

CHAPTER 2

The Dawn of Development



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CHAPTER OUTLINE

1. GENETICS

- Biological foundations
- Genetic disorders
- Behavior genetics

2. PRENATAL DEVELOPMENT

- Stages of prenatal development
- Critical factors in prenatal development
- Complications in pregnancy
- Prenatal care
- Reactions to pregnancy

3. BIRTH AND THE NEWBORN

- Labor and delivery
- Complications during delivery and at birth
- The newborn
- Transitions



If I asked you to reflect upon your life and remember your most important moments, what would come to mind? You may recall your high school graduation, birth of a sibling, or other such monumental events. Did you think about your moment of conception? Arguably, this is your most important moment in life, because it is when you became a life. As you will learn in this chapter, the period of prenatal development is a magical time of incredible growth and development. We will also discuss genetics and the birth process.

1. GENETICS

LEARNING OBJECTIVES:

1. To have a general knowledge of genetic terminology and processes
2. Awareness of some of the different types of genetic disorders
3. Appreciation for the field of behavior genetics within the context of studying life span development

We know, we know—most of you just learned about genetics in your college or high school biology class. That's good! Some of the basic terminology and processes will simply be review for you. However, it is possible that you will learn some new material as well. We will explain some genetic disorders that are of interest to developmentalists in this section. Most of them are heart wrenching. We will also briefly touch upon the field of behavior genetics. In general, we will try to keep the focus on why genetics is important to the field of human development, hopefully providing a new perspective for you.

BIOLOGICAL FOUNDATIONS

What color are your eyes? How tall are you? What shape is your nose (before any breaks or plastic surgery)? Clearly, genetics play a role in how you answer each of these questions. Are you shy or outgoing? Do any of your relatives have schizophrenia? Are you smarter than a fifth grader? Did you also know that genetics play a role in answering these questions as well? Genetics, in conjunction with the environment, play a role in all aspects of your development: biological, cognitive, and socioemotional. In this section we will discuss some of the basic biological aspects of genetics.



1. What does the nucleus of all cells contain?

The Basics in Genetics

At the moment of conception a complex hereditary process is initiated. This allows for a new genetic blueprint of a human being who is similar to others but genetically unique. It has been estimated, for example, that there is the possibility of 17 million different genetic combinations available for the makeup of a human being when conception occurs

Chromosomes

A collection of genes contained within a cell nucleus; the total number per cell is constant for each species, with humans having forty-six in each cell, except for the gametes, which have twenty-three.

Autosomes

A single chromosome; any one of the forty-six chromosomes found in the nucleus of a human cell.

Sex chromosomes

The twenty-third pair of chromosomes, which determines a person's gender.

Gene

The basic agents of heredity from one generation of humans to the next.

(Kowles, 1985; Patten, 1976). Genetics can be defined as "the study of how parents pass on characteristics to their offspring" (Jenkins, 1998, p. 16).

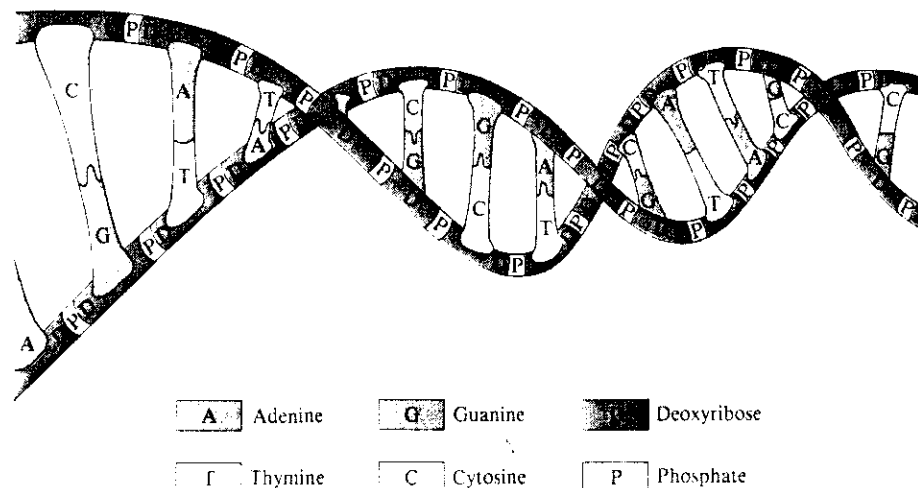
The nucleus of all cells contains **chromosomes**. The number of chromosomes typically found in a cell nucleus is species-dependent. For example, dogs and chickens have seventy-eight chromosomes, chimpanzees have forty-eight chromosomes, goldfish have ninety-four chromosomes, and alligators have thirty-two chromosomes (Jenkins, 1998). For a number of years in the past, humans were thought to have forty-eight chromosomes in each cell of their bodies. Investigations conducted in 1965 determined this to be an error. These reported only forty-six chromosomes per each normal human cell, which is widely accepted today as the accurate chromosome count. Therefore, you have twenty-three pairs of chromosomes, half from your mother and half from your father. Geneticists refer to the first twenty-two pairs of chromosomes as **autosomes**, and the twenty-third pair as your **sex chromosomes**.

Chromosomes are composed of **genes**, which are the basic agents of heredity from one generation of humans to the next. Genes are known today to be composed of chemical molecules. It is through genes that one's biological make-up is passed on to offspring. They also direct the daily functioning of individual cells as well as organ systems. The total genetic makeup of an individual is known as that person's **genotype**. The interactions of genes with one another and with the environment produce the person's **phenotype**. We cannot directly see a person's genotype (it's inside his or her genes); however, we can observe a person's phenotype in certain traits and characteristics such as hair color, skin color, and behavior.

Each gene contained within a chromosome package is a single but uniquely composed molecule of **deoxyribonucleic acid (DNA)**. DNA molecules have a special structure

FIGURE 2-1 A MODEL OF THE DNA MOLECULE

DNA molecules have a special structure called a double helix. DNA passes genetic material to the next generation.



Genotype

The total genetic makeup of an individual.

Phenotype

The traits and characteristics such as hair color, skin color, and behavior that can be observed.

Deoxyribonucleic acid (DNA)

A complex molecule composed of four basic nucleotides that is the carrier of genetic inheritance.

Mitosis

The splitting of each chromosome in the body cell to form a new pair.

Meiosis

The process by which the gametes (sperm and ova) are produced in the male testicles and the female ovaries.

Mutation

A change in the chemical structure of the gene or genes and can occur during cell division or as a result of environmental influences.

called a double helix (see Figure 2-1). It resembles a twisting ladder or a spiral staircase. There are two known functions for DNA: passing genetic material on to the next generation and the instructions for cells to make proteins (Werner, 2007). Any DNA molecule is formed of four basic nucleotides (commonly referred to as A, T, C, and G—see below). These are paired in repeated sequences to form a specific genetic code. These nucleotides are composed of a carbohydrate (deoxyribose), a phosphate, a purine (adenine or guanine), and a pyrimidine (cystocine or thymine).

It is important to distinguish between the replacement of other body cells and the manufacture of the sex cells responsible for fertilization. The average body cell is eventually replaced by new ones as growth and development occur over the life span. Through a process called **mitosis**, each chromosome in a body cell splits to form a new pair. The result is a new daughter cell containing forty-six chromosomes that are identical with those of the original cell. **Meiosis** is the process by which the gametes (sperm and ova) are produced in the male testicles and the female ovaries. Two cell divisions usually occur when the testicles (or ovaries) produce a new sperm cell (or ovum). The result is that the nucleus of the gamete contains only twenty-three rather than the usual forty-six chromosomes. At conception, the sperm and the ovum (produced via meiosis) join together. The process of mitosis is initiated and the new genetically constituted human being begins to grow.

As most of you know, your biological sex was determined at conception. The female ovum contains twenty-three chromosomes, one of which is known as the X sex chromosome. Every normal ovum contains only an X sex chromosome.

Sperm cells from the male also contain twenty-three chromosomes. Some sperm contain an X sex chromosome, like the one found in the female ovum, whereas other sperm cells contain a Y sex chromosome. When a sperm containing an X chromosome fertilizes an ovum (containing its own X chromosome), a biological female is created. When a sperm containing a Y sex chromosome unites with an ovum (containing its X chromosome), a biological male is created. Males have a genotype of XY and females have a genotype of XX. It is the type of sperm from the father, then, that determines the biological sex of the offspring.

Gene Mutation

Sometimes one or more genes change as a result of a **mutation**. A mutation changes the chemical structure of the gene or genes and can occur during cell division or as a result of environmental influences. Three types of gene mutations are insertion mutations, deletion mutations, and point mutations. Most mutations cause illness or death; relatively few result in a desirable outcome.

Genetic Processes

Okay, so half of your genetic material (twenty-three chromosomes) comes from your mother and half (the other twenty-three chromosomes) comes from your father. For each pair of chromosomes, the genes that you inherit may be the same (homozygous) or may be

different (heterozygous). This is because the gene may have identical or different alleles (Jenkins, 1998, p.159). This sounds confusing, so maybe the following passage from a developmental biology textbook will help:

"For each kind of a gene there is a position—a locus—where it is found along the length of a chromosome. The locus for most genes is found on two chromosomes—one inherited from our mother and one from our father. That is, we have two copies (alleles) of most genes. These copies may be identical or different. If they are different, they may both be expressed, or one copy (dominant) may mask the other (recessive)" (Dye, 2000, p. 16).

For example, you may have inherited an allele for five fingers from your dad and an allele for six fingers from your mom. Will you end up with five and half fingers? Or is one allele stronger than the other allele? We will see that some genes have a dominant/recessive process to determine how a genotype is expressed as a phenotype. Other genes have a polygenetic process to determine phenotype. Still others work by genetic processes that we are just beginning to understand. Things are much more complicated than Gregor Mendel (often called the father of genetics) may have imagined.

Dominant/Recessive Processes

Sometimes, one allele is stronger than another allele. For example, look at your fingers. Are they long and slender (let's call this L for its genotype) or are they short and clublike (let's call this S for its genotype)? The allele for short, clublike fingers is **dominant**, whereas the allele for long, slender fingers is **recessive**. This means that if you have long, slender fingers, both of your alleles are recessive (genotype LL). If just one of your alleles was S, you would have short, clublike fingers because it is a dominant allele. This means that people with either genotypes SL or SS have the phenotype of short, clublike fingers.

Gene dominance occurs when any two partner alleles are not identical for a gene. One allele is said to be dominant and the other recessive. The dominant gene of the pair acts to produce the trait this pair of genes is supposed to affect, and the activity of the recessive gene is repressed. However, sometimes there can be **incomplete dominance** (such as when a red flower and a white flower bred together can create a pink flower) and **codominance** or **intermediate inheritance** (such as when a white cow and a red bull will produce a calf with red and white hairs). Occasionally, a specific trait or characteristic may have more than one pair of alleles possible (multiple allelism). Blood type is an example of this (Dye, 2000; Jenkins, 1998).

Sex-Linked Inheritance

As mentioned earlier, there are two sex chromosomes that control the biological sex of a child (XX or XY). The X chromosome is larger than the Y chromosome and seems to carry more genetically rich information (Dye, 2000). Later in this chapter we will briefly discuss some sex-linked chromosome disorders. If a male inherits a recessive gene on his X chromosome,

Dominant

A gene from one parent that controls or suppresses the influence of the complementary (recessive) gene from the other parent in the offspring.

Recessive

A gene from one parent whose influence is repressed by the complementary (dominant) gene from the other parent in the offspring.

Incomplete dominance

Occurs when one allele is not completely dominant over the second allele.

Codominance

Occurs when both alleles are fully expressed.

Polygenic process

The interaction of alleles from more than one gene.

Discontinuous variation

When a trait or variation can be placed into distinct categories.

Continuous variation

When a trait or variation is distributed on a continuum or spectrum.

Epigenetic information

A characteristic of developmental changes meaning that changes that are currently observed were determined by those that occurred earlier in time, and changes that follow will be influenced by the ones currently being observed.

Genetic imprinting

The repression or expression of a gene or chromosome in an offspring that is dependent upon which parent it is inherited from.

he will exhibit the recessive trait. However, if a female inherits a recessive gene on one of her X chromosomes, she will be a carrier of the gene, but may not exhibit the recessive trait if her other X chromosome has a dominant gene. This is why males are more likely to inherit certain sex-linked traits, characteristics, or disorders such as color-blindness, baldness, or hemophilia.



A pink flower is an example of incomplete dominance.
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Polygenic Inheritance

Although some inherited traits and characteristics follow a dominant/recessive process, others involve a **polygenic process** (or the interaction of several genes). Intelligence, skin color, eye color, and height are just some of the human traits that involve polygenic inheritance (Dye, 2000; Jenkins, 1998). For instance, you may have been taught that eye color is a matter of dominant/recessive alleles; however, eye color is determined by the amount of melanin present in your iris. Light-colored eyes have lower amounts of melanin than dark-colored eyes. Skin color is the same way, and many geneticists believe that at least three genes interact to determine skin color.

Some human traits and characteristics are coded for an either/or presentation (i.e., **discontinuous variation**) driven by dominant/recessive processes. For example, either you have five fingers or six fingers, depending upon your genotype. However, other human traits and characteristics are coded for a **continuous variation** as seen with polygenic inheritance. For example, an individual's intelligence or height is limited by a range set forth in the genotype, but it is the interaction of genes (and sometimes environmental influences) that ultimately determines that person's phenotype (Dye, 2000; Jenkins, 1998).

Beyond the Genes

A child receives three kinds of information during prenatal development: "genes, maternally derived substances, and differential chemical modification of parental genes" (Dye, 2000, p. 16). The first, the genes, we have already covered. The other two forms of information can be collectively referred to as **epigenetic information**. These mechanisms are still in the process of being understood, but some preliminary information is known.

Genetic imprinting can be considered one form of epigenetic information. It is the fascinating process whereby how genetic material is expressed is dependent upon from which parent it is inherited (Moore & Persaud, 1998). For example, some chromosome disorders will manifest as different syndromes dependent upon whether the chromosome

deletion is carried by the mother or the father. Another form of epigenetic information is the cytoplasmic environment during ovum development (Dye, 2000). As stated, epigenetic information is a new area of research; however, some preliminary findings suggest that longevity, metabolism rates, and height may be influenced by epigenetic information from both the parents and possibly the grandparents.

In summary, each of us is endowed with a unique genetic make-up at the moment of conception. Sometimes, however, mistakes can happen in our genes and a genetic disorder is the result. The next section will discuss some ways in which our genetic process can go awry.

Test Yourself



1. Distinguish between genotype and phenotype.
2. Explain the genetic processes of dominant/recessive genes and polygenic inheritance.

GENETIC DISORDERS

There are different categories of genetic disorders (ACOG, 2005); we will discuss three broad categories here. Some disorders are caused by a single gene. Other disorders are caused at the chromosomal level (or by many genes). Still others are multifactorial in cause (or caused by genes and environmental factors). Below, we will briefly highlight several genetic disorders and then discuss a few of the more common ones at length.

Inherited Disorders

As mentioned above, some genetic disorders are initiated by a single gene. These are referred to as **inherited disorders**. They may originate from dominant genes, recessive genes, or sex-linked genes.

Inherited disorder

A disorder or disease that develops due to a gene mutation, chromosomal problem, or other genetic factor.

If a disorder is inherited from a dominant gene, then it can be given to a child by a single gene from one parent. These disorders can range from life-threatening to nonserious. See Table (2a-1) of some dominant-gene (or autosomal dominant) disorders (ACOG, 2005; Carlson, 1999).

If a disorder is inherited from a recessive gene, then both parents must be carriers of the gene in order for the child to have the disorder. If only one parent is a carrier, then the child may be a carrier but will not have the disorder. Many of these disorders have different prevalence rates for different ethnic groups. See Table (2a-2) of some recessive-gene (or autosomal recessive) disorders (ACOG, 2005; Carlson, 1999).

Sex-linked chromosome disorders are carried on the X chromosome; hence, they are sometimes referred to as X-linked recessive disorders. These disorders are much more common in males. This is because males have only one X chromosome; therefore, if there is a recessive gene on it, they will develop the disorder. On the other hand, females have two X chromosomes, so if one has a recessive gene, the other may have a dominant gene that prevents the disorder from materializing or will mitigate the materialization of the disorder. See Table (2a-3) of some sex-linked disorders (ACOG, 2005; Carlson, 1999).

TABLE 2A-1 DOMINANT-GENE DISORDERS

DOMINANT-GENE DISORDERS	BRIEF DESCRIPTION
Anchondroplasia	Dwarfism with short limbs
Aniridia	Incomplete iris
Crouzon syndrome	Abnormalities to the cranium structure
Huntington's disease	Degeneration of the nervous system
Neurofibromatosis	Pigmentation abnormalities and tumors on the skin
Polycystic kidney disease type III	Having cysts in the kidneys
Polydactyly	Having extra fingers or toes

Chromosomal Disorders

Chromosomal disorder

A disorder due to a chromosomal abnormality or defect.

Chromosomal disorders stem from a missing, duplicate, or damaged chromosome (ACOG, 2005). In this category of disorders, the problem typically originates during fertilization. The risk of having a baby with a chromosome disorder increases with the mother's age. For example, a twenty-five-year-old woman has a 1/476 chance of having a baby with any chromosomal disorder; conversely, a thirty-five-year-old woman has a 1/192 chance and a forty-five-year-old woman has a 1/21 chance of having a baby with

TABLE 2A-2 RECESSIVE-GENE DISORDERS

RECESSIVE-GENE DISORDERS	BRIEF DESCRIPTION
Albinism	Reduction or lack of pigmentation in the skin, eyes, and/or hair; eye problems
Bloom syndrome	Prenatal and childhood growth problems, cognitive deficits
Cystic fibrosis	Mucus build-up in the respiratory system, frequent respiratory infections
Polycystic kidney disease type I	Having cysts in the kidneys
Phocomelia syndrome	Deformities in the limbs
Sickle-cell disease	Misshapen red blood cells that cannot properly carry oxygen to all parts of the body and block white blood cells
Tay-Sachs disease	Nervous system degeneration and early childhood death

TABLE 2A-3 SEX-LINKED DISORDERS

SEX-LINKED DISORDERS	BRIEF DESCRIPTION
Fragile X syndrome	Cognitive deficiencies possible, including learning disabilities or mental retardation
Hemophilia	Inability to clot blood normally
Hydrocephalus	Large cranium
Icthyosis	Skin disorder
Testicular feminization syndrome	Genetic male with a female phenotype

such a disorder (as cited by the ACOG, 2005). The two most discussed chromosome disorders are Down syndrome and trisomy 18.

Multifactorial Disorders

Multifactorial disorder

A disorder that results from the interaction of genetics with the environment.

Multifactorial disorders come from a combination of genetic and environmental causes. Often, doctors are never quite certain what the specific cause of such disorders is. Some examples of multifactorial disorders include neural tube defects and cleft palates.

Support for Families Coping with Genetic Disorders

Genetic disorders may be minor in nature or life-threatening. Regardless, the impact of learning that you or your loved one is facing such a disorder cannot be underestimated. Some of these disorders are widely known and have established support networks. Others are so rare, that finding support can be difficult. The genesis of the World Wide Web has offered individuals facing a genetic disorder a new hope in finding support. Information, support groups (online and in person), medical interventions, and research information are now available in an easy-to-use interface. Again, the rarer disorders may still be hard to find support for; however, families can reach out and try to find help in ways never thought possible.



Test Yourself

1. What is the difference between inherited disorders and chromosomal disorders?
2. Why are males more likely to inherit some genetic disorders than females?

BEHAVIOR GENETICS

The field of behavior genetics seeks to understand how genetic and environmental factors interact to produce particular behaviors, characteristics, and traits. This is not the nature

versus nurture argument of old; instead, it is an endeavor to truly understand the interactive dance between nature and nurture and their coactive influence on development. Environmental factors can be broadly conceptualized as external environmental factors and internal environmental factors that influence the expression of genes (National Research Council, 2000). This section will address some of the research designs used in behavior genetics and some of the ways in which genetics and the environment interact and influence one another.

Research Designs

Because developmentalists can neither ethically nor practically enact selective breeding programs to study behavioral genetics, they have heavily relied upon twin and adoption research. Both approaches have their strengths and their limitations.

In adoption research, a child's characteristics are compared with his biological and adoptive mothers' characteristics. For example, let's say you are interested in how musical preferences are influenced by genetics and environment. You could compare an adopted child's preference for classical music to his biological mother's like of classical music (where the child and mother share genes, but not the home environment). You could also compare the adopted child's preference for classical music to his adoptive mother's like of classical music (where the child and mother share a home environment, but not genes). What could you assume if the child's preferences closely resemble the adoptive mother's preferences but not the biological mother's preferences? One possible assumption could be that home environment is more important in the development of musical preferences than genetic endowment. This is an overly simplified example of the adoptive research design, but it gives you a general idea of what the approach is like. There are variations on this theme that may focus upon biologically related and unrelated siblings.

There are some potential problems with the adoption research design (National Research Council, 2000). Can you guess what they may be? First, adoption designs can neglect to consider the possibilities that adoption agencies are selective in their placements and how that may bias the research. Second, adoption studies may neglect to consider the impact of prenatal experiences on the child. Finally, a child is not a lump of clay when placed with an adoptive family. He or she comes with their own set of characteristics that may evoke certain responses and interactions from adoptive parents. This can also bias, or at least impact, the outcomes of any study.

Twin studies compare the traits/characteristics/behaviors of monozygotic (genetically identical—identical twins) and dizygotic (genetically similar, but not identical—fraternal twins) twins. What would you suppose if monozygotic twins were more alike in their music preferences than dizygotic twins? It would be easy to assume that music preference is at least somewhat influenced by genetics. Again, this is an overly simplified example, but it gives you the big picture of twin studies. Sometimes, twin studies compare twins that were raised together against those that were separated at birth and reared apart (think *The*



9. What are the two types of twins?



Twin studies compares the traits/characteristics/behaviors of monozygotic and dizygotic twins. (iStock)

Parent Trap here). This allows researchers the additional layer of considering home environment influences.

Twin study designs also have some potential problems (National Research Council, 2000). It is possible that monozygotic twins and dizygotic differ in regards to how similar their home environments are. Perhaps parents are more likely to treat monozygotic twins more alike than dizygotic twins. If the twin study involves separation at birth and adoption, then we have the same issues mentioned earlier for the adoption studies. Additionally, maybe twin development is not the same as development in individuals who are not twins. In this case, the research findings are applicable only to twins, not people in general. Still, adoption and twin studies within the paradigm of behavior genetics have offered some interesting insights into the co-influence of genetics and environment.

Genetic/Environment Interactions

How do genes and the environment interact? The answer is that it depends. There are a few different ways that we can see genes and the environment interact (Scarr, 1993). These are largely false categorizations, because in the real world, all of these different interactions are probably happening simultaneously and continuously.

One perspective on gene/environment interactions highlights the dynamic nature of such interactions. A child's genetic endowment may lead to some behavioral propensities, which in turn, evoke certain responses from the environment. For example, a child with impulsive behaviors may elicit impulsive behaviors from the parents. Hence, this type of relationship could be viewed as an **evocative genotype-environment** relationship (or correlation).

Another perspective on gene/environment interactions may focus upon the influence of the environment in activating genes. For example, a person may have the genetic propensity for developing bipolar disorder; however, whether those genes are activated

Evocative genotype-environment correlation

An environment in which the child elicits certain environments or behaviors due to his or her genetics.

Passive genotype-environment correlation

An environment in which the child passively receives an environment.

depends upon environmental factors. This type of relationship is viewed as a **passive genotype-environment** relationship (or correlation).

A final perspective on gene/environment interactions may emphasize what is referred to as niche-picking. Within this perspective, attention is paid to the fact that people, influenced by their genetics, seek out environments that are in harmony with their genetic propensities. For example, a child who is, by nature, social and active may seek out sports that are social and active. Conversely, a child who is, by nature, quiet and introspective may seek out activities that mesh better with his or her nature. This type of a relationship is viewed as an **active genotype-environment** relationship (or correlation) in which individuals seek environments in tune with their biological preferences.

Active genotype-environment correlation

An environment that the child seeks due to genetic preferences.



Test Yourself

1. What is the goal of behavior genetics?
2. Describe adoption and twin studies.

2. PRENATAL DEVELOPMENT

LEARNING OBJECTIVES:

1. Understand and describe the nature of developmental changes occurring between conception and birth
2. Identify and describe various hazards that may be experienced during a woman's pregnancy
3. Discuss complications that may arise during pregnancy
4. Relate common prenatal care
5. Understand typical reactions to pregnancy

The period before birth is perhaps the most crucial stage in the life span. During the average 280-day period, the biological foundations are established that are influential for the entire life span.

In earlier times, development before birth was surrounded by mystery. Because it is hidden from direct observation, the beginnings of life were largely misunderstood, even by scientists. In these less-informed times, folklore and superstition governed popular speculation about pregnancy. One folk belief held that everything a pregnant woman experienced affected the developing child within her uterus. Birthmarks on the baby's body, for example, were attributed to the mother's having a frightening or stressful experience, spilling wine at a meal, or eating too many strawberries during pregnancy. A newborn's harelip (a deformation of the upper lip and palate that produces a rodentlike appearance) was attributed to the mother's viewing a rabbit during pregnancy. On a more elevated plane, many women believed that if they listened to classical music, read fine literature,

and thought “good” thoughts, their child would be born with an appreciation for music, high intelligence, and a good character.

These folklore beliefs were discarded in modern times as scientists gained information on how life begins, how the process of genetic transmission occurs, and how the internal and external maternal environments influence the individual’s development during pregnancy. These advances in knowledge are discussed in this section. Other topics explored are the course by which these changes occur, the factors that critically influence how they occur, and the tools used by modern medical science to provide the kind of prenatal care that will enhance an individual’s development.

STAGES OF PRENATAL DEVELOPMENT

The developmental changes that occur before birth are significant in many ways. Many experts consider this the most important stage of life. The changes an individual experiences during this time have a critical bearing on development in subsequent stages in the life span.

The time before birth is the shortest stage of the life span. The average length of pregnancy is 280 days (about nine calendar months or ten, twenty-eight-day lunar months). Although the length of pregnancy is somewhat variable, there are invariably many remarkable changes between conception and birth. Essentially, an individual develops from a genetically unique, one-celled human into a newborn with more than 200 billion cells during this relatively short time. As we will soon learn, the most rapid rate of growth and development of the entire life span occurs before birth! As we will also soon learn, this is a highly critical period in human development, in which the person is sensitive to many hazards and benefits to its development provided through the maternal environment.



The average length of pregnancy is 280 days. During this time life begins with one cell and quickly grows into a newborn with more than 200 billion cells. (shutterstock)

Stages versus Trimesters

When thinking about pregnancy, most people think about the three trimesters. The first trimester would be the first three months of pregnancy. Many women experience morning sickness, or all day sickness, during this time. The second trimester would be the second three months of pregnancy. This trimester is sometimes alluded to as the honeymoon trimester because morning sickness subsides for most women and the woman is still comfortable physically. The third trimester would be the final three months of pregnancy. This is the trimester when the baby gains weight rapidly and the woman can begin to have aches and pains due to the weight of the baby and shift in her center of gravity.

Developmentalists, however, view prenatal development as occurring in three periods that do *not* correspond with the three trimesters. These periods are based on biological milestones and are not broken into equivalent lengths. The germinal period is from conception to two weeks. The embryonic period is from three to eight weeks. The fetal period is from nine weeks until birth. As you will see, each of these periods is highlighted by unique developmental milestones during this prenatal stage of life.

Conception

Fertilization

The penetration of the ovum by a sperm cell.

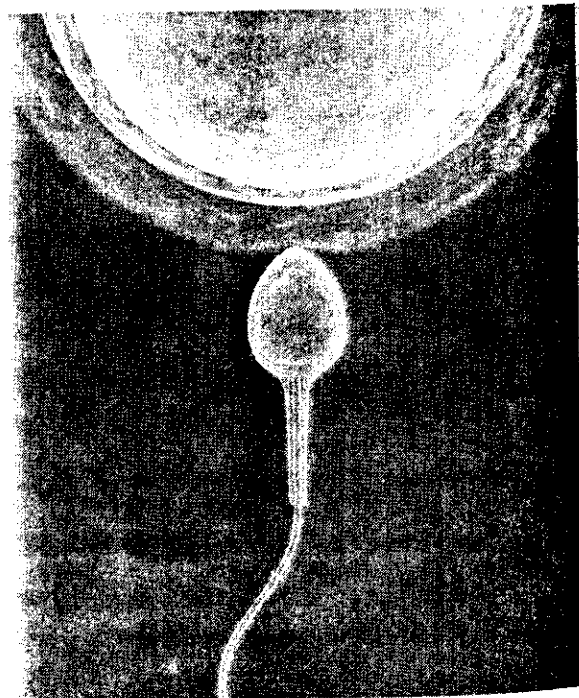
Conception

The fertilization of an ovum by a sperm cell.

The development of an individual begins with **fertilization** of an ovum by a sperm cell. This is called **conception**. The sperm contained in the semen from the male are deposited by ejaculation into the vaginal tract. One ejaculation—about a teaspoon of fluid—normally contains about 300 million to 500 million sperm cells. Of this vast number, only several hundred survive to reach the fallopian tube that harbors the ovum.

Sperm cells are propelled on the journey by their long, whipping tails, which move them up the vaginal tract to the cervix. From this point, sperm are assisted through the uterus and fallopian tubes by small, weak contractions of these organs. The great majority of sperm fail to survive the journey to the ovum because of the highly acidic condition of the female reproductive tract, the immaturity of some sperm cells, breakage of tails, fatigue, and moving into the wrong fallopian tube.

Conception begins when the surviving sperm encounter the ovum in the upper end of the fallopian tube



A sperm cell fertilizes an ovum. This is the point of conception and the beginning of an individual. (iStock)

into which the ovum was deposited after ovulation. The sperm cells gather around the ovum with their head areas pointing toward the surface. The head region of the sperm cells releases an enzyme. A pathway may then be opened through the cellular matter surrounding the ovum.

When the head of one sperm comes into contact with the ovum's surface, a biochemical change occurs within the ovum that prevents the entry of other sperm cells. This process is not clearly understood. The sperm cell in contact enters the ovum, initiating a complex process leading to the completion of a fully constituted, single-cell human. If normal, this single cell now contains forty-six chromosomes, twenty-three from the sperm cell and twenty-three from the ovum. Hence, from the moment of conception, the human being has a unique, genetic composition (Moore & Persaud, 1998).

Germinal Period

Germinal period

The phase of prenatal developing lasting from conception until implantation in the uterus (around ten to fourteen days).

Zygote

The name of the developing individual during the germinal period.

The **germinal period** lasts from conception of the individual until his or her implantation into the uterus (about ten to fourteen days). We refer to the baby as a **zygote** during this period of prenatal development. From the moment of fertilization, the zygote's sex is already determined by the sperm (X-bearing or Y-bearing sperm). Fertilization also initiates cleavage—or cell division—in the zygote (Moore & Persaud, 1998).

The first two weeks following conception constitute a critical period for the developing individual. For the first three or four days after conception, cilia lining the fallopian tube move the zygote on his or her journey to the uterus. Again, the zygote experiences cleavage as he or she moves along the tube.

The one-celled zygote created at conception divides by mitosis into two genetically identical cells within twelve to fifteen hours. These cells reproduce themselves to make four, then eight, then sixteen, and so on. Cell division begins slowly, but then rapidly picks up speed. By the third day following conception, the cells have divided sufficiently through mitotic cleavage to form a small ball that is known as a blastocyst. It is in this form that the zygote enters the uterus. Attachment in the uterus begins about six days after conception, although the process of implantation takes some time to complete (Moore & Persaud, 1998).

The endometrial tissue has been prepared for accepting the zygote by hormones. The outer layer of the blastocyst, called the trophoblast, will develop into the support structures for the individual during prenatal development (e.g., placenta). The inner part of the blastocyst (or inner cell mass) is the part where the zygote resides.

Implantation occurs when the blastocyst sinks into the endometrium. With this event, an important process begins that serves to ensure the survival of the zygote. Through the action of hormones produced by the blastocyst, an intensive chemical exchange occurs between the blastocyst and the mother's tissue to signal his or her presence in the mother's womb. The exchange temporarily impairs the mother's immune system to prevent antibodies from attaching the blastocyst as foreign matter. Said in plain English, the baby has a unique genetic composition. As such, the mother's immune system

Implantation

Occurs when the zygote burrows into the uterus.

would see the baby's body as foreign tissue and attack it. However, implantation triggers biochemical activity that is equivalent to the zygote saying, "I'm here! Please don't reject me!" If this biochemical reaction did not occur, all pregnancies would result in miscarriage due to the woman's body rejecting the baby.

While the blastocyst is implanting itself in the uterine wall, other changes are taking place within. During the second week after conception, the inner cell mass separates into three distinct layers that specialize and give rise to different organ systems and structures of the body.

The outer layer is known as the ectoderm. It gives rise to cells that form skin, hair, sweat glands, tooth enamel, salivary glands, and all the nervous tissue, including the brain. The middle layer, or mesoderm, forms the muscles, bones, blood, circulatory system, teeth, connective tissues, and kidneys. The inner layer, the endoderm, is the one from which most of the internal organs (stomach, intestines, liver, lungs, heart, and so on) are formed. The implantation process is usually completed by the second week after conception.

Embryonic Period

Embryonic period

The two weeks after conception until around eight weeks after conception.

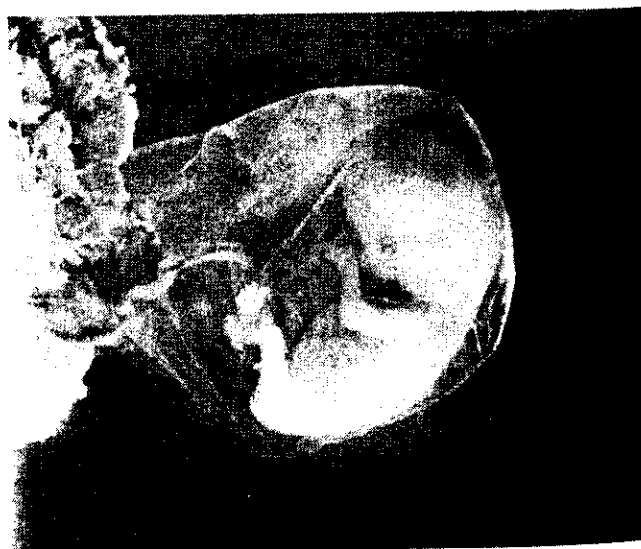
Embryo

The name of the developing individual during the embryonic period.

The **embryonic period** spans from two weeks after conception until around eight weeks after conception. The individual is called an **embryo** during this time. Developmental changes during this crucial period are characterized generally by rapid cell growth and differentiation, the formation of the placenta, and initial organ functioning. While all the organs are formed and begin functioning at some level during this period, some organs are not fully mature until the person is in his or her early to mid-twenties.

Several important functional systems of pregnancy appear early in the embryonic period. These are the development of the placenta, the umbilical cord, and the amniotic fluid. Their function is to ensure the survival and proper development of the individual throughout the pregnancy.

The placenta has three primary functions: (1) metabolism; (2) transfer of gases and chemicals between the developing individual and the mother; and (3) hormone production. A wide variety of chemical and nutrient matter is exchanged across the placental tissue between the developing child and its mother. The blood of the two never mixes in this transfer process. Rather, exchanges are made through the chemical process of osmo-



An individual is called an embryo from two to eight weeks after conception. (Photo courtesy of T. Grayson)

sis. The placenta acts as a barrier to many harmful substances that could enter the developing baby's body. However, it also can expose the child to many adverse environmental influences before birth.

The umbilical cord extends from the center of the placenta into the baby's abdomen. Two major arteries and one vein from the embryo's body lead into the placenta. The structure is twisted in a way that resembles a coiled rope or cord. It has no nerves.

The amniotic fluid is saline in nature. This material fills the amniotic sac during pregnancy. It cushions the developing child from jolts and bumps by allowing it to float freely and buoyantly within the cavity. It also maintains a constant temperature environment for the baby. Because it enables freedom of movement, it encourages muscle development. Amniotic fluid is swallowed by the developing child, which serves to prime the intestines and kidneys for functioning after birth. It is also useful in determining the health status of the child in a type of prenatal diagnostic test discussed later in this chapter.

The main body organs make their first appearance during the third week following conception. The central nervous system and the circulatory system are the first primary organ systems to appear. The heart begins to beat and circulate blood during this early time. By the eighth week, all of the organ systems are present in their early forms and functioning at some level. Although human since conception, the embryo now has a human appearance. **Organogenesis** is the term given to organ formation and it is the completion of organogenesis that marks the end of the embryonic period.

Fetal Period

The developing individual is known as the **fetus** from the beginning of the ninth week after conception until birth (around forty weeks). The **fetal period** of prenatal life is characterized by refinements in organs formed earlier, by reflexive actions, and by rapid increases in the weight and length of the developing individual.

Although the baby has been on the move since conception, the mother will usually feel the baby move for the first time around the fourth or fifth month of pregnancy, called the **quickening**. The baby's body also becomes covered with a fine downlike hair called **lanugo**.

Meanwhile, the skin begins to be covered with a substance called the **vernix caseosa** that is much like thick cold cream. It serves to protect the skin from chapping in the liquid environment of the uterus before birth. It also lubricates the fetus's passage through the birth canal and protects the infant from skin infections for a short time after birth.

The **age of viability** is the point in prenatal development where the baby stands a chance of surviving outside of the womb. This typically happens between the twenty-second and twenty-fourth week. Even though the baby may survive if born at this point in time, there can be serious complications and difficulties associated with premature birth. We will discuss this in more depth in the next section.

Organogenesis

The formation of organs during the embryonic period.

Fetus

The name of the developing individual beginning in the ninth week after conception until birth.

Fetal period

The phase of prenatal development that spans from eight weeks after conception to birth (at around forty weeks).

Quickening

The first detection by a mother of movements made by a fetus.

Lanugo

A fine down-like hair covering the baby's body.

Vernix caseosa

A thick, cold cream-like substance covering the baby's skin. It serves to protect the skin and lubricate the fetus for passage through the birth canal.

Age of viability

The point in prenatal development where the baby stands a chance of surviving outside of the womb.

During the seventh, eighth, and ninth months, there are continued refinements in the body and large gains in body weight. The lanugo is shed and the vernix covers the entire body by the end of this last trimester.



Test Yourself

1. What are the three periods of prenatal development? How are they different than the three trimesters of pregnancy?
2. Which period of prenatal development is when the organ systems develop and begin functioning? When is organogenesis complete?

CRITICAL FACTORS IN PRENATAL DEVELOPMENT

The individual is exposed to many factors before birth that can influence his or her development positively or adversely. In this section, we will learn about some critical factors in prenatal development.

General Factors of Concern

One general risk factor during pregnancy is the age of the mother. Women younger than eighteen and older than thirty-five years of age have a higher probability of having a high-risk pregnancy—one that is characterized by complications that endanger the health and well-being of either the mother or child or both.

Adolescents are more likely to have problems during pregnancy or delivery than women in their twenties. However, proper nutrition and prenatal care can help prevent these problems. Older women seem especially prone both to miscarriage and to bearing children with a genetic disease. For example, the incidence of Down syndrome (a type of mental retardation caused by a genetic disorder) increases significantly among women older than thirty-five. Older women are also more likely to struggle with infertility.

Another general risk factor during pregnancy is poor nutrition. The



Women over thirty-five are more likely to have children with Down syndrome. (iStock)

nutrition of the pregnant woman is an important influence on the quality of development of her child. This factor also strongly affects the mother's well-being and can influence the course of subsequent pregnancies.

One of the most significant aspects of nutrition in pregnancy is the association between adequate weight gains by the mother and the infant's weight (and health) at birth (Brazelton, 1987). Birthweight is related to the baby's ability to survive as well as to his or her susceptibility to certain health risks (Cassady & Strange, 1987). Most women of average weight should gain between 25 and 35 pounds during pregnancy. Underweight women should gain slightly more and overweight women should gain slightly less. Due to an increase in obesity among women of childbearing age, medical professionals are currently researching what a safe weight gain is for them. However, current research indicates that it is never advisable for a woman to diet and/or lose weight during pregnancy.

Beyond just weight gain, the quality of the food a woman eats is reflected in the health and well-being of her child. Adequate folic acid intake is critical early in pregnancy, as it can help prevent neural tube defects such as **spina bifida** (ACOG, 2005). Calcium and iron are also important for health and development. Most doctors recommend that a woman take a prenatal vitamin during pregnancy (if not before) in order to ensure proper levels of vitamins and minerals.

Spina bifida

A birth defect in which the tissue surrounding the spinal cord does not properly close during prenatal development.

Teratology

A branch of science that studies the causes, mechanisms, and patterns of abnormal development.

Teratogen

Anything that can cause abnormal development.

Teratogens

"**Teratology** is the branch of science that studies the causes, mechanisms, and patterns of abnormal development" (Moore & Persaud, 1998). Therefore, a **teratogen** is anything that can cause abnormal development: drugs, diseases, or environmental hazards. The influence of a teratogen depends upon the following:

- The genetics of the child
- During what stage of prenatal development exposure occurred
 - Germinal period—miscarriage or no effect
 - Embryonic period—major abnormalities in limbs, tissues, and organs
 - Fetal period—functional or morphologic abnormalities (especially in the brain or eyes)
- What the teratogen is
- Amount of teratogen the baby is exposed to in utero
- Impact may be first apparent during prenatal development, at birth, or years later

Drugs

Physicians generally urge their pregnant patients not to take any drugs without their advice. This warning is based on the knowledge that certain drugs can cause malformations and



16. What is a teratogen?

Fetal alcohol syndrome

A disorder that may include physical abnormalities and cognitive deficits due to a mother drinking alcohol during pregnancy.

other related problems in the developing individual (Moore & Persaud, 1998). The effects of drugs vary widely, depending upon the factors listed above.

The list of drugs that can cause abnormal development is long. One of the most common is alcohol. No amount of alcohol consumption during pregnancy can be considered safe (Moore & Persaud, 1998). Alcohol consumption during pregnancy is one of the leading causes of mental retardation and even learning disabilities (ACOG, 2005). Moderate to heavy drinking during pregnancy can lead to **fetal alcohol syndrome (FAS)**. FAS results in a baby with characteristic malformations to areas of the face, mild to severe mental retardation or lowered intelligence, severe growth disturbances, and heart malformation. However, even light drinking during pregnancy can cause cognitive deficiencies and behavioral troubles. It is really sad that the inability or unwillingness to give up alcohol during pregnancy can lead to a life-sentence of struggles for the baby.

Caffeine is widely consumed in the United States and abroad. It is not known, at this time, to cause any birth defects (Moore & Persaud, 1998). Heavy consumption may be associated with miscarriage early in the pregnancy or low birth weight at delivery. More research on the potential effects of caffeine is still needed.

Nicotine and cigarette smoking is a well-known teratogen. Cigarette smoking doubles the risk of premature birth (and all the complications that come with that). It is also a leading cause of low birthweight and the strongest predictor of infant death (Moore & Persaud, 1998). Lowered intelligence, heart defects, and limb defects are also related with smoking in both mom and dad. One of the reasons smoking is so detrimental to the child during prenatal development is that nicotine decreases the amount of oxygen in the blood. No amount of smoking is considered safe during pregnancy, by either mom or dad.

Entire chapters of embryology textbooks are devoted to the teratogenic effects of drugs. Certain antibiotics can lead to teeth discoloration and deafness. Aspirin may lead to cognitive and motor deficiencies. The effects of illegal drugs vary depending upon the type of drug, but common effects include low birthweight, irritability in the newborn, and cognitive and motor deficiencies (Moore & Persaud, 1998). In general, all drugs should be avoided unless a doctor gives the okay.

Diseases

Several types of infectious diseases are transmitted by the mother to the developing child through the placental membrane. The severity of their effects depends on when during the pregnancy the disease is contracted. Other diseases can damage the baby during delivery as it passes through the birth canal.

German measles (rubella) is one of the best known diseases that can harm a developing baby. Infection with this virus can result in deafness, blindness, heart defects, central nervous system damage, and mental deficiencies, or a combination of these, depending on when the virus enters the mother's body (Moore & Persaud, 1998).

Other viral agents that are known to damage the central nervous system during the prenatal period include the cytomegalovirus and toxoplasmosis. The cytomegalovirus

is found in the vaginal tracts of many women. This virus enters the nasal and throat passages of the baby during delivery and quickly becomes established in the central nervous system. Infection can cause learning disabilities and related behavior problems in children later in life. Toxoplasmosis is a common parasite in cats and other animals. Women are typically tested for these two agents during pregnancy so that the proper precautions may be taken.

The HIV (human immunodeficiency virus) that causes AIDS (acquired immune deficiency syndrome) can also be passed by an infected pregnant woman to her developing child. Other STDs, such as syphilis and gonorrhea, can also cause permanent defects if passed from mother to child. Early detection and treatment is vital.

Environmental Hazards

We are just beginning to understand some of the dangers that environmental factors can pose to prenatal development. For example, pregnant women are now advised to avoid eating certain seafood due to mercury. Mercury can cause cerebral palsy, mental retardation, and growth deficiencies in a developing child. Exposure to lead can lead to miscarriage, growth deficiencies, mental retardation, and other abnormalities. Polychlorinated biphenyls (PCBs), found in some water and fish, can lead to growth deficiencies, skin discoloration, and cognitive deficiencies. X-rays can lead to leukemia, mental retardation, and growth deficiencies. Radiation is linked to mental retardation. The list could go on; however, the moral of the story is for pregnant women to stay healthy, avoid toxins, and receive prenatal care. To do otherwise is to risk causing the developing child a lifetime of suffering.



Certain fish contain high levels of mercury. (iStock)

Test Yourself



1. What is a teratogen? What influences how a teratogen will impact a developing child?
2. Which teratogen surprised you the most and why?

COMPLICATIONS IN PREGNANCY

Most pregnancies proceed with little difficulty for the mother or child. Some, however, are complicated by one or more conditions that threaten the well-being of the mother or child or both. The purpose of prenatal care is to monitor the progress of a pregnancy to enhance the health and well-being of both mother and baby. Proper prenatal care improves the probability of detecting problems and treating them to minimize their effects.

Extrauterine Pregnancy

Ectopic pregnancy

A pregnancy that develops in a location outside the uterus.

An **ectopic**, or extrauterine, **pregnancy** is one that develops in a location outside the uterus. The individual may implant in the fallopian tube, on the ovary itself, or on the lining of the intestine. These pregnancies necessitate the surgical removal of the area on which the child has implanted. As of yet, there is no way to save the child and transplant him or her to the uterus for the duration of the pregnancy.

Loss of Pregnancy

Miscarriage

The unwanted ending of a pregnancy, usually within the first three months of pregnancy.

A **miscarriage** is the unwanted ending of a pregnancy, usually within the first three months of pregnancy (ACOG, 2005). Up to 15–20 percent of all pregnancies end in miscarriage, so it is far from uncommon. Generally, they are caused by abnormalities in the developing child, most frequently resulting from chromosome errors or acute infectious diseases. In addition to chromosome abnormalities and maternal illness, hormone imbalances, immune system disorders, and uterine problems can all lead to miscarriages. The loss of the child is devastating to most parents. We will discuss coping with the loss of a pregnancy and stillbirth in the last chapter of the textbook.

Toxemia

Toxemia

An acute hypertensive disease of pregnancy characterized by high blood pressure, retention of body fluids, and the presence of protein in the urine.

Maternal **toxemia** is an acute hypertensive disease of pregnancy. Typically, it is characterized by high blood pressure, retention of body fluids, and the presence of protein in the urine. It generally appears after the sixth month of pregnancy. Toxemia varies in severity but will become progressively worse if left untreated. This condition is highly dangerous to both the mother and child. It can be treated successfully with medication and diet.

Although these are clearly not all of the complications that can occur during pregnancy, they are some of the more common ones. They point toward the importance of early prenatal care, which is the topic of our next section.

Test Yourself



1. Where in the woman's body can an ectopic pregnancy occur?
2. What are potential causes for a miscarriage? Why do you think that up to one in five pregnancies end in miscarriage?

PRENATAL CARE

Perinatology

Concerned with the detection and treatment of illness in developing individuals before birth.

Prenatal development is important for the health of the child and mother. **Perinatology** is concerned with the detection and treatment of illness in developing individuals before birth. This field was made possible by recent advances in diagnostic methods and intervention techniques in prenatal medical care. However, prenatal care is not simply the detection and treatment of medical problems. Prenatal care includes counseling, education, childbirth and parenting preparation, and identification of necessary community resources (ACOG, 2005).

Prenatal care is very important for preventing abnormalities in children. It includes: being in good health before conception; eating a balanced diet and getting a sufficient amount of the right kinds of exercise during pregnancy; ceasing all alcohol consumption, smoking, or other drug use; avoiding excessive stress while pregnant; and making regular visits to a health-care provider all through the pregnancy. Family health histories should also be given to the health-care provider.

Typical Prenatal Care

A woman's first prenatal visit usually takes longer than most of her subsequent visits. On this first visit, a health history will be taken, a physical exam will be conducted, lab work may be completed, an estimated due date is calculated, and the baby's heart beat will be heard for the first time (either by an external Doppler ultrasound device or an internal Doppler ultrasound device—depending on how far along the baby is in development). The baby's heart begins beating around the time a woman finds out she is pregnant (about eighteen to twenty-four days after conception); however, it takes several weeks to be able to be heard by an external Doppler device. Prior to that, an internal Doppler ultrasound device can detect the heartbeat.

Monthly visits are typically scheduled for the first thirty weeks, unless health concerns necessitate more frequent visits. During most of these visits, the expectant mother's weight and blood pressure is recorded, urine is tested, uterus height is measured (externally), the baby's heart beat is heard, and the woman can ask any questions she may have of her health-care provider.

Typical prenatal tests include various lab tests throughout the pregnancy. The first test a woman will receive will be a pregnancy test. This can be either a blood test or a urine test to check for the human chorionic gonadotropin (HCG) hormone. As mentioned above, urine checks are also conducted regularly to check for various issues such as infection or diabetes. At various points during the pregnancy, blood tests may be conducted to check for anemia, HIV, STDs, Rh factor, or thyroid levels. Additionally, lab tests from pelvic exams can check for various infections. Finally, a glucose screening test to check for gestational diabetes is normally done in the later part of pregnancy.

Beyond these typical prenatal tests, other forms of fetal assessment are possible—some are routine and others are need-based. During the third trimester, expectant mothers may be asked to chart their baby's kicks/movements each day as an easy check

on fetal well-being. Ultrasounds are conducted for multiple reasons. The most common reason ultrasounds are conducted is to assess the age and sex of the baby, as well as to identify the placenta's location and baby's position. Ultrasounds can also monitor potential problems such as retarded growth or low amniotic fluid. Amazingly, ultrasounds can sometimes identify birth defects, some of which can be fixed prenatally or shortly after birth.

Prenatal Diagnostic Methods

Amniocentesis

The withdrawal of a sample of amniotic fluid (which includes the baby's sloughed off skin cells) from the mother's uterus.

One of the best known and most widely used prenatal diagnostic tools is **amniocentesis**, or the withdrawal of a sample of amniotic fluid (which includes the baby's sloughed off skin cells) from the mother's uterus. This procedure is done to help determine whether the child has a hereditary disorder. Amniocentesis is usually performed between the fifteenth and twentieth week of pregnancy. The positive part of this test is that if the baby has a disorder, such as hypothyroidism, medication can be provided during pregnancy to help correct the problem. If it is a disorder that cannot be treated or cured, the parents have time to become educated about the disorder prior to birth. Two negative possibilities associated with an amniocentesis are a false positive (i.e., the amniocentesis saying the child has a disorder, when in fact they do not) and an increased risk of miscarriage after the procedure (~0.5 percent) (ACOG, 2005).

Chorionic villus sampling

A procedure by which chorionic villi (hair-like structures that are the predecessors of the placenta) are removed and analyzed to determine if genetic disease is present.

Another procedure that is used to diagnose genetic disease is **chorionic villus sampling** (CVS). Chorionic villi are small hairlike structures that are the predecessors of the placenta. Ultrasound is used to locate the tissue, then a small catheter is inserted through the vagina into the cervix and a very small section of chorionic villi is removed from the uterine wall. CVS allows an earlier diagnosis of genetic disease than is possible with amniocentesis because it is typically performed between the tenth and twelfth week of pregnancy. CVS carries the same potential benefits and costs as an amniocentesis; except, the risk of miscarriage after the procedure is slightly higher (~1 percent) (ACOG, 2005).

Both the CVS and the amniocentesis are offered or recommended based upon the parents' genetic profiles and the mother's age. Women who conceive after the age of thirty-five have a higher probability of having a child with genetic abnormalities than younger women. Sadly, these tests have sometimes resulted in what some consider prejudicial outcomes. It is estimated that 88–92 percent of babies identified as having Down syndrome by these tests are aborted (Bristow, 2008). Hence, some feel that one potential outcome of these tests is discrimination against the disabled who have yet to be born.

Fetal medicine

Any medical intervention or care directed at the developing, in utero individual.

Fetal Medicine

Any medical intervention or care directed at the developing, in utero individual could be considered **fetal medicine**. For example, if an amniocentesis indicates a hormonal deficiency, medication may be able to be administered prenatally to help reduce or eliminate the consequences of such a deficiency.

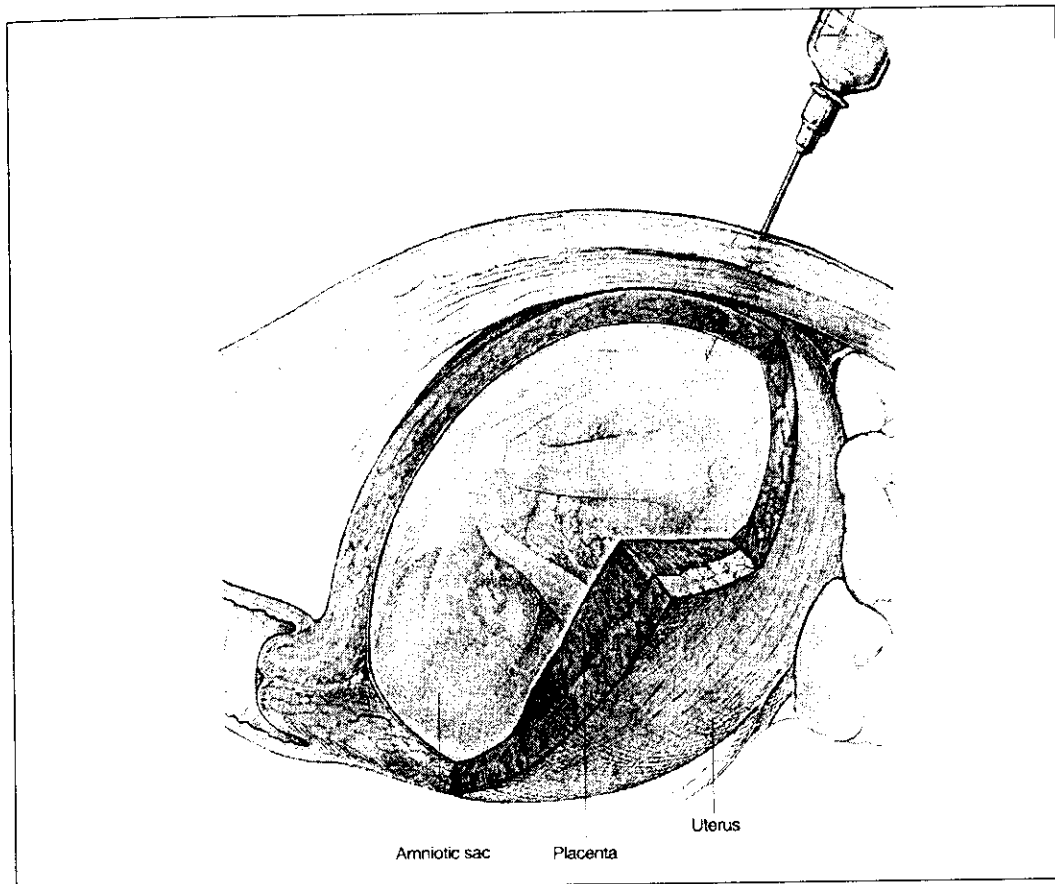
Fetal surgery

Surgery that is conducted while the child is still developing prenatally.

Fetal surgery is also a growing, although still experimental, field. Fetal surgeries have been successful in correcting or lessening certain heart defects, spinal cord abnor-

FIGURE 2-2 AMNIOCENTESIS PROCEDURE

This procedure consists of inserting a needle through the woman's abdominal wall into the uterine cavity to draw out a sample of amniotic fluid (fluid surrounding the fetus). Fetal cells from the fluid are cultured for chromosomal analysis.



malities, vascular lung issues, and other organ problems. However, this is still a field in its infancy. Just as there are potential risks with any surgery, there are severe potential costs to fetal surgery. First, both the mother and fetus must be given pain medication and face the potential side effects inherent in such drug administration. Second, the mother could face such complications as infection, blood clots, or early labor. Third, the fetus could be accidentally injured by surgical instruments, be born prematurely, or die. Clearly, the potential benefits for such a potentially dangerous procedure must outweigh the costs. Still, these surgeries have already been credited with saving lives and reducing the need for surgery and drugs after birth for those in which the surgery was successful (Kalb, 2005).

**Test Yourself**

1. What is prenatal care? Why is it important?
2. Compare and contrast amniocentesis and CVS.

REACTIONS TO PREGNANCY

There is a wise old saying that the reason pregnancy lasts nine months is to allow the expectant parents plenty of time to get used to the idea of being parents and to prepare. The initiation of a pregnancy can produce several reactions in a couple. Although the pregnancy has an impact on the mother and father, each may react differently.

Holmes and Rahe (1967) report that pregnancy is the twelfth most stressful life event during adulthood. The initiation of a pregnancy causes many reactions in the expectant mother. Among these are changes in her body image and a sense of physical and psychological well-being, feelings of uncertainty about what it is like to be pregnant (if this is her first pregnancy), and alterations in her mood. Many women and their partners react with excitement to the confirmation of pregnancy, especially if the pregnancy was planned and desired.

Pregnancy is a common human experience, but it carries many different meanings for couples. For some, it validates their sexuality. The woman proves her femininity by conceiving, and the man proves his masculinity by impregnating. For others, impending parenthood revives memories of childhood and anticipation of a happy future as a parent. For still others, expecting a child fulfills an expectation laid when they took their marriage vows. They now can share the excitement of bringing a life into the world that they created together.

Not everyone reacts with pleasure to the confirmation of a pregnancy, however. Less positive emotional reactions are often attributed to feelings of ambivalence about becoming a parent, marital difficulties, and lack of an adequate social network to provide emotional support during the pregnancy (Flemming et al., 1988). Pregnancy crisis centers are wonderful places to turn to in such circumstances. They can help an expectant couple prepare emotionally for the child's arrival, as well as provide social and financial support. Many can even provide sup-

Couples experience different reactions to the idea of being a parent. Pregnancy is the twelfth most stressful life event during adulthood. (iStock)



port after the birth of the child, or help find additional sources of support in the local community. We live in a society where no woman needs to face a pregnancy alone; there is always help to be found. Two websites that may be a good starting place are www.pregnancycenters.org and www.care-net.org. The Care-net offers a toll-free hotline at 1-800-395-HELP.

Pregnancy, especially a first one, focuses a couple's thinking on many new issues. They ponder what it will be like to be a parent or what kind of parent they will make. Some prepare for the immense change a baby will make in their lives—at least intellectually. Pregnancy lasts long enough to allow couples to do some preparation for parenthood—to begin transforming their identity from a couple without children to parents. Many couples prepare for first-time parenthood by attending childbirth preparation classes, reading books and articles about child development, and arranging for prenatal and birth care. They equip a nursery and enjoy getting gifts at baby showers. They may spend some time caring for babies and young children of relatives and friends. In all these ways, couples begin the process of accepting a radical change in their identities and lifestyles.



Pause and Process:

1. What are some common reactions to pregnancy?
2. What are the contributing factors to a negative reaction to pregnancy?
What can be done to help in these circumstances?

3. BIRTH AND THE NEWBORN

LEARNING OBJECTIVES:

1. Understand and describe the process by which birth occurs as well as the different types of birth experiences
2. Identify complications associated with the birth process
3. Describe the characteristics of newborns
4. Describe the transition that newborns and parents go through during this period

Birth is obviously a major event in the life of an individual and the family into which he or she is born. This section will discuss the birth process, complications that can arise during birth, characteristics of the newborn, and the transitions that the newborn and family go through the first couple of weeks after birth.

THE BIRTH PROCESS

As you learned in the previous section, a pregnant woman waits around forty weeks to meet her baby face to face for the first time. Late in the third trimester, the expectant

mother is probably both excited for this first meeting and a bit anxious about the birth process. First time mothers often wonder what this birth process will be like. How long will labor and delivery last? How painful is labor really? What are the options for medicated pain control? What techniques work best to control pain that do not involve medication? What can go wrong during labor and delivery? What will the little bundle of joy be like immediately after birth? How will life change after the baby is born?

This section will address all of these questions. Even if you (or your partner) never have a child, chances are that you will experience the birth of a child of a relative or close friend at some point in your life. The information you learn in this chapter will help you to know, at least somewhat, what to expect. It will also help you to be able to critically evaluate television shows and movies that depict birth and newborns. After all, you must have wondered at some point in time why shows that depict a person assisting a woman giving birth outside of a hospital are always in need of water, towels, and string of some sort.

Spotlight



22. How many stages of labor are there?

Labor

The process by which the cervix is opened prior to birth and the fetus is moved from the uterus through the birth canal; accomplished by means of contractions of the uterus, which increase in strength, duration, and frequency as delivery nears.

Braxton-Hicks contraction

Practice contractions by the uterus.

Lightening

Occurs when the fetus' head drops down into the pelvis.

Labor and Delivery

It's called **labor** for a reason, as we will see. Women often know that labor is getting close due to several preceding events. The woman will be visiting her doctor or midwife frequently toward the end of pregnancy. If the doctor or midwife believes that labor may be starting soon, he or she can check the condition of the woman's cervix. Certain physical changes to the cervix can let the doctor or midwife know that the body is preparing for labor. Other events can also occur as labor nears. **Braxton-Hicks contractions** will often increase in frequency and strength as the uterus starts practicing for the big event. Vaginal discharge may also increase and/or change in color as the body prepares for labor. Finally, the fetus may become less active and may drop into the pelvic cavity of the woman (**lightening**). Experts are still uncertain as to what actually initiates labor, but most believe it is the fetus that triggers its start (Hrdy 1999).

If you remember, prenatal development occurs in three stages. Well, labor occurs in three stages as well. Just like the periods of prenatal development, the stages of labor are not equal in length of time.

During the first stage of labor, the Braxton-Hicks contractions give way to real contractions. These real contractions typically come at regular intervals and increase in intensity, length, and frequency. The contractions help efface and dilate the cervix, and push the baby down. If the membranes did not rupture (i.e., water break) at the onset of labor, they will break (or be broken) sometime during this stage. Typically, the first stage of labor is the longest, lasting an average of six to twelve hours. The first stage is usually shorter in second and subsequent childbirths. This stage is over when the cervix has dilated to 10 centimeters and the baby is ready to be pushed out.

The contractions during the second stage of labor are paired with the urge to push down. The crowning of the baby's head signals that birth is imminent. Delivery is the actual birth or expulsion of the baby from the uterus and is the highlight of this stage of labor. This part of

Cephalic presentation

Head first delivery.

Breech

When a child is upside down for delivery, with the bottom being delivered first.

Transverse

When a child is sideways during labor (requires either that the child is physically moved to the head-down position, or delivered c-section).

Afterbirth

The final stage of labor which involves the expulsion of the placenta and the membranes as well as any remaining amniotic fluid from a woman's uterus.

the birth process typically lasts from twenty minutes to three hours (ACOG, 2005). In a normal delivery, the baby is delivered head first (known as a **cephalic presentation**). Once the head is out, the rest of the body is usually quick to follow. Sometimes the baby is not head down, which can cause complications during the delivery process. **Breech** and **transverse** presentations are often delivered via cesarean-section, which we will discuss later in the chapter.

You may think that labor is over after the birth of the child, but you would be wrong. The final stage of labor is referred to as the **afterbirth** phase. The afterbirth phase involves the expulsion of the placenta and the membranes, as well as any remaining amniotic fluid from a woman's uterus. This part of the birth process usually lasts less than twenty minutes (ACOG, 2005). The uterus continues to contract after the birth of the baby. These contractions and the assistance of a nurse or midwife manipulating the woman's abdomen help the uterus to cleanse itself of the debris of birth. The umbilical cord is cut when the doctor or midwife can no longer detect a pulse in the cord. The baby feels no discomfort because the cord does not contain nerves. The woman's husband or support person may cut the cord if all has gone well.

Approaches to Labor and Delivery

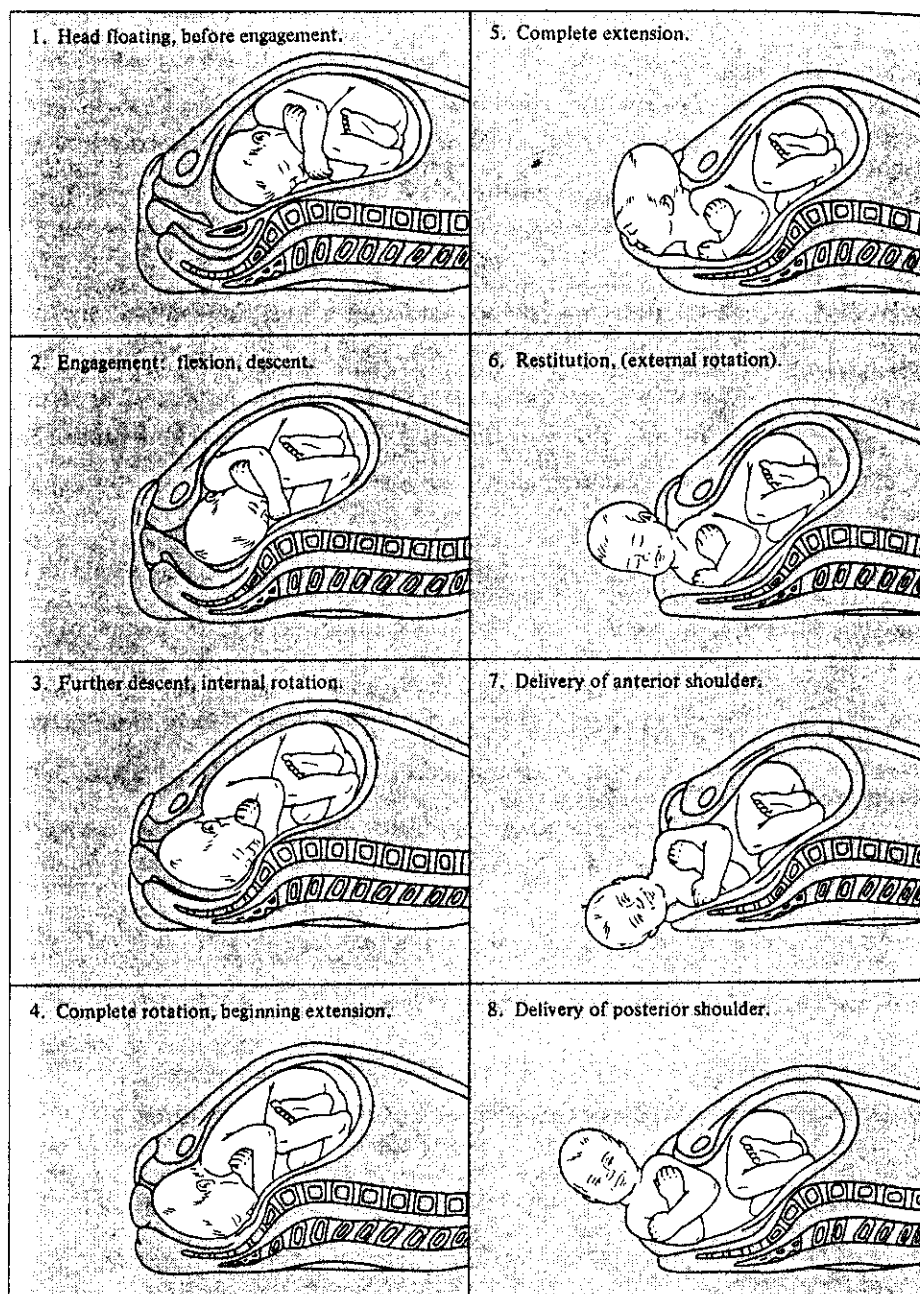
Now that we know the nuts and bolts of labor and delivery, we can take time to examine some of the finer details. Let's start with the well-known saying that "misery loves company." Now, of course, no one should consider giving birth to a beautiful child misery. Nonetheless, the fact of the matter is that labor is physically—well—uncomfortable to say the least. Pain is a very subjective experience, and the degree of discomfort or pain endured during labor and delivery varies greatly across women. However, research shows that women experience less pain and discomfort when they have a support person during the birth process (ACOG, 2005).



When a pulse can no longer be detected in the umbilical cord it can then be cut. The husband or support person may cut the cord if they wish. (Photo courtesy of T. Grayson)

FIGURE 2-3 BIRTH OF A FETUS

Illustration of birth of a fetus showing rotation of the head and trunk through the woman's pelvis.



The customary choice of a support person is the expectant woman's partner; except, this is not always possible for a number of reasons. A friend or relative can also be an excellent support person. Ideally, any support person should attend childbirth classes with the expectant mother in order to be best prepared to be a labor coach. An

Doula

A professional labor coach.

expectant mother may also want or need a professional support person. In that case, she may want to consider a **doula**. A doula is a professional labor coach. He or she can offer emotional, psychological, and physical support during the birth process; however, a doula cannot assist in any medical care. The doula can offer support to the woman alone or can work in partnership with the woman's support person to offer a support network.

Regardless of whom an expectant mother's support person is, this labor partner can be invaluable. According to the American College of Obstetricians and Gynecologists (2005), a support person can assist in many ways, including: timing contractions and talking the woman through them, monitoring room conditions (such as lighting), giving massages or assisting in various labor positions, coaching the woman through breathing techniques, and offering general encouragement and assistance.

Thus, one approach to lessen pain during the birth process is to have a support person. Another approach is commonly referred to as prepared childbirth. Although there are a few different, specific strategies that fall under this general umbrella (e.g., Bradley, Lamaze, Read, etc.), the general idea is the same. Prepared childbirth asserts that expectant mothers being educated as to what to expect during the birth process will lessen anxiety, and in turn, lessen pain. Specific strategies may include breathing techniques, labor postures, and other relaxation techniques. Having a support person is usually instrumental in prepared childbirth. Successful implementation of prepared childbirth includes minimal (if any) use of pain medication during labor, active participation of both the mother and support person in the birth process, and a reduction of fear and anxiety about labor and delivery.



The pain and discomfort that is experienced during labor varies between women. However, studies show that the pain experienced is lessened when there is a support person present. (iStock)

Even with support and preparation, some women opt for the use of pain medication during labor and delivery. There are two general classes of pain medications: analgesics and anesthetics. Systemic analgesics lessen pain by working on the entire nervous system. The woman will maintain consciousness, but may be tired. Regional analgesia numbs a specific area. Epidurals and spinal blocks are two examples of regional analgesics. After insertion of the epidural tube by an anesthesiologist, some hospitals now allow women to self-administer pain medication via their epidural using a hand held button control. There are pros and cons to using pain medication during labor and delivery, and these issues should be considered prior to the onset of labor.

There are numerous alternative or supplemental strategies for pain control not yet mentioned. For example, hypnosis is sometimes used in place of drugs to reduce pain during delivery. The technique is somewhat limited by the fact that not every mother can be trained to enter a hypnotic state. Also, it requires special training that not many physicians have. The use of birthing tubs is also increasing in popularity. Massages, acupuncture, and music therapy are also possible choices for pain management during the birth process. The thing to keep in mind is that all women will experience pain differently during labor and delivery, and there are a variety of options for pain management.

Settings for Labor and Delivery

For a healthy and uncomplicated vaginal birth, there are some options for labor and delivery (ACOG, 2005). Some women give birth at home with the assistance of a doctor or midwife. As long as the pregnancy has been healthy and there are no risk factors or complications, this is a viable choice for many women. There are also birthing centers. These are free-standing centers that are devoted to labor and delivery. Again, as long as the pregnancy has been healthy and there are no risk factors or complications, this is a viable choice. Birthing centers may offer labor options, such as tubs and massages, which a typical hospital may not offer. However, if complications arise during labor or delivery, precious time may be lost in transit to a hospital. Most American women choose to give birth in a hospital.

Many modern hospitals have entire wings devoted to labor and delivery. These wings can offer separate entrances (so women in labor do not need to come in through the emergency room), birthing rooms, and easy access to operating rooms in case an emergency cesarean-section is needed. Modern birthing rooms typically have a homelike atmosphere, with a sleeper sofa for dad, room for the baby after birth, soft lighting, and personal bathrooms with showers. The beds can be transformed from a typical bed one can sleep in into a delivery bed, and back into a typical bed with a few easy maneuvers. This means that labor, delivery, and recovery can all occur in the same room. Most of the medical equipment can be strategically hidden from view until needed.

Of course, around one out of four births are not vaginal, but cesarean-sections (ACOG, 2005). What can cause a woman to need a C-section? Is it more dangerous than a vaginal birth? Our next section will address this topic.

Cesarean Deliveries

C-sections are performed when delivery through the vaginal birth canal may be hazardous to the baby, the mother, or both. Possible reasons for a C-section include (ACOG, 2005):

1. A small pelvis or large baby (cephalopelvic disproportion)
2. Transmittable infections (such as an active herpes outbreak)
3. Insufficient dilation of the cervix, making it likely that passage of the fetus from the uterus to the birth canal would perforate or tear this structure
4. Placenta previa in which the placenta is at least partially blocking the cervix
5. Multiple births or an irregular presentation (e.g., breech or transverse presentation) that makes vaginal delivery difficult

C-sections can be planned ahead of time (such as when it is known that the baby is breech or that there is placenta previa) or done when an emergency arises (such as when the cervix ceases to dilate or the umbilical cord becomes pinched). It is performed by making an incision into the woman's abdominal wall and uterus to remove the baby and placenta. This surgical procedure requires the use of general or regional anesthetic. Like all surgeries, a C-section carries an increased risk for complications including infection, blood loss, and blood clots.



Test Yourself

1. Describe the three stages of labor.
2. What are some reasons that a C-section may be needed?

COMPLICATIONS [‡]

Most pregnancies and deliveries cause little difficulty to the mother or baby. Some, however, are complicated by one or more conditions. The purpose of prenatal care is to monitor the progress of a pregnancy to ensure the good health and well-being of both mother and baby. Proper medical attention during the course of a pregnancy can detect problems. Treatment during pregnancy, or delivery, can minimize the effects of the complications discussed in this section.

Complications During Delivery

The previous section already mentioned two complications that can happen during delivery: cephalopelvic disproportion and irregular presentation. A prolapsed umbilical cord is another complication. Sometimes, the umbilical cord will get pinched in the birth canal as the baby is being delivered. This can cut off the baby's vital oxygen supply. If this occurs, and doctors are aware of it, an emergency C-section may be necessary.

Anoxia

Anoxia

Oxygen starvation of tissues.

Oxygen starvation of tissues, or **anoxia**, is a major concern in the delivery of a baby. A baby who is normal and has not experienced complications during delivery can be expected to establish respiration on his or her own within one minute after birth—usually spontaneously. Some babies, however, have difficulty initiating respiration, and this can quickly lead to anoxia. Brain tissue is especially sensitive to oxygen starvation, and the damage is irreversible. Anoxia may be caused by several factors including hemorrhages, prolonged labor, and placenta previa.

A variety of problems can affect the baby, depending on the degree of anoxia experienced. Cerebral palsy, mild to severe mental retardation, hearing and speech impairments, mild to severe learning disabilities of various types in later years, and related behavioral disturbances are the most common problems. Fetal monitoring during labor and delivery can help to minimize the risk of birth traumas resulting in anoxia.

Low-Birthweight and Prematurity

Premature baby

A baby who weighs five and one half pounds or less at birth and has a gestational age of less than thirty-seven weeks.

A low-birthweight or **premature baby** is one who weighs five and one half pounds or less at birth and has a gestational age of less than thirty-seven weeks. In the United States, approximately 12 percent of all babies are born prematurely (ACOG, 2005). Although babies at or past the age of viability stand the best chance of survival, long-term problems are less likely in those who make it past thirty-two weeks. Many preterm babies experience learning or attention disorders later in life. Preterm babies are also at risk for breathing problems, infections, and feeding problems (ACOG, 2005).

When babies are born too soon, their lungs and brains are particularly vulnerable. If a woman is experiencing preterm labor, she may be given shots to help mature the baby's lungs ahead of schedule. Recent research also suggests that preterm babies' brains also lack the ability to filter out the multitude of information it will be bombarded with in the world. This means that the blaring lights and beeping sounds of a typical NICU (neonatal intensive care unit) may overwhelm the preterm infant's brain and contribute to future learning and attention difficulties. Based on recent research, the care of pre-term infants is changing. Sounds and sights are now muted, infant massages are given, and kangaroo care is promoted. The outcomes of such interventions seem encouraging. For example, pre-term babies provided with massages and kangaroo care demonstrate better growth and earlier release dates from hospitals than pre-term babies not provided with such care (Field, Hernandez-Reif & Freedman, 2004; Hill, Brooks-Gu & Waldfogel, 2003; Ludington-Hoe et al., 2006; Teti, 2005). It is hopeful that these early interventions will prevent the learning and attention disabilities that traditionally plague preterm babies throughout childhood.

Baby blues

Feelings of sadness and exhaustion that over seventy percent of women experience the first week or two after birth.

Postpartum depression

The feelings of sadness and exhaustion persist or even worsen past the two week mark.

Postpartum Depression and Psychosis

Many of you have probably heard of the baby blues. The **baby blues** are feelings of sadness and exhaustion that more than 70 percent of women experience the first week or two after



Premature babies weigh five and one half pounds or less at birth. Because they are pre-term they are at risk for breathing problems, infections, and feeding problems. (iStock)

Postpartum psychosis

When a woman is afraid to be left alone with the baby and has thoughts of hurting herself or the baby.

birth (ACOG, 2005). With rest, support, and time, these feelings pass quickly for most women. However, for around 10 percent of women, the feelings persist or even worsen past the two week mark. **Postpartum depression** interferes with a woman's ability to function in everyday life, including caring properly for her newborn. Medical help should be sought when postpartum depression is suspected. Rarely, symptoms may go beyond postpartum depression and instead be **postpartum psychosis**. If a woman is afraid to be left alone with the baby and has thoughts of hurting herself or the baby, postpartum psychosis may be the cause and immediate medical intervention is needed.



Test Yourself

1. What are some complications that can occur during birth?
2. What is the difference between the baby blues and postpartum depression?

THE NEWBORN

Physical Appearance

Newborns usually weigh between five and one-half and nine and one-half pounds with an average weight of seven and one-half pounds (ACOG, 2005). Average length is between eighteen and twenty-two inches. During the first several days following birth, newborns usually lose a small amount of weight before beginning to gain weight.

Unlike the diaper commercials you have probably seen on TV (which usually use infants a couple of months old); newborns are not very attractive physically. Because they have spent nine months in the wet environment of the uterus, their skin is exceptionally wrinkled. It is



30. What quick assessment is made of the newborn to determine the presence and/or extent of any injury?

Vernix

The lubricating, creamlike substance that has formed during the fetal period.

Apgar score

An evaluation method for assessing the health status of a newborn.

Colostrum

The first liquid secreted by the mammary glands, full of antibodies and nutrition.

Meconium

A newborn's first bowel movement.

Reflexes

A response controlled by the autonomic nervous system, over which an individual has no willful control.

also covered with **vernix**, the lubricating, creamlike substance that was formed during the fetal period. The skin is loose and lies in folds on the neonate's body. This is because newborns have little fat in the cells that lie immediately under their skin. The skin is very soft to the touch, however, and is sometimes covered with fine, downlike hair called lanugo.

The eyes of a newborn are always striking. They are quite large because of their advanced maturation. Newborns squint their eyes a great deal, probably because of the initially unpleasant task of adjusting to a bright environment after months of being in the mother's uterus.

The newborn's head occupies almost one-fourth of its total body length. In adulthood, its head will be about one-seventh of its total body length. The trunk of a newborn also occupies a large proportion of its body length. The extremities are short in comparison with other body features.

In summary, the newborn is wrinkly and looks scrunched up. However, they will quickly lose the newborn appearance and look more like the adorable babies on commercials.

Assessment of the Newborn

The health status of the newborn is assessed immediately to determine the presence and/or extent of any injury. Several factors are observed and evaluated: (1) heart rate, (2) respiratory effort, (3) reflex irritability (ease of elicitation), (4) color (indicative of oxygenation of blood and lung functioning), and (5) muscle tone (see Table 2-4). The baby is assessed usually at one minute and then again at five minutes following its birth. Each factor is given a rating of zero (absence of observed effect), one (average functioning of the factor), or two (excellent functioning of the factor). These ratings are summed to obtain a total score that may range from zero to ten. Scores below five indicate difficult health status; those above five indicate a more optimistic health status. The total score is known as the **Apgar score**. It is named for Dr. Virginia Apgar, the pediatrician who devised this assessment method.

There are also two widely used assessments for newborns that are more comprehensive than the Apgar in assessing neurological development and problems: the Brazelton Neonatal Behavioral Assessment Scale (NBAS) and the Neonatal Intensive Care Unit Network Neurobehavioral Scale (NNS). Typically, these assessments are given only if prob-

TABLE 2-4 THE APGAR RATING SCALE

FACTOR	ASSIGNED VALUE		
	0	1	2
Heart rate	Absent	Slow (<100)	Rapid (>100)
Respiratory effort	Absent	Slow	Good; crying
Reflex irritability	Absent	Grimace	Cough; sneeze
Color	Blue, pink	Body pink; extremities blue	Completely pink
Muscle tone	Flaccid	Weak	Strong

Source: Adapted from Apgar, V. A. (1954). A proposal for a new method of evaluation of the newborn infant. *Current Research in Anesthesia and Analgesics*, 4, 105-116.

lems are expected or in research. Reflexes and reactions to stimuli are some newborn behaviors measured with these scales.

So far, we have learned that the Apgar is administered to nearly all newborn babies as a quick assessment of newborn health. The NBAS and NNNS may be given if neurological problems are suspected. In addition to these assessments, nearly all newborns are given a routine hearing test at the hospital and have a blood test for certain genetic or congenital disorders (specific tests can vary by state).

Sucking reflex

The sucking reflex is closely associated with both the rooting and swallowing reflexes. It is produced when the soft palate in the baby's mouth is stimulated.

Rooting reflex

This is a searching reflex motion that helps the neonate to locate a breast or bottle nipple. It occurs when the baby's cheeks are stroked or the corner of its mouth is touched. The response is "rooting," in which the baby turns its head in the direction of the stimulation, and as it does so, opens its mouth. The baby's tongue begins to move forward and backward in its mouth.

Adaptive reflexes

This group of reflexes aids the neonate to locate and obtain food, thus helping to ensure its survival.

Vestigial reflexes

Several reflexes present at birth that seem to be relics of adaptive experiences sometime in our vast evolutionary past.

Physical Adjustments

In order to survive outside the uterus, the newborn must make adjustments—some of them rather quickly. The most important adjustments are: (1) establishing the ability to breathe, (2) regulating its own body temperature, and (3) initiating the functioning of its digestive system.

Independent breathing begins as soon as the baby is born. This is one of the most dramatic aspects of birth. Most newborns begin respiration without assistance. Help may be provided by the medical staff by suctioning the mouth and nasal passages to clear them of fluid and mucus.

The newborn emerges warm and wet from the uterus into the cooler environment of the delivery room. The processes of evaporation and radiation work to produce a drop in the baby's body temperature. Newborns are usually wrapped in towels or receiving blankets immediately after birth and placed in the mother's arms. A newborn struggles to maintain body temperature and will need to be kept comfortably warm.

Usually within a day after birth, a baby will have his or her first bowel movement. **Colostrum** primes the newborn's digestive track for digestion of more complex nutritional substances contained in human milk or formula. **Meconium** is eliminated from the intestines for several days following birth. This material is composed of metabolized bile and other digestive juices, cellular material, and mucous built up in the intestinal tract during the final days of prenatal development.

Newborn Behavior

Developmentalists have determined through observation and study that newborns show distinctive behavioral patterns at birth. This research has changed our ideas about human development in the first weeks following birth. Newborns are born with the capacity to adapt and selectively choose among stimuli to respond to in the environment.

Reflexes

Newborns are thought to have more than two dozen distinct reflexes that are functional either before birth or at birth (Illingworth, 1975). **Reflexes** are involuntary actions that occur in response to particular stimulation. Eye blinking is an example of

Moro reflex

This reflex is associated with a sudden change in movement or support of the newborn. If a neonate is raised or lowered suddenly or if support of its head is released, the baby responds by raising its arms upward very quickly and curling its fingers. Moving of the legs accompanies these reflex motions.

Startle reflex

This reflex is most often elicited by loud noises and unexpected, sudden touching of the newborn's trunk area.

Palmar (hand) and plantar (foot) grasping reflex

These reflex movements are produced by touching or stroking the palm of the newborn's hands or the soles of its feet. Both fingers and toes curl in the grasping manner in response. The strength of these reflexes is remarkable.

Babinski reflex

Named for its discoverer, this reflex occurs when the sole of the baby's foot is stroked along the outer edge. In response, the neonate's toes spread wide in a fanning action, relax somewhat, curl forward tightly closed, and return to their original position.

a reflex. Some reflexes disappear in the months after birth; others are with us our entire lives.

Reflexes are useful indicators of neurological functioning at birth. Tests of reflexes allow assessment of the newborn's health status (e.g., Apgar ratings). Some reflexes have immediate survival value, such as the **sucking reflex** and **rooting reflex**. These are called **adaptive reflexes**. Many reflexes serve as the foundation of future behavior. Others are possibly remnants of behaviors that apparently had survival value earlier in evolutionary history, but are no longer useful in humans. These are called **vestigial reflexes**. Some examples of vestigial reflexes are the **moro reflex**, **startle reflex**, **palmar grasping reflex**, and **plantar reflex**. Reflexes that tend to defy categorization include the **Babinski reflex**, **tonic neck reflex**, **walking reflex**, and **swimming reflex**. You can probably tell what most of these reflexes are by their name. For unfamiliar ones, they are defined in the glossary.

The Senses at Birth

As mentioned in the previous section, the senses become functional during prenatal development. However, vision is the sense that takes the longest to reach mature levels during the first year after birth.

Newborns are sensitive to brightness. Their pupils contract and dilate in response to changes in degrees of light. Their ability to focus on an object is rather rudimentary, however. This is because the muscles that control this function are immature. It is estimated that a typical newborn can focus clearly on objects only within seven to ten inches from his or her face. **Visual acuity** is about 20/600, compared to about 20/20 for an adult with normal vision (Banks & Salpatek, 1983; Maurer & Maurer, 1988).

Given the newborns' visual abilities and restrictions, things apparently look blurry to them. What is it in the environment that interests them? What do they like to look at and how do they see these things? It seems newborns are selective in their visual exploration (Fantz, 1958, 1963; Fantz, Fagan & Miranda, 1975; Haith, 1980). They are attracted to the human face and like to explore its features. They also apparently enjoy looking at objects that have patterns rather than solid colors, especially bold patterns. Newborns tend to gaze at the edges of an object for a period of time rather than attempting to explore it in more detail (as they will when they are a bit older).

Babies are born with the ability to imitate the facial gestures and features of other people (Maltzoff & Moore, 1977, 1979, 1983). For example, sticking out the tongue and opening and closing the mouth are imitated by newborns shortly after birth. Apparently, newborns can integrate various senses to match their own behavior with that of someone they observe.

We already know that a baby can hear sounds (and remember these sounds) within his or her mother's uterus during at least the last three months before birth. However, hearing is not quite at adult levels at birth. Newborns cannot hear soft sounds or low

Tonic neck reflex

This reflex usually occurs when the neonate is placed on its back. The arms, legs, and head move to a characteristic "fencing" position in which the arm and leg on one side are extended, while those on the other side are flexed. The baby's head turns to one side, usually in the direction of its extended limbs.

Walking reflex

Step-like motions of the legs occur reflexively when the neonate is held in an upright position and allowed to touch a flat surface with its feet. The legs respond by flexing alternately as if the child is walking.

pitched sounds as well as adults. These abilities will develop within the first couple of years after birth.

The senses of smell, taste, and touch are well-developed at birth. Newborns can recognize the smell of their own amniotic fluid and mother's milk. They prefer some smells, such as vanilla, over other smells, such as fish. Newborns also prefer the taste of sweet foods, over bitter or sour foods. Finally, newborns are sensitive to touch and pain. The American College of Obstetricians and Gynecologists (2005) advises parents to be certain that their sons receive pain medication prior to circumcision.

Sleep

Labor is not just hard on the mother; it is stressful for the baby as well. Newborns are often alert for a while after birth and then sleepy for the next several hours or days. All babies are born with their own unique personalities. Some babies like to sleep more than other babies. Some babies are more predictable in their sleep patterns than other babies. In general, newborns will sleep an average of fourteen to eighteen hours a day, in small stretches at a time (ACOG, 2005).

Newborn sleep cycles are different than adult sleep cycles. Interestingly, newborns will often begin their sleep cycle in the REM (rapid eye movement) stage. This is thought to be a stage where dreaming occurs. Adults begin sleep in a state of non-REM sleep. Additionally, newborns will spend around 50 percent of their sleeping hours in REM sleep, whereas adults spend only 20 percent of their sleep time in this stage. It is speculated that newborns, and infants in general, spend so much time in REM sleep due to the brain's need for stimulation, brain development, or learning.

**Test Yourself**

1. In what ways are newborns' health assessed?
2. Which senses are fairly well-developed by birth? What sense is the least-developed at birth?

TRANSITIONS**Swimming reflex**

This unusual reflex occurs when the neonate is submerged on its abdomen in water. The baby holds its breath and makes swimming motions with both arms and legs.

Every human being is unique in many ways. Any quality, trait, or characteristic that distinguishes one person from others is referred to as an **individual difference**. These individual differences are present from birth (and some prenatally). Just look through the window of a newborn nursery, some babies are quiet and content. Other babies cry a lot. All babies are born with mini-personalities. Some research suggests that activity level in the womb is predictive of activity level after birth.

One individual difference proposed in newborns is **temperament**. A temperament can be thought of as a baby's general approach to the world and behavioral orientation.

Visual acuity

Sharpness or clarity of vision.

Individual difference

Any quality, trait, or characteristic that distinguishes one person from others.

Temperament

A baby's general approach to the world and behavioral orientation.

Difficult temperament

The resisting of physical handling, crying inconsolably, and showing irregular sleeping and eating patterns.

Slow-to-warm-up temperament

The display of quiet activity levels, somewhat fussy, and wary around others and situations.

Some see temperament as the foundation from which personality will grow. Because temperament is apparent so early in life, it is assumed that it is at least somewhat genetic in origin (Paludi, 2002).

Thomas and Chess (1987) suggest a temperament classification scheme in which neonates are described as **difficult** (resisting physical handling, crying inconsolably, showing irregular sleeping and eating patterns), **slow-to-warm-up** (quiet activity levels, somewhat fussy, wary around others and situations), and **easy** (adaptable, cheerful and happy, responsive to others and situations), or a mixture of these.

A critical issue is what effect these individual differences are likely to have on the adults who care for newborns. For example, a newborn classified as difficult is probably frustrating for his parents. This child may even be abused if his parents' frustration limits are exceeded. A newborn described as quiet or slow-to-warm-up may be equally frustrating to parents, but for different reasons. Caregivers may have to try hard to stimulate any type of response in a newborn with this type of temperament. An easy newborn has the type of temperament that most American parents want.

Thomas (1986) proposes that there is such a thing as "goodness of fit" between the personality of the parents' and the temperament of the child at birth. This fit may enhance development and growth among all family members. Conversely, lack of fit may make interactions in the family difficult.

All parents should realize that their offspring will be different in many respects from one or both of them. Furthermore, individual differences make using a "standard" childrearing style for all one's children questionable (Bigner, 1989). The best approach is for family members to acquire an empathic understanding of the individual differences of each new member.

The birth of a couple's first child moves the family into a new stage of the family life-cycle. The couple must redefine their roles and develop new behaviors. This transitional period can

Thomas and Chess suggested a temperament classification. Thomas proposed the "goodness of fit" idea that exists between the personality of the parents and baby. (iStock)



Easy temperament

A baby who is adaptable, cheerful and happy, and responsive to others and situations.

take time and may be difficult. The adjustments that couples make at this time constitute a transition to being parents as well as redefining their role in the marriage. It is important to still make time for each other during the hectic period of caring for a newborn.

The hospital will try to provide educational materials to new parents prior to discharge. New parents may be required to watch videos or attend short classes on newborn care. A lactation consultant will probably visit the mother to give tips on breastfeeding. Nurses or doctors will provide instructions on the first bath, belly-button care, diapering, feeding, and possible problems for which to watch. Nurses are also usually taught to watch for signs of bonding between the newborn and parents. Parents will also be provided with resource information for the road ahead.

*Test Yourself*

1. What are the three basic temperaments that newborns may be classified as?
2. How can a hospital help to prepare parents for taking home and caring for their newborn?

SUMMARY

1. Genetic information contained in the male and female gametes intermingles at conception, resulting in a new combination of chromosomes (and genes). The chemical basis of genetic inheritance is DNA. The genetic blueprint determined at conception will be identical in all cells that are produced during the individual's life span. Most cells reproduce themselves through a process known as mitosis. The production of sex cells, however, occurs through a process called meiosis.
2. Genetic processes include the dominant/recessive process, polygenetic inheritance, and epigenetic information. Some traits and characteristics behave according to the either/or nature of dominant/recessive genes, whereas others behave according to the continuous variation nature of the polygenetic process. Epigenetic information, such

as the cytoplasmic environment during ovum development and genetic imprinting are new areas of research that are just beginning to be understood.

3. One category of genetic disorders may be inherited by a single gene that may be dominant, recessive, or sex-linked. A second category of genetic disorders may be inherited at the chromosomal level. A third category of genetic disorders are multifactorial. Although it is often unknown what specifically causes a multifactorial genetic disorder, it is thought that an interaction of genetics and environmental issues give rise to the problem. An increasing number of organizations are available to offer support and information to individuals with genetic disorders and their loved ones.
4. The field of behavioral genetics investigates how interactions between genetic and environmental factors influence cognitive and behavioral

processes. Research designs in behavioral genetics have typically included adoption studies and twin studies. Gene/environment relationships can be viewed as passive, active, or dynamic in nature.

5. The prenatal stage is thought to be the most crucial stage of the life span. Changes experienced during this time have a critical bearing on development throughout the rest of the individual's life.
6. The individual can be exposed to many factors before birth that could positively or negatively affect his or her development. These include the age of the mother, maternal nutrition, and exposure to teratogens. The effects of teratogens depend upon genetics, dose, timing of exposure, and specific teratogen. Different teratogens target different parts of the body at different stages of prenatal development. In general, the embryonic period is the most vulnerable stage.
7. There are several common complications that can occur during pregnancy. Three include miscarriage, ectopic pregnancy, and toxemia. A miscarriage usually occurs during the first three months of pregnancy as a result of chromosomal abnormalities or other health factors. An ectopic pregnancy is a pregnancy that occurs outside the uterus. Toxemia can be life-threatening to the mother and child, but is treatable.
8. Adequate prenatal care is vital for preventing and/or treating birth defects and related problems of pregnancy. Prenatal tests provide a means for diagnosis of potential genetic and metabolic disease before birth. Fetal medicine offers hope for treating some medical disorders or diseases prior to birth.
9. Both partners react to the initiation of a pregnancy in the woman. Validation of one's sexuality, marriage vow fulfillment, changes in body image, and reassessment of personal well-being are among the more common reactions. Reactions may be largely positive or negative. Negative reactions are typically due to a lack of social support or marital difficulties. Pregnancy crisis centers are a wonderful place to receive emotional, social, and financial support throughout the pregnancy or even after the birth. Pregnancy provides time for couples to adjust to impending changes in their identities and lifestyles. A couple's preparation during their first pregnancy assists them to move to a new stage in their family life-cycle.
10. This chapter discussed birth, delivery, and the newborn. The birth process has three distinct phases of labor: stage one involves the effacement and dilation of the cervix; stage two involves the delivery of the baby from the uterus; stage three involves the expulsion of the placenta and other matter from the uterus. The length of time each phase lasts is variable. It usually depends partly upon whether or not the woman is having her first baby.
11. Birth can occur vaginally or via C-section. Pain management during a vaginal birth can include support coach, prepared childbirth techniques, medication, or strategies such as hypnosis or massage. A C-section requires the use of general or regional anesthesia. A healthy woman who has had a healthy pregnancy with no risk factors can sometimes choose to give birth at home, in a birthing center, or in a hospital. A C-section should always be done in a hospital. Modern hospitals often have entire wings devoted to labor and delivery with birthing rooms that accommodate labor, delivery, and recovery.
12. Delivery and birth may be complicated by one or more conditions. Anoxia, or oxygen starvation, to the baby during delivery may occur for a variety of reasons. Low-birthweight and prematurity may give rise to many complications. Postpartum depression of the new mother may affect her ability to function adequately.
13. The average weight of a newborn is between five and one-half and nine and one-half pounds, and the average length is between eighteen and twenty-two inches. The appearance of the newborn reflects the nature of their existence before birth—their skin

very wrinkled and is covered with vernix. The eyes are a prominent feature, and the head is large in proportion to total body length. Overall health of the newborn is assessed with the Apgar at birth.

Newborns must make some physical adjustments to ensure their survival following birth. They must establish independent respiration, regulate their body temperature, and initiate the process of digestion and elimination of body wastes. Newborns are also born ready to interact with the world with reflexes and senses functioning. They

are also born with mini-personalities commonly referred to as temperaments. Babies typically have one of three types of temperaments: difficult, slow-to-warm-up, or easy.

15. The period after birth is a period of adjustment for both newborn and parents. New parents will need to redefine their roles within the marriage. This adjustment period can be stressful, but at the risk of sounding like a hippy, this too shall pass. The hospital provides basic care information prior to discharge.

KEY TERMS

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