the fifth to the eighth

**amnion** Prenatal life-support system that is a bag or envelope that contains a clear fluid in which the developing embryo floats.

**umbilical cord** A life-support system that contains two arteries and one vein and connects the baby to the placenta.

**placenta** A life-support system that consists of a disk-shaped group of tissues in which small blood vessels from the mother and offspring intertwine.

**organogenesis** Organ formation that takes place during the first two months of prenatal development.



**FIGURE 3.2**

**THE PLACENTA AND THE UMBILICAL CORD.** The area bound by the square in the right half of the illustration is enlarged. Arrows indicate the direction of blood flow. Maternal blood flows through the uterine arteries to the spaces housing the placenta, and it returns through the uterine veins to the maternal circulation. Fetal blood flows through the umbilical arteries into the capillaries of the placenta and returns through the umbilical vein to the fetal circulation. The exchange of materials takes place across the layer separating the maternal and fetal blood supplies, so the bloods never come into contact. *What is known about how the placental barrier works and its importance?*

The history of man for nine months preceding his birth would, probably, be far more interesting, and contain events of greater moment than all three score and ten years that follow it.

—SAMUEL TAYLOR COLERIDGE  
English Poet, Essayist, 19th Century

week, arms and legs differentiate further; at this time, the face starts to form but still is not very recognizable. The intestinal tract develops and the facial structures fuse. At eight weeks, the developing organism weighs about 1/30 ounce and is just over 1 inch long.

**The Fetal Period** The **fetal period**, lasting about seven months, is the prenatal period between two months after conception and birth in typical pregnancies. Growth and development continue their dramatic course during this time.

Three months after conception, the fetus is about 3 inches long and weighs about 3 ounces. It has become active, moving its arms and legs, opening and closing its mouth, and moving its head. The face, forehead, eyelids, nose, and chin are distinguishable, as are the upper arms, lower arms, hands, and lower limbs. In most cases, the genitals can be identified as male or female. By the end of the fourth month of pregnancy, the fetus has grown to 6 inches in length and weighs 4 to 7 ounces. At this time, a growth spurt occurs in the body's lower parts. For the first time, the mother can feel arm and leg movements.

By the end of the fifth month, the fetus is about 12 inches long and weighs close to a pound. Structures of the skin have formed—toenails and fingernails, for example. The fetus is more active, showing a preference for a particular position in the womb. By the end of the sixth month, the fetus is about 14 inches long and has gained another half pound to a pound. The eyes and eyelids are completely formed, and a fine layer of hair covers the head. A grasping reflex is present and irregular breathing movements occur.

As early as six months of pregnancy (about 24 to 25 weeks after conception), the fetus for the first time has a chance of surviving outside of the womb—that is, it is *viable*. Infants who are born early, or between 24 and 37 weeks of pregnancy, usually need help breathing because their lungs are not yet fully mature. By the end of the seventh month, the fetus is about 16 inches long and weighs about 3 pounds.

During the last two months of prenatal development, fatty tissues develop, and the functioning of various organ systems—heart and kidneys, for example—steps

**fetal period** The period from two months after conception until birth, lasting about seven months in typical pregnancies.

**First trimester (first 3 months)****Conception to 4 weeks**

- Is less than  $\frac{1}{10}$  inch long
- Beginning development of spinal cord, nervous system, gastrointestinal system, heart, and lungs
- Amniotic sac envelops the preliminary tissues of entire body
- Is called a “zygote”

**8 weeks**

- Is just over 1 inch long
- Face is forming with rudimentary eyes, ears, mouth, and tooth buds
- Arms and legs are moving
- Brain is forming
- Fetal heartbeat is detectable with ultrasound
- Is called an “embryo”

**12 weeks**

- Is about 3 inches long and weighs about 1 ounce
- Can move arms, legs, fingers, and toes
- Fingerprints are present
- Can smile, frown, suck, and swallow
- Sex is distinguishable
- Can urinate
- Is called a “fetus”

**Second trimester (middle 3 months)****16 weeks**

- Is about 6 inches long and weighs about 4 to 7 ounces
- Heartbeat is strong
- Skin is thin, transparent
- Downy hair (lanugo) covers body
- Fingernails and toenails are forming
- Has coordinated movements; is able to roll over in amniotic fluid

**20 weeks**

- Is about 12 inches long and weighs close to 1 pound
- Heartbeat is audible with ordinary stethoscope
- Sucks thumb
- Hiccups
- Hair, eyelashes, eyebrows are present

**24 weeks**

- Is about 14 inches long and weighs 1 to  $1\frac{1}{2}$  pounds
- Skin is wrinkled and covered with protective coating (vernix caseosa)
- Eyes are open
- Waste matter is collected in bowel
- Has strong grip

**Third trimester (last 3 months)****28 weeks**

- Is about 16 inches long and weighs about 3 pounds
- Is adding body fat
- Is very active
- Rudimentary breathing movements are present

**32 weeks**

- Is  $16\frac{1}{2}$  to 18 inches long and weighs 4 to 5 pounds
- Has periods of sleep and wakefulness
- Responds to sounds
- May assume the birth position
- Bones of head are soft and flexible
- Iron is being stored in liver

**36 to 38 weeks**

- Is 19 to 20 inches long and weighs 6 to  $7\frac{1}{2}$  pounds
- Skin is less wrinkled
- Vernix caseosa is thick
- Lanugo is mostly gone
- Is less active
- Is gaining immunities from mother

**FIGURE 3.3****THE THREE TRIMESTERS OF PRENATAL**

**DEVELOPMENT.** Both the germinal and embryonic periods occur during the first trimester. The end of the first trimester as well as the second and third trimesters are part of the fetal period.

up. During the eighth and ninth months, the fetus grows longer and gains substantial weight—about another 4 pounds. At birth, the average American baby weighs  $7\frac{1}{2}$  pounds and is about 20 inches long.

Figure 3.3 gives an overview of the main events during prenatal development. Notice that instead of describing development in terms of germinal, embryonic, and fetal periods, Figure 3.3 divides prenatal development into equal periods of three months, called *trimesters*. Remember that the three trimesters are not the same as the three prenatal periods we have discussed. The germinal and embryonic periods occur in the first trimester. The fetal period begins toward the end of the first trimester and continues through the second and third trimesters. Viability (the possibility of surviving outside the womb) occurs at the very end of the second trimester.

**The Brain** One of the most remarkable aspects of the prenatal period is the development of the brain (Nelson, 2011). By the time babies are born, they have approximately 100 billion **neurons**, or nerve cells, which handle information processing at the cellular level in the brain. During prenatal development, neurons spend time

**neurons** Nerve cells, which handle information processing at the cellular level in the brain.



Yelyi Nordone, 12, of New York City, recently cast her line out into the pond during Camp Spifida at Camp Victory, near Millville, Pennsylvania. Camp Spifida is a week-long residential camp for children with spina bifida.

### developmental connection

**Brain Development.** At birth, the brain's weight is approximately 25 percent of its adult weight. Chapter 4, p. ...



**FIGURE 3.4**

**EARLY FORMATION OF THE NERVOUS SYSTEM.** The photograph shows the primitive, tubular appearance of the nervous system at six weeks in the human embryo.

moving to the right locations and are starting to become connected. The basic architecture of the human brain is assembled during the first two trimesters of prenatal development. In typical development, the third trimester of prenatal development and the first two years of postnatal life are characterized by connectivity and functioning of neurons (Moulson & Nelson, 2008).

As the human embryo develops inside its mother's womb, the nervous system begins forming as a long, hollow tube located on the embryo's back. This pear-shaped *neural tube*, which forms at about 18 to 24 days after conception, develops out of the ectoderm. The tube closes at the top and bottom at about 24 days after conception. Figure 3.4 shows that the nervous system still has a tubular appearance six weeks after conception.

Two birth defects related to a failure of the neural tube to close are anencephaly and spina bifida. The highest regions of the brain fail to develop when fetuses have anencephaly or when the head end of the neural tube fails to close. Such infants die in the womb, during childbirth, or shortly after birth (Levene & Chervenak, 2009). Spina bifida results in varying degrees of paralysis of the lower limbs. Individuals with spina bifida usually need assistive devices such as crutches, braces, or wheelchairs. A strategy that can help to prevent neural tube defects is for women to take adequate amounts of the B vitamin folic acid, a topic we will discuss later in the chapter (Bell & Oakley, 2009; Rasmussen & Clemmenson, 2010; Shookoff & Ian Gallicano, 2010). And both maternal

diabetes and obesity place the fetus at risk for developing neural tube defects (McGuire, Dyson, & Renfrew, 2010; Yazdy & others, 2010).

In a normal pregnancy, once the neural tube has closed, a massive proliferation of new immature neurons begins to take place at about the fifth prenatal week and continues throughout the remainder of the prenatal period. The generation of new neurons is called *neurogenesis* (Kronenberg & others, 2010). At the peak of neurogenesis, it is estimated that as many as 200,000 neurons are being generated every minute.

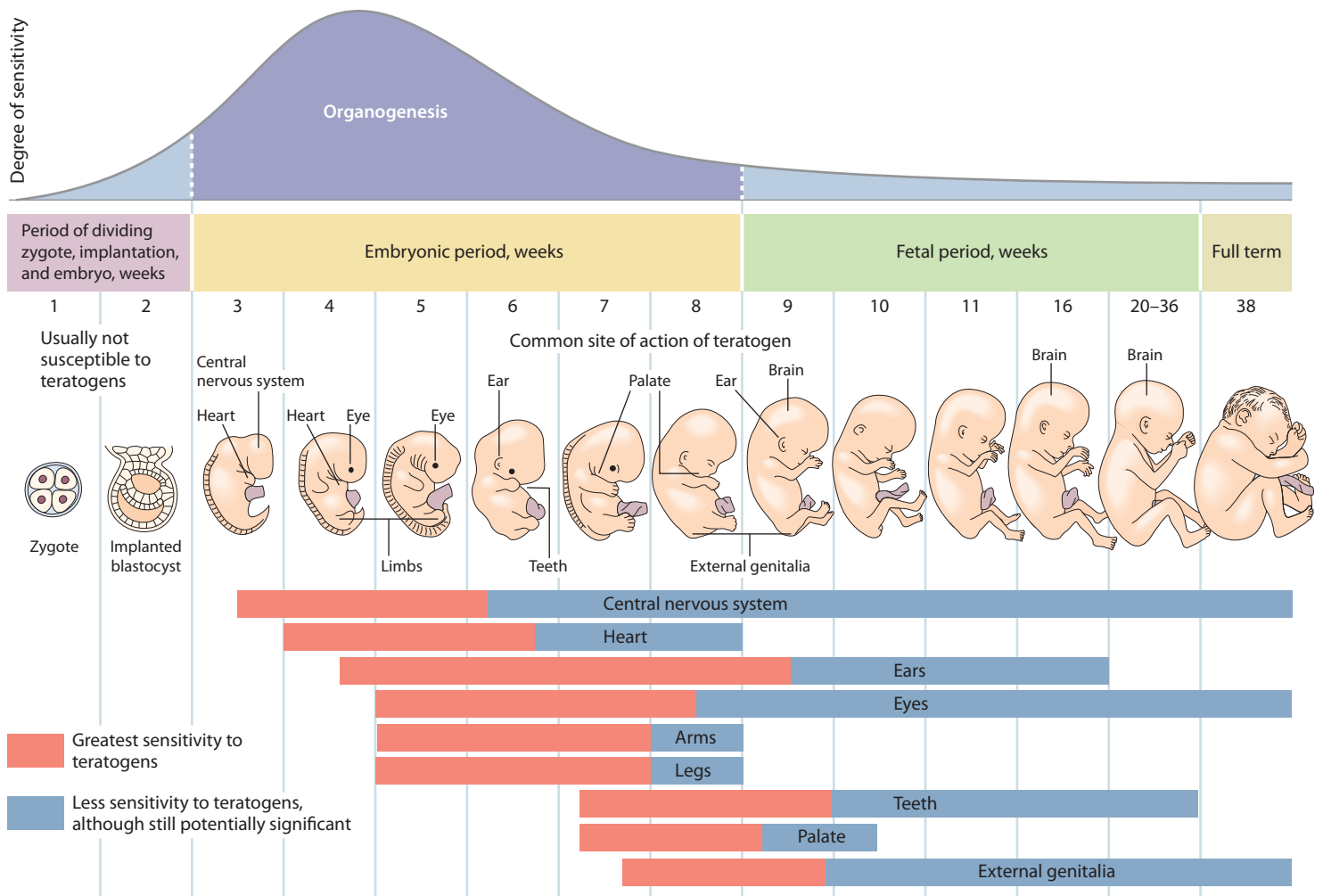
At approximately 6 to 24 weeks after conception, *neuronal migration* occurs (Nelson, 2011). This involves cells moving outward from their point of origin to their appropriate locations and creating the different levels, structures, and regions of the brain (Cozzi & others, 2010; Kuriyama & Mayor, 2009). Once a cell has migrated to its target destination, it must mature and develop a more complex structure.

At about the 23rd prenatal week, connections between neurons begin to occur, a process that continues postnatally (Moulson & Nelson, 2008). We will have much more to say about the structure of neurons, their connectivity, and the development of the infant brain in Chapter 4.

## TERATOLOGY AND HAZARDS TO PRENATAL DEVELOPMENT

For Alex, the baby discussed at the opening of this chapter, the course of prenatal development went smoothly. His mother's womb protected him as he developed. Despite this protection, the environment can affect the embryo or fetus in many well-documented ways.

**General Principles** A **teratogen** is any agent that can potentially cause a birth defect or negatively alter cognitive and behavioral outcomes. (The word comes from the Greek word *tera*, meaning "monster."). So many teratogens exist that practically every fetus is exposed to at least some teratogens. For this reason, it is difficult to determine which teratogen causes which problem. In addition, it may take a long time for the effects of a teratogen to show up. Only about half of all potential effects appear at birth.



**FIGURE 3.5**  
**TERATOGENS AND THE TIMING OF THEIR EFFECTS ON PRENATAL DEVELOPMENT.**

The danger of structural defects caused by teratogens is greatest early in embryonic development. The period of organogenesis (red color) lasts for about six weeks. Later assaults by teratogens (blue-green color) mainly occur in the fetal period and instead of causing structural damage are more likely to stunt growth or cause problems of organ function.

The field of study that investigates the causes of birth defects is called *teratology*. Some exposures to teratogens do not cause physical birth defects but can alter the developing brain and influence cognitive and behavioral functioning, in which case the field of study is called *behavioral teratology*.

The dose, genetic susceptibility, and the time of exposure to a particular teratogen influence both the severity of the damage to an embryo or fetus and the type of defect:

- **Dose.** The dose effect is rather obvious—the greater the dose of an agent, such as a drug, the greater the effect.
- **Genetic susceptibility.** The type or severity of abnormalities caused by a teratogen is linked to the genotype of the pregnant woman and the genotype of the embryo or fetus (Lidral & Murray, 2005). For example, how a mother metabolizes a particular drug can influence the degree to which the drug effects are transmitted to the embryo or fetus. The extent to which an embryo or fetus is vulnerable to a teratogen may also depend on its genotype (Marinucci & others, 2009). Also, for unknown reasons, male fetuses are far more likely to be affected by teratogens than female fetuses.
- **Time of exposure.** Teratogens do more damage when they occur at some points in development than at others (Weiner & Buhimschi, 2009). Damage during the germinal period may even prevent implantation. In general, the embryonic period is more vulnerable than the fetal period.

Figure 3.5 summarizes additional information about the effects of time of exposure to a teratogen. The probability of a structural defect is greatest early in the

**teratogen** From the Greek word *tera*, meaning “monster.” Any agent that causes a birth defect. The field of study that investigates the causes of birth defects is called *teratology*.



embryonic period, when organs are being formed (Hill, 2007). Each body structure has its own critical period of formation. Recall from Chapter 1 that a *critical period* is a fixed time period very early in development during which certain experiences or events can have a long-lasting effect on development. The critical period for the nervous system (week 3) is earlier than for arms and legs (weeks 4 and 5).

After organogenesis is complete, teratogens are less likely to cause anatomical defects. Instead, exposure during the fetal period is more likely instead to stunt growth or to create problems in the way organs function. To examine some key teratogens and their effects, let's begin with drugs.

**Prescription and Nonprescription Drugs** Many U.S. women are given prescriptions for drugs while they are pregnant—especially antibiotics, analgesics, and asthma medications. Prescription as well as nonprescription drugs, however, may have effects on the embryo or fetus that the women never imagine (Weiner & Buhimschi, 2009).

Prescription drugs that can function as teratogens include antibiotics, such as streptomycin and tetracycline; some antidepressants; certain hormones, such as progestin and synthetic estrogen; and Accutane (which often is prescribed for acne) (Bayraktar & others, 2010; Teichert & others, 2010).

Antidepressant use by pregnant women has been extensively studied (Pedersen & others, 2009; Reis & Kallen, 2010; Simoncelli, Martin, & Berard, 2010). A recent study revealed that the offspring of pregnant women who redeemed prescriptions for more than one type of SSRI (selective serotonin reuptake inhibitor) early in pregnancy had an increased risk of heart defects (Pedersen & others, 2009). In this study, negative effects on children's heart functioning increased when their mothers took two SSRIs early in pregnancy—sertraline and citalopram. However, a recent research review by the American Psychiatric Association and the American College of Obstetricians and Gynecologists indicated that although some studies have found negative outcomes for antidepressant use during pregnancy, failure to control for various factors that can influence birth outcomes, such as maternal illness or problematic health behaviors, make it difficult to draw conclusions about a link between prenatal antidepressant use and birth outcomes (Yonkers & others, 2009). Later in the chapter, we will further discuss depression during pregnancy.

Nonprescription drugs that can be harmful include diet pills and high dosages of aspirin (Norgard & others, 2006). However, recent research indicated that low doses of aspirin pose no harm for the fetus but that high doses can contribute to maternal and fetal bleeding (James, Brancazio, & Price, 2008; Marret & others, 2010).

**Psychoactive Drugs** *Psychoactive drugs* are drugs that act on the nervous system to alter states of consciousness, modify perceptions, and change moods. Examples include caffeine, alcohol, and nicotine, as well as illicit drugs such as cocaine, methamphetamine, marijuana, and heroin.

**Caffeine** People often consume caffeine by drinking coffee, tea, or colas, or by eating chocolate. A recent study revealed that pregnant women who consumed 200 or more milligrams of caffeine a day had an increased risk of miscarriage (Weng, Odouli, & Li, 2008). Taking into account such results, the Food and Drug Administration recommends that pregnant women either not consume caffeine or consume it only sparingly.

**Alcohol** Heavy drinking by pregnant women can be devastating to offspring. **Fetal alcohol spectrum disorders (FASD)** are a cluster of abnormalities and problems that appear in the offspring of mothers who drink alcohol heavily during pregnancy. The abnormalities include facial deformities and defective limbs, face, and heart (Klingenberg & others, 2010). Most children with FASD have learning problems and many are below average in intelligence, while some are mentally retarded (Caley & others, 2008). Recent studies revealed that children and adults with FASD have impaired memory development (Coles & others, 2010; Pei & others, 2008). Another recent study found that children with FASD have impaired math ability linked to



Fetal alcohol spectrum disorders (FASD) are characterized by a number of physical abnormalities and learning problems. Notice the wide-set eyes, flat cheekbones, and thin upper lip in this child with FASD.

**fetal alcohol spectrum disorders (FASD)** A cluster of abnormalities and problems that appear in the offspring of mothers who drink alcohol heavily during pregnancy.

multiple regions of the brain (Lebel & others, 2010). Although many mothers of FASD infants are heavy drinkers, many mothers who are heavy drinkers do not have children with FASD or have one child with FASD and other children who do not have it.

What are some guidelines for alcohol use during pregnancy? Even drinking just one or two servings of beer or wine or one serving of hard liquor a few days a week can have negative effects on the fetus, although it is generally agreed that this level of alcohol use will not cause fetal alcohol syndrome. The U.S. Surgeon General recommends that *no* alcohol be consumed during pregnancy. And research suggests that it may not be wise to consume alcohol at the time of conception. One study revealed that alcohol intake by both men and women during the weeks of conception increased the risk of early pregnancy loss (Henriksen & others, 2004).

**Nicotine** Cigarette smoking by pregnant women can also adversely influence prenatal development, birth, and postnatal development (Blood-Siegfried & Rende, 2010). Preterm births and low birth weights, fetal and neonatal deaths, respiratory problems, sudden infant death syndrome (SIDS, also known as crib death), and cardiovascular problems are all more common among the offspring of mothers who smoked during pregnancy (Feng & others, 2010; Lazic & others, 2010). Maternal smoking during pregnancy also has been identified as a risk factor for the development of attention deficit hyperactivity disorder in offspring (Knopik, 2009; Pinkhardt & others, 2009). A recent research review also indicated that environmental tobacco smoke was linked to increased risk of low birth weight in offspring (Leonardi-Bee & others, 2008).

**Cocaine** Does cocaine use during pregnancy harm the developing embryo and fetus? The most consistent finding is that cocaine exposure during prenatal development is associated with reduced birth weight, length, and head circumference (Smith & others, 2001). Also, in other studies, prenatal cocaine exposure has been linked to lower arousal, less effective self-regulation, higher excitability, and lower quality of reflexes at 1 month of age (Lester & others, 2002); to impaired motor development at 2 years of age and a slower rate of growth through 10 years of age (Richardson, Goldschmidt, & Willford, 2008); to deficits in behavioral self-regulation (Ackerman, Riggins, & Black, 2010) to impaired language development and information processing (Beeghly & others, 2006), including attention deficits (especially in sustained attention) in preschool and elementary school children (Accornero & others, 2006; Ackerman, Riggins, & Black, 2010); and to increased likelihood of being in a special education program that involves support services (Levine & others, 2008).

Some researchers argue that these findings should be interpreted cautiously (Accornero & others, 2006). Why? Because other factors in the lives of pregnant women who use cocaine (such as poverty, malnutrition, and other substance abuse) often cannot be ruled out as possible contributors to the problems found in their children (Hurt & others, 2005). For example, cocaine users are more likely than nonusers to smoke cigarettes, use marijuana, drink alcohol, and take amphetamines.

Despite these cautions, the weight of research evidence indicates that children born to mothers who use cocaine are likely to have neurological, medical, and cognitive deficits (Field, 2007; Mayer & Zhang, 2009). Cocaine use by pregnant women is never recommended.

**Methamphetamine** Methamphetamine, like cocaine, is a stimulant, speeding up an individual's nervous system. Babies born to mothers who use methamphetamine, or "meth," during pregnancy are at risk for a number of problems, including higher rates of infant mortality, low birth weight, and developmental and behavioral problems. A recent study also found memory deficits in children whose mothers used methamphetamine during pregnancy (Lu & others, 2009).



*What are some links between expectant mothers' drinking and cigarette smoking and outcomes for their offspring?*



*This baby was exposed to cocaine prenatally. What are some of the possible effects on development of being exposed to cocaine prenatally?*

**Marijuana** An increasing number of studies find that marijuana use by pregnant women also has negative outcomes for offspring. For example, a recent study found that prenatal marijuana exposure was related to lower intelligence in children (Goldschmidt & others, 2008). Another study indicated that prenatal exposure to marijuana was linked to marijuana use at 14 years of age (Day, Goldschmidt, & Thomas, 2006). In sum, marijuana use is not recommended for pregnant women.

**Heroin** It is well documented that infants whose mothers are addicted to heroin show several behavioral difficulties at birth (Steinhausen, Blattmann, & Pfund, 2007). The difficulties include withdrawal symptoms, such as tremors, irritability, abnormal crying, disturbed sleep, and impaired motor control. Many still show behavioral problems at their first birthday, and attention deficits may appear later in development. The most common treatment for heroin addiction, methadone, is associated with very severe withdrawal symptoms in newborns (Binder & Vavrinkova, 2008).



An explosion at the Chernobyl nuclear power plant in the Ukraine produced radioactive contamination that spread to surrounding areas. Thousands of infants were born with health problems and deformities as a result of the nuclear contamination, including this boy whose arm did not form. *Other than radioactive contamination, what are some other types of environmental hazards to prenatal development?*

**Incompatible Blood Types** Incompatibility between the mother's and father's blood type poses another risk to prenatal development. Blood types are created by differences in the surface structure of red blood cells. One type of difference in the surface of red blood cells creates the familiar blood groups—A, B, O, and AB. A second difference creates what is called Rh-positive and Rh-negative blood. If a surface marker, called the *Rh-factor*, is present in an individual's red blood cells, the person is said to be Rh-positive; if the Rh-marker is not present, the person is said to be Rh-negative. If a pregnant woman is Rh-negative and her partner is Rh-positive, the fetus may be Rh-positive. If the fetus' blood is Rh-positive and the mother's is Rh-negative, the mother's immune system may produce antibodies that will attack the fetus. This can result in any number of problems, including miscarriage or stillbirth, anemia, jaundice, heart defects, brain damage, or death soon after birth (Moise, 2005).

Generally, the first Rh-positive baby of an Rh-negative mother is not at risk, but with each subsequent pregnancy the risk increases. A vaccine (RhoGAM) may be given to the mother within three days of the first child's birth to prevent her body from making antibodies that will attack any future Rh-positive fetuses in subsequent pregnancies. Also, babies affected by Rh incompatibility can be given blood transfusions before or right after birth (Flegal, 2007).

**Environmental Hazards** Many aspects of our modern industrial world can endanger the embryo or fetus. Some specific hazards to the embryo or fetus include radiation, toxic wastes, and other chemical pollutants (O'Connor & Roy, 2008).

X-ray radiation can affect the developing embryo or fetus, especially in the first several weeks after conception, when women do not yet know they are pregnant (Urbano & Tait, 2004). Women and their physicians should weigh the risk of an X-ray when an actual or potential pregnancy is involved (Baysinger, 2010; Menias & others, 2007). However, a routine diagnostic X-ray of a body area other than the abdomen, with the woman's abdomen protected by a lead apron, is generally considered safe (Brent, 2009).

Environmental pollutants and toxic wastes are also sources of danger to unborn children. Among the dangerous pollutants are carbon monoxide, mercury, and lead, as well as certain fertilizers and pesticides.

**Maternal Diseases** Maternal diseases and infections can produce defects in offspring by crossing the placental barrier, or they can cause damage during birth. Rubella (German measles) is one disease that can cause prenatal defects. Women who plan to have children should have a blood test before they become pregnant to determine whether they are immune to the disease (Coonrod & others, 2008).

Syphilis (a sexually transmitted infection) is more damaging later in prenatal development—four months or more after conception. Damage includes eye lesions, which can cause blindness, and skin lesions.

Another infection that has received widespread attention is genital herpes. Newborns contract this virus when they are delivered through the birth canal of a mother with genital herpes (Hollier & Wendel, 2008). About one-third of babies delivered through an infected birth canal die; another one-fourth become brain damaged. If an active case of genital herpes is detected in a pregnant woman close to her delivery date, a cesarean section can be performed (in which the infant is delivered through an incision in the mother's abdomen) to keep the virus from infecting the newborn (Sellner & others, 2009).

AIDS is a sexually transmitted infection that is caused by the human immunodeficiency virus (HIV), which destroys the body's immune system. A mother can infect her offspring with HIV/AIDS in three ways: (1) during gestation across the placenta, (2) during delivery through contact with maternal blood or fluids, and (3) postpartum (after birth) through breast feeding. The transmission of AIDS through breast feeding is especially a problem in many developing countries (UNICEF, 2010). Babies born to HIV-infected mothers can be (1) infected and symptomatic (show HIV symptoms), (2) infected but asymptomatic (not show HIV symptoms), or (3) not infected at all. An infant who is infected and asymptomatic may still develop HIV symptoms until 15 months of age.

The more widespread disease of diabetes, characterized by high levels of sugar in the blood, also affects offspring (Huda & others, 2010; Oostdam & others, 2009; Most & others, 2009). A recent large-scale study revealed that twice as many women and five times as many adolescents giving birth had diabetes in 2005 as in 1999 (Lawrence & others, 2008).

A research review indicated that newborns with physical defects are more likely to have diabetic mothers (Eriksson, 2009). Women who have gestational diabetes also may deliver very large infants (weighing 10 pounds or more), and these infants are at risk for diabetes themselves (Gluck & others, 2009).

**Other Parental Factors** So far we have discussed a number of drugs, environmental hazards, maternal diseases, and incompatible blood types that can harm the embryo or fetus. Here we will explore other characteristics of the mother and father that can affect prenatal and child development, including nutrition, age, and emotional states and stress.

**Maternal Diet and Nutrition** A developing embryo or fetus depends completely on its mother for nutrition, which comes from the mother's blood (Shapira, 2008). The nutritional status of the embryo or fetus is determined by the mother's total caloric intake and by her intake of proteins, vitamins, and minerals. Children born to malnourished mothers are more likely than other children to be malformed.

Being overweight before and during pregnancy can also put the embryo or fetus at risk, and an increasing number of pregnant women in the United States are overweight (Griffiths & others, 2010; Sullivan & others, 2010). A recent research review concluded that obesity during pregnancy is linked to increased maternal risks of infertility, hypertensive disorders, diabetes, and delivery by Caesarean section (Arendas, Qui, & Gruslin, 2008). In this review, obesity during pregnancy was associated with the following increased risks to the fetus: macrosomia (newborn with excessive birth weight), intrauterine fetal death, stillbirth, and admission to the neonatal intensive care unit (NICU).

One aspect of maternal nutrition that is important for normal prenatal development is consumption of folic acid, a B-complex vitamin (Rasmussen & Clemmensen,



Because the fetus depends entirely on its mother for nutrition, it is important for the pregnant woman to have good nutritional habits. In Kenya, this government clinic provides pregnant women with information about how their diet can influence the health of their fetus and offspring. *What might the information about diet be like?*

**developmental connection**

**Biological Processes.** What are some key factors that influence whether children become obese? Chapter 4, p. ...



What are some of the risks for infants born to adolescent mothers?

2010). A recent study of more than 34,000 women indicated that taking folic acid either alone or as part of a multivitamin for at least one year prior to conceiving was linked with a 70 percent lower risk of delivering from 20 to 28 weeks and a 50 percent lower risk of delivering between 28 and 32 weeks (Bukowski & others, 2008). Another recent study revealed that toddlers of mothers who did not use folic acid supplements in the first trimester of pregnancy had more behavior problems (Roza & others, 2010). Also, as indicated earlier in the chapter, a lack of folic acid is related to neural tube defects in offspring, such as spina bifida (a defect in the spinal cord) (Levene & Chervenak, 2009; Shookhoff & Ian Gallicano, 2010). The U.S. Department of Health and Human Services (2009) recommends that pregnant women consume a minimum of 400 micrograms of folic acid per day (about twice the amount the average woman gets in one day). Orange juice and spinach are examples of foods rich in folic acid.

Eating fish is often recommended as part of a healthy diet, but pollution has made many fish a risky choice for pregnant women. Some fish contain high levels of mercury, which is released into the air both naturally and by industrial pollution (Genuis, 2009). When mercury falls into the water it can become toxic and accumulate in large fish, such as shark, swordfish, king mackerel, and some species of large tuna (Mayo Clinic, 2009; Ramon & others, 2009). Mercury is easily transferred across the placenta, and the embryo's developing brain and nervous system are highly sensitive to the metal. Researchers have found that prenatal mercury exposure is linked to adverse outcomes, including miscarriage, preterm birth, and lower intelligence (Triche & Hossain, 2007; Xue & others, 2007).

**Maternal Age** When possible harmful effects on the fetus and infant are considered, two maternal ages are of special interest: adolescence and 35 years and older (Malizia, Hacker, & Penzias, 2009). The mortality rate of infants born to adolescent mothers is double that of infants born to mothers in their twenties. Adequate prenatal care decreases the probability that a child born to an adolescent girl will have physical problems. However, among women in all age groups adolescents are the least likely to obtain prenatal assistance from clinics and health services.

Maternal age is also linked to the risk that a child will have Down syndrome (Allen & others, 2009; Ghosh & others, 2010). As discussed in Chapter 2, an individual with *Down syndrome* has distinctive facial characteristics, short limbs, and retardation of motor and mental abilities. A baby with Down syndrome rarely is born to a mother 16 to 34 years of age. However, when the mother reaches 40 years of age, the probability is slightly over 1 in 100 that a baby born to her will have Down syndrome, and by age 50 it is almost 1 in 10. When mothers are 35 years and older, risks also increase for low birth weight, for preterm delivery, and for fetal death (Mbugua Gitau, & others, 2009).

We still have much to learn about the role of the mother's age in pregnancy and childbirth. As women remain active, exercise regularly, and are careful about their nutrition, their reproductive systems may remain healthier at older ages than was thought possible in the past.

**Emotional States and Stress** When a pregnant woman experiences intense fears, anxieties, and other emotions or negative mood states, physiological changes occur that may affect her fetus (Entringer & others, 2009; Leung & others, 2010). A mother's stress may also influence the fetus indirectly by increasing the likelihood that the mother will engage in unhealthy behaviors, such as taking drugs and engaging in poor prenatal care.

High maternal anxiety and stress during pregnancy can have long-term consequences for the offspring. A recent research review indicated that pregnant women with high levels of stress are at increased risk for having a child with emotional or cognitive problems, attention deficit hyperactivity disorder (ADHD), and language delay (Taige & others, 2007).

Might maternal depression also have an adverse effect on prenatal development and birth? A recent study revealed maternal depression was linked to preterm birth and slower prenatal growth rates (Diego & others, 2009). In this study, mothers who were depressed had elevated cortisol levels, which likely contributed to the negative outcomes for the fetus and newborn.

**Paternal Factors** So far, we have discussed how characteristics of the mother—such as drug use, disease, diet and nutrition, age, and emotional states—can influence prenatal development and the development of the child. Might there also be some paternal risk factors? Indeed, there are several. Men’s exposure to lead, radiation, certain pesticides, and petrochemicals may cause abnormalities in sperm that lead to miscarriage or diseases, such as childhood cancer (Cordier, 2008). The father’s smoking during the mother’s pregnancy also can cause problems for the offspring. In one study, heavy paternal smoking was associated with the risk of early pregnancy loss (Venner & others, 2004). This negative outcome may be related to secondhand smoke.

## PRENATAL CARE

Although prenatal care varies enormously, it usually involves a defined schedule of visits for medical care, which typically includes screening for manageable conditions and treatable diseases that can affect the baby or the mother (Lu & Lu, 2008). In addition to medical care, prenatal programs often include comprehensive educational, social, and nutritional services.

Does prenatal care matter? Information about pregnancy, labor, delivery, and caring for the newborn can be especially valuable for first-time mothers (Lowdermilk, Perry, & Cashion, 2010; Murray & McKinney, 2010). Prenatal care is also very important for women in poverty because it links them with other social services (Mattson & Smith, 2011; Perry & others, 2010).

An innovative program that is rapidly expanding in the United States is CenteringPregnancy (Steming, 2008). This program is relationship-centered and provides complete prenatal care in a group setting. CenteringPregnancy replaces traditional 15-minute physician visits with 90-minute peer group support settings and self-examination led by a physician or certified nurse-midwife. Groups of up to 10 women (and often their partners) meet regularly beginning at 12 to 16 weeks of pregnancy. The sessions emphasize empowering women to play an active role in experiencing a positive pregnancy. A recent study revealed that CenteringPregnancy groups made more prenatal visits, had higher breast feeding rates, and were more satisfied with their prenatal care than women in individual care (Klima & others, 2009).

Some prenatal programs for parents focus on home visitation (Eckenrode & others, 2010; Lee & others, 2009). Research evaluations indicate that the Nurse Family Partnership created by David Olds and his colleagues (2004, 2007) has been successful. The Nurse Family Partnership involves home visits by trained nurses beginning in the second or third trimester of prenatal development. The extensive program consists of approximately 50 home visits starting with the prenatal period and continuing through two years of age. The home visits focus on the mother’s health, access to health care, parenting, and improvement of the mother’s life by providing guidance in education, work, and relationships. Research revealed that the Nurse Family Partnership has numerous positive outcomes including fewer pregnancies, better work circumstances, and stability in relationship partners for the mother, and improved academic success and social development for the child (Olds & others, 2004, 2007). In another home visitation program, high-risk pregnant women and adolescents, many living in poverty conditions, were provided with biweekly home visitation services that encouraged healthy prenatal behavior, social support, and links to medical and other community services (Lee & others, 2009). Compared with a control group of pregnant women and adolescents who did not receive the home visits, the home visitation group gave birth to fewer low birth weight infants.



In one study, in China, the longer fathers smoked the greater the risk that their children would develop cancer (Ji & others, 1997). *What are some other paternal factors that can influence the development of the fetus and the child?*



Many husbands, or coaches, take childbirth classes with their wives or friends.

A Centering Pregnancy program in St. Louis Park, MN. This rapidly expanding program alters routine prenatal care by bringing women out of exam rooms and into relationship-oriented groups.



**Normal Prenatal Development** Much of our discussion so far in this chapter has focused on what can go wrong with prenatal development. Prospective parents should take steps to avoid the vulnerabilities to fetal development that we have described. But it is important to keep in mind that most of the time, prenatal development does not go awry, and development occurs along the positive path that we described at the beginning of the chapter.

## Review *Connect* Reflect

**LG1** Describe prenatal development.

### Review

- What is the course of prenatal development?
- What is teratology, and what are some of the main hazards to prenatal development?
- What are some good prenatal care strategies?
- Why is it important to take a positive approach to prenatal development?

### Connect

- In Chapter 2, we discussed chromosomal and gene-linked abnormalities that can affect prenatal development. How are the

symptoms of the related conditions or risks similar or different from those caused by teratogens or other hazards?

### Reflect Your Own Personal Journey of Life

- If you are a woman, imagine that you have just found out that you are pregnant. What health-enhancing strategies will you follow during the prenatal period? For men, imagine that you are the partner of a woman who has just found out she is pregnant. What will be your role in increasing the likelihood that the prenatal period will go smoothly?

## Birth

**LG2** Discuss the birth process.

The Birth Process

Assessing the Newborn

Preterm and Low Birth Weight Infants

Nature writes the basic script for how birth occurs, but parents make important choices about conditions surrounding birth. We look first at the sequence of physical steps that take place when a child is born.

## THE BIRTH PROCESS

The birth process occurs in stages, occurs in different contexts, and in most cases involves one or more attendants.

There was a star danced, and  
under that I was born.

—WILLIAM SHAKESPEARE  
*English Playwright, 17th Century*

**Stages of Birth** The birth process occurs in three stages. The first stage is the longest of the three. Uterine contractions are 15 to 20 minutes apart at the beginning and last up to a minute each. These contractions cause the woman's cervix to stretch and open. As the first stage progresses, the contractions come closer together, appearing every two to five minutes. Their intensity increases. By the end of the first birth stage, contractions dilate the cervix to an opening of about 10 centimeters (4 inches), so that the baby can move from the uterus into the birth canal. For a woman having her first child, the first stage lasts an average of 6 to 12 hours; for subsequent children, this stage typically is much shorter.

The second birth stage begins when the baby's head starts to move through the cervix and the birth canal. It terminates when the baby emerges completely from the mother's body. With each contraction, the mother bears down hard to push the baby out of her body. By the time the baby's head is out of the mother's body, the contractions come almost every minute and last for about a minute each. This stage typically lasts approximately 45 minutes to an hour.

**Afterbirth** is the third stage, at which time the placenta, umbilical cord, and other membranes are detached and expelled. This final stage is the shortest of the three birth stages, lasting only minutes.



After the long journey of prenatal development, birth takes place. During birth the baby is on a threshold between two worlds. *What is the fetus/newborn transition like?*

**Childbirth Setting and Attendants** In the United States, 99 percent of births take place in hospitals, a figure that has remained constant for several decades (Martin & others, 2005). The people who help a mother during birth vary across cultures. In U.S. hospitals, it has become the norm for fathers or birth coaches to be with the mother throughout labor and delivery. In the East African Nigoni culture, men are completely excluded from the childbirth process. When a woman is ready to give birth, female relatives move into the woman's hut and the husband leaves, taking his belongings (clothes, tools, weapons, and so on) with him. He is not permitted to return until after the baby is born. In some cultures, childbirth is an open, community affair. For example, in the Pukapukan culture in the Pacific Islands, women give birth in a shelter that is open for villagers to observe.

**Midwives** Midwifery is practiced in most countries throughout the world (Wickham, 2009). In Holland, more than 40 percent of babies are delivered by midwives rather than doctors. However, in 2003, 91 percent of U.S. births were attended by physicians, and only 8 percent of women who delivered a baby were attended by a *midwife* (Martin & others, 2005). Nonetheless, the 8 percent figure in 2003 represents a substantial increase from less than 1 percent of U.S. women attended by a midwife in 1975 (Martin & others, 2005). Ninety-five percent of the midwives who delivered babies in the United States in 2003 were certified nurse-midwives.

**Doulas** In some countries, a doula attends a childbearing woman. *Doula* is a Greek word that means "a woman who helps." A **doula** is a caregiver who provides continuous physical, emotional, and educational support for the mother before, during, and after childbirth. Doulas remain with the parents throughout labor, assessing and



In India, a midwife checks on the size, position, and heartbeat of a fetus. Midwives deliver babies in many cultures around the world. *What are some cultural variations in prenatal care?*

**afterbirth** The third stage of birth, when the placenta, umbilical cord, and other membranes are detached and expelled.

**doula** A caregiver who provides continuous physical, emotional, and educational support for the mother before, during, and after childbirth.





A doula assisting a birth. What types of support do doulas provide?

responding to the mother's needs. Researchers have found positive effects when a doula is present at the birth of a child (Berghella, Baxter, & Chauhan, 2008).

In the United States, most doulas work as independent providers hired by the expectant parents. Doulas typically function as part of a "birthing team," serving as an adjunct to the midwife or the hospital's obstetric staff.

**Methods of Childbirth** U.S. hospitals often allow the mother and her obstetrician a range of options regarding their method of delivery. Key choices involve the use of medication, whether to use any of a number of nonmedicated techniques to reduce pain, and when to have a cesarean delivery.

**Medication** Three basic kinds of drugs that are used for labor are analgesia, anesthesia, and oxytocin/pitocin.

*Analgesia* is used to relieve pain. Analgesics include tranquilizers, barbiturates, and narcotics (such as Demerol).

*Anesthesia* is used in late first-stage labor and during delivery to block sensation in an area of the body or to block consciousness. There is a trend toward not using general anesthesia, which blocks consciousness, in normal births because general anesthesia can be transmitted through the placenta to the fetus (Lieberman & others, 2005). An *epidural block* is regional anesthesia that numbs the woman's body from the waist down. Researchers are continuing to explore safer drug mixtures for use at lower doses to improve the effectiveness and safety of epidural anesthesia (Balaji, Dhillon, & Russell, 2009).

*Oxytocin* is a synthetic hormone that is used to stimulate contractions; pitocin is the most widely used oxytocin. The benefits and risks of oxytocin as a part of childbirth continue to be debated (Vasdev, 2008).

Predicting how a drug will affect an individual woman and her fetus is difficult (Lowdermilk, Perry, & Cashion, 2010; Smith, 2009). A particular drug might have only a minimal effect on one fetus yet have a much stronger effect on another. The drug's dosage also is a factor. Stronger doses of tranquilizers and narcotics given to decrease the mother's pain potentially have a more negative effect on the fetus than mild doses. It is important for the mother to assess her level of pain and have a voice in the decision of whether she should receive medication.

**Natural and Prepared Childbirth** For a brief time not long ago, the idea of avoiding all medication during childbirth gained favor in the United States. Instead, many women chose to reduce the pain of childbirth through techniques known as natural childbirth and prepared childbirth. Today, at least some medication is used in the typical childbirth, but elements of natural childbirth and prepared childbirth remain popular (Oates & Abraham, 2010).

**Natural childbirth** is the method that aims to reduce the mother's pain by decreasing her fear through education about childbirth and by teaching her and her partner to use breathing methods and relaxation techniques during delivery.

French obstetrician Ferdinand Lamaze developed a method similar to natural childbirth that is known as **prepared childbirth**, or the Lamaze method. It includes a special breathing technique to control pushing in the final stages of labor, as well as more detailed education about anatomy and physiology. The Lamaze method has become very popular in the United States. The pregnant woman's partner usually serves as a coach who attends childbirth classes with her and helps her with her breathing and relaxation during delivery.

In sum, proponents of current prepared childbirth methods conclude that when information and support are provided, women *know* how to give birth. To read about one nurse whose research focuses on fatigue during childbearing and breathing exercises during labor, see the *Connecting With Careers* profile on Linda Pugh. And to read about the increased variety of techniques now being used to reduce stress and control pain during labor, see *Caring Connections*.

**natural childbirth** This method attempts to reduce the mother's pain by decreasing her fear through education about childbirth and relaxation techniques during delivery.

**prepared childbirth** Developed by French obstetrician Ferdinand Lamaze, this childbirth strategy is similar to natural childbirth but includes a special breathing technique to control pushing in the final stages of labor and a more detailed anatomy and physiology course.

## connecting with careers

### Linda Pugh, Perinatal Nurse

Perinatal nurses work with childbearing women to support health and well-being during the childbearing experience. Linda Pugh, Ph.D., R.N.C., is a perinatal nurse on the faculty at The Johns Hopkins University School of Nursing. She is certified as an inpatient obstetric nurse and specializes in the care of women during labor and delivery. She teaches undergraduate and graduate students, educates professional nurses, and conducts research. In addition, Pugh consults with hospitals and organizations about women's health issues and topics we discuss in this chapter.

Her research interests include nursing interventions with low-income breast feeding women, discovering ways to prevent and ameliorate fatigue during childbearing, and using breathing exercises during labor.



Linda Pugh (right) with a new mother and baby.

## caring connections

### From Waterbirth to Music Therapy

The effort to reduce stress and control pain during labor has recently led to an increase in the use of some older and some newer nonmedicated techniques (Field, 2007; Kalder & others, 2010; Moleti, 2009; Simkin & Bolding, 2004). These include waterbirth, massage, acupuncture, hypnosis, and music therapy.

#### Waterbirth

*Waterbirth* involves giving birth in a tub of warm water. Some women go through labor in the water and get out for delivery; others remain in the water for delivery. The rationale for waterbirth is that the baby has been in an amniotic sac for many months and that delivery in a similar environment is likely to be less stressful for the baby and the mother (Meyer, Weible, & Woeber, 2010). Mothers get into the warm water when contractions become closer together and more intense. Getting into the water too soon can cause labor to slow or stop. Reviews of research have indicated mixed results for waterbirths (Cluett & Burns, 2009; Pinette, Wax, & Wilson, 2004; Thöni & Moroder, 2004). Waterbirth has been practiced more often in European countries such as Switzerland and Sweden in recent decades than in the United States, but it is increasingly being included in U.S. birth plans.



What characterizes the use of waterbirth in delivering a baby?

#### Massage

Massage is increasingly used prior to and during delivery (Field, 2007; Kimber & others, 2008; Stager 2009–2010). Researchers have found that

(continued)

## caring *connections*

(continued)

massage can reduce pain and anxiety during labor (Chang, Chen, & Huang, 2006). A recent study revealed that massage therapy reduced pain during labor and delivery and alleviated prenatal depression in both parents while improving their relationship (Field & others, 2008).

### Acupuncture

*Acupuncture*, the insertion of very fine needles into specific locations in the body, is used as a standard procedure to reduce the pain of childbirth in China, although only recently has it begun to be used in the United States for this purpose (Moleti, 2009). One study revealed that acupuncture resulted in less time spent in labor and a reduction in the need for oxytocin to augment labor (Gaudernack, Forbord, & Hole, 2006).

### Hypnosis

*Hypnosis*, the induction of a psychological state of altered attention and awareness in which the individual is unusually responsive to suggestions, is also increasingly being used during childbirth (Wilcox, 2010). Some studies have indicated positive effects of hypnosis for reducing pain during childbirth (Abasi & others, 2009; Barabasz & Perez, 2007).



### Music Therapy

Music therapy during childbirth, which involves the use of music to reduce stress and manage pain, is becoming more prevalent (Tagore, 2009). More research is needed to determine its effectiveness (Laopaiboon & others, 2009).

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*What are some reasons that natural childbirth methods such as these might be chosen instead of the use of medication?*



*What characterizes the transition from fetus to newborn?*

**Cesarean Delivery** Normally, the baby's head comes through the vagina first. But if the baby is in a **breech position**, the baby's buttocks are the first part to emerge from the vagina. In 1 of every 25 deliveries, the baby's head is still in the uterus when the rest of the body is out. Breech births can cause respiratory problems. As a result, if the baby is in a breech position, a surgical procedure known as a cesarean section, or a cesarean delivery, is usually performed. In a **cesarean delivery**, the baby is removed from the mother's uterus through an incision made in her abdomen (Lee, El-Sayed, & Gould, 2008). The benefits and risks of cesarean sections continue to be debated (Bangdiwala & others, 2010).

## ASSESSING THE NEWBORN

Almost immediately after birth, after the baby and its parents have been introduced, a newborn is taken to be weighed, cleaned up, and tested for signs of developmental problems that might require urgent attention (Als & Butler, 2008; Therrells & others, 2010). The **Apgar Scale** is widely used to assess the health of newborns at one and five minutes after birth. The Apgar Scale evaluates infants' heart rate, respiratory effort, muscle tone, body color, and reflex irritability. An obstetrician or a nurse does the evaluation and gives the newborn a score, or reading, of 0, 1, or 2 on each of these five health signs (see Figure 3.6). A total score of 7 to 10 indicates that the newborn's condition is good. A score of 5 indicates there may be

Score	0	1	2
<b>Heart rate</b>	Absent	Slow—less than 100 beats per minute	Fast—100–140 beats per minute
<b>Respiratory effort</b>	No breathing for more than one minute	Irregular and slow	Good breathing with normal crying
<b>Muscle tone</b>	Limp and flaccid	Weak, inactive, but some flexion of extremities	Strong, active motion
<b>Body color</b>	Blue and pale	Body pink, but extremities blue	Entire body pink
<b>Reflex irritability</b>	No response	Grimace	Coughing, sneezing and crying



**FIGURE 3.6**

**THE APGAR SCALE.** A newborn's score on the Apgar Scale indicates whether the baby has urgent medical problems. *What are some trends in the Apgar scores of U.S. babies?*

developmental difficulties. A score of 3 or below signals an emergency and indicates that the baby might not survive.

The Apgar Scale is especially good at assessing the newborn's ability to cope with the stress of delivery and the new environment (Oberlander & others, 2008; Reynolds & others, 2010). It also identifies high-risk infants who need resuscitation. For a more thorough assessment of the newborn, the Brazelton Neonatal Behavioral Assessment Scale or the Neonatal Intensive Care Unit Network Neurobehavioral Scale may be used.

The **Brazelton Neonatal Behavioral Assessment Scale (NBAS)** is typically performed within 24 to 36 hours after birth. It is also used as a sensitive index of neurological competence up to one month after birth for typical infants and as a measure in many studies of infant development (Mamtani, Patel, & Kulkarni, 2008). The NBAS assesses the newborn's neurological development, reflexes, and reactions to people and objects. Sixteen reflexes, such as sneezing, blinking, and rooting, are assessed, along with reactions to animate stimuli (such as a face and voice) and inanimate stimuli (such as a rattle). (We will have more to say about reflexes in Chapter 4, when we discuss motor development in infancy.)

An "offspring" of the NBAS, the **Neonatal Intensive Care Unit Network Neurobehavioral Scale (NNNS)** provides another assessment of the newborn's behavior, neurological and stress responses, and regulatory capacities (Brazelton, 2004; Lester, Tronick, & Brazelton, 2004). Whereas the NBAS was developed to assess normal, healthy, full-term infants, T. Berry Brazelton, along with Barry Lester and Edward Tronick, developed the NNNS to assess the "at-risk" infant. It is especially useful for evaluating preterm infants (although it may not be appropriate for those of less than 30 weeks' gestational age) and substance-exposed infants (Boukydis & Lester, 2008). A recent NNNS assessment (at one month of age) of preterm infants who were exposed to substance abuse prenatally revealed that the NNNS predicted

**breech position** The baby's position in the uterus that causes the buttocks to be the first part to emerge from the vagina.

**cesarean delivery** Removal of the baby from the mother's uterus through an incision made in her abdomen.

**Apgar Scale** A widely used method to assess the health of newborns at one and five minutes after birth. The Apgar Scale evaluates infants' heart rate, respiratory effort, muscle tone, body color, and reflex irritability.

**Brazelton Neonatal Behavioral Assessment Scale (NBAS)** A measure that is used in the first month of life to assess the newborn's neurological development, reflexes, and reactions to people and objects.

**Neonatal Intensive Care Unit Network Neurobehavioral Scale (NNNS)** An "offspring" of the NBAS, the NNNS provides an assessment of the "at-risk" newborn's behavior, neurological and stress responses, and regulatory capacities.



A “kilogram kid,” weighing less than 2.3 pounds at birth. What are some long-term outcomes for weighing so little at birth?

certain developmental outcomes, such as neurological difficulties, IQ, and school readiness at 4.5 years of age (Liu & others, 2010).

## PRETERM AND LOW BIRTH WEIGHT INFANTS

Different conditions that pose threats for newborns have been given different labels. We will examine these conditions and discuss interventions for improving outcomes of preterm infants.

**Preterm and Small for Date Infants** Three related conditions pose threats to many newborns: low birth weight, preterm delivery, and being small for date. **Low birth weight infants** weigh less than 5½ pounds at birth. *Very low birth weight* newborns weigh under 3½ pounds, and *extremely low birth weight* newborns weigh under 2 pounds. **Preterm infants** are those born three weeks or more before the pregnancy has reached its full term—in other words, before the completion of 37 weeks of gestation (the time between fertilization and birth). **Small for date infants** (also called *small for gestational age infants*) are those whose birth weight is below normal when the length of the pregnancy is considered. They weigh less than 90 percent of all babies of the same gestational age. Small for date infants may be preterm or full term. One study found that small for date infants had more than a fourfold increased risk of death (Regev & others, 2003).

In 2006, 12.8 percent of U.S. infants were born preterm—a 36 percent increase since the 1980s (National Center for Health Statistics, 2008). The increase in preterm birth is likely due to several factors, including the increasing number of births to women 35 years and older, increasing rates of multiple births, increased management of maternal and fetal conditions (for example, inducing labor preterm if medical technology indicates it will increase the likelihood of survival), increased substance abuse (tobacco, alcohol), and increased stress (Goldenberg & Culhane, 2007). Ethnic variations characterize preterm birth (Balchin & Steer, 2007). For example, in 2006, the likelihood of being born preterm was 12.8 percent for all U.S. infants, but the rate was 18.5 percent for African American infants (National Center for Health Statistics, 2009).

Recently, there has been considerable interest in exploring the role that progesterin might play in reducing preterm births (O’Brien & Lewis, 2009). Recent research reviews indicate that progesterin is most effective in reducing preterm births when it is administered to women with a history of a previous spontaneous birth at less than 37 weeks (da Fonseca & others, 2009), to women who have a short cervical length of 15 mm or less (da Fonseca & others, 2009), and to women pregnant with a singleton rather than twins (Norman & others, 2009; Rode & others, 2009).

Might exercise during pregnancy reduce the likelihood of preterm birth? A recent study found that compared to sedentary pregnant women, women who engaged in light leisure time physical activity had a 24 percent reduced likelihood of preterm delivery, and those who participated in moderate to heavy leisure time physical activity had a 66 percent reduced risk of preterm delivery (Hegaard & others, 2008). Researchers also have found that yoga is positively linked to pregnancy outcomes (Narendran & others, 2005).

The incidence of low birth weight varies considerably from country to country. To read about cross-cultural variations in low birth weight, see *Connecting With Diversity*.

**Consequences of Preterm Birth and Low Birth Weight** Although most preterm and low birth weight infants are healthy, as a group they experience more health and developmental problems than infants of normal birth weight (Minde & Zelkowitz, 2008). For preterm birth, the terms *extremely preterm* and *very preterm* are increasingly used (Smith, 2009). *Extremely preterm infants* are those born before the 28th week of pregnancy, and *very preterm infants* are those born before 33 weeks of

**low birth weight infant** Infant that weighs less than 5½ pounds at birth.

**preterm infants** Those born before the completion of 37 weeks of gestation (the time between fertilization and birth).

**small for date infants** Also called small for gestational age infants, these infants have birth weights that are below normal when the length of pregnancy is considered. Small for date infants may be preterm or full term.

**kangaroo care** Treatment for preterm infants that involves skin-to-skin contact.

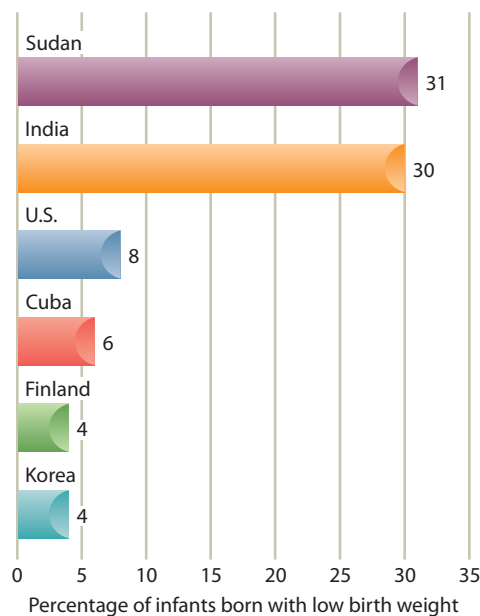
## connecting with diversity

### Cross-Cultural Variations in the Incidence and Causes of Low Birth Weight

In some countries, such as India and Sudan, where poverty is rampant and the health and nutrition of mothers are poor, the percentage of low birth weight babies reaches as high as 31 percent (see Figure 3.7). In the United States, there has been an increase in low birth weight infants in the last two decades. The U.S. low birth weight rate of 8 percent in 2004 is considerably higher than that of many other developed countries (Hoyert & others, 2006). For example, only 4 percent of the infants born in Sweden, Finland, Norway, and Korea are low birth weight, and only 5 percent of those born in New Zealand, Australia, and France are low birth weight.

In both developed and developing countries, adolescents who give birth when their bodies have not fully matured are at risk for having low birth weight babies (Malamitsi-Puchner & Boutsikou, 2006). In the United States, the increase in the number of low birth weight infants has been attributed to drug use, poor nutrition, multiple births, reproductive technologies, and improved technology and prenatal care that result in more high-risk babies surviving (Chen & others, 2007). Nonetheless, poverty continues to be a major factor in preterm birth in the United States. Women living in poverty are more likely to be obese, have diabetes and hypertension, smoke cigarettes, and use illicit drugs, and they are less likely to receive regular prenatal care (Goldenberg & Nagahawatte, 2008).

In the preceding sentence, we learned that women living in poverty are less likely to receive regular prenatal care. *What did you learn earlier in the chapter about the benefits of regular prenatal care? Aside from women living in poverty, which other demographic group is not likely to receive adequate prenatal care?*

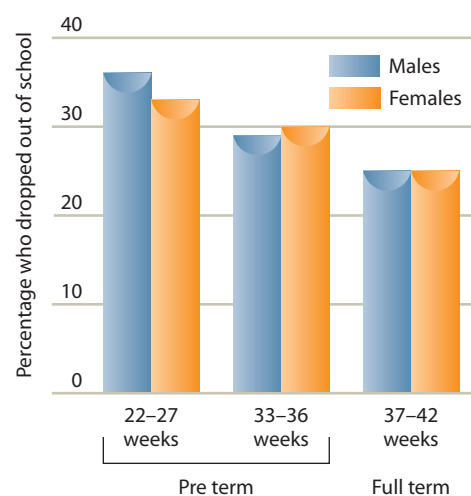


**FIGURE 3.7**  
PERCENTAGE OF INFANTS BORN WITH LOW BIRTH WEIGHT IN SELECTED COUNTRIES

gestational age. Figure 3.8 shows the results of a recent Norwegian study indicating that the earlier preterm infants are born, the more likely they are to drop out of school (Swamy, Ostbye, & Skjaerven, 2008).

The number and severity of these problems increase when infants are born very early and as their birth weight decreases. Survival rates for infants who are born very early and very small have risen, but with this improved survival rate have come increases in rates of severe brain damage (Casey, 2008). Children born at low birth weights are more likely than their normal birth weight counterparts to develop a learning disability, attention deficit hyperactivity disorder, or breathing problem such as asthma (Espirito Santo, Portuguese, & Nunes, 2009). Approximately 50 percent of all low birth weight children are enrolled in special education programs.

**Nurturing Low Birth Weight and Preterm Infants** Two increasingly used interventions in the neonatal intensive care unit (NICU) are kangaroo care and massage therapy. **Kangaroo care** involves skin-to-skin contact in which the baby, wearing only a diaper, is held upright against the parent's bare chest, much as a baby kangaroo is carried inside its mother's pouch. Kangaroo care is typically practiced for two to three hours per day, skin-to-skin, over an extended time in early infancy.



**FIGURE 3.8**  
PERCENTAGE OF PRETERM AND FULL-TERM BIRTH INFANTS WHO DROPPED OUT OF SCHOOL



A new mother practicing kangaroo care. *What is kangaroo care?*

Why use kangaroo care with preterm infants? Preterm infants often have difficulty coordinating their breathing and heart rate, and the close physical contact with the parent provided by kangaroo care can help to stabilize the preterm infant's heartbeat, temperature, and breathing (Begum & others, 2008; Ludington-Hoe & Others, 2006; Nyqvist & others, 2010). Preterm infants who experience kangaroo care also gain more weight than their counterparts who are not given this care (Gathwala, Singh, & Balhara, 2008). A recent study also revealed that kangaroo care decreased pain responses in preterm infants (Johnston & others, 2009).

Many adults will attest to the therapeutic effects of receiving a massage. In fact, many will pay a premium to receive one at a spa on a regular basis. But can massage play a role in improving developmental outcomes for preterm infants? To find out, see *Connecting Through Research*.

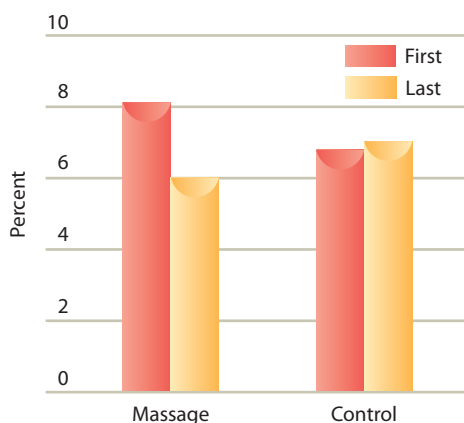
## connecting through research

### How Does Massage Therapy Affect the Mood and Behavior of Babies?

Throughout history and in many cultures, caregivers have massaged infants. In Africa and Asia, infants are routinely massaged by parents or other family members for several months after birth. In the United States, interest in using touch and massage to improve the growth, health, and well-being of infants has been stimulated by the research of Tiffany Field (2001, 2007; Diego, Field, & Hernandez-Reif, 2008; Field, Diego, & Hernandez-Reif, 2008, 2010; Field & others, 2006; Hernandez-Reif, Diego, & Field, 2007), director of the Touch Research Institute at the University of Miami School of Medicine.

In a recent study, preterm infants in a neonatal intensive care unit (NICU) were randomly assigned to a massage therapy group or a con-

trol group (Hernandez-Reif, Diego, & Field, 2007). For five consecutive days, the preterm infants in the massage group were given three 15-minute moderate pressure massages. Behavioral observations of the following stress behaviors were made on the first and last days of the study: crying, grimacing, yawning, sneezing, jerky arm and leg movements, startles, and finger flaring. The various stress behaviors were summarized in a composite stress behavior index. As indicated in Figure 3.9, massage had a stress-reducing effect on the preterm infants,



**FIGURE 3.9**  
PRETERM INFANTS SHOW REDUCED STRESS BEHAVIORS AND ACTIVITY AFTER FIVE DAYS OF MASSAGE THERAPY (HERNANDEZ-REIF, DIEGO, & FIELD, 2007)



Shown here is Tiffany Field massaging a newborn infant. *What types of infants has massage therapy been shown to help?*

(continued)

## connecting through research

(continued)

which is especially important because they encounter numerous stressors while they are hospitalized.

In another study, Field and her colleagues (2004) tested a more cost-effective massage strategy. They taught mothers how to massage their full-term infants rather than having health-care professionals do the massage. Beginning from day one of the newborn's life to the end of the first month, once a day before bedtime the mothers massaged the babies using either light or moderate pressure. Infants who were massaged with moderate pressure gained more weight, performed better on the orientation scale of the Brazelton, were less excitable and less depressed, and were less agitated during sleep.

Field has demonstrated the benefits of massage therapy for infants who face a variety of problems. For example, preterm infants exposed to cocaine in utero who received massage therapy gained weight and improved their scores on developmental tests (Wheeden & others, 1993). Another study investigated 1- to 3-month-old infants born to de-

pressed adolescent mothers (Field & others, 1996). The infants of depressed mothers who received massage therapy had lower stress—as well as improved emotionality, sociability, and soothability—compared with the nonmassaged infants of depressed mothers.

In a research review of massage therapy with preterm infants, Field and her colleagues (2004) concluded that the most consistent findings involve two positive results: (1) increased weight gain and (2) discharge from the hospital from three to six days earlier.

Infants are not the only ones who may benefit from massage therapy (Field, 2007). In other studies, Field and her colleagues have demonstrated the benefits of massage therapy with women in reducing labor pain (Field, Hernandez-Reif, Taylor, & others, 1997), with children who have asthma (Field, Henteleff, & others, 1998), with autistic children's attentiveness (Field, Lasko, & others, 1997), and with adolescents who have attention deficit hyperactivity disorder (Field, Quintino, & others, 1998).

### Review Connect Reflect

**LG2** Discuss the birth process.

#### Review

- What are the three main stages of birth? What are some different birth strategies? What is the transition from fetus to newborn like for the infant?
- What are three measures of neonatal health and responsiveness?
- What are the outcomes for children if they are born preterm or with a low birth weight?

#### Connect

- What correlations have been found between birth weight and country of birth, and what might the causes be?

#### Reflect Your Own Personal Journey of Life

- If you are a female who would like to have a baby, which birth strategy do you prefer? Why? If you are a male, how involved would you want to be in helping your partner through the birth of your baby? Explain.

### The Postpartum Period

**LG3**

Explain the changes that take place in the postpartum period.

Physical Adjustments

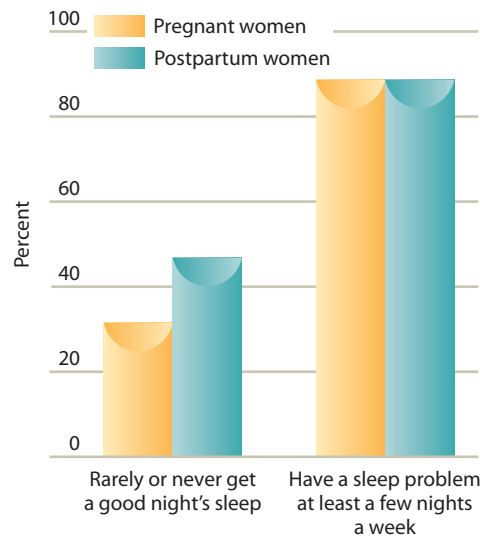
Emotional and Psychological Adjustments

Bonding

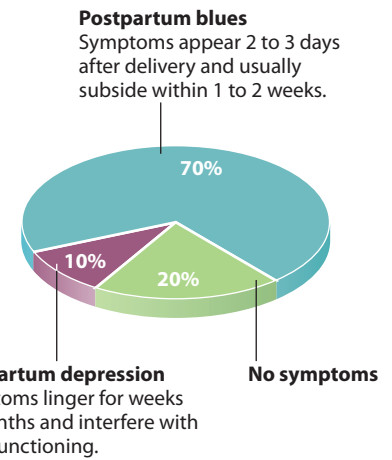
The weeks after childbirth present challenges for many new parents and their offspring. This is the **postpartum period**, the period after childbirth or delivery that lasts for about six weeks or until the mother's body has completed its adjustment and has returned to a nearly prepregnant state. It is a time when the woman adjusts, both physically and psychologically, to the process of childbearing.

**postpartum period** The period after childbirth when the mother adjusts, both physically and psychologically, to the process of childbirth. This period lasts about six weeks or until her body has completed its adjustment and returned to a near prepregnant state.





**FIGURE 3.10**  
SLEEP DEPRIVATION IN PREGNANT AND POSTPARTUM WOMEN



**FIGURE 3.11**  
POSTPARTUM BLUES AND POSTPARTUM DEPRESSION AMONG U.S. WOMEN. Some health professionals refer to the postpartum period as the “fourth trimester.” Though the time span of the postpartum period does not necessarily cover three months, the term “fourth trimester” suggests continuity and the importance of the first several months after birth for the mother.

The postpartum period involves a great deal of adjustment and adaptation. The adjustments needed are physical, emotional, and psychological.

## PHYSICAL ADJUSTMENTS

A woman’s body makes numerous physical adjustments in the first days and weeks after childbirth (Smith, 2009). She may have a great deal of energy or feel exhausted and let down. Though these changes are normal, the fatigue can undermine the new mother’s sense of well-being and confidence in her ability to cope with a new baby and a new family life (Runquist, 2007).

A concern is the loss of sleep that the primary caregiver experiences in the postpartum period (Gunderson & others, 2008). In the 2007 Sleep in America survey, a substantial percentage of women reported loss of sleep during pregnancy and in the postpartum period (National Sleep Foundation, 2007) (see Figure 3.10). The loss of sleep can contribute to stress, marital conflict, and impaired decision making (Meerlo, Sgoifo, & Suchecki, 2008).

After delivery, a mother’s body undergoes sudden and dramatic changes in hormone production. When the placenta is delivered, estrogen and progesterone levels drop steeply and remain low until the ovaries start producing hormones again.

*Involution* is the process by which the uterus returns to its prepregnant size five or six weeks after birth. Immediately following birth, the uterus weighs 2 to 3 pounds. By the end of five or six weeks, the uterus weighs 2 to 3½ ounces. Nursing the baby helps contract the uterus at a rapid rate.

## EMOTIONAL AND PSYCHOLOGICAL ADJUSTMENTS

Emotional fluctuations are common for mothers in the postpartum period. For some women, emotional fluctuations decrease within several weeks after the delivery, but other women experience more long-lasting mood swings.

As shown in Figure 3.11, about 70 percent of new mothers in the United States have what are called the postpartum blues. About two to three days after birth, they begin to feel depressed, anxious, and upset. These feelings may come and go for

### developmental connection

**Theories.** Lorenz demonstrated the importance of bonding in graylag geese, but the first few days of life are unlikely to be a critical period for bonding in human infants. Chapter 1, p. 28

**postpartum depression** Characteristic of women who have such strong feelings of sadness, anxiety, or despair that they have trouble coping with daily tasks during the postpartum period.

## connecting with careers

### Diane Sanford, Clinical Psychologist and Postpartum Expert

Diane Sanford has a doctorate in clinical psychology, and for many years she had a private practice that focused on marital and family relationships. But after she began collaborating with a psychiatrist whose clients included women with postpartum depression, Dr. Sanford, together with a women's health nurse, founded Women's Healthcare Partnership in St. Louis, Missouri, which specializes in women's adjustment during the postpartum period. Subsequently, they added a marriage and family relationships counselor and a social worker to their staff, and then later hired nurse educators, a dietician, and a fitness expert as consultants (Clay, 2001).

*For more information about what clinical psychologists do, see page 45 in the Careers in Child Development appendix following Chapter 1.*



Diane Sanford holding an infant of one of the mothers who comes to her for help in coping with postpartum issues.

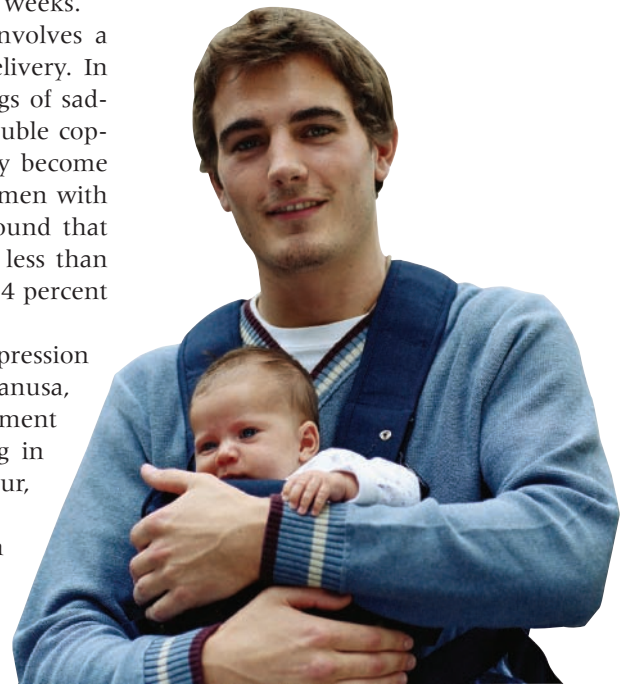
several months after the birth, often peaking about three to five days after birth. Even without treatment, these feelings usually go away after one or two weeks.

However, some women develop **postpartum depression**, which involves a major depressive episode that typically occurs about four weeks after delivery. In other words, women with postpartum depression have such strong feelings of sadness, anxiety, or despair that for at least a two-week period they have trouble coping with their daily tasks. Without treatment, postpartum depression may become worse and last for many months (Nolen-Hoeksema, 2011). And many women with postpartum treatment don't seek help. For example, one recent study found that 15 percent of the women reported postpartum depression symptoms but less than half sought help (McGarry & others, 2009). Estimates indicate that 10 to 14 percent of new mothers experience postpartum depression.

Several antidepressant drugs are effective in treating postpartum depression and appear to be safe for breast feeding women (Logsdon, Wisner, & Hanusa, 2009). Psychotherapy, especially cognitive therapy, also is an effective treatment of postpartum depression for many women (Beck, 2006). Also, engaging in regular exercise may help in treating postpartum depression (Daley, Macarthur, & Winter, 2007).

Can a mother's postpartum depression affect the way she interacts with her infant? A recent research review concluded that the interaction difficulties of depressed mothers and their infants occur across cultures and socioeconomic status groups, and encompass less sensitivity of the mothers and less responsiveness on the part of their infants (Field, 2010). Several caregiving activities also are compromised, including feeding (especially breast feeding), sleep routines, and safety practices. To read about one individual who specializes in women's adjustment during the postpartum period, see *Connecting With Careers*.

Fathers also undergo considerable adjustment during the postpartum period, even when they work away from home all day. Many fathers feel that the baby



The postpartum period is a time of considerable adjustment and adaptation for both the mother and the father. Fathers can provide an important support system for mothers, especially in helping mothers care for young infants. *What kinds of tasks might the father of a newborn do to support the mother?*



A mother bonds with her infant moments after it is born. *How critical is bonding for the development of social competence later in childhood?*

comes first and gets all of the mother's attention; some feel that they have been replaced by the baby.

The father's support and caring can play a role in whether the mother develops postpartum depression (Dietz & others, 2009; Gao, Chan, & Mao, 2009). A recent study revealed that higher support by fathers was related to lower incidence of postpartum depression in women (Smith & Howard, 2008).

## BONDING

A special component of the parent-infant relationship is **bonding**, the formation of a connection, especially a physical bond between parents and the newborn in the period shortly after birth. Sometimes hospitals seem determined to deter bonding. Drugs given to the mother to make her delivery less painful can make the mother drowsy, interfering with her ability to respond to and stimulate the newborn. Mothers and newborns are often separated shortly after delivery, and preterm infants are isolated from their mothers even more than full-term infants.

Do these practices do any harm? Some physicians believe that during the period shortly after birth, the parents and newborn need to form an emotional attachment as a foundation for optimal development in the years to come (Kennell, 2006; Kennell & McGrath, 1999). Is there evidence that close contact between mothers and infants in the first several days after birth is critical for optimal development later in life? Although some research supports this bonding hypothesis (Klaus & Kennell, 1976), a body of research challenges the significance of the first few days of life as a critical period (Bakeman & Brown, 1980; Rode & others, 1981). Indeed, the extreme form of the bonding hypothesis—that the newborn must have close contact with the mother in the first few days of life to develop optimally—simply is not true.

Nonetheless, the weakness of the bonding hypothesis should not be used as an excuse to keep motivated mothers from interacting with their newborns. Such contact brings pleasure to many mothers. In some mother-infant pairs—including preterm infants, adolescent mothers, and mothers from disadvantaged circumstances—early close contact may establish a climate for improved interaction after the mother and infant leave the hospital.

Many hospitals now offer a *rooming-in* arrangement, in which the baby remains in the mother's room most of the time during its hospital stay. However, if parents choose not to use this rooming-in arrangement, the weight of the research suggests that this decision will not harm the infant emotionally (Lamb, 1994).

**bonding** The formation of a close connection, especially a physical bond, between parents and their newborn in the period shortly after birth.

## Review Connect Reflect

**LG3** Explain the changes that take place in the postpartum period.

### Review

- What does the postpartum period involve? What physical adjustments does the woman's body make during this period?
- What emotional and psychological adjustments characterize the postpartum period?
- Is bonding critical for optimal development?

### Connect

- How can exercise help pregnant women before delivery and women with postpartum depression after giving birth?

### Reflect Your Own Personal Journey of Life

- If you are a female who plans to have children, what can you do to adjust effectively in the postpartum period? If you are the partner of a new mother, what can you do to help in the postpartum period?

# Prenatal Development and Birth

## Prenatal Development

**LG1** Describe prenatal development.

### The Course of Prenatal Development

- Prenatal development is divided into three periods: germinal (conception until 10 to 14 days later), which ends when the zygote (a fertilized egg) attaches to the uterine wall; embryonic (two to eight weeks after conception), during which the embryo differentiates into three layers, life-support systems develop, and organ systems form (organogenesis); and fetal (two months after conception until about nine months, or when the infant is born), a time when organ systems have matured to the point at which life can be sustained outside of the womb. The growth of the brain during prenatal development is nothing short of remarkable. By the time babies are born they have approximately 100 billion neurons, or nerve cells. Neurogenesis is the term that means the formation of new neurons. The nervous system begins with the formation of a neural tube at 18 to 24 days after conception. Proliferation and migration are two processes that characterize brain development in the prenatal period. The basic architecture of the brain is formed in the first two trimesters of prenatal development.

### Teratology and Hazards to Prenatal Development

- Teratology is the field that investigates the causes of congenital (birth) defects. Any agent that causes birth defects is called a teratogen. The dose, genetic susceptibility, and time of exposure influence the severity of the damage to an unborn child and the type of defect that occurs. Prescription drugs that can be harmful include antibiotics, some antidepressants, certain hormones, and Accutane. Nonprescription drugs that can be harmful include diet pills and aspirin. Legal psychoactive drugs that are potentially harmful to prenatal development include caffeine, alcohol, and nicotine. Fetal alcohol spectrum disorders are a cluster of abnormalities that appear in offspring of mothers who drink heavily during pregnancy. Even when pregnant women drink moderately (one to two drinks a few days a week), negative effects on their offspring have been found. Cigarette smoking by pregnant women has serious adverse effects on prenatal and child development (such as low birth weight). Illegal psychoactive drugs that are potentially harmful to offspring include methamphetamine, marijuana, cocaine, and heroin. Incompatibility of the mother's and the father's blood types can also be harmful to the fetus. Environmental hazards include radiation, environmental pollutants, and toxic wastes. Syphilis, rubella (German measles), genital herpes, and AIDS are infectious diseases that can harm the fetus. Other parental factors include maternal diet and nutrition, age, emotional states and stress, and paternal factors. A developing fetus depends entirely on its mother for nutrition. Maternal age can negatively affect the offspring's development if the mother is an adolescent or over 35. High stress in the mother is linked with less than optimal prenatal and birth outcomes. Paternal factors that can adversely affect prenatal development include exposure to lead, radiation, certain pesticides, and petrochemicals.

### Prenatal Care

- Prenatal care varies extensively but usually involves medical care services with a defined schedule of visits.

### Normal Prenatal Development

- It is important to remember that, although things can and do go wrong during pregnancy, most of the time pregnancy and prenatal development go well.

## Birth

**LG2** Discuss the birth process.

### The Birth Process

- Childbirth occurs in three stages. The first stage, which lasts about 6 to 12 hours for a woman having her first child, is the longest stage. The cervix dilates to about 10 centimeters (4 inches) at the end of the first stage. The second stage begins

when the baby's head starts to move through the cervix and ends with the baby's complete emergence. The third stage involves the delivery of the placenta after birth. Childbirth strategies involve the childbirth setting and attendants. In many countries, a doula attends a childbearing woman. Methods of delivery include medicated, natural or prepared, and cesarean. Being born involves considerable stress for the baby, but the baby is well prepared and adapted to handle the stress. Anoxia—insufficient oxygen supply to the fetus/newborn—is a potential hazard.

#### Assessing the Newborn

- For many years, the Apgar Scale has been used to assess the health of newborn babies. The Brazelton Neonatal Behavioral Assessment Scale (NBAS) examines the newborn's neurological development, reflexes, and reactions to people. Recently, the Neonatal Intensive Care Unit Network Neurobehavioral Scale (NNNS) was created to assess at-risk infants.

#### Preterm and Low Birth Weight Infants

- Low birth weight infants weigh less than 5½ pounds, and they may be preterm (born before the completion of 37 weeks of gestation) or small for date (also called small for gestational age), which refers to infants whose birth weight is below normal when the length of pregnancy is considered. Small for date infants may be preterm or full term. Although most low birth weight and preterm infants are normal and healthy, as a group they experience more illness and developmental problems than normal birth weight infants. Kangaroo care and massage therapy have been shown to have benefits for preterm infants.

## The Postpartum Period

LG3

Explain the changes that take place in the postpartum period.

#### Physical Adjustments

- The postpartum period is the period after childbirth or delivery. The period lasts for about six weeks or until the woman's body has completed its adjustment. Physical adjustments in the postpartum period include fatigue, involution (the process by which the uterus returns to its prepregnant size five or six weeks after birth), and hormonal changes.

#### Emotional and Psychological Adjustments

- Emotional fluctuations on the part of the mother are common in this period, and they can vary greatly from one mother to the next. Postpartum depression characterizes women who have such strong feelings of sadness, anxiety, or despair that they have trouble coping with daily tasks in the postpartum period. Postpartum depression occurs in about 10 percent of new mothers. The father also goes through a postpartum adjustment.

#### Bonding

- Bonding is the formation of a close connection, especially a physical bond, between parents and the newborn shortly after birth. Early bonding has not been found to be critical in the development of a competent infant.

## key terms

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blastocyst 78  
trophoblast 78  
embryonic period 78  
amnion 79  
umbilical cord 79  
placenta 79  
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