Page inserted in order to view spreads in pdf file.
A complex blend of genetic and environmental influences leads members of this three-generation family of Mexico to be both alike and different in physical characteristics and behavior.
It’s a girl!” announces the doctor, holding up the squalling little creature as her parents gaze with amazement at their miraculous creation.

“A girl! We’ve named her Sarah!” exclaims the proud father to eager relatives waiting for news of their new family member.

As we join these parents in thinking about how this wondrous being came into existence and imagining her future, we are struck by many questions. How could this baby, equipped with everything necessary for life outside the womb, have developed from the union of two tiny cells? What ensures that Sarah will, in due time, roll over, walk, talk, make friends, learn, imagine, and create—just like other typical children born before her? Why is she a girl and not a boy, dark-haired rather than blond, calm and cuddly instead of wiry and energetic? What difference will it make that Sarah is given a name and place in one family, community, nation, and culture rather than another?

To answer these questions, this chapter takes a close look at the foundations of development: heredity and environment. Because nature has prepared us for survival, all humans have features in common. Yet each of us is also unique.

Think about several of your friends, and jot down the most obvious physical and behavioral similarities between them and their parents. Did you find that one person shows combined features of both parents, another resembles just one parent, whereas a third is not like either parent? These directly observable characteristics are called phenotypes. They depend in part on the individual’s genotype—the complex blend of genetic information that determines our species and influences all our unique characteristics. Yet phenotypes are also affected by each person’s lifelong history of experiences.

We begin our discussion at the moment of conception, an event that establishes the hereditary makeup of the new individual. First we review basic genetic principles that help explain similarities and differences among us in
language and cognitive capacities. And the genetic variation from one human to the next is even less! Individuals around the world are about 99.1 percent genetically identical (Gibbons, 1998; Gibbons et al., 2004). But it takes a change in only a single base pair to influence human traits and capacities. And such tiny changes can combine in unique ways across multiple genes, thereby amplifying variability within the human species (National Center for Biotechnology Information, 2004).

A unique feature of DNA is that it can duplicate itself through a process called mitosis. This special ability permits the one-celled fertilized ovum to develop into a complex human being composed of a great many cells. Refer again to Figure 2.2, and you will see that during mitosis, the chromosomes copy themselves. As a result, each new body cell contains the same number of chromosomes and the identical genetic information.

Genes accomplish their task by sending instructions for making a rich assortment of proteins to the cytoplasm, the area surrounding the cell nucleus. Proteins, which trigger chemical reactions throughout the body, are the biological foundation on which our characteristics are built. How do humans, with far fewer genes than scientists once thought (only twice as many as the worm or fly), manage to develop into such complex beings? The answer lies in the proteins our genes make, which break up and reassemble in staggering variety—about 10 to 20 million altogether. Simpler species have far fewer proteins. Furthermore, the communication system between the cell nucleus and cytoplasm, which fine-tunes gene activity, is more intricate in humans than in simpler organisms. Within the cell, a wide range of environmental factors modify gene expression (Lashley, 2007). So even at this microscopic level, biological events are the result of both genetic and nongenetic forces.

The Sex Cells

New individuals are created when two special cells called gametes, or sex cells—the sperm and ovum—combine. A gamete contains only 23 chromosomes, half as many as a regular body cell. Gametes are formed through a cell division
process called meiosis, which halves the number of chromosomes normally present in body cells. When sperm and ovum unite at conception, the resulting cell, called a zygote, will again have 46 chromosomes. Meiosis ensures that a constant quantity of genetic material is transmitted from one generation to the next.

In meiosis, the chromosomes pair up and exchange segments, so that genes from one are replaced by genes from another. Then chance determines which member of each pair will gather with others and end up in the same gamete. These events make the likelihood extremely low—about 1 in 700 trillion—that non-twin siblings will be genetically identical (Gould & Keeton, 1996). The genetic variability produced by meiosis is adaptive: It increases the chances that at least some members of a species will cope with ever-changing environments and will survive.

In the male, four sperm are produced when meiosis is complete. Also, the cells from which sperm arise are produced continuously throughout life. For this reason, a healthy man can father a child at any age after sexual maturity. In the female, meiosis results in just one ovum. In addition, the female is born with all her ova already present in her ovaries, and she can bear children for only three to four decades. Still, there are plenty of female sex cells. About 1 to 2 million are present at birth, 40,000 remain at adolescence, and approximately 350 to 450 will mature during a woman’s childbearing years (Moore & Persaud, 2008).

**Boy or Girl?**

Return to Figure 2.1 and note that 22 of the 23 pairs of chromosomes are matching pairs, called autosomes. The twenty-third pair consists of sex chromosomes. In females, this pair is called XX; in males, it is called XY. The X is a relatively large chromosome, whereas the Y is short and carries little genetic material. When gametes form in males, the X and Y chromosomes separate into different sperm cells. The gametes that form in females all carry an X chromosome. Therefore, the sex of the new organism is determined by whether an X-bearing or a Y-bearing sperm fertilizes the ovum.

**Multiple Offspring**

Ruth and Peter, a couple I know well, tried for several years to have a child, without success. When Ruth reached age 33, her doctor prescribed a fertility drug, and twins—Jeannie and Jason—were born. Jeannie and Jason are fraternal, or dizygotic, twins, the most common type of multiple birth, resulting from the release and fertilization of two ova. Genetically, they are no more alike than ordinary siblings. Table 2.1 summarizes genetic

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>Occurs in 4 per 1,000 births among Asians, 8 per 1,000 births among whites among blacks*</td>
</tr>
<tr>
<td>Family history of twinning</td>
<td>Occurs more often among women whose mothers and sisters gave birth to fraternal twins</td>
</tr>
<tr>
<td>Age</td>
<td>Rises with maternal age, peaking between 35 and 39 years, and then rapidly falls</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Occurs less often among women with poor diets; occurs more often among women who are tall and overweight or of normal weight as opposed to slight body build</td>
</tr>
<tr>
<td>Number of births</td>
<td>Is more likely with each additional birth</td>
</tr>
<tr>
<td>Fertility drugs and in vitro fertilization</td>
<td>Is more likely with fertility hormones and in vitro fertilization (see page 54), which also increase the chances of bearing triplets, quadruplets, or quintuplets</td>
</tr>
</tbody>
</table>

*Worldwide rates, not including multiple births resulting from use of fertility drugs.

Sources: Hall, 2003; Hoekstra et al., 2008; Lashley, 2007.
Patterns of Genetic Inheritance

Jeannie has her parents’ dark, straight hair; Jason is curly-haired and blond. Patterns of genetic inheritance—the way genes from each parent interact—explain these outcomes. Recall that, except for the XY pair in males, all chromosomes come in corresponding pairs. Two forms of each gene occur at the same place on the chromosomes, one inherited from the mother and one from the father. Each form of a gene is called an allele. If the alleles from both parents are alike, the child is homozygous and will display the inherited trait. If the alleles differ, then the child is heterozygous, and relationships between the alleles determine the trait that will appear.

DOMINANT–RECESSIVE INHERITANCE. In many heterozygous pairings, dominant–recessive inheritance occurs: Only one allele affects the child’s characteristics. It is called dominant; the second allele, which has no effect, is called recessive. Hair color is an example. The allele for dark hair is dominant (we can represent it with a capital D), whereas the one for blond hair is recessive (symbolized by a lowercase b). A child who inherits a homozygous pair of dominant alleles (DD) and a child who inherits a heterozygous pair (Db) will both be dark-haired, even though their genotypes differ. Blond hair (like Jason’s) can result only from having two recessive alleles (bb). Still, heterozygous individuals with just one recessive allele (Db) can pass that trait to their children. Therefore, they are called carriers of the trait.

Some human characteristics that follow the rules of dominant–recessive inheritance are listed in Tables 2.2 and 2.3.

TABLE 2.2 Examples of Dominant and Recessive Characteristics

<table>
<thead>
<tr>
<th>DOMINANT</th>
<th>RECESSIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark hair</td>
<td>Blond hair</td>
</tr>
<tr>
<td>Normal hair</td>
<td>Pattern baldness</td>
</tr>
<tr>
<td>Curly hair</td>
<td>Straight hair</td>
</tr>
<tr>
<td>Nonred hair</td>
<td>Red hair</td>
</tr>
<tr>
<td>Facial dimples</td>
<td>No dimples</td>
</tr>
<tr>
<td>Normal hearing</td>
<td>Some forms of deafness</td>
</tr>
<tr>
<td>Normal vision</td>
<td>Nearsightedness</td>
</tr>
<tr>
<td>Farsightedness</td>
<td>Normal vision</td>
</tr>
<tr>
<td>Normal vision</td>
<td>Congenital eye cataracts</td>
</tr>
<tr>
<td>Normally pigmented skin</td>
<td>Albinism</td>
</tr>
<tr>
<td>Double-jointedness</td>
<td>Normal joints</td>
</tr>
<tr>
<td>Type A blood</td>
<td>Type O blood</td>
</tr>
<tr>
<td>Type B blood</td>
<td>Type O blood</td>
</tr>
<tr>
<td>Rh-positive blood</td>
<td>Rh-negative blood</td>
</tr>
</tbody>
</table>

Note: Many normal characteristics that were previously thought to result from dominant–recessive inheritance, such as eye color, are now regarded as due to multiple genes. For the characteristics listed here, most experts agree that the simple dominant–recessive relationship holds.


and environmental factors that increase the chances of giving birth to fraternal twins. Older maternal age, fertility drugs, and in vitro fertilization (to be discussed shortly) are major causes of the dramatic rise in fraternal twinning and other multiple births in industrialized nations over the past several decades (Machin, 2005; Russell et al., 2003). Currently, fraternal twins account for 1 in about every 60 births in the United States (U.S. Department of Health and Human Services, 2008b).

Twins can be created in another way. Sometimes a zygote that has started to duplicate separates into two clusters of cells that develop into two individuals. These are called identical, or monozygotic, twins because they have the same genetic makeup. The frequency of identical twins is the same around the world—about 1 in every 330 births (Hall, 2003). Animal research has uncovered a variety of environmental influences that prompt this type of twinning, including temperature changes, variation in oxygen levels, and late fertilization of the ovum. In a minority of cases, the identical twinning runs in families, suggesting a genetic influence (Lashley, 2007).

During their early years, children of single births often are healthier and develop more rapidly than twins. Jeannie and Jason, like most twins, were born early—three weeks before Ruth’s due date. And, like other premature infants—as you will see in Chapter 3—they required special care after birth. When the twins came home from the hospital, Ruth and Peter had to divide time between them. Perhaps because neither baby received as much attention as the average single infant, Jeannie and Jason walked and talked several months later than most other children their age, although both caught up by middle childhood (Lytton & Gallagher, 2002). Parental energies are further strained after the birth of triplets, whose early development is slower than that of twins (Feldman, Eidelman, & Rotenberg, 2004).
### TABLE 2.3 Examples of Dominant and Recessive Diseases

<table>
<thead>
<tr>
<th>DISEASE</th>
<th>DESCRIPTION</th>
<th>MODE OF INheritance</th>
<th>INCIDENCE</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AUTOSOMAL DISEASES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooley’s anemia</td>
<td>Pale appearance, retarded physical growth, and lethargic behavior begin in infancy.</td>
<td>Recessive</td>
<td>1 in 500 births to parents of Mediterranean descent</td>
<td>Frequent blood transfusion; death from complications usually occurs by adolescence.</td>
</tr>
<tr>
<td>Cystic fibrosis</td>
<td>Lungs, liver, and pancreas secrete large amounts of thick mucus, leading to breathing and digestive difficulties.</td>
<td>Recessive</td>
<td>1 in 2,000 to 2,500 Caucasian births; 1 in 16,000 births to North Americans of African descent</td>
<td>Bronchial drainage, prompt treatment of respiratory infection, dietary management. Advances in medical care allow survival with good life quality into adulthood.</td>
</tr>
<tr>
<td>Phenylketonuria (PKU)</td>
<td>Inability to metabolize the amino acid phenylalanine, contained in many proteins, causes severe central nervous system damage in the first year of life.</td>
<td>Recessive</td>
<td>1 in 8,000 births</td>
<td>Placing the child on a special diet results in average intelligence and normal lifespan. Subtle deficits in memory, planning, decision making, and problem solving are often present.</td>
</tr>
<tr>
<td>Sickle cell anemia</td>
<td>Abnormal sickling of red blood cells causes oxygen deprivation, pain, swelling, and tissue damage. Anemia and susceptibility to infections, especially pneumonia, occur.</td>
<td>Recessive</td>
<td>1 in 400 to 600 births to North Americans of African descent</td>
<td>Blood transfusions, painkillers, prompt treatment of infection. No known cure; 50 percent die by age 55.</td>
</tr>
<tr>
<td>Tay-Sachs disease</td>
<td>Central nervous system degeneration, with onset at about 6 months, leads to poor muscle tone, blindness, deafness, and convulsions.</td>
<td>Recessive</td>
<td>1 in 3,600 births to Jews of European descent and to French Canadians</td>
<td>None. Death occurs by 3 to 4 years of age.</td>
</tr>
<tr>
<td>Huntington disease</td>
<td>Central nervous system degeneration leads to muscular coordination difficulties, mental deterioration, and personality changes. Symptoms usually do not appear until age 35 or later.</td>
<td>Dominant</td>
<td>1 in 18,000 to 25,000 births to North Americans</td>
<td>None. Death occurs 10 to 20 years after symptom onset.</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>Tall, slender build; thin, elongated arms and legs; and heart defects and eye abnormalities, especially of the lens. Excessive lengthening of the body results in a variety of skeletal defects.</td>
<td>Dominant</td>
<td>1 in 5,000 to 10,000 births</td>
<td>Correction of heart and eye defects is sometimes possible. Death from heart failure in young adulthood is common.</td>
</tr>
<tr>
<td><strong>X-LINKED DISEASES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duchenne muscular dystrophy</td>
<td>Degenerative muscle disease. Abnormal gait, loss of ability to walk between ages 7 and 13 years.</td>
<td>Recessive</td>
<td>1 in 3,000 to 5,000 male births</td>
<td>None. Death from respiratory infection or weakening of the heart muscle usually occurs in adolescence.</td>
</tr>
<tr>
<td>Hemophilia</td>
<td>Blood fails to clot normally. Can lead to severe internal bleeding and tissue damage.</td>
<td>Recessive</td>
<td>1 in 4,000 to 7,000 male births</td>
<td>Blood transfusions. Safety precautions may prevent injury.</td>
</tr>
<tr>
<td>Diabetes insipidus</td>
<td>Insufficient production of the hormone vasopressin, resulting in excessive thirst and urination. Dehydration can cause central nervous system damage.</td>
<td>Recessive</td>
<td>1 in 2,500 male births</td>
<td>Hormone replacement.</td>
</tr>
</tbody>
</table>

Note: For recessive disorders listed, carrier status can be detected in prospective parents through a blood test or genetic analyses.
For all disorders listed, prenatal diagnosis is available (see page 56).
Sources: Kliegman et al., 2008; Lashley, 2007; McKusick, 2007.
As you can see, many disabilities and diseases are the product of recessive alleles. One of the most frequently occurring recessive disorders is phenylketonuria, or PKU, which affects the way the body breaks down proteins contained in many foods. Infants born with two recessive alleles lack an enzyme that converts one of the basic amino acids that make up proteins (phenylalanine) into a byproduct essential for body functioning (tyrosine). Without this enzyme, phenylalanine quickly builds to toxic levels that damage the central nervous system. By 1 year, infants with PKU are permanently mentally retarded.

Despite its potentially damaging effects, PKU provides an excellent illustration of the fact that inheriting unfavorable genes does not always lead to an untreatable condition. All U.S. states require that each newborn be given a blood test for PKU. If the disease is found, doctors place the baby on a diet low in phenylalanine. Children who receive this treatment nevertheless take slightly longer to process information and show mild deficits in certain cognitive skills, such as memory, planning, decision making, and problem solving, because even small amounts of phenylalanine interfere with brain functioning (Anderson et al., 2007; Channon, Mockler, & Lee, 2005; Christ et al., 2006). But as long as dietary treatment begins early and continues, children with PKU usually attain an average level of intelligence and have a normal lifespan.

In dominant–recessive inheritance, if we know the genetic makeup of the parents, we can predict the percentage of children in a family who are likely to display or carry a trait. Figure 2.3 illustrates this for PKU. Notice that for a child to inherit the condition, each parent must have a recessive allele.

![Figure 2.3: Dominant–recessive mode of inheritance, as illustrated by PKU.](image)

Only rarely are serious diseases due to dominant alleles. Think about why this is so. Children who inherit the dominant allele always develop the disorder. They seldom live long enough to reproduce, so the harmful dominant allele is eliminated from the family’s heredity in a single generation. Some dominant disorders, however, do persist. One is Huntington disease, a condition in which the central nervous system degenerates. Why has this disorder endured? Its symptoms usually do not appear until age 35 or later, after the person has passed on the dominant gene to his or her children.

- **Incomplete Dominance.** In some heterozygous circumstances, the dominant–recessive relationship does not hold completely. Instead, we see incomplete dominance, a pattern of inheritance in which both alleles are expressed, resulting in a combined trait, or one that is intermediate between the two.

The sickle cell trait, a heterozygous condition present in many black Africans, provides an example. Sickle cell anemia (see Table 2.3) occurs in full form when a child inherits two recessive genes. They cause the usually round red blood cells to become sickle (crescent-moon) shaped, especially under low-oxygen conditions. The sickled cells clog the blood vessels and block the flow of blood, causing intense pain, swelling, and tissue damage. Despite medical advances that today allow 85 percent of affected children to survive to adulthood, North Americans with sickle cell anemia have an average life expectancy of only 55 years (Driscoll, 2007). Heterozygous individuals are protected from the disease under most circumstances. However, when they experience oxygen deprivation—for example, at high altitudes or after intense physical exercise—the single recessive allele asserts itself, and a temporary, mild form of the illness occurs.

The sickle cell allele is common among black Africans for a special reason. Carriers of it are more resistant to malaria than are individuals with two alleles for normal red blood cells. In Africa, where malaria is common, these carriers survived and reproduced more frequently than others, leading the gene to be maintained in the black population. But in regions where the risk of malaria is low, the frequency of the gene is declining. For example, only 8 percent of African Americans are carriers, compared with 20 percent of black Africans (Goldbloom, 2004).

- **X-Linked Inheritance.** Males and females have an equal chance of inheriting recessive disorders carried on the autosomes, such as PKU and sickle cell anemia. But when a harmful allele is carried on the X chromosome, X-linked inheritance applies. Males are more likely to be affected because their sex chromosomes do not match. In females, any recessive allele on one X chromosome has a good chance of being suppressed by a dominant allele on the other X. But the Y chromosome is only about one-third as long and therefore lacks many corresponding genes to override those on the X. A well-known example is hemophilia, a disorder in which the blood fails to clot normally. Figure 2.4 shows its greater likelihood of inheritance by male children whose mothers carry the abnormal allele.

Besides X-linked disorders, many sex differences reveal the male to be at a disadvantage. Rates of miscarriage, infant
and childhood deaths, birth defects, learning disabilities, behavior disorders, and mental retardation all are higher for boys (Butler & Meaney, 2005). It is possible that these sex differences can be traced to the genetic code. The female, with two X chromosomes, benefits from a greater variety of genes. Nature, however, seems to have adjusted for the male’s disadvantage. Worldwide, about 106 boys are born for every 100 girls, and judging from miscarriage and abortion statistics, an even greater number of males are conceived (United Nations, 2006b).

Nevertheless, in recent decades the proportion of male births has declined in many industrialized countries, including the United States, Canada, and European nations (Jongbloet et al., 2001). Some researchers attribute the trend to a rise in stressful living conditions, which heighten spontaneous abortions, especially of male fetuses. In a test of this hypothesis, male-to-female birth ratios in East Germany were examined between 1946 and 1999. The ratio was lowest in 1991, the year that the country’s economy collapsed (Catalano, 2003). Similarly, in a California study spanning the decade of the 1990s, the percentage of male fetal deaths increased in months in which unemployment (a major stressor) also rose above its typical level (Catalano et al., 2005).

**Genomic imprinting**. More than 1,000 human characteristics follow the rules of dominant–recessive and incomplete-dominance inheritance (McKusick, 2007). In these cases, whichever parent contributes a gene to the new individual, the gene responds in the same way. Geneticists, however, have identified exceptions. In **genomic imprinting**, alleles are imprinted, or chemically marked, so that one pair member (either the mother’s or the father’s) is activated, regardless of its makeup. The imprint is often temporary; it may be erased in the next generation, and it may not occur in all individuals (Everman & Cassidy, 2000).

Imprinting helps us understand certain puzzling genetic patterns. For example, children are more likely to develop diabetes if their father, rather than their mother, suffers from it. And people with asthma or hay fever tend to have mothers, not fathers, with the illness. Imprinting is involved in several childhood cancers and in **Prader-Willi syndrome**, a disorder with symptoms of mental retardation and severe obesity (Benarroch et al., 2007). It may also explain why Huntington disease, when inherited from the father, tends to emerge earlier and progress more rapidly (Navarrete, Martinez, & Salamanca, 1994).

Genomic imprinting can also operate on the sex chromosomes, as **fragile X syndrome**—the most common inherited cause of mental retardation—reveals. In this disorder, which affects about 1 in 2,000 males and 1 in 4,000 females, an abnormal repetition of a sequence of DNA bases occurs on the X chromosome, damaging a particular gene. Fragile X has been linked to 2 to 3 percent of cases of **autism**, a serious disorder usually diagnosed in early childhood that involves impaired social interaction, delayed or absent language and communication, and repetitive motor behavior (Goodlin-Jones et al., 2004). Research reveals that the defective gene at the fragile site is expressed only when it is passed from mother to child (Reiss & Dant, 2003).

**Mutation.** Although less than 3 percent of pregnancies result in the birth of a baby with a hereditary abnormality, these children account for about 20 percent of infant deaths and contribute substantially to lifelong impaired physical and mental functioning (U.S. Department of Health and Human Services, 2008b). How are harmful genes created in the first place? The answer is mutation, a sudden change in a segment of DNA. A mutation may affect only one or two genes, or it may involve many genes, as in the chromosomal disorders we will discuss shortly. Some mutations occur spontaneously, simply by chance. Others are caused by hazardous environmental agents.

Although nonionizing forms of radiation—electromagnetic waves and microwaves—have no demonstrated impact on DNA, ionizing (high-energy) radiation is an established cause of mutation. Women who receive repeated doses before conception are more likely to miscarry or to give birth to children with hereditary defects. The incidence of genetic abnormalities, such as physical malformations and childhood cancer, is also higher in children whose fathers are exposed to radiation in their occupation. However, infrequent and mild exposure to radiation does not cause genetic damage (Jacquet, 2004). Rather, high doses over a long period impair DNA.

The examples just given illustrate **germline mutation**, which takes place in the cells that give rise to gametes. When
the affected individual mates, the defective DNA is passed on to the next generation. In a second type, called somatic mutation, normal body cells mutate, an event that can occur at any time of life. The DNA defect appears in every cell derived from the affected body cell, eventually becoming widespread enough to cause disease or disability. Other diseases, such as epilepsy and heart disease, are also believed to be due to somatic mutation (Gottlieb, Beitel, & Trifiro, 2001; Steinlein, 2004).

It is easy to see how disorders that run in families can result from germline mutation. But somatic mutation may be involved in these disorders as well. Some people may harbor a genetic susceptibility that causes certain body cells to mutate easily in the presence of triggering events (Weiss, 2005). This helps explain why some individuals develop serious illnesses as a result of smoking, exposure to pollutants, or psychological stress, while others do not.

Somatic mutation shows that each of us does not have a single, permanent genotype. Rather, the genetic makeup of each cell can change over time. Somatic mutation increases with age, raising the possibility that it contributes to the age-related rise in disease and to the aging process itself (Salvioli et al., 2008).

Finally, although virtually all mutations that have been studied are harmful, some spontaneous ones (such as the sickle cell allele in malaria-ridden regions of the world) are necessary and desirable. By increasing genetic variation, they help individuals adapt to unexpected environmental challenges. Scientists, however, seldom go looking for mutations that underlie favorable traits, such as an exceptional talent or an especially sturdy immune system. They are far more concerned with identifying and eliminating unfavorable genes that threaten health and survival.

**POLYGENIC INHERITANCE.** So far, we have discussed patterns of inheritance in which people either do or do not display a trait. These cut-and-dried individual differences are much easier to trace to their genetic origins than are characteristics that vary on a continuum among people, such as height, weight, intelligence, and personality. These traits are due to polygenic inheritance, in which many genes influence the characteristic in question. Polygenic inheritance is complex, and much about it is still unknown. In the final section of this chapter, we will discuss how researchers infer the influence of heredity on human attributes when they do not know the precise patterns of inheritance.

**Chromosomal Abnormalities**

Besides harmful recessive alleles, abnormalities of the chromosomes are a major cause of serious developmental problems. Most chromosomal defects result from mistakes occurring during meiosis, when the ovum and sperm are formed. A chromosome pair does not separate properly, or part of a chromosome breaks off. Because these errors involve far more DNA than problems due to single genes, they usually produce many physical and mental symptoms.

**DOWN SYNDROME.** The most common chromosomal disorder, occurring in 1 out of every 1,000 live births, is Down syndrome. In 95 percent of cases, it results from a failure of the twenty-first pair of chromosomes to separate during meiosis, so the new individual inherits three of these chromosomes rather than the normal two. In other, less frequent forms, an extra broken piece of a twenty-first chromosome is attached to another chromosome (called translocation pattern). Or an error occurs during the early stages of mitosis, causing some but not all body cells to have the defective chromosomal makeup (called mosaic pattern) (Saitta & Zackai, 2005). Because the mosaic type involves less genetic material, symptoms may be less extreme.

The consequences of Down syndrome include mental retardation, memory and speech problems, limited vocabulary, and slow motor development. Affected individuals also have distinct physical features—a short, stocky build, a flattened
face, a protruding tongue, almond-shaped eyes, and (in 50 percent of cases) an unusual crease running across the palm of the hand. In addition, infants with Down syndrome are often born with eye cataracts, hearing loss, and heart and intestinal defects. Because of medical advances, fewer individuals with Down syndrome die early than was the case in the past. Many survive into their fifties and a few into their sixties to eighties (Roizen & Patterson, 2003).

Infants with Down syndrome smile less readily, show poor eye-to-eye contact, have weak muscle tone, and explore objects less persistently (Slonims & McConachie, 2006). But when parents encourage them to engage with their surroundings, Down syndrome children develop more favorably. They also benefit from infant and preschool intervention programs, although emotional, social, and motor skills improve more than intellectual performance (Carr, 2002). Clearly, environmental factors affect how well children with Down syndrome fare.

The risk of bearing a Down syndrome baby rises dramatically with maternal age, from 1 in 1,900 births at age 20, to 1 in 300 at age 35, to 1 in 30 at age 45 (Halliday et al., 1995; Meyers et al., 1997). Why is this so? Geneticists believe that the ova, present in the woman's body since her own prenatal period, weaken over time. As a result, chromosomes do not separate properly as they complete the process of meiosis at conception. But in about 5 to 10 percent of cases, the extra genetic material originates with the father. The reasons for this mutation are unknown. Some studies suggest a role for advanced paternal age, while others show no age effects (Dzurova & Pikhart, 2005; Fisch et al., 2003; Sherman et al., 2005).

**ABNORMALITIES OF THE SEX CHROMOSOMES.** Disorders of the autosomes other than Down syndrome usually disrupt development so severely that miscarriage occurs. When such babies are born, they rarely survive beyond early childhood. In contrast, abnormalities of the sex chromosomes usually lead to fewer problems. In fact, sex chromosome disorders often are not recognized until adolescence when, in some deviations, puberty is delayed. The most common problems involve the presence of an extra chromosome (either X or Y) or the absence of one X in females.

A variety of myths about individuals with sex chromosome disorders have been discredited by research. For example, males with XYY syndrome are not necessarily more aggressive and antisocial than XY males. And most children with sex chromosome disorders do not suffer from mental retardation. Rather, their intellectual problems usually are very specific. Verbal difficulties—for example, with reading and vocabulary—are common among girls with triple X syndrome and boys with Klinefelter syndrome; both of whom inherit an extra X chromosome. In contrast, girls with Turner syndrome, who are missing an X, have trouble with spatial relationships—for example, drawing pictures, telling right from left, following travel directions, and noticing changes in facial expressions (Kesler, 2007; Lawrence et al., 2003; Simpson et al., 2003). Brain-imaging research confirms that adding to or subtracting from the usual number of X chromosomes alters the development of certain brain structures, yielding particular intellectual deficits (Cutter et al., 2006; Itti et al., 2006).

**ASK YOURSELF**

**REVIEW**

Explain the genetic origins of PKU and Down syndrome. Cite evidence that both heredity and environment contribute to the development of individuals with these disorders.

**REVIEW**

Using your knowledge of X-linked inheritance, explain why males are more vulnerable than females to miscarriage, infant death, genetic disorders, and other problems.

**APPLY**

Gilbert’s genetic makeup is homozygous for dark hair. Jan’s is homozygous for blond hair. What color is Gilbert’s hair? How about Jan’s? What proportion of their children are likely to be dark-haired? Explain.

**CONNECT**

Referring to ecological systems theory (Chapter 1, pages 24–26), explain why parents of children with genetic disorders often experience increased stress. What factors, within and beyond the family, can help these parents support their children’s development?

**Reproductive Choices**

Two years after they married, Ted and Marianne gave birth to their first child. Kendra appeared to be a healthy infant, but by 4 months her growth slowed, and she was diagnosed as having Tay-Sachs disease (see Table 2.3 on page 49). When Kendra died at 2 years of age, Ted and Marianne were devastated. Although they did not want to bring another infant into the world who would endure such suffering, they badly wanted to have a child. They began to avoid family gatherings, where little nieces and nephews were constant reminders of the void in their lives.

In the past, many couples with genetic disorders in their families chose not to bear a child at all rather than risk the birth of an abnormal baby. Today, genetic counseling and prenatal diagnosis help people make informed decisions about conceiving, carrying a pregnancy to term, or adopting a child.

**Genetic Counseling**

Genetic counseling is a communication process designed to help couples understand genetic principles, genetic testing, and prevention of genetic disorders; assess their chances of giving birth to a baby with a hereditary disorder; and choose the best course of action in view of risks and family goals (Resta et al., 2006). Individuals likely to seek counseling are
The Pros and Cons of Reproductive Technologies

Some couples decide not to risk pregnancy because of a history of genetic disease. Many others—in fact, one-sixth of all couples who try to conceive—discover that they are infertile. And some never-married adults and gay and lesbian partners want to bear children. Today, increasing numbers of individuals are turning to alternative methods of conception—technologies that, although they fulfill the wish for parenthood, have become the subject of heated debate.

Donor Insemination and In Vitro Fertilization

For several decades, donor insemination— injection of sperm from an anonymous man into a woman—has been used to treat male reproductive difficulties. In recent years, it has also permitted women without a male partner to become pregnant. Donor insemination is 70 to 80 percent successful, resulting in about 40,000 deliveries and 52,000 newborn babies in the United States each year (Jackson, 2007). In vitro fertilization is another reproductive technology that has become increasingly common. Since the first “test tube” baby was born in England in 1978, 1 percent of all children in developed countries—about 40,000 babies in the United States—have been conceived through this technique annually (Jackson, Gibson, & Wu, 2004). With in vitro fertilization, a woman is given hormones that stimulate the ripening of several ova. These are removed surgically and placed in a dish of nutrients, to which sperm are added. Once an ovum is fertilized and begins to duplicate into several cells, it is injected into the mother’s uterus.

By mixing and matching gametes, pregnancies can be brought about when either or both partners have a reproductive problem. Usually, in vitro fertilization is used to treat women whose fallopian tubes are permanently damaged. But a recently developed technique permits a single sperm to be injected directly into an ovum, thereby overcoming most male fertility problems. And a “sex sorter” method helps ensure that couples who carry X-linked diseases (which usually affect males) have a daughter. Fertilized ova and sperm can even be frozen and stored in embryo banks for use at some future time, thereby guaranteeing healthy zygotes should age or illness lead to fertility problems.

The overall success rate of in vitro fertilization is about 35 percent. However, success declines steadily with age, from 40 percent in women younger than age 35 to 7 percent in women age 43 and older (Wright et al., 2008). Children conceived through these methods may be genetically unrelated to one or both of their parents (if donor gametes are used). In addition, most parents who have used in vitro fertilization do not tell their children about their origins, even though health professionals usually encourage them to do so. Does lack of genetic ties or secrecy surrounding these techniques interfere with parent-child relationships? Perhaps because of a strong desire for parenthood, caregiving tends to be somewhat warmer for young children conceived through donor insemination or in vitro fertilization. And in vitro infants are as securely attached to their parents, and in vitro children and adolescents as well-adjusted, as their counterparts who were naturally conceived (Golombok & MacCallum, 2003; Golombok et al., 2004; Punamaki, 2006).

Although donor insemination and in vitro fertilization have many benefits, serious questions have arisen about their use. Most U.S. states have few legal guidelines for these procedures. As a result, doctors are not always screened for genetic or sexually transmitted diseases. Furthermore, in many countries (including the United States and Canada), doctors are not required to keep records of donor characteristics (Richards, 2004). Canada does retain a file on donor identities, permitting contact only in cases of serious disease, where knowledge of the child’s genetic background might have medical value (Bioethics Consultative Committee, 2003). Another concern is that the in vitro “sex sorter” method will lead to parental sex selection, thereby eroding the moral value that children of both sexes are equally precious.

Finally, about 50 percent of in vitro procedures result in multiple births. Most are twins, but 9 percent are triplets and higher-order multiples. Consequently, among in vitro babies, the rate of low birth weight is nearly three times as high as in the general population (Wright et al., 2008). Risk of major birth defects also doubles because of many factors, including drugs used to induce ripening of ova and delays in fertilizing the ova outside the womb (Machin, 2005). In sum, in vitro fertilization poses greater risks than natural conception to infant survival and healthy development.

Surrogate Motherhood

An even more controversial form of medically assisted conception is surrogate motherhood. Typically in this procedure, sperm from a man whose wife is infertile are used to inseminate a woman, called a surrogate, who is paid a fee for her childbearing services. In return, the surrogate agrees to turn the baby over to the man (who is the natural father). The child is then adopted by his wife.

Although most of these arrangements proceed smoothly, those that end up in court highlight serious risks for all concerned. In one case, both parties rejected the child with severe disabilities who resulted from the pregnancy. In several others, the surrogate mother wanted to keep the baby, or the couple changed their mind during the pregnancy. These children came into the world in the midst of conflict that threatened to last for years.

Because surrogacy favors the wealthy as contractors for infants and the less economically advantaged as surrogates, it may promote those who have had difficulties bearing children—for example, repeated miscarriages—or who know that genetic problems exist in their families. In addition, women who delay childbearing past age 35 are candidates for genetic counseling. After this time, the overall rate of chromosomal abnormalities rises sharply, from 1 in every 190 to as many as 1 in every 20 pregnancies at age 43 (Wille et al., 2004). But because younger mothers give birth in far greater numbers than older mothers, they bear the majority of babies with genetic defects. Therefore, some experts argue that maternal needs, not age, should determine referral for genetic counseling (Berkowitz, Roberts, & Minkoff, 2006).

If a family history of mental retardation, physical defects, or inherited diseases exists, the genetic counselor interviews the
exploitation of financially needy women. In addition, most surrogates already have children of their own who may be deeply affected by the pregnancy. Knowledge that their mother would give away a baby for profit may cause these youngsters to worry about the security of their own family circumstances.

New Reproductive Frontiers

Reproductive technologies are evolving faster than societies can weigh the ethics of these procedures. Doctors have used donor ova from younger women in combination with in vitro fertilization to help postmenopausal women become pregnant. Most recipients are in their forties, but several women in their fifties and sixties have given birth. These cases raise questions about bringing children into the world whose parents may not live to see them reach adulthood. Based on U.S. life expectancy data, 1 in 3 mothers and 1 in 2 fathers having a baby at age 55 will die before their child enters college (U.S. Census Bureau, 2009b).

Currently, experts are debating other reproductive options. At donor banks, customers can select ova or sperm on the basis of physical characteristics and even IQ. And scientists are devising ways to alter the DNA of human ova, sperm, and embryos to protect against hereditary disorders—techniques that could be used to engineer other desired characteristics. Many worry that these practices are a dangerous step toward selective breeding through “designer babies”—controlling offspring characteristics by manipulating genetic makeup.

Furthermore, scientists have successfully cloned (made multiple copies of) fertilized ova in sheep, cattle, and monkeys, and they are working on effective ways to do so in humans. By providing extra ova for injection, cloning might improve the success rate of in vitro fertilization. But it also opens the possibility of mass-producing genetically identical people. Therefore, it is widely condemned.

Although reproductive technologies permit many barren couples to rear healthy newborn babies, laws are needed to regulate such practices. In Australia, New Zealand, Sweden, and Switzerland, individuals conceived with donated gametes have a right to information about their genetic origins (Frith, 2001). Pressure from those working in the field of assisted reproduction may soon lead to similar policies in the United States. Australia, Canada, and the Netherlands prohibit any genetic alteration of human gametes, with other nations following suit (Isasi, Nguyen, & Knoppers, 2006). But some scientists argue that this total ban is too restrictive because it interferes with serving therapeutic needs. In the case of surrogate motherhood, the ethical problems are so complex that 18 U.S. states have sharply restricted the practice. Australia, Canada, and many European nations have banned it, arguing that the status of a baby should not be a matter of commercial arrangement and that a part of the body should not be rented or sold (Chen, 2003; McGee, 1997). Denmark, France, and Great Britain have prohibited in vitro fertilization for women past menopause (Bioethics Consultative Committee, 2003). At present, nothing is known about the psychological consequences of being a product of these procedures. Research on how such children grow up, including later-appearing medical conditions and knowledge and feelings about their origins, is important for weighing the pros and cons of these techniques.

Fertility drugs and in vitro fertilization often lead to multiple fetuses. Although these sextuplets are healthy, reproductive technologies can pose grave ethical dilemmas. When two or more fetuses fill the womb, pregnancy complications may be so severe that doctors recommend aborting one or more to save the others.

18 U.S. states have sharply restricted the practice. Australia, Canada, and many European nations have banned it, arguing that the status of a baby should not be a matter of commercial arrangement and that a part of the body should not be rented or sold (Chen, 2003; McGee, 1997). Denmark, France, and Great Britain have prohibited in vitro fertilization for women past menopause (Bioethics Consultative Committee, 2003). At present, nothing is known about the psychological consequences of being a product of these procedures. Research on how such children grow up, including later-appearing medical conditions and knowledge and feelings about their origins, is important for weighing the pros and cons of these techniques.

Although reproductive technologies permit many barren couples to rear healthy newborn babies, laws are needed to regulate such practices. In Australia, New Zealand, Sweden, and Switzerland, individuals conceived with donated gametes have a right to information about their genetic origins (Frith, 2001). Pressure from those working in the field of assisted reproduction may soon lead to similar policies in the United States. Australia, Canada, and the Netherlands prohibit any genetic alteration of human gametes, with other nations following suit (Isasi, Nguyen, & Knoppers, 2006). But some scientists argue that this total ban is too restrictive because it interferes with serving therapeutic needs. In the case of surrogate motherhood, the ethical problems are so complex that 18 U.S. states have sharply restricted the practice. Australia, Canada, and many European nations have banned it, arguing that the status of a baby should not be a matter of commercial arrangement and that a part of the body should not be rented or sold (Chen, 2003; McGee, 1997). Denmark, France, and Great Britain have prohibited in vitro fertilization for women past menopause (Bioethics Consultative Committee, 2003). At present, nothing is known about the psychological consequences of being a product of these procedures. Research on how such children grow up, including later-appearing medical conditions and knowledge and feelings about their origins, is important for weighing the pros and cons of these techniques.

Although reproductive technologies permit many barren couples to rear healthy newborn babies, laws are needed to regulate such practices. In Australia, New Zealand, Sweden, and Switzerland, individuals conceived with donated gametes have a right to information about their genetic origins (Frith, 2001). Pressure from those working in the field of assisted reproduction may soon lead to similar policies in the United States. Australia, Canada, and the Netherlands prohibit any genetic alteration of human gametes, with other nations following suit (Isasi, Nguyen, & Knoppers, 2006). But some scientists argue that this total ban is too restrictive because it interferes with serving therapeutic needs. In the case of surrogate motherhood, the ethical problems are so complex that 18 U.S. states have sharply restricted the practice. Australia, Canada, and many European nations have banned it, arguing that the status of a baby should not be a matter of commercial arrangement and that a part of the body should not be rented or sold (Chen, 2003; McGee, 1997). Denmark, France, and Great Britain have prohibited in vitro fertilization for women past menopause (Bioethics Consultative Committee, 2003). At present, nothing is known about the psychological consequences of being a product of these procedures. Research on how such children grow up, including later-appearing medical conditions and knowledge and feelings about their origins, is important for weighing the pros and cons of these techniques.

Although reproductive technologies permit many barren couples to rear healthy newborn babies, laws are needed to regulate such practices. In Australia, New Zealand, Sweden, and Switzerland, individuals conceived with donated gametes have a right to information about their genetic origins (Frith, 2001). Pressure from those working in the field of assisted reproduction may soon lead to similar policies in the United States. Australia, Canada, and the Netherlands prohibit any genetic alteration of human gametes, with other nations following suit (Isasi, Nguyen, & Knoppers, 2006). But some scientists argue that this total ban is too restrictive because it interferes with serving therapeutic needs. In the case of surrogate motherhood, the ethical problems are so complex that 18 U.S. states have sharply restricted the practice. Australia, Canada, and many European nations have banned it, arguing that the status of a baby should not be a matter of commercial arrangement and that a part of the body should not be rented or sold (Chen, 2003; McGee, 1997). Denmark, France, and Great Britain have prohibited in vitro fertilization for women past menopause (Bioethics Consultative Committee, 2003). At present, nothing is known about the psychological consequences of being a product of these procedures. Research on how such children grow up, including later-appearing medical conditions and knowledge and feelings about their origins, is important for weighing the pros and cons of these techniques.
Prenatal Diagnosis and Fetal Medicine

If couples who might bear an abnormal child decide to conceive, several prenatal diagnostic methods—medical procedures that permit detection of problems before birth—are available (see Table 2.4). Women of advanced maternal age are prime candidates for amniocentesis or chorionic villus sampling (see Figure 2.5). Except for maternal blood analysis, however, prenatal diagnosis should not be used routinely because other methods pose some risk of injury to the developing organism.

Prenatal diagnosis has led to advances in fetal medicine. For example, by inserting a needle into the uterus, doctors can administer drugs to the fetus. Surgery has been performed to repair such problems as heart, lung, and diaphragm malformations, urinary tract obstructions, and neural defects (Kunisaki & Jennings, 2008). Fetuses with blood disorders have been given blood transfusions. And those with immune deficiencies have received bone marrow transplants that succeeded in creating a normally functioning immune system (Williams, 2006).

These techniques frequently result in complications, the most common being premature labor and miscarriage (Flake, 2003). Yet parents may be willing to try almost any option, even one with only a slim chance of success. Currently, the medical profession is struggling with how to help parents make informed decisions about fetal surgery.

Advances in genetic engineering also offer hope for correcting hereditary defects. As part of the Human Genome Project—an ambitious international research program aimed at deciphering the chemical makeup of human genetic material (genome)—researchers have mapped the sequence of all human DNA base pairs. Using that information, they are “annotating” the genome—identifying all its genes and their functions, including their protein products and what they do. A major goal is to understand the estimated 4,000 human disorders, those due to single genes and those resulting from a complex interplay of multiple genes and environmental factors.

Already, thousands of genes have been identified, including those involved in hundreds of diseases, such as cystic fibrosis; Duchenne muscular dystrophy; Huntington disease; Marfan

### TABLE 2.4  Prenatal Diagnostic Methods

<table>
<thead>
<tr>
<th>METHOD</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amniocentesis</td>
<td>The most widely used technique. A hollow needle is inserted through the abdominal wall to obtain a sample of fluid in the uterus. Cells are examined for genetic defects. Can be performed by the 14th week after conception; 1 to 2 more weeks are required for test results. Small risk of miscarriage.</td>
</tr>
<tr>
<td>Chorionic villus sampling</td>
<td>A procedure that can be used if results are desired or needed very early in pregnancy. A thin tube is inserted into the uterus through the vagina, or a hollow needle is inserted through the abdominal wall. A small plug of tissue is removed from the end of one or more chorionic villi, the hairlike projections on the membrane surrounding the developing organism. Cells are examined for genetic defects. Can be performed at 9 weeks after conception; results are available within 24 hours. Entails a slightly greater risk of miscarriage than amniocentesis. Also associated with a small risk of limb deformities, which increases the earlier the procedure is performed.</td>
</tr>
<tr>
<td>Fetoscopy</td>
<td>A small tube with a light source at one end is inserted into the uterus to inspect the fetus for defects of the limbs and face. Also allows a sample of fetal blood to be obtained, permitting diagnosis of such disorders as hemophilia and sickle cell anemia, as well as neural defects (see below). Usually performed between 15 and 18 weeks after conception but can be done as early as 5 weeks. Entails some risk of miscarriage.</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>High-frequency sound waves are beamed at the uterus; their reflection is translated into a picture on a video screen that reveals the size, shape, and placement of the fetus. By itself, permits assessment of fetal age, detection of multiple pregnancies, and identification of gross physical defects. Also used to guide amniocentesis, chorionic villus sampling, and fetoscopy. When used five or more times, may increase the chances of low birth weight.</td>
</tr>
<tr>
<td>Maternal blood analysis</td>
<td>By the second month of pregnancy, some of the developing organism’s cells enter the maternal bloodstream. An elevated level of alpha-fetoprotein may indicate kidney disease, abnormal closure of the esophagus, or neural tube defects, such as anencephaly (absence of most of the brain) and spina bifida (bulging of the spinal cord from the spinal column). Isolated cells can be examined for genetic defects.</td>
</tr>
<tr>
<td>Preimplantation genetic diagnosis</td>
<td>After in vitro fertilization and duplication of the zygote into a cluster of about 8 to 10 cells, 1 or 2 cells are removed and examined for hereditary defects. Only if that sample is free of detectable genetic disorders is the fertilized ovum implanted in the woman’s uterus.</td>
</tr>
</tbody>
</table>

FIGURE 2.5 Amniocentesis and chorionic villus sampling. Today, hundreds of defects and diseases can be detected before birth using these two procedures. (a) In amniocentesis, a hollow needle is inserted through the abdominal wall into the uterus during the fourteenth week after conception, or later. Fluid is withdrawn, and fetal cells are cultured, a process that takes one to two weeks. (b) Chorionic villus sampling can be performed much earlier in pregnancy, at nine weeks after conception, and results are available within 24 hours. Two approaches to obtaining a sample of chorionic villus are shown: inserting a thin tube through the vagina into the uterus and inserting a needle through the abdominal wall. In both amniocentesis and chorionic villus sampling, an ultrasound scanner is used for guidance. (Adapted from Before We Are Born, 7th ed. by K. L. Moore and T. V. N. Persaud, p. 69. Copyright © 2008, reprinted with permission from Elsevier, Inc.)

This mother sings while delivering medication through a nebulizer to her 2-year-old daughter, who has cystic fibrosis. The girl also wears a vest for a twice-daily treatment that pounds her chest to clear her lungs of thick mucus. In the future, such children may benefit from the discovery of gene-based treatments for hereditary disorders.

Adoption

Adults who are infertile, who are likely to pass along a genetic disorder, or who are older and single but want a family are turning to adoption in increasing numbers. Those who have children by birth, too, sometimes choose to expand their families through adoption. Adoption agencies try to ensure a good fit by seeking parents of the same ethnic and religious background as the child and, where possible, trying to choose parents who are the same age as typical biological parents. Because the availability of syndrome; heart, digestive, blood, eye, and nervous system abnormalities; and many forms of cancer (National Institutes of Health, 2008). As a result, new treatments are being explored, such as gene therapy—correcting genetic abnormalities by delivering DNA carrying a functional gene to the cells. In recent experiments, gene therapy relieved symptoms in hemophilia patients and in patients with severe immune system dysfunction. A few, however, experienced serious side effects (Anson & Fletcher, 2007). In another approach, called proteomics, scientists modify gene-specified proteins involved in biological aging and disease (Bradshaw & Burlingame, 2005).

Genetic treatments seem some distance in the future for most single-gene defects, however, and even farther off for diseases involving multiple genes that combine in complex ways with one another and the environment. Applying What We Know on page 58 summarizes steps that prospective parents can take before conception to protect the genetic health of their child.
healthy babies has declined (fewer young unwed mothers give up their babies than in the past), more people in North America and Western Europe are adopting from other countries or accepting children who are past infancy or who have known developmental problems (Schweiger & O’Brien, 2005).

Adopted children and adolescents—whether or not they are born in their adoptive parents’ country—have more learning and emotional difficulties than other children, a difference that increases with the child’s age at time of adoption (Brodzinsky & Pinderhughes, 2002; Nickman et al., 2005; van IJzendoorn, Juffer, & Poelhuis, 2005). There are many possible reasons for adoptees’ more problematic childhoods. The biological mother may have been unable to care for the child because of problems believed to be partly genetic, such as alcoholism or severe depression, and may have passed this tendency to her offspring. Or perhaps she experienced stress, poor diet, or inadequate medical care during pregnancy—factors that can affect the child (as we will see in Chapter 3). Furthermore, children adopted after infancy often have a preadoptive history of conflict-ridden family relationships, lack of parental affection, neglect and abuse, or deprived institutional rearing. Finally, adoptive parents and children, who are genetically unrelated, are less alike in intelligence and personality than are biological relatives—differences that may threaten family harmony.

Despite these risks, most adopted children fare well, and those with preexisting problems usually make rapid progress (Bimmel et al., 2003; Johnson, 2002). In a study of internationally adopted children in the Netherlands, sensitive maternal care and secure attachment in infancy predicted cognitive and social competence at age 7 (Stams, Juffer, & van IJzendoorn, 2002). Overall, international adoptees fare much better in development than birth siblings or institutionalized agemates who stay behind. By middle childhood, those who were adopted in infancy have mental test scores resembling those of their non-biological siblings and school classmates, although they tend to achieve less well in school, to have more learning problems that require special treatment, and to be slightly delayed in language skills (van IJzendoorn, Juffer, & Poelhuis, 2005). Children adopted at older ages develop feelings of trust and affection for their adoptive parents as they come to feel loved and supported in their new families (Veríssimo & Salvaterra, 2006). As we will see in Chapter 4, however, later-adopted children are more likely than their agemates to have persistent cognitive, emotional, and social problems.

By adolescence, adoptees’ lives are often complicated by unresolved curiosity about their roots. Some have difficulty accepting the possibility that they may never know their birth parents. Others worry about what they would do if their birth parents suddenly reappeared. Nevertheless, the decision to search for birth parents is usually postponed until early adulthood, when marriage and childbirth may trigger it. Despite concerns about their origins, most adoptees appear well-adjusted as adults. And as long as their parents took steps to help them learn about their heritage in childhood, young people adopted into a different ethnic group or culture generally develop identities...
that are healthy blends of their birth and rearing backgrounds (Nickman et al., 2005; Thomas & Tessler, 2007).

As we conclude our discussion of reproductive choices, perhaps you are wondering how things turned out for Ted and Marianne. Through genetic counseling, Marianne discovered a history of Tay-Sachs disease on her mother’s side of the family. Ted had a distant cousin who died of the disorder. The genetic counselor explained that the chances of giving birth to another affected baby were 1 in 4. Ted and Marianne took the risk. Their son Douglas is now 12 years old. Although Douglas is a carrier of the recessive allele, he is a normal, healthy boy. In a few years, Ted and Marianne will tell Douglas about his genetic history and explain the importance of seeking genetic counseling before he has children of his own.

Return to Bronfenbrenner’s ecological systems theory, discussed in Chapter 1. It emphasizes that environments extending beyond the microsystem—the immediate settings just mentioned—powerfully affect development. Indeed, my students rarely mention one important context. Its impact is so pervasive that we seldom stop to think about it in our daily lives. This is the macrosystem, or broad social climate of society—its values and programs that support and protect human development. All people need help with the demands of each period of the lifespan—through affordable housing and health care, safe neighborhoods, good schools, well-equipped recreational facilities, and high-quality child care and other services that permit them to meet both work and family responsibilities. And some people, because of poverty or special tragedies, need considerably more help than others.

In the following sections, we take up these contexts for development. Because they affect every age and aspect of change, we will return to them in later chapters. For now, our discussion emphasizes that environments, as well as heredity, can enhance or create risks for development.

The Family

In power and breadth of influence, no other context equals the family. The family creates bonds among people that are unique. Attachments to parents and siblings usually last a lifetime and serve as models for relationships in the wider world of neighborhood, school, and community. Within the family, children learn the language, skills, and social and moral values of their culture. And at all ages, people turn to family members for information, assistance, and pleasurable interaction. Warm, gratifying family ties predict physical and psychological health throughout development. In contrast, isolation or alienation from the family is often associated with developmental problems (Deković & Buist, 2005; Parke & Buriel, 2006).

Contemporary researchers view the family as a social system, or network of interdependent relationships (Bronfenbrenner & Morris, 2006; Lerner et al., 2002). Recall from ecological systems theory that bidirectional influences exist in which the behaviors of each family member affect those of others. Indeed, the very term system implies that the responses of family members are related. These system influences operate both directly and indirectly.

Environmental Contexts for Development

Just as complex as genetic inheritance is the surrounding environment—a many-layered set of influences that combine to help or hinder physical and psychological well-being. Take a moment... Think back to your childhood, and jot down a brief description of events and people that you believe significantly influenced your development. Next, do the same for your adult life. Do the items on your list resemble those of my students, who mostly mention experiences that involve their families? This emphasis is not surprising, since the family is the first and longest-lasting context for development. Other influences that make the top ten are friends, neighbors, school, workplace, and community and religious organizations.
cooperate. And when children willingly comply, their parents are likely to be warm and gentle in the future. In contrast, children whose parents discipline with harshness and impatience are likely to refuse and rebel. And because children’s misbehavior is stressful for parents, they may increase their use of punishment, leading to more unruliness by the child (Stormshak et al., 2000; Whiteside-Mansell et al., 2003). This principle also applies to other two-person family relationships—siblings, marital partners, parent and adult child. In each case, the behavior of one family member helps sustain a form of interaction in the other that either promotes or undermines psychological well-being.

**INDIRECT INFLUENCES.** The impact of family relationships on development becomes even more complicated when we consider that interaction between any two members is affected by others present in the setting. Bronfenbrenner calls these indirect influences the effect of *third parties*.

Third parties can serve as supports for or barriers to development. For example, parents who have a warm, considerate marital relationship praise and stimulate their children more. In contrast, parents whose marriage is tense and hostile tend to be less responsive to their children’s needs and more likely to criticize, express anger, and punish (Cox, Paley, & Harter, 2001; McHale et al., 2002). Children chronically exposed to angry, unresolved parental conflict have serious emotional problems (Harold et al., 2004). These include both *internalizing difficulties* (especially among girls), such as feeling worried and afraid and trying to repair their parents’ relationship, and *externalizing difficulties* (especially among boys), including verbal and physical aggression (Davies & Lindsay, 2004). These child problems can further disrupt parents’ marital relationship.

Yet even when third parties strain family ties, other members may help restore effective interaction. Grandparents, for example, can promote children’s development both directly, by responding warmly to the child, and indirectly, by providing parents with child-rearing advice, models of child-rearing skill, and even financial assistance. Of course, as with any indirect influence, grandparents can sometimes be harmful. When quarrelsome relations exist between grandparents and parents, parent–child communication may suffer.

**ADAPTING TO CHANGE.** Think back to the *chronosystem* in Bronfenbrenner’s theory (see page 26 in Chapter 1). The interplay of forces within the family is dynamic and ever-changing. Important events, such as the birth of a baby, a change of jobs, or the addition to the household of an elderly parent in declining health, create challenges that modify existing relationships. The way such events affect family interaction depends on the support other family members provide and on the developmental status of each participant. For example, the arrival of a new baby prompts very different reactions in a toddler than in a school-age child. And caring for an ill elderly parent is more stressful for a middle-aged adult still rearing young children than for an adult of the same age who has no child-rearing responsibilities.

Historical time period also contributes to a dynamic family system. In recent decades, a declining birth rate, a high divorce rate, and expansion of women’s roles have led to a smaller family size. This, combined with a longer lifespan, means that more generations are alive, with fewer members in the youngest ones, leading to a “top-heavy” family structure. Young people today are more likely to have older relatives than at any time in history—a circumstance that can be enriching as well as a source of tension. In sum, as this complex intergenerational system moves through time, relationships are constantly revised as members adjust to their own and others’ development as well as to external pressures.

Despite these variations, some general patterns in family functioning do exist. In the United States and other Western nations, one important source of these consistencies is socioeconomic status.

**Socioeconomic Status and Family Functioning**

People in industrialized nations are stratified on the basis of what they do at work and how much they earn for doing it—factors that determine their social position and economic well-being. Researchers assess a family’s standing on this continuum through an index called *socioeconomic status* (SES), which combines three related, but not completely overlapping, variables: (1) years of education and (2) the prestige of one’s job and the skill it requires, both of which measure social status; and (3) income, which measures economic status. As SES rises...
and falls, people face changing circumstances that profoundly affect family functioning.

SES affects the timing and duration of phases of the family life cycle. People who work in skilled and semiskilled manual occupations (for example, construction workers, truck drivers, and custodians) tend to marry and have children earlier as well as give birth to more children than people in professional and technical occupations. The two groups also differ in values and expectations. For example, when asked about personal qualities they desire for their children, lower-SES parents tend to emphasize external characteristics, such as obedience, politeness, neatness, and cleanliness. In contrast, higher-SES parents emphasize psychological traits, such as curiosity, happiness, self-direction, and cognitive and social maturity (Duncan & Magnuson, 2003; Hoff, Laursen, & Tardif, 2002; Tudge et al., 2000).

These differences are reflected in family interaction. Parents higher in SES talk to, read to, and otherwise stimulate their infants and preschoolers more. When their children are older, higher-SES parents use more warmth, explanations, and verbal praise. Commands (“You do that because I told you to”), criticism, and physical punishment all occur more often in low-SES households (Bradley & Corwyn, 2003).

Education contributes substantially to these variations in child rearing. Higher-SES parents’ interest in providing verbal stimulation and nurturing inner traits is supported by years of schooling, during which they learned to think about abstract, subjective ideas. In diverse cultures around the world, as the Lifespan Vista box on page 62 makes clear, education of women in particular fosters patterns of thinking that greatly improve quality of life, for both parents and children.

Because of limited education and low social status, many lower-SES parents feel a sense of powerlessness and lack of influence in their relationships beyond the home. At work, for example, they must obey rules of others in positions of power and authority. When they get home, their parent–child interaction seems to duplicate these experiences—but now they are in authority. Higher levels of stress combined with a stronger belief in the value of physical punishment contribute to low-SES parents’ greater use of coercive discipline (Conger & Donnellan, 2007; Pinderhughes et al., 2000). Higher-SES parents, in contrast, typically have more control over their own lives. At work, they are used to making independent decisions and convincing others of their point of view. At home, they teach these skills to their children (Greenberger, O’Neil, & Nagel, 1994).

**Affluence**

Despite advanced education and great material wealth, affluent parents—those in highly prestigious occupations with six-figure annual incomes—too often fail to engage in family interaction and parenting that promote favorable development. In several studies, researchers tracked the adjustment of youths growing up in wealthy suburbs (Luthar & Latendresse, 2005a). By seventh grade, many showed serious problems that worsened in high school. Their school grades were poor, and they were more likely to engage in alcohol and drug use and to report high levels of anxiety and depression than low-SES youths (Luthar & Becker, 2002). Furthermore, among affluent (but not low-SES) teenagers, substance use was correlated with anxiety and depression, suggesting that wealthy youths took drugs to self-medicate—a practice that predicts persistent abuse (Luthar & Sexton, 2004).

Why are so many affluent youths troubled? Compared to their better-adjusted counterparts, poorly adjusted affluent young people report less emotional closeness and supervision from their parents, who lead professionally and socially demanding lives. As a group, wealthy parents are nearly as physically and emotionally unavailable to their youngsters as parents coping with serious financial strain. At the same time, these parents often make excessive demands for achievement (Luthar & Becker, 2002). Adolescents whose parents value their accomplishments more than their character are more likely to have academic and emotional problems.

For both affluent and low-SES youths, a simple routine—eating dinner with parents—is associated with a reduction in adjustment difficulties, even after many other aspects of parenting are controlled (see Figure 2.6) (Luthar & Latendresse, 2005b). Interventions that make wealthy parents aware of the high costs of a competitive, overscheduled lifestyle and minimal family time are badly needed.

![FIGURE 2.6 Relationship of regularly eating dinner with parents to affluent youths’ adjustment problems.](Image) Compared with sixth graders who often ate dinner with their parents, those who rarely did so were far more likely to display anxiety and depression, delinquency and substance use, and poor school grades, even after many other aspects of parenting were controlled. In this study, frequent family mealtimes also protected low-SES youths from delinquency and substance use and from classroom learning problems. (Adapted from Luthar & Latendresse, 2005b.)
Worldwide Education of Girls: Transforming Current and Future Generations

When a new school opened in the Egyptian village of Beni Shara’an, some villagers complained that the school would deprive them of their children’s help in the wheat fields and small businesses. Ahmen, an illiterate shopkeeper, heard an elderly merchant, who had donated space to the school, say, “I have come to believe that a girl’s education is even more important than a boy’s.” Immediately, Ahmen enrolled his 8-year-old daughter Rawia (Bellamy, 2004, p. 19). Until that day, Rawia had divided her days between backbreaking farming and confinement to her home.

Before long, Rawia’s advancing language, literacy, and reasoning skills transformed her family’s quality of life. “My store accounts were in a mess, but soon Rawia started straightening out the books,” Ahmen recalled. She also began helping her older sister learn to read and write and explaining to her family the instructions on prescription medicines and the news on television. In addition, Rawia began to envision a better life for herself. “When I grow up,” she told her father, “I want to be a doctor. Or maybe a teacher.”

Over the past century, the percentage of children in the developing world who go to school has increased from a small minority of boys to a majority of all children in most regions. Still, some 73 million children, most of them poverty-stricken girls, do not start elementary school, and more than 200 million, again mostly girls, do not go to secondary school (UNICEF, 2006).

Although schooling is vital for all children, educating girls has an especially powerful impact on the welfare of families, societies, and future generations. The diverse benefits of girls’ schooling largely accrue in two ways: (1) through enhanced verbal skills—reading, writing, and oral communication; and (2) through empowerment—a growing desire to improve their life conditions. In studies carried out on three continents, in three cultures, and in three community settings—rural Nepal, a small Mexican town, and a large city in Zambia—the more education women obtained, the better their language and literacy skills and the higher their aspirations for a better life. Their knowledge and attitudes, in turn, dramatically influenced family health, relationships, and parenting (LeVine, LeVine, & Schnell, 2001).

Family Health

Education gives people the communicative skills and confidence to seek health services and to benefit from public health information. As a result, years of schooling strongly predicts women’s preventive health behavior: prenatal visits, child immunizations, healthy diet, and sanitary practices (LeVine et al., 2004; Peña, Wall, & Person, 2000). In addition, because educated women have more life opportunities, they are more likely to take advantage of family planning services, delay marriage and childbearing, and have more widely spaced and fewer children (Stromquist, 2007). All these practices are linked to increased maternal and child survival and family health.

For these girls huddling in an open-air class in a village in Pakistan, attending school will dramatically improve their life opportunities and their nation’s welfare. In both developed and developing nations, educating girls leads to gains in family income and relationships that carry over to improved health, education, and economic well-being in the next generation.

Family Relationships and Parenting

In developed and developing nations alike, the empowerment that springs from education is associated with more equitable husband–wife relationships and a reduction in harsh disciplining of children (LeVine et al., 1991; LeVine, LeVine, & Schnell, 2001). Also, educated mothers engage in more verbal stimulation and teaching of literacy skills to their children, which fosters success in school, higher educational attainment, reduced crime rates, and economic gains in the next generation. Regions of the world that have invested more in girls’ education, such as southeast Asia and Latin America, tend to have higher levels of economic development (King & Mason, 2001).

Donor nations and international organizations are increasingly coming to the same conclusion: The education of girls is the most effective means of combating the most profound, global threats to human development: poverty, maternal and child mortality, and disease (Bellamy, 2004; Herz, 2004). As a result, the United Nations is encouraging all developing nations to make education a high priority and to take special steps to enable girls to go to school.

Rawia got the chance to go to school because of an Egyptian national initiative, which led to the establishment of several thousand one-classroom schools in rural areas with the poorest record in educating girls. Because of cultural beliefs about gender roles or reluctance to give up a daughter’s work at home, parents sometimes resist. But the largest barrier is that many countries continue to charge parents a fee for each child enrolled in school, often amounting to nearly one-third of the income of poverty-stricken families. Under these conditions, parents—if they send any children—tend to send only sons.

In 2003, Kenya eliminated fees for primary school. Immediately, enrollments of both boys and girls surged—by more than 30 percent. Uganda followed suit, increasing its primary school enrollment by 70 percent (Alter, 2008; RESULTS, 2006). When governments abolish enrollment fees, provide information about the benefits of education for girls, and create employment possibilities for women, the overwhelming majority of parents—including the very poor—choose to send their daughters to school, and some make great sacrifices to do so.
Poverty

When families slip into poverty, development is seriously threatened. Consider the case of Zinnia Mae, who grew up in a close-knit black community located in a small southeastern American city (Heath, 1990). As unemployment struck in the 1980s and citizens moved away, 16-year-old Zinnia Mae caught a ride to Atlanta. Two years later, she was the mother of a daughter and twin boys, and she had moved into a high-rise in public housing.

Zinnia Mae worried constantly about scraping together enough money to put food on the table, finding baby-sitters so she could go to the laundry or grocery, freeing herself from a cycle of rising debt, and finding the twins’ father, who had stopped sending money. Her most frequent words were “I’m so tired.” The children had only one set meal—breakfast; otherwise, they ate whenever they were hungry or bored. Their play space was limited to the living room sofa and a mattress on the floor. Toys consisted of scraps of a blanket, spoons and food cartons, a small rubber ball, a few plastic cars, and a roller skate abandoned in the building. At the researcher’s request, Zinnia Mae agreed to tape record her interactions with her children. Cut off from family and community ties and overwhelmed by financial strain and feelings of helplessness, she found herself unable to join in activities with her children. In 500 hours of tape, she started a conversation with them only 18 times.

Although poverty rates in the United States declined slightly in the 1990s, in recent years they have risen. Today, about 13 percent—nearly 40 million Americans—are affected. Those hit hardest are parents under age 25 with young children and elderly people who live alone. Poverty is also magnified among ethnic minorities and women. For example, 19 percent of U.S. children are poor, a rate that climbs to 30 percent for Hispanic children, 32 percent for Native-American children, and 34 percent for African-American children. For single mothers with preschool children and elderly women on their own, the poverty rate is close to 50 percent (DeNavas-Walt, Proctor, & Smith, 2009).

Joblessness, a high divorce rate, a lower remarriage rate among women than men, widowhood, and (as we will see later) inadequate government programs to meet family needs are responsible for these disheartening statistics. The poverty rate is higher among children than any other age group. And of all Western nations, the United States has the highest percentage of extremely poor children. Nearly 8 percent of U.S. children live in deep poverty (at less than half the poverty threshold, the income level judged necessary for a minimum living standard). In contrast, in Denmark, Finland, Norway, and Sweden, child poverty rates have remained at 5 percent or less for two decades, and deep child poverty is rare (UNICEF, 2005). The earlier poverty begins, the deeper it is, and the longer it lasts, the more devastating are its effects. Children of poverty are more likely than other children to suffer from life-long poor physical health, persistent deficits in cognitive development and academic achievement, high school dropout, mental illness, and antisocial behavior (Aber, Jones, & Raver, 2007; Deearing, McCartney, & Taylor, 2006; Ryan, Fauth, & Brooks-Gunn, 2006).

The constant stressors that accompany poverty gradually weaken the family system. Poor families have many daily hassles—bills to pay, the car breaking down, loss of welfare and unemployment payments, something stolen from the house, to name just a few. When daily crises arise, family members become depressed, irritable, and distracted, and hostile interactions increase (Conger & Donnellan, 2007; Evans, 2006). Negative outcomes are especially severe in single-parent families and families that must live in poor housing and dangerous neighborhoods—conditions that make everyday existence even more difficult, while reducing social supports that help people cope with economic hardship (Leventhal & Brooks-Gunn, 2003).

Besides poverty, another problem—one that has become more common in the past 30 years—has reduced the life chances of many children and adults. On any given night, approximately 350,000 people in the United States have no place to live. The majority are adults on their own, many of whom suffer from serious mental illness. But 23 percent of the homeless are families with children (National Coalition for the Homeless, 2008). The rise in homelessness is mostly due to two factors: a decline in the availability of government-supported, low-cost housing and the release of large numbers of mentally ill people from institutions, without an increase in community treatment programs to help them adjust to ordinary life and get better.

Most homeless families consist of women with children under age 5. Besides health problems (which affect the majority of homeless people), many homeless children suffer from developmental delays and chronic emotional stress due to their harsh, insecure daily lives (Bratt, 2002; Pardeck, 2005). An estimated 25 to 30 percent who are old enough do not attend school. Those who do enroll achieve less well than other poverty-stricken children because of poor attendance and health and emotional difficulties (Shinn et al., 2008).

Beyond the Family: Neighborhoods, Towns, and Cities

As the concepts of mesosystem and exosystem in ecological systems theory make clear, connections between family and community are vital for psychological well-being. From our discussion of poverty, perhaps you can see why: In poverty-stricken urban areas, community life is usually disrupted. Families move often, parks and playgrounds are in disarray, and community centers providing organized leisure time activities do not exist. In such neighborhoods, family violence, child abuse and neglect, children’s problem behavior, youth antisocial activity, and adult criminal behavior are especially high
A boy hugs his mother as they wait to board a bus that will take them away from Galveston, Texas, following Hurricane Ike, which in 2008 left a massive path of destruction on the island. For low-income families, dislocation caused by a natural disaster is especially likely to result in long-term homelessness, poverty, and emotional stress.

(Brody et al., 2003; Kohen et al., 2002). In contrast, strong family ties to the surrounding social context—as indicated by frequent contact with friends and relatives and regular church, synagogue, or mosque attendance—reduce family stress and enhance adjustment (Boardman, 2004; Leventhal & Brooks-Gunn, 2003).

NEIGHBORHOODS. Let’s look closely at the functions of communities in the lives of children and adults by beginning with the neighborhood. What were your childhood experiences like in the yards, streets, and parks surrounding your home? How did you spend your time, whom did you get to know, and how important were these moments to you?

Neighborhoods offer resources and social ties that play an important part in children’s development. In several studies, low-SES families were randomly assigned vouchers to move out of public housing into neighborhoods varying widely in affluence. Compared with their peers who remained in poverty-stricken areas, children and youths who moved into low-poverty neighborhoods showed substantially better physical and mental health and school achievement (Goering, 2003; Leventhal & Brooks-Gunn, 2003).

Neighborhood resources have a greater impact on economically disadvantaged than well-to-do young people. Higher-SES families are less dependent on their immediate surroundings for social support, education, and leisure pursuits. They can afford to reach beyond the streets near their homes, transporting their children to lessons and entertainment and, if necessary, to better-quality schools in distant parts of the community. In low-income neighborhoods, in-school and after-school programs that substitute for lack of resources by providing enrichment activities are associated with improved academic performance and a reduction in emotional and behavior problems in middle childhood (Peters, Petrunka, & Arnold, 2003; Vandell & Posner, 1999). Neighborhood organizations and informal social activities predict favorable development in adolescence, including increased self-confidence, school achievement, and educational aspirations (Barnes et al., 2007; Gonzales et al., 1996).

The Better Beginnings, Better Futures Project of Ontario, Canada, is a government-sponsored set of pilot programs aimed at preventing the dire consequences of neighborhood poverty, including child and adolescent internalizing and externalizing difficulties, antisocial activity, school failure, and high school dropout (Gershoff & Aber, 2006). The most successful of these efforts, using a local elementary school as its base, provided children with in-class and summer enrichment activities. Project staff also visited each child’s parents regularly, informed them about community resources, and encouraged their involvement in the child’s school and neighborhood life (Peters, 2005; Peters, Petrunka, & Arnold, 2003). An evaluation after four years revealed gains in neighborhood satisfaction, family functioning, effective parenting, and children’s reading skills, along with a reduction in emotional and behavior problems.

As these outcomes suggest, neighborhoods also affect adults’ well-being. An employed parent who can rely on a neighbor to assist her school-age child in her absence and who lives in an area safe for walking to and from school gains the peace of mind essential for productive work. In low-SES areas with high resident stability and social cohesion, where neighbors collaborate in keeping the environment clean and watching out for vandalism and other crimes, adults report less stress, which in turn predicts substantially better physical health (Boardman, 2004; Feldman & Steptoe, 2004).

During late adulthood, neighborhoods become increasingly important because people spend more time in their homes. Despite the availability of planned housing for elders, about 90 percent remain in regular housing, usually in the same neighborhood where they lived during their working lives (U.S. Census Bureau, 2009b). Proximity to relatives and friends is a significant factor in the decision to move or stay put late in life. In the absence of nearby family members, the elderly mention neighbors and nearby friends as resources they rely on most for physical and social support (Hooyman & Kiyak, 2008).

TOWNS AND CITIES. Neighborhoods are embedded in towns and cities, which also mold children’s and adults’ daily lives. In rural areas and small towns, children and youths are more likely to be given important work tasks—caring for live-
At a block party in an inner-city neighborhood, children participate in a doughnut-eating contest while their parents look on with amusement. According to the social systems perspective, ties to the community are essential for families to function at their best.

They usually perform these tasks alongside adults, who instill in them a strong sense of responsibility and teach them practical and social skills needed to sustain their community. Compared with large urban areas, small towns also offer stronger connections between settings that influence children’s lives. For example, because most citizens know each other and schools serve as centers of community life, contact between teachers and parents occurs often—an important factor in promoting children’s academic achievement (Hill & Taylor, 2004).

Adults in small towns participate in more civic groups, such as school board or volunteer fire brigade. And they are more likely to occupy positions of leadership because a greater proportion of residents are needed to meet community needs (Elder & Conger, 2000). In late adulthood, people residing in small towns and suburbs have neighbors who are more willing to provide assistance. As a result, they form a greater number of warm relationships with nonrelatives. As one 99-year-old resident of a small Midwestern community, living alone and leading an active life, commented, “I don’t think I could get along if I didn’t have good neighbors.” The family next door helps him with grocery shopping, checks each night to make sure his basement light is off (the signal that he is out of the shower and into bed), and looks out in the morning to see that his garage door is raised (the signal that he is up and OK) (Fergus, 1995).

Of course, small-town residents cannot visit museums, go to professional baseball games, or attend orchestra concerts on a regular basis. The variety of settings is not as great as in a large city. In small towns, however, active involvement in the community is likely to be greater throughout the lifespan. Also, public places in small towns are relatively safe and secure. Responsible adults are present in almost all settings to keep an eye on children. And the elderly feel safer—a strong contributor to how satisfied they are with their place of residence (Parmelee & Lawton, 1990; Shields et al., 2002). These conditions are hard to match in today’s urban environments.

The Cultural Context

Our discussion in Chapter 1 emphasized that human development can be fully understood only when viewed in its larger cultural context. In the following sections, we expand on this theme by taking up the role of the macrosystem in development. First, we discuss ways that cultural values and practices affect environmental contexts for development. Second, we consider how healthy development depends on laws and government programs that shield people from harm and foster their well-being.

■ CULTURAL VALUES AND PRACTICES. Cultures shape family interaction and community settings beyond the home—in short, all aspects of daily life. Many of us remain blind to aspects of our own cultural heritage until we see them in relation to the practices of others.

TAKE A MOMENT... Consider the question, Who should be responsible for rearing young children? How would you answer it? Here are some typical responses from my students: “If parents decide to have a baby, then they should be ready to care for it.” “Most people are not happy about others intruding into family life.” These statements reflect a widely held opinion in the United States—that the care and rearing of children, and paying for that care, are the duty of parents, and only parents. This view has a long history—one in which independence, self-reliance, and the privacy of family life emerged as central American values (Halfon & McLearn, 2002). It is one reason, among others, that the public has been slow to endorse government-supported benefits for all families, such as high-quality child care and paid employment leave for meeting family needs. And it has also contributed to the large number of U.S. families who remain poor, even though family members are gainfully employed (Gruendel & Aber, 2007; Pohl, 2002; UNICEF, 2005).
The African-American Extended Family

The African-American extended family can be traced to the African heritage of most black Americans. In many African societies, newly married couples do not start their own households. Instead, they live with a large extended family, which assists its members with all aspects of daily life. This tradition of maintaining a broad network of kin ties traveled to North America during the period of slavery. Since then, it has served as a protective shield against the destructive impact of poverty and racial prejudice on African-American family life. Today, more black than white adults have relatives other than their own children living in the same household. African-American parents also live closer to kin, often establish family-like relationships with friends and neighbors, see more relatives during the week, and perceive relatives as more important figures in their lives (Boyd-Franklin, 2006; Kane, 2000).

By providing emotional support and sharing essential resources, the African-American extended family helps reduce the stress of poverty and single parenthood. Extended-family members often help with child rearing, and adolescent mothers living in extended families are more likely to complete high school and get a job and less likely to be living with extended-family members who have helped protect many African-American children against the destructive impact of poverty and racial prejudice (Gordon, Chase-Lansdale, & Brooks-Gunn, 2004; Trent & Harlan, 1994).

For single mothers who were very young at the time of their child’s birth, extended-family living continues to be associated with more positive mother–child interaction during the preschool years. Otherwise, establishing an independent household with the help of nearby relatives is related to improved child rearing. Perhaps this arrangement permits the more mature teenage mother who has developed effective parenting skills to implement them (Chase-Lansdale, Brooks-Gunn, & Zamsky, 1994). In families rearing adolescents, kinship support increases the likelihood of effective parenting, which is related to adolescents’ self-reliance, emotional well-being, and reduced antisocial behavior (Hamilton, 2005; Simons et al., 2006).

Finally, the extended family plays an important role in transmitting African-American culture. Compared with nuclear-family households (which include only parents and their children), extended-family arrangements place more emphasis on cooperation and on moral and religious values. And older black adults, such as grandparents and great-grandparents, regard educating children about their African heritage as especially important (Mosely-Howard & Evans, 2000; Taylor, 2000).

Although the culture as a whole may value independence and privacy, not all citizens share the same values. Some belong to subcultures—groups of people with beliefs and customs that differ from those of the larger culture. Many ethnic minority groups in the United States have cooperative family structures, which help protect their members from the harmful effects of poverty. As the Cultural Influences box above indicates, the African-American tradition of extended family households, in which three or more generations live together, is a vital feature of black family life that has enabled its members to survive, despite a long history of prejudice and economic deprivation. Within the extended family, grandparents play meaningful roles in guiding younger generations; adults who face employment, marital, or child-rearing difficulties receive assistance and emotional support; and caregiving is enhanced for children and the elderly. Active, involved extended families also characterize other minorities, such as Asian, Native-American, and Hispanic subcultures (Becker et al., 2003; Harwood et al., 2002).

Our discussion so far reflects a broad dimension on which cultures and subcultures differ: the extent to which collectivism versus individualism is emphasized. In collectivist societies, people define themselves as part of a group and stress group goals over individual goals. In individualistic societies, people think of themselves as separate entities and are largely concerned with their own personal needs (Triandis, 1995, 2005). As these definitions suggest, the two cultural patterns are associ-
ated with two distinct views of the self. Collectivist societies value an **interdependent self**, which stresses social harmony, obligations and responsibility to others, and collaborative endeavors. In contrast, individualistic societies value an **independent self**, which emphasizes personal exploration, discovery, and achievement and individual choice in relationships. Both interdependence and independence are part of the makeup of every person and occur in varying mixtures (Greenfield et al., 2003; Tamis-LeMonda et al., 2008). But societies vary greatly in the extent to which they emphasize each alternative and—as later chapters will reveal—instill it in their young.

Although individualism tends to increase as cultures become more complex, cross-national differences remain. The United States is strongly individualistic, whereas most Western European countries lean toward collectivism. As we will see next, collectivist versus individualistic values have a powerful impact on a nation’s approach to protecting the well-being of its children, families, and aging citizens.

**PUBLIC POLICIES AND LIFESPAN DEVELOPMENT.** When widespread social problems arise, such as poverty, homelessness, hunger, and disease, nations attempt to solve them through **public policies**—laws and government programs designed to improve current conditions. For example, when poverty increases and families become homeless, a country might decide to build more low-cost housing, raise the minimum wage, and increase welfare benefits. When reports indicate that many children are not achieving well in school, federal and state or provincial governments might grant more tax money to school districts, strengthen teacher preparation, and make sure that help reaches children who need it most. And when senior citizens have difficulty making ends meet because of inflation, a nation might increase its social security benefits.

Nevertheless, U.S. public policies safeguarding children and youths have lagged behind policies for the elderly. And compared with other industrialized nations, both sets of policies have been especially slow to emerge in the United States.

**Policies for Children, Youths, and Families.** We have already seen that although many U.S. children fare well, a large number grow up in environments that threaten their development. As Table 2.5 reveals, the United States does not rank well on any key measure of children’s health and well-being.

The problems of children and youths extend beyond the indicators in the table. The United States is the only industrialized nation in the world without a universal, publicly funded health-care system. Hence, approximately 10 percent of U.S. children—most of them in low-income families—

---

**TABLE 2.5** How Does the United States Compare to Other Nations on Indicators of Children’s Health and Well-Being?

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>U.S. RANK</th>
<th>SOME COUNTRIES THE UNITED STATES TRAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood poverty (among 25 industrialized nations considered)</td>
<td>25th</td>
<td>Canada, Czech Republic, Germany, Norway, Sweden, Poland, Spainb</td>
</tr>
<tr>
<td>Infant deaths in the first year of life (worldwide)</td>
<td>26th</td>
<td>Canada, Hong Kong, Ireland, Singapore, Spain</td>
</tr>
<tr>
<td>Teenage birth rate (among 28 industrialized nations considered)</td>
<td>28th</td>
<td>Australia, Canada, Czech Republic, Denmark, Hungary, Iceland, Poland, Slovak Republic</td>
</tr>
<tr>
<td>Public expenditures on education as percentage of gross domestic productb (among 22 industrialized nations considered)</td>
<td>12th</td>
<td>Belgium, France, Iceland, New Zealand, Portugal, Spain, Sweden</td>
</tr>
<tr>
<td>Public expenditures on early childhood education and child care as a percentage of gross domestic productc (among 14 industrialized nations considered)</td>
<td>9th</td>
<td>Austria, Germany, Italy, Netherlands, France, Sweden</td>
</tr>
<tr>
<td>Public expenditures on health as a percentage of gross domestic product (among 22 industrialized nations considered)</td>
<td>16th</td>
<td>Austria, Australia, Canada, France, Hungary, Iceland, Switzerland, New Zealand</td>
</tr>
</tbody>
</table>

*a1 = highest, or best, rank.

*bU.S. childhood poverty and, especially, deep poverty rates greatly exceed poverty in these nations. For example, the poverty rate is 12 percent in Canada, 6 percent in the Czech Republic, 4 percent in Norway, and 2.5 percent in Sweden. Deep poverty affects just 2.5 percent of children in Canada, and a fraction of 1 percent in the other countries just listed.

cGross domestic product is the value of all goods and services produced by a nation during a specified time period. It provides an overall measure of a nation’s wealth.

have no health insurance (DeNavas-Walt, Proctor, & Smith, 2009). Furthermore, the United States has been slow to move toward national standards and funding for child care: Affordable care is in short supply, and much of it is substandard in quality (Lamb & Ahnert, 2006; Muenchow & Marsland, 2007). In families affected by divorce, weak enforcement of child support payments heightens poverty in mother-headed households. By the time they finish high school, many American non-college-bound young people lack the vocational preparation they need to contribute fully to society. And by ages 18 to 20, about 11 percent of U.S. adolescents have not yet earned a high school diploma (U.S. Department of Education, 2009).

Why have attempts to help children and youths been difficult to realize in the United States? A complex set of political and economic forces is involved. Cultural values of self-reliance and privacy have made government hesitant to become involved in family matters. Furthermore, good social programs are expensive, and they must compete for a fair share of a country’s economic resources. Children can easily remain unrecognized in this process because they cannot vote or speak out to protect their own interests, as adult citizens do (Ripple & Zigler, 2003). Instead, they must rely on the goodwill of others to become an important government priority.

Policies for the Elderly. Until well into the twentieth century, the United States had few policies in place to protect its aging population. For example, Social Security benefits, which address the income needs of retired citizens who contributed to society through prior employment, were not awarded until the late 1930s. Yet most Western nations had social security systems in place a decade or more earlier (Karger & Stoesz, 2008). In the 1960s, U.S. federal spending on programs for the elderly expanded rapidly. Medicare, a national health insurance program for older people that pays partial health-care costs, was initiated. But it mainly covers acute care services and requires participants to pay part of those costs, too. This leaves about half of elderly health spending to be covered by supplemental private insurance, government health insurance for the poor, or out-of-pocket payments (U.S. Department of Health and Human Services, 2008).

Social Security and Medicare consume 96 percent of the U.S. federal budget for the elderly; only 4 percent is devoted to other programs. Consequently, U.S. programs for the aged have been criticized for neglecting social services (Hooyman & Kiyak, 2008). To meet this need, a national network for planning, coordinating, and delivering assistance to the aged has been established. Approximately 660 Area Agencies on Aging operate at regional and local levels, assessing community needs and offering communal and home-delivered meals, self-care education, elder abuse prevention, and a wide range of other social services. But limited funding means that the Area Agencies help far too few people in need.

As noted earlier, many senior citizens—especially women, ethnic minorities, and those living alone—remain in dire economic straits. Those who had interrupted employment histories, held jobs without benefits, or suffered lifelong poverty are not eligible for Social Security. Although all Americans age 65 and older are guaranteed a minimum income, the guaranteed amount is below the poverty line—the amount judged necessary for bare subsistence by the federal government. Furthermore, Social Security benefits are rarely adequate as a sole source of retirement income; they must be supplemented through other pensions and family savings. But a substantial percentage of U.S. aging citizens do not have access to these resources. Therefore, they are more likely than other age groups to be among the “near poor” (Greenberg, 2007).

Nevertheless, the U.S. aging population is financially much better off now than in the past. Today, the elderly are a large, powerful, well-organized constituency, far more likely than children...
or low-income families to attract the support of politicians. As a result, the number of aging poor has declined from 1 out of 3 people in 1960 to 1 out of 10 in the early twenty-first century (U.S. Census Bureau, 2009b). And senior citizens are healthier and more independent than ever before. Still, as Figure 2.7 shows, the elderly in the United States are less well off than those in many other Western nations, which provide more generous, government-funded income supplements to older adults.

**LOOKING TOWARD THE FUTURE.** Despite the worrisome state of many children, families, and aging citizens, efforts are being made to improve their condition. Throughout this book, we will discuss many successful programs that could be expanded. Also, growing awareness of the gap between what we know and what we do to better people’s lives has led experts in human development to join with concerned citizens as advocates for more effective policies. As a result, several influential interest groups devoted to the well-being of children or the elderly have emerged.

In the United States, the Children’s Defense Fund (CDF)—a private, nonprofit organization founded by Marian Wright Edelman in 1973—engages in research, public education, legal action, drafting of legislation, congressional testimony, and community organizing. Among its publications is its *Annual Report*, which provides a comprehensive analysis of children’s condition, government-sponsored programs that serve children and families, and CDF initiatives aimed at improving those programs. To learn more about the Children’s Defense Fund, visit its website at [www.childrensdefense.org](http://www.childrensdefense.org).

Nearly half of Americans over age 50, both retired and employed, are members of AARP (originally known as the American Association of Retired Persons). Founded by Ethel Percy Andrus in 1958, AARP has a large and energetic lobbying staff that works for increased government benefits of all kinds for the aged. Each year, it releases the *AARP Public Policy Agenda*, which forms the basis for advocacy activities in diverse areas, including income, health care, social services, housing, and personal and legal rights. Among AARP’s programs is an effort to mobilize elderly voters, an initiative that keeps lawmakers highly sensitive to policy proposals affecting older Americans. A description of AARP and its activities can be found at [www.aarp.org](http://www.aarp.org).

Besides strong advocacy, public policies that enhance human development depend on policy-relevant research that documents needs and evaluates programs to spark improvements. Today, more researchers are collaborating with community and government agencies to enhance the social relevance of their investigations. They are also doing a better job of disseminating their findings to the public in easily understandable, compelling ways, through television documentaries, newspaper...
stories, magazine articles, websites, and direct reports to government officials. As a result, they are helping to create a sense of immediacy about the condition of children, families, and the aged that is necessary to spur a society into action.

**ASK YOURSELF**

**REVIEW**
Links between family and community foster development throughout the lifespan. Cite several examples from our discussion that support this idea.

**APPLY**
Check your local newspaper or one or two national news magazines to see how often articles on the condition of children, families, and the aged appear. Why is it important for researchers to communicate with the general public about the well-being of these sectors of the population?

**CONNECT**
How does poverty affect the family system, placing all aspects of development at risk?

**REFLECT**
Review the discussion of cultural values and practices on pages 65–67. Under what circumstances do you believe government should become involved in family life?

### Understanding the Relationship Between Heredity and Environment

So far in this chapter, we have discussed a wide variety of genetic and environmental influences, each of which has the power to alter the course of development. Yet people who are born into the same family (and who therefore share genes and environments) are often quite different in characteristics. We also know that some individuals are affected more than others by their homes, neighborhoods, and communities. In some cases, a child who is given many advantages nevertheless does poorly, while another, though exposed to unfavorable rearing conditions, does well. How do scientists explain the impact of heredity and environment when they seem to work in so many different ways?

All contemporary researchers agree that both heredity and environment are involved in every aspect of development. But for polygenic traits (those due to many genes), such as intelligence and personality, scientists are a long way from knowing the precise hereditary influences involved. Although they are making progress in identifying the multiple variations in DNA sequences associated with complex traits, so far these genetic markers explain only a small amount of variation in human behavior, and a minority of cases of most psychological disorders (Plomin, 2005; Plomin et al., 2003). For the most part, scientists are still limited to investigating the impact of genes on complex characteristics indirectly.

Some believe that it is useful and possible to answer the question of how much each factor contributes to differences among people. A growing consensus, however, regards that question as unanswerable. These investigators believe that genetic and environmental influences are inseparable (Gottlieb, Wahlsten, & Lickliter, 2006). The important question, they maintain, is how nature and nurture work together. Let’s consider each position in turn.

### The Question, “How Much?”

To infer the role of heredity in complex human characteristics, researchers use special methods, the most common being the heritability estimate. Let’s look closely at the information this procedure yields, along with its limitations.

#### HERITABILITY

Heritability estimates measure the extent to which individual differences in complex traits in a specific population are due to genetic factors. We will take a brief look at heritability findings on intelligence and personality here and will return to them in later chapters, when we consider these topics in greater detail. Heritability estimates are obtained from kinship studies, which compare the characteristics of family members. The most common type of kinship study compares identical twins, who share all their genes, with fraternal twins, who, on average, share only half. If people who are genetically more alike are also more similar in intelligence and personality, then the researcher assumes that heredity plays an important role.

Kinship studies of intelligence provide some of the most controversial findings in the field of human development. Some experts claim a strong genetic influence, whereas others believe that heredity is barely involved. Currently, most kinship findings support a moderate role for heredity. When many twin studies are examined, correlations between the scores of identical twins are consistently higher than those of fraternal twins. In a summary of more than 10,000 twin pairs, the correlation for intelligence was .86 for identical twins and .60 for fraternal twins (Plomin & Spinath, 2004).

Researchers use a complex statistical procedure to compare these correlations, arriving at a heritability estimate ranging from 0 to 1.00. The value for intelligence is about .50 for child and adolescent twin samples in Western industrialized nations. This suggests that differences in genetic makeup explain half the variation in intelligence. However, heritability increases in adulthood, with some estimates as high as .80. As we will see later, one explanation is that, compared to children, adults exert greater personal control over their intellectual experiences—for example, how much time they spend reading or solving challenging problems (McClearn et al., 1997; McGu & Christensen,
Adopted children’s mental test scores are more strongly related to their biological parents’ scores than to those of their adoptive parents, offering further support for the role of heredity (Petrill & Deater-Deckard, 2004).

Heritability research also reveals that genetic factors are important in personality. For frequently studied traits, such as sociability, anxiety, agreeableness, and activity level, heritability estimates obtained on child, adolescent, and young adult twin samples are moderate, in the .40s and .50s (Bouchard, 2004; Caspi & Shiner, 2006; Rothbart & Bates, 2006). Unlike intelligence, however, heritability of personality does not increase over the lifespan (Heiman et al., 2003; Loehlin et al., 2005).

Twin studies of schizophrenia—a psychological disorder involving delusions and hallucinations, difficulty distinguishing fantasy from reality, and irrational and inappropriate behaviors—consistently yield high heritabilities, around .80. The role of heredity in antisocial behavior and major depression, though still apparent, is less strong, with heritabilities in the .30s and .40s (Bouchard, 2004). Again, adoption studies support these results. Biological relatives of schizophrenic and depressed adoptees are more likely than adoptive relatives to share the same disorder (Plomin et al., 2001; Ridenour, 2000; Tienari et al., 2003).

**LIMITATIONS OF HERITABILITY.** Serious questions have been raised about the accuracy of heritability estimates, which depends on the extent to which the twin pairs studied reflect genetic and environmental variation in the population. Within a population in which all people have very similar home, school, and community experiences, individual differences in intelligence and personality would be largely genetic, and heritability estimates would be close to 1.00. Conversely, the more environments vary, the more likely they are to account for individual differences, yielding lower heritability estimates. In twin studies, most of the twin pairs are reared together under highly similar conditions. Even when separated twins are available for study, social service agencies have often placed them in advantaged homes that are alike in many ways (Rutter et al., 2001). Because the environments of most twin pairs are less diverse than those of the general population, heritability estimates are likely to exaggerate the role of heredity.

Hereditability estimates are controversial measures because they can easily be misapplied. For example, high heritabilities have been used to suggest that ethnic differences in intelligence, such as the poorer performance of black children compared to white children, have a genetic basis (Jensen, 1969, 1998, 2001; Rushton & Jensen, 2005, 2006). Yet this line of reasoning is widely regarded as incorrect. Heritabilities computed on mostly white twin samples do not tell us what is responsible for test score differences between ethnic groups. We have already seen that large economic and cultural differences are involved. In Chapter 9, we will discuss research indicating that when black children are adopted into economically advantaged homes at an early age, their scores are well above average and substantially higher than those of children growing up in impoverished families.

Perhaps the most serious criticism of heritability estimates has to do with their limited usefulness. Though interesting, these statistics give us no precise information on how intelligence and personality develop or how children might respond to environments designed to help them develop as far as possible (Rutter, 2002; Wachs, 1999). Indeed, the heritability of children’s intelligence increases as parental education and income increase—that is, as children grow up in conditions that allow them to make the most of their genetic endowment. In disadvantaged environments, children are prevented from realizing their potential. Consequently, enhancing their experiences through interventions—such as increasing parent education and income and providing high-quality preschool or child care—has a greater impact on development (Bronfenbrenner & Morris, 2006; Turkheimer et al., 2003).
According to one group of experts, heritability estimates have too many problems to yield any firm conclusions about the relative strength of nature and nurture (Collins et al., 2000). Although these statistics confirm that heredity contributes to complex traits, they do not tell us how environment can modify genetic influences.

The Question, “How?”

Today, most researchers view development as the result of a dynamic interplay between heredity and environment. How do nature and nurture work together? Several concepts shed light on this question.

**Reaction Range.** The first of these ideas is reaction range, each person’s unique, genetically determined response to the environment (Gottesman, 1963). Let’s explore this idea in Figure 2.8. Reaction range can apply to any characteristic; here it is illustrated for intelligence. Notice that when environments vary from extremely unstimulating to highly enriched, Ben’s intelligence increases steadily, Linda’s rises sharply and then falls off, and Ron’s begins to increase only after the environment becomes modestly stimulating.

Reaction range highlights two important points. First, it shows that because each of us has a unique genetic makeup, we respond differently to the same environment. Notice in Figure 2.8 how a poor environment results in similarly low scores for all three individuals. But when the environment provides an intermediate level of stimulation, Linda is by far the best-performing child. And in a highly enriched environment, Ben does best, followed by Ron, both of whom now outperform Linda.

Second, sometimes different genetic–environmental combinations can make two people look the same! For example, if Linda is reared in a minimally stimulating environment, her score will be about 100—average for people in general. Ben and Ron can also obtain this score, but to do so, they must grow up in a fairly enriched home. In sum, range of reaction reveals that unique blends of heredity and environment lead to both similarities and differences in behavior (Gottlieb, Wahlsten, & Lickliter, 2006).

**Canalization.** Another way of understanding how heredity and environment combine comes from the concept of canalization—the tendency of heredity to restrict the development of some characteristics to just one or a few outcomes. A behavior that is strongly canalized develops similarly in a wide range of environments; only strong environmental forces can change it (Waddington, 1957). For example, infant perceptual and motor development seems to be strongly canalized because all normal human babies eventually roll over, reach for objects, sit up, crawl, and walk. It takes extreme conditions to modify these behaviors or cause them not to appear. In contrast, intelligence and personality are less strongly canalized; they vary much more with changes in the environment.

When we look at behaviors constrained by heredity, we can see that canalization is highly adaptive. Through it, nature ensures that children will develop certain species-typical skills under many rearing conditions, thereby promoting survival.

**Genetic–Environmental Correlation.** A major problem in trying to separate heredity and environment is that they are often correlated (Plomin et al., 2001; Scarr & McCartney, 1983). According to the concept of genetic–environmental correlation, our genes influence the environments to which we are exposed. The way this happens changes with age.

**Passive and Evocative Correlation.** At younger ages, two types of genetic–environmental correlation are common. The first is called passive correlation because the child has no control over it. Early on, parents provide environments influenced by their own heredity. For example, parents who are good athletes emphasize outdoor activities and enroll their children in swimming and gymnastics. Besides being exposed to an “athletic environment,” the children may have inherited their parents’ athletic ability. As a result, they are likely to become good athletes for both genetic and environmental reasons.

The second type of genetic–environmental correlation is evocative. Children evoke responses that are influenced by the child’s heredity, and these responses strengthen the child’s original style. For example, an active, friendly baby is likely to receive more social stimulation than a passive, quiet infant.
a cooperative, attentive child probably receives more patient and sensitive interactions from parents than an inattentive, distractible child. In support of this idea, the less genetically alike siblings are, the more their parents treat them differently, in both warmth and negativity. Thus, parents’ treatment of identical twins is highly similar, whereas their treatment of fraternal twins and nontwin biological siblings is only moderately so. And little resemblance exists in parents’ warm and negative interactions with unrelated stepsiblings (see Figure 2.9) (Reiss, 2003).

**Active Correlation.** At older ages, active genetic–environmental correlation becomes common. As children extend their experiences beyond the immediate family and are given the freedom to make more choices, they actively seek environments that fit with their genetic tendencies. The well-coordinated, muscular child spends more time at after-school sports, the musically talented youngster joins the school orchestra and practices his violin, and the intellectually curious child is a familiar patron at her local library.

This tendency to actively choose environments that complement our heredity is called **niche-picking** (Scarr & McCartney, 1983). Infants and young children cannot do much niche-picking because adults select environments for them. In contrast, older children, adolescents, and adults are increasingly in charge of their environments.

The niche-picking idea explains why pairs of identical twins reared apart during childhood and later reunited may find, to their surprise, that they have similar hobbies, food preferences, and vocations—a trend that is especially marked when twins’ environmental opportunities are similar (Plomin, 1994). Niche-picking also helps us understand why identical twins become somewhat more alike, and fraternal twins and adopted siblings less alike, in intelligence with age (Bouchard, 2004; Loehlin, Horn, & Willerman, 1997). And niche-picking sheds light on why identical twins, compared to fraternal twins and other adults, select more similar spouses and best friends—in height, weight, personality, political attitudes, and other characteristics (Rushton & Bons, 2005).

The influence of heredity and environment is not constant but changes over time. With age, genetic factors may become more important in influencing the environments we experience and choose for ourselves.

**FIGURE 2.9** Similarity in mothers’ interactions for pairs of siblings differing in genetic relatedness. The correlations shown are for maternal negativity. The pattern illustrates evocative genetic–environmental correlation. Identical twins evoke similar maternal treatment because of their identical heredity. As genetic resemblance between siblings declines, the strength of the correlation drops. Mothers vary their interactions as they respond to each child’s unique genetic makeup. (Adapted from Reiss, 2003.)
ENVIRONMENTAL INFLUENCES ON GENE EXPRESSION.
Notice how, in the concepts just considered, heredity is granted priority. In range of reaction, it determines individual responsiveness to varying environments. In canalization, it restricts the development of certain behaviors. Similarly, some theorists regard genetic–environmental correlation as entirely driven by genetics (Harris, 1998; Rowe, 1994). They believe that children’s genetic makeup causes them to receive, evoke, or seek experiences that actualize their inborn tendencies.

Others argue that heredity does not dictate children’s experiences or development in a rigid way. In one study, boys with a genetic tendency toward antisocial behavior (based on the presence of a gene on the X chromosome known to predispose both animals and humans to aggression) were no more aggressive than boys without this gene, unless they also had a history of severe child abuse (Caspi et al., 2002). Boys with and without the gene did not differ in their experience of abuse, indicating that the “aggressive genotype” did not increase exposure to abuse. And in a large Finnish adoption study, children of schizophrenic mothers reared by healthy adoptive parents showed little mental illness—no more than a control group with healthy biological and adoptive parents. In contrast, schizophrenia and other psychological impairments piled up in adoptees whose biological and adoptive parents were both disturbed (Tienari et al., 2003; Tienari, Wahlberg, & Wynne, 2006).

Furthermore, parents and other caring adults can provide children with experiences that modify the expression of heredity, yielding favorable outcomes. For example, in a study that tracked the development of 5-year-old identical twins, pair members tended to resemble each other in level of aggression. And the more aggression they displayed, the more maternal anger and criticism they received (a genetic–environmental correlation). Nevertheless, some mothers treated their twins differently. When followed up at age 7, twins who had been targets of more maternal negativity engaged in even more antisocial behavior. In contrast, their better-treated, genetically identical counterparts showed a reduction in disruptive acts (Caspi et al., 2004). Good parenting protected them from a spiraling, antisocial course of development.

Other research confirms that parents’ unequal treatment of siblings is not just the straightforward result of children’s heredity but is affected by aspects of family life. In single-parent families, low-income families, and families with unhappy marriages, siblings receive more differential treatment from parents (Jenkins, Rasbash, & O’Connor, 2003). Perhaps parents who are under stress concentrate their limited energies on one child.

Accumulating evidence reveals that the relationship between heredity and environment is not a one-way street, from genes to environment to behavior. Rather, like other system influences considered in this and the previous chapter, it is bidirectional: Genes affect people’s behavior and experiences, but their experiences and behavior also affect gene expression (Gottlieb, 2000, 2003; Rutter, 2006; Ryff & Singer, 2005).

Researchers call this view of the relationship between heredity and environment the epigenetic framework (Gottlieb, 1998, 2007). It is depicted in Figure 2.10. Epigenesis means development resulting from ongoing, bidirectional exchanges between heredity and all levels of the environment.
illustrate, providing a baby with a healthy diet increases brain growth, leading to new connections between nerve cells, which transform gene expression. This opens the door to new gene–environment exchanges—for example, advanced exploration of objects and interaction with caregivers, which further enhance brain growth and gene expression. These ongoing, bidirectional influences foster cognitive and social development. In contrast, harmful environments can dampen gene expression, at times so profoundly that later experiences can do little to change characteristics (such as intelligence and personality) that were flexible to begin with.

A major reason that researchers are interested in the nature–nurture issue is that they want to improve environments so that people can develop as far as possible. The concept of epigenesis reminds us that development is best understood as a series of complex exchanges between nature and nurture. Although people cannot be changed in any way we might desire, environments can modify genetic influences. The success of any attempt to improve development depends on the characteristics we want to change, the genetic makeup of the individual, and the type and timing of our intervention.

Genetic Foundations

What are genes, and how are they transmitted from one generation to the next?

- Each individual’s phenotype, or directly observable characteristics, is a product of both genotype and environment. Chromosomes, rodlike structures within the cell nucleus, contain our hereditary endowment. Along their length are genes, segments of DNA that send instructions for making a rich assortment of proteins to the cell’s cytoplasm—a process that makes us distinctly human and influences our development and characteristics. We share most of our genetic makeup with other mammals, especially primates.
- Gametes, or sex cells, result from a process of cell division called meiosis, in which each individual receives a unique set of genes from each parent. Once sperm and ovum unite, the resulting zygote starts to develop into a complex human being through cell duplication, or mitosis.
- If the fertilizing sperm carries an X chromosome, the child will be a girl; if it contains a Y chromosome, a boy. Fraternal, or dizygotic, twins result when two ova are released from the mother’s ovaries and each is fertilized. Identical, or monozygotic, twins develop when a zygote divides in two during the early stages of cell duplication.

Describe various patterns of genetic inheritance.

- Traits controlled by single genes follow dominant–recessive and incomplete-dominance patterns of inheritance. Homozygous individuals have two identical alleles, or forms of a gene. Heterozygous individuals, with one dominant and one recessive allele, are carriers of the recessive trait.
- X-linked inheritance applies when recessive disorders are carried on the X chromosome and, therefore, are more likely to affect males. In genomic imprinting, one parent’s gene is activated, regardless of its makeup.
- Unfavorable genes arise from mutation, which can occur spontaneously or be caused by hazardous environmental agents. Germ-line mutation affects the cells that give rise to gametes; somatic mutation can occur in body cells at any time of life.
- Polygenic inheritance of human traits, such as intelligence and personality, is influenced by many genes. For such characteristics, scientists must study the influence of heredity indirectly.

Describe major chromosomal abnormalities, and explain how they occur.

- Most chromosomal abnormalities are due to errors in meiosis. The most common, Down syndrome, results in physical defects and mental retardation. Disorders of the sex chromosomes are generally milder than defects of the autosomes. Specific intellectual problems occur in children who...
have either more or fewer X chromosomes than usual, as in triple X, Klinefelter, and Turner syndromes.

Within the family system, which must continually adjust to new events and changes in its members.

Socioeconomic status (SES) profoundly affects family functioning. Higher-SES families tend to be smaller, to emphasize psychological traits, and to engage in warm, verbally stimulating interaction with children. Lower-SES families often stress external characteristics and use more commands, criticism, and physical punishment. Many affluent parents are physically and emotionally unavailable, thereby impairing their children’s adjustment. Poverty and homelessness can seriously undermine development.

Connections between family and community are vital for psychological well-being. Stable, socially cohesive neighborhoods in which residents have access to enrichment activities and social support promote favorable development in both children and adults. Compared with urban environments, small towns foster greater community involvement, warm ties among nonrelatives, and a sense of safety among the elderly.

The values and practices of cultures and subcultures affect all aspects of daily life. Extended-family households, which are common among ethnic minorities, help protect family members from negative effects of poverty and other stressful life conditions.

Reproductive Choices
What procedures can assist prospective parents in having healthy children?

Genetic counseling helps couples at risk for giving birth to children with genetic abnormalities decide whether or not to conceive. Prenatal diagnostic methods permit early detection of genetic problems.

Reproductive technologies such as donor insemination, in vitro fertilization, surrogate motherhood, and postmenopausal-assisted childbirth permit many individuals to become parents who otherwise would not, but they raise serious legal and ethical concerns.

Many parents who cannot conceive or who are at high risk of transmitting a genetic disorder decide to adopt. Although adopted children have more learning and emotional problems than children in general, most fare well in the long run. Warm, sensitive parenting predicts favorable development.

Environmental Contexts for Development
Describe the social systems perspective on family functioning, along with aspects of the environment that support family well-being and development.

Human development takes place within a complex, many-layered environment. The first and foremost context for development is the family, a dynamic system characterized by bidirectional influences, in which each family member’s behaviors affect those of others. Both direct and indirect influences operate within the family system, which must continually adjust to new events and changes in its members.

In our complex world, favorable development depends on public policies. Factors promoting effective social programs include cultural values emphasizing collectivism over individualism, a nation’s economic resources, and the presence of organizations and individuals that work to improve quality of life. U.S. policies safeguarding children and their families are less well developed than those safeguarding the elderly, which also lag behind those of other Western nations.

Understanding the Relationship Between Heredity and Environment
Explain the various ways heredity and environment may combine to influence complex traits.

Researchers use kinship studies to compute heritability estimates, which show that genetic factors influence such traits as intelligence and personality. However, the accuracy and usefulness of heritability estimates have been challenged.

According to the concepts of range of reaction and canalization, heredity influences each individual’s unique response to varying environments. Genetic-environmental correlation and niche-picking describe how genes affect the environments to which people are exposed. Epigenesis reminds us that development is best understood as a series of complex exchanges between nature and nurture that change over the lifespan.
Important Terms and Concepts

allele (p. 48)  genetic counseling (p. 53)  mutation (p. 51)
autosomes (p. 47)  genetic–environmental correlation (p. 72)  niche-picking (p. 73)
channelization (p. 72)  genomic imprinting (p. 51)  phenotype (p. 45)
carrier (p. 48)  genotype (p. 45)  polygenic inheritance (p. 52)
chromosomes (p. 46)  heritability estimate (p. 70)  prenatal diagnostic methods (p. 56)
collectivist societies (p. 66)  heterozygous (p. 48)  public policies (p. 67)
deoxyribonucleic acid (DNA) (p. 46)  homozygous (p. 48)  range of reaction (p. 72)
dominant–recessive inheritance (p. 48)  identical, or monozygotic, twins (p. 48)  sex chromosomes (p. 47)
epigenesis (p. 74)  incomplete dominance (p. 50)  socioeconomic status (SES) (p. 60)
extended-family household (p. 66)  individualistic societies (p. 66)  subculture (p. 66)
fraternal, or dizygotic, twins (p. 47)  kinship studies (p. 70)  X-linked inheritance (p. 50)
gametes (p. 46)  meiosis (p. 47)  zygote (p. 47)
genome (p. 46)  mitosis (p. 46)