CHAPTER 2
GENETIC AND ENVIRONMENTAL FOUNDATIONS

BRIEF CHAPTER SUMMARY

This chapter examines the foundations of development: heredity and environment. The discussion begins at the moment of conception, an event that establishes the new individual’s hereditary makeup. Chromosomes containing genetic information from each parent combine to determine characteristics that make us human and also contribute to individual differences in appearance and behavior. Serious developmental problems often result from inheritance of harmful recessive genes and from chromosomal abnormalities. Fortunately, genetic counseling and prenatal diagnostic methods make early detection of genetic problems possible. Many families turn to adoption, and most adoptees ultimately fare well, despite some challenges.

Just as complex as heredity are the environments in which human development takes place. The family has an especially powerful impact on development, operating as a network of interdependent relationships in which members exert direct, indirect, and third-party influences on one another. Family functioning and individual well-being are influenced considerably by child-rearing practices as well as by socioeconomic status. Poverty and homelessness can pose serious threats to development, while children in affluent families may suffer from overscheduling and lack of emotional closeness.

Beyond the immediate family, the quality of community life in neighborhoods, schools, towns, and cities also affects children’s and adults’ development. Cultural values—for example, the degree to which a society emphasizes collectivism versus individualism—combine with laws and government programs to shape experiences in all of these contexts. Public policies are needed to support the economic and social well-being of both children and the elderly. Largely because of its strongly individualistic values, U.S. policies safeguarding children and families, as well as those safeguarding the elderly, lag behind those of other Western nations.

Heredity and environment are involved in every aspect of development. Behavioral geneticists examine the contributions of nature and nurture to diversity in human traits and abilities. Epigenesis reminds us that development is best understood as a series of complex exchanges between heredity and all levels of the environment.
LEARNING OBJECTIVES

After reading this chapter, you should be able to answer the following:

2.1 What are genes, and how are they transmitted from one generation to the next? (pp. 46–48)
2.2 Describe various patterns of genetic inheritance. (pp. 48–52)
2.3 Describe major chromosomal abnormalities, and explain how they occur. (pp. 52–53)
2.4 What procedures can assist prospective parents in having healthy children? (pp. 53–59)
2.5 Describe family functioning from the perspective of ecological systems theory, along with aspects of the environment that support family well-being and development. (pp. 59–69)
2.6 Explain the various ways heredity and environment may combine to influence complex traits. (pp. 69–75)

LECTURE OUTLINE

I. GENETIC FOUNDATIONS (pp. 46–53)
   A. The foundations of development are heredity and environment. Heredity supplies each individual’s genotype, while heredity and environment combine to create phenotypes.
   B. The Genetic Code (p. 46)
      1. The nucleus of each cell in the human body contains 23 pairs of chromosomes. They store and transmit genetic information and are made up of the chemical substance deoxyribonucleic acid (DNA).
      2. A gene is a segment of DNA along the length of the chromosome.
      3. We share some of our genetic makeup with even the simplest organisms and most of it with other mammals, especially primates.
      4. DNA duplicates itself through a process called mitosis, in which the chromosomes copy themselves. The result is that each new body cell contains the same number of chromosomes and genetic information.
      5. Genes accomplish their task by making proteins, some 10 to 20 million in the human species.
   C. The Sex Cells (pp. 46–47)
      1. New individuals are created when the gametes, or sex cells—the sperm and ovum—combine. Each gamete has only 23 chromosomes, but when the sperm and ovum combine at conception, they form a new cell, a zygote, which has 46 chromosomes.
      2. Gametes are formed through the cell division process called meiosis, in which the chromosomes pair up and exchange segments, so that genes from one are replaced by genes from another. The result is genetic variability that is adaptive and increases the chances that at least some members of a species will survive in ever-changing environments.
   D. Boy or Girl? (p. 47)
      1. Each human cell contains 22 matching pairs of chromosomes, called autosomes.
      2. The twenty-third pair consists of sex chromosomes. In females, this pair is called XX. In males, it is called XY, and the X and Y chromosomes separate into different sperm cells.
      3. The sex of the new organism is determined by whether an X-bearing or a Y-bearing sperm fertilizes the ovum.
   E. Multiple Offspring (pp. 47–48)
      1. Fraternal, or dizygotic, twins result from the release and fertilization of two ova.
      2. Identical, or monozygotic, twins result when a single zygote that has started to duplicate separates into two clusters of cells that develop into two individuals.
   F. Patterns of Genetic Inheritance (pp. 48–52)
      1. 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 is called an allele.
      2. 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 phenotype.
      3. Dominant–Recessive Inheritance
         a. In dominant–recessive inheritance, only one allele (the dominant) affects the child’s characteristics, while the second allele (the recessive) has no effect.
b. Heterozygous individuals with just one recessive allele are **carriers** of the trait and can pass it to their children.
c. One of the most frequently occurring recessive disorders is **phenylketonuria**, or PKU.
d. Knowing the parents’ genetic makeup allows us to predict their children’s likelihood of displaying or carrying an inherited trait.
e. Dominant alleles rarely transmit serious diseases from one generation to the next, because the affected individuals seldom live long enough to reproduce. However, some dominant disorders, such as **Huntington disease**, do persist.

4. Incomplete Dominance
a. **Incomplete dominance** is a pattern of inheritance in which both alleles are expressed in the phenotype, resulting in a combined trait, or one that is intermediate between the two.
b. The **sickle cell trait**, a heterozygous condition present in many black Africans, provides an example. **Sickle cell anemia** occurs in full form when a child inherits two recessive genes.

5. X-Linked Inheritance
a. 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.
b. Males are also at a disadvantage for miscarriage, infant and childhood deaths, birth defects, learning disabilities, behavior disorders, and mental retardation.
   (1) Nonetheless, more boys than girls are born worldwide.
   (2) However, in recent decades, the proportion of male births has declined in many industrialized countries, possibly because of a rise in stressful living conditions, which heighten spontaneous abortions, especially of male fetuses.

6. Genomic Imprinting
a. **Genomic imprinting** is a pattern of inheritance in which some 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.
b. Imprinting is involved in several childhood cancers and **Prader-Willi syndrome**.
c. Genomic imprinting can also operate on the sex chromosomes, as **fragile X syndrome** reveals. About 25 to 30 percent of individuals with fragile X syndrome also have symptoms of autism.

7. Mutation
a. Harmful genes are created through **mutation**, a sudden but permanent change in a DNA segment.
b. **Germline mutation** takes place in the cells that give rise to gametes and is passed on when the affected individual mates.
c. **Somatic mutation** occurs when normal body cells mutate.

8. Polygenic Inheritance
a. **Polygenic inheritance**, in which many genes influence a characteristic, accounts for traits such as height, weight, intelligence, and personality.
b. Polygenic inheritance is complex, and much about it is still unknown.

G. Chromosomal Abnormalities (pp. 52–53)
1. Most chromosomal defects occur during meiosis, when the ovum and sperm are formed. The resulting abnormalities often produce disorders with many mental and physical symptoms.
2. Down Syndrome
   a. The most common chromosomal disorder, occurring in 1 out of every 770 live births, is **Down syndrome**.
   b. It results when the twenty-first pair of chromosomes fails to separate during meiosis, so the individual inherits three, not two, of these chromosomes.
3. Abnormalities of the Sex Chromosomes
   a. Sex chromosome disorders often are not recognized until adolescence when, in some deviations, puberty is delayed.
   b. Brain-imaging evidence confirms that adding to or subtracting from the usual number of X chromosomes results in particular intellectual deficits.

II. REPRODUCTIVE CHOICES (pp. 53–59)
A. Genetic counseling and prenatal diagnosis help people make informed decisions about conceiving, carrying a pregnancy to term, or adopting a child.
B. Genetic Counseling (pp. 53–55)
   1. Genetic counseling helps couples 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.
   2. Individuals likely to seek counseling are those who have had difficulties bearing children or who know that genetic problems exist in their families.
   3. If a family history of mental retardation, psychological disorders, physical defects, or inherited diseases exists, the genetic counselor interviews the couple and prepares a pedigree, a picture of the family tree in which affected relatives are identified. The pedigree is used to estimate the likelihood that parents will have an abnormal child.

C. Increasing numbers of individuals are turning to alternative methods of conception—technologies that have become the subject of heated debate.

D. Prenatal Diagnosis and Fetal Medicine (pp. 56–57)
   1. Prenatal diagnostic methods—medical procedures that permit detection of developmental problems before birth—include amniocentesis, ultrasound, and maternal blood analysis.
   2. Prenatal diagnosis has led to advances in fetal medicine; however, some procedures frequently result in complications.
   3. Advances in genetic engineering offer hope for correcting hereditary defects.

E. Adoption (pp. 57–59)
   1. Because the availability of healthy babies in need of adoptive families has declined, more people in North American and Western Europe are adopting from other countries or accepting children who are past infancy or who have known developmental problems.
   2. Adopted children and adolescents tend to have more emotional and learning difficulties than other children—a difference that increases with the child’s age at the time of adoption—but most adopted children fare well, and by adulthood, most appear well-adjusted.

III. ENVIRONMENTAL CONTEXTS FOR DEVELOPMENT (pp. 59–69)
   A. Many environmental influences combine to affect the course of a child’s development. These include the family, friends, neighbors, school, workplace, and community and religious organizations.
   B. The microsystem—the individual’s immediate settings—powerfully affect development.
   C. The macrosystem, the broad social climate of society, includes its values and programs that support and protect human development.

D. The Family (pp. 59–61)
   1. In power and breadth of influence, no other microsystem context equals the family.
   2. Researchers view the family as a network of interdependent relationships—a system in which the behaviors of each family member affect those of others.
   3. Direct Influences: The behavior of each family member helps sustain a form of interaction in the other that either promotes or undermines psychological well-being.
   4. Indirect Influences: Interaction between any two family members is affected by third parties, who can serve as supports for or barriers to development. For example, when a marital relationship is warm and considerate, the parents are more likely to engage in effective coparenting, mutually supporting each other’s parenting behaviors.
   5. Adapting to Change
      a. The family is a dynamic, ever-changing system that is modified by life events.
      b. The developmental status of each family member and the historical time period in which a family lives also contribute to a dynamic family system.

E. Socioeconomic Status and Family Functioning (p. 61)
   1. Socioeconomic status (SES) is an index of a family’s or an individual’s social position and economic well-being based on years of education, the prestige and skill level of one’s job, and income.
   2. SES is linked to timing of marriage and parenthood and to family size, as well as families’ values and expectations.
      a. Lower-SES parents tend to value external characteristics, such as obedience, politeness, and neatness. High levels of stress sparked by economic insecurity contribute to low-SES parents’ reduced provision of stimulating interaction and activities as well as greater use of coercive discipline.
      b. Higher-SES parents, who have more control over their lives and are used to making independent decisions and convincing others of their point of view, are more likely to teach these skills to their children.
F. Poverty (pp. 61–62)
2. Of all Western nations, the United States has the highest percentage of extremely poor children. Children of poverty are more likely than others to suffer from lifelong poor physical health, persistent deficits in cognitive development and academic achievement, high school dropout, mental illness, and antisocial behavior.
3. The stressors accompanying poverty weaken the family system.
   a. Parents experience daily hassles and crises that reduce their ability to deal with their children effectively.
   b. Single parenthood, poor housing, and dangerous neighborhoods make everyday existence difficult and reduce social supports.
   c. In the past 30 years, homelessness has become more common, and most homeless families consist of women with children under age 5. Many homeless children suffer from developmental delays and chronic emotional stress.

G. Affluence (pp. 62–63)
1. Some affluent parents—those in prestigious and high-paying occupations—fail to engage in family interaction and parenting that promote favorable development.
2. Poorly adjusted affluent young people report less emotional closeness with or supervision from parents. Excessive parental demands for achievement can also lead to problems.

H. Beyond the Family: Neighborhoods, Towns, and Cities (pp. 63–65)
1. Connections between family and community are vital for psychological well-being.
2. Strong family ties to the community reduce stress and enhance development. But when community life is disrupted—as often occurs in poverty-stricken urban areas—family violence, child abuse and neglect, child and youth internalizing and externalizing difficulties, and other social problems are especially high.
3. Neighborhoods
   a. Neighborhood resources and social ties play an important part in children’s development.
   b. Yet in dangerous, disorganized neighborhoods, high-quality activities for children and adolescents are scarce.
   c. Neighborhoods also affect adults’ well-being, especially the elderly, who spend more time in their homes.
4. Towns and Cities
   a. Rural areas and small towns offer children and youths more chances to work alongside adults at important work tasks.
   b. Compared with large urban areas, small towns offer stronger community connections for children and adults and are relatively safer.

I. The Cultural Context (pp. 65–69)
1. The macrosystem affects the environmental contexts for development.
2. Healthy development depends on laws and government programs that shield people from harm and foster their well-being.
3. Cultural Values and Practices
   a. Cultures shape all aspects of daily life.
   b. In the United States, central values include independence, self-reliance, and the privacy of family life, making the public reluctant to endorse government-supported benefits for all families.
   c. Within the United States, some citizens belong to subcultures with beliefs and customs different from those of the larger culture.
      (1) The African-American tradition of extended-family households, in which three or more generations live together, has helped black families survive despite a long history of prejudice and economic deprivation.
      (2) Active, involved extended families also characterize Asian, Native-American, and Hispanic subcultures.
   d. Cultures and subcultures differ in the emphasis they place on collectivism versus individualism.
      (1) In collectivist societies, people define themselves as part of a group and stress group over individual goals.
      (2) In individualistic societies, people think of themselves as separate entities and are largely concerned with their own personal needs.
4. Public Policies and Lifespan Development
   a. **Public policies**—laws and government programs designed to improve current conditions—are developed to solve widespread social problems.
   b. Policies for Children, Youths, and Families
      (1) While many U.S. children fare well, the United States, compared to other industrialized nations, does not rank well on any key measure of children’s health and well-being.
      (2) Adequate programs for children and youths in low-income families, such as universal publicly funded health care, affordable child care, and vocational training, are lacking.
   c. Policies for the Elderly
      (1) U.S. federal spending on programs for the elderly lagged behind that of other Western nations but expanded rapidly in the 1960s with the initiation of Medicare.
      (2) Although the U.S. aging population is financially much better off now than in the past, the elderly in the United States are less well off than those in many other Western nations.

5. Looking Toward the Future
   a. Despite worrisome problems, efforts are being made in improving the condition of many children, families, and aging citizens, and many successful programs are in place.
   b. Researchers are collaborating with community and government agencies to enhance the social relevance of their investigations.

IV. UNDERSTANDING THE RELATIONSHIP BETWEEN HEREDITY AND ENVIRONMENT (pp. 69–75)

A. **Behavioral genetics** is a field devoted to uncovering the contributions of nature and nurture to the diversity in human traits and abilities.

B. Researchers agree that both heredity and environment are involved in every aspect of development, and despite investigations on the role of specific genes, many scientists maintain that the important question is how nature and nurture work together.

C. The Question, “How Much?” (pp. 70–71)
   1. Heritability
      a. **Heritability estimates**, which measure the extent to which individual differences in complex traits in a specific population are due to genetic factors, are obtained from kinship studies, which compare characteristics of family members.
      b. Kinship studies of intelligence have led to controversy over the role of heredity in intelligence, but most findings now support a moderate role for heredity.
   2. Limitations of Heritability
      a. The accuracy of heritability estimates depends on the extent to which the twin pairs studied reflect genetic and environmental variation in the population. 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.
      b. Heritability estimates can easily be misapplied, as when high heritabilities have been used to suggest a genetic basis for ethnic differences in intelligence.

D. The Question, “How?” (pp. 71–75)
   1. Most researchers today view development as the result of the dynamic interplay of heredity and environment.
   2. Gene–Environment Interaction
      a. **Gene–environment interaction** is the idea that because of their genetic makeup, individuals differ in their responsiveness to qualities of the environment. People have unique, genetically influenced reactions to particular experiences.
      b. Recently, researchers have made strides in identifying gene–environment interactions in personality development.
   3. Canalization
      a. **Canalization** is the tendency of heredity to restrict the development of some characteristics to just one or a few outcomes.
      b. A behavior that is strongly canalized develops similarly in a wide range of environments; only strong environmental forces can change it.
4. Gene–Environment Correlation
   a. The concept of **gene–environment correlation** states that our genes influence the environments to which we are exposed.
   
   b. Passive and Evocative Correlation
      (1) In **passive** correlation, parents provide their children with environments influenced by their own heredity.
      (2) In **evocative** correlation, children evoke responses influenced by their own heredity, and these responses strengthen the child’s original style.
   
   c. Active Correlation
      (1) At older ages, **active** gene–environment correlation becomes common.
      (2) This tendency to actively choose environments that complement our heredity is called **niche-picking**.

5. Environmental Influences on Gene Expression
   a. In gene–environment interaction, canalization, and gene–environment correlation, heredity is granted priority.
   b. A growing number of researchers take issue with the supremacy of heredity, arguing that it does not dictate children’s experiences or development in a rigid way.
   c. Accumulating evidence reveals that the relationship between heredity and environment is **bidirectional**: Genes affect people’s behavior and experiences, but their experiences and behavior also affect gene expression.
      (1) **Epigenesis** refers to development resulting from ongoing, bidirectional exchanges between heredity and all levels of the environment.
      (2) The concept of epigenesis reminds us that development is best understood as a series of complex exchanges between nature and nurture.

**LEARNING ACTIVITIES**

**LEARNING ACTIVITY 2.1**
**Observing Similarities and Differences in Phenotypes Among Family Members (pp. 45–47, 48)**

Ask students to jot down the most obvious similarities in physical characteristics and behavior for several children and parents whom they know well (for example, height, weight, eye and hair color, personality, interests, hobbies). Did they find that one child shows combined features of both parents, another resembles just one parent, or another is unlike either parent? Next, ask students to trace a visible genetic trait (phenotype), such as hair or eye color, through as many of their family members as possible. When the genetic family tree is complete, try to determine genotypes. Note that you must begin with the most recent generation and work back. Also note that inferences must be made because homozygosity and heterozygosity cannot be determined for some dominant traits. For example, it may not be known whether someone is homozygous for dark hair or heterozygous—that is, a genetic makeup consisting of a dominant dark-hair and a recessive light-hair gene. Have students explain how differences among family members in the first activity may have occurred. Integrate the terms **phenotype**, **genotype**, and **meiosis** into the discussion.

**LEARNING ACTIVITY 2.2**
**Demonstrating Environmental Influence by Comparing Identical Twins (pp. 48, 70)**

As discussed in the text, identical, or monozygotic, twins have the same genetic makeup—that is, they are genetically identical clones. Phenotypic variation of identical twins is perhaps the best evidence of the extent to which environmental influences can modify genetic expression. To demonstrate, invite a pair of identical twins (who are friends or relatives of a class member) to join your class for observation and interviews. Before the visit, have students generate a list of questions that they would like to ask each twin. These questions should be based on attributes or abilities that are thought to have a strong genetic component. For example, students may want to ask each twin questions about IQ, personality, interests, and talents. Students should also note any physical differences between the twins (for example, height, weight, handedness). After the visit, engage students in a discussion about similarities and differences among the twins, including how the environment may have contributed to differences.
LEARNING ACTIVITY 2.3
Identifying Dominant and Recessive Characteristics (p. 48)

Present the following exercise as an in-class activity or quiz.

Directions: Read each of the following sentences and indicate whether the individual has dominant (D) or recessive (R) characteristics.

1. Joe has Type A blood.  
2. Raul is farsighted.  
3. Megan has blonde hair.  
4. Jamar is double-jointed.  
5. Eva has Type O blood.  
6. Coral has straight hair.  
7. Indria has facial dimples.  
8. Grace is nearsighted.  
9. Vinny has albinism.  
10. Yan has Rh-positive blood.

Answers:
1. D  
2. D  
3. R  
4. D  
5. R  
6. R  
7. D  
8. R  
9. T  
10. D

LEARNING ACTIVITY 2.4
True or False: The Pros and Cons of Reproductive Technology (pp. 54–55)

Present the following exercise as an in-class activity or quiz.

Directions: Read each of the following statements and determine if it is True (T) or False (F).

1. One-fourth of all couples who try to conceive discover that they are sterile.  
2. Donor insemination is 30 to 40 percent successful.  
3. Each year, 1 percent of all children in developed countries are conceived through in vitro fertilization.  
4. The overall success rate of in vitro fertilization is about 70 percent.  
5. Most parents who have used in vitro fertilization do not tell their children about their origins.  
6. In the United States doctors are not required to keep records of donor characteristics.  
7. Because surrogacy favors the wealthy as contractors for infants and the less economically advantaged as surrogates, it may promote the exploitation of financially needy women.  
8. Most recipients of in vitro fertilization are in their fifties and sixties.  
9. One concern about surrogacy is that it may promote exploitation of financially needy women.  
10. At present, little is known about the psychological consequences of being a product of reproductive technologies.

Answers:
1. F  
2. F  
3. T  
4. F  
5. T  
6. T  
7. T  
8. F  
9. T  
10. T

LEARNING ACTIVITY 2.5
Researching Social Indicators of Children’s Well-Being in the United States (pp. 65–67)

Although the United States is one of the wealthiest nations in the world, it does not rank among the top countries on any measure of children’s health and well-being.
Direct students to the Child Trends website: www.childtrends.org. Position your mouse over Databank and click on Indicators by Topic Area in the drop-down menu. Then choose Child Well-Being and select an article to review. Ask students to briefly summarize the article. What child or adolescent indicator was highlighted in the article? What trends were revealed? For example, were there any significant state-to-state trends? Did the article include past research? If so, how does the current research compare? Is there any cultural or ethnic data reported? Does the article include implications of the research? If so, briefly explain. Once students have researched their articles, ask them to share their findings with the class.

LEARNING ACTIVITY 2.6
Conducting a Survey of Attitudes Toward Government Intervention into Family Life (pp. 65–68)

Government support for children and families has been more difficult to realize in the United States than in other industrialized nations. For example, affordable child care is in short supply, and much of it is substandard in quality. The United States remains the only industrialized nation in the world without a universal, publicly-funded health-care system. Approximately 10 percent of U.S. children, most in low-income families, have no health insurance. For older people, Medicare 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.

Based on this information, ask students to interview two or three friends, family members, or acquaintances. To what extent should tax dollars be devoted to child-rearing issues or the elderly? Should government support serve as a safety net for families in dire need or should policies be applied more broadly? Once students have conducted their interviews, ask them to share some findings in class. Do students agree with the responses? Why or why not?

LEARNING ACTIVITY 2.7
Researching Social Indicators and Public Policies for the Elderly (pp. 65, 67–68)

According to the text, parents under the age of 25 and elderly people who live alone are hit hardest by the effects of poverty. In addition, until the mid-twentieth century, the United States had few policies in place to protect the aging population. To supplement research in the text, have students visit www.agingstats.gov, which provides information on the health and well-being of the elderly in the United States. While exploring the site, ask students to list key indicators of well-being among the elderly. What resources are available to the elderly? Using information obtained from Learning Activity 2.5, how do these findings compare to the findings on children?

LEARNING ACTIVITY 2.8
Matching: Understanding the Relationship Between Heredity and Environment (pp. 70–75)

Present the following exercise as an in-class activity or quiz.

**Directions:** Match each of the following terms with its correct description.

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<td>Heritability estimates</td>
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<td>Gene–environment correlation</td>
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**Descriptions:**
A. Each person’s unique, genetically determined response to the environment
B. Our genes influence the environments to which we are exposed
C. Measure of the extent to which individual differences in complex traits in a specific population are due to genetic factors
D. The tendency to actively choose environments that complement our heredity
E. Development resulting from ongoing, bidirectional exchanges between heredity and all levels of the environment
F. Comparison of the characteristics of family members
G. Because of their genetic makeup, individuals differ in their responsiveness to qualities of the environment
H. The tendency of heredity to restrict the development of some characteristics to just one or a few outcomes
LEARNING ACTIVITY 2.9
Exploring Epigenesis (pp. 73–75)

Have students review the definition and example of epigenesis on pages 73–75 of the text. Next, ask them to form small groups and create two scenarios—one that would likely enhance gene expression and one that would likely dampen gene expression. For example, providing an economically at-risk preschooler with intensive early intervention promotes cognitive, social, and emotional growth, which translates into better academic performance and peer relations on entering school, thereby transforming gene expression. In contrast, not providing the same preschooler with early intervention and denying that child appropriate environmental stimulation can dampen gene expression so severely that later intervention has little impact. As this example illustrates, environment–gene exchanges can contribute to vastly different outcomes in the same child. Encourage students to create one scenario for a child and another for an adult.

ASK YOURSELF . . .

REVIEW: Cite evidence indicating that both heredity and environment contribute to the development of individuals with PKU and Down syndrome. (pp. 50, 52–53)

In phenylketonuria, or PKU, one of the most frequently occurring recessive disorders, 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. But 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. Newborns diagnosed with PKU who are placed on a diet low in phenylalanine usually attain an average level of intelligence and have a normal lifespan, although they show mild cognitive deficits.

Down syndrome, the most common chromosomal disorder, occurs in 1 out of every 770 live births. In 95 percent of cases, it results from a failure of the twenty-first pair of chromosomes to separate during meiosis. As a result, the new individual receives three of these chromosomes rather than the normal two. In other, less frequent forms, an extra broken piece of twenty-first chromosome is attached to another chromosome. Or an error occurs during the early stages of mitosis, causing some but not all body cells to have the defective chromosomal makeup.

Although Down syndrome leads to mental retardation and other cognitive, motor, and physical problems, environment plays a role in how well affected children fare. 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. Finally, because of medical advances, fewer individuals with Down syndrome die early than in the past; many survive into their fifties and a few into their sixties to eighties.

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. (pp. 50–51)

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 alleles to override those on the X.

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 greater for boys. 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.
CONNECT: Referring to ecological systems theory (Chapter 1, pages 24–27), 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? (pp. 52–53)

Ecological systems theory views the individual as developing within a complex system of relationships affected by multiple levels of the surrounding environment. Caring for a disabled child can be expensive, exhausting, and stressful for parents. In addition to their daily care-taking needs, children with genetic disorders often require special medical and educational services. For example, infants with Down syndrome are more difficult to care for than normal infants. They are often born with eye cataracts, hearing loss, and heart and intestinal defects. They smile less readily, show poorer eye-to-eye contact, have weak muscle tone, and explore objects less persistently than other children. From the viewpoint of ecological systems theory, factors in the mesosystem—for example, the availability of specialized infant and preschool intervention programs—can help these parents support their children’s development, both by providing experiences that promote the child’s physical and cognitive development and by relieving the parents of the sole burden of caring for the child.

APPLY: Gilbert’s genetic makeup is homozygous for dark hair. Jan’s is homozygous for blond hair. What proportion of their children are likely to be dark-haired? Explain. (p. 48)

Because homozygous individuals inherit similar alleles from both parents, they will always display the inherited trait. As a result, Gilbert has dark hair, while Jan has blond hair. Because Gilbert can pass on only the dominant dark-hair allele, all of Gilbert and Jan’s children will have dark hair. However, because their children will also receive the recessive blond-hair allele from Jan, they will all be heterozygous. They will be carriers of the gene for blond hair, which they can pass on to their own children.

REVIEW: Why is genetic counseling called a communication process? Who should seek it? (pp. 53–55)

Genetic counseling is called a communication process because the counselor provides information that helps couples assess their chances of giving birth to a baby with a heredity disorder and then choose the best course of action in view of risks and family goals. If a family history of mental retardation, psychological disorders, physical defects, or inherited diseases exists, the genetic counselor interviews the couple and prepares a pedigree—a picture of the family tree in which affected relatives are identified. The pedigree is used to estimate the likelihood that parents will have an abnormal child, based on genetic principles. For many disorders, molecular genetic analyses can reveal whether the parent is a carrier of the harmful gene. When all the relevant information is in, the genetic counselor helps the prospective parents consider appropriate options.

Individuals should seek genetic counseling if they have had difficulties bearing children—for example, repeated miscarriages—or if they know that genetic problems exist in their families. Women who delay childbearing past age 35, the age at which the overall rate of chromosomal abnormalities rises sharply, are also candidates for genetic counseling.

CONNECT: How does research on adoption reveal resilience? Which factor related to resilience (see Chapter 1, pages 10–11) is central in positive outcomes for adoptees? (pp. 58–59)

Research shows that adopted children and adolescents have more learning and emotional difficulties than other children, a difference that increases with the child’s age at time of adoption. But despite the risks, most adopted children display resilience, and those with preexisting problems usually make rapid progress. For example, 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. And children with troubled family histories who are adopted at older ages generally improve in feelings of trust and affection for their adoptive parents, as they come to feel loved and supported. Although adolescent adoptees’ lives are often complicated by unresolved curiosity about their roots, most appear well-adjusted as adults. When parents have been warm, open, and supportive in their communication about adoption, their children typically forge a positive sense of self. 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. In general, a warm parental relationship, which is a key ingredient of resilience, contributes to favorable outcomes for adoptees.

APPLY: Imagine that you must counsel a couple considering in vitro fertilization using donor ova to overcome infertility. What medical and ethical risks would you raise? (pp. 54–55)

The couple should be told that the overall success rate of in vitro fertilization is only about 35 percent and that success declines steadily with age, from about 40 percent in women younger than age 35 to only 8 percent in those age 43 and older. In addition, in vitro fertilization poses greater risks than natural conception to infant survival and healthy development. More than 50 percent of in vitro procedures result in multiple births, usually twins but also 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, and
the risk of major birth defects doubles. In many countries, including the United States, doctors are not required to keep records of donor characteristics. As a result, issues may arise in situations where knowledge of the child’s genetic background might be crucial in the case of serious disease. Another concern is that the in vitro “sex sorter” method may lead to parental sex selection, eroding the moral value that boys and girls are equally precious.

**REFLECT:** Suppose you are a carrier of fragile X syndrome and want to have children. Would you choose pregnancy, adoption, or surrogacy? If you became pregnant, would you opt for prenatal diagnosis? Explain your decisions. (pp. 53–59)

This is an open-ended question with no right or wrong answer.

**REVIEW:** Links between family and community foster development throughout the lifespan. Provide examples from our discussion that support this idea. (p. 63)

Connections between family and community are vital for psychological well-being throughout the lifespan. For example, 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, child and youth internalizing and externalizing difficulties, adult criminal behavior, and elderly depression and declines in cognitive functioning are especially high. In contrast, strong family ties to the surrounding social context—as indicated by frequent contact with friends and relatives, organized youth activities, and regular church, synagogue, or mosque attendance—reduce family stress and enhance adjustment.

**CONNECT:** How does poverty affect the family system, placing all aspects of development at risk? (pp. 61–62)

Poverty is accompanied by constant stressors that 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. Negative outcomes are especially severe in single-parent families and in families who 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.

Besides poverty, another problem that places the development of children and families at risk is homelessness, which has become more common in the past 30 years. 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. An estimated 25 to 30 percent of those who are old enough do not attend school, and those who do enroll achieve less well than other poverty-stricken children because of poor attendance and health and emotional difficulties.

**APPLY:** Check your local newspaper and one or two national news magazines or news websites 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? (pp. 65–69)

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. Growing awareness of the gap between what we know and what we do to better people’s lives has led experts in developmental science to join with concerned citizens as advocates for more effective policies. Besides strong advocacy, public policies that enhance development depend on policy-relevant research that documents needs and evaluates programs to spark improvements. By collaborating with community and government agencies, researchers can enhance the social relevance of their investigations. And by communicating with the general public about their findings—through reports to government officials, websites aimed at increasing public understanding, and collaboration with the media to ensure accurate and effective reporting in newspaper stories, magazine articles, and radio and television documentaries—researchers can help create a sense of immediacy about the conditions of children, families, and the aged that is necessary to spur a society into action.

**REFLECT:** Do you agree with the widespread American sentiment that government should not become involved in family life? Explain. (pp. 65–67)

This is an open-ended question with no right or wrong answer.
REVIEW: What is epigenesis, and how does it differ from gene–environment interaction and gene–environment correlation? Provide an example of epigenesis. (pp. 71–73, 75)

Epigenesis refers to development resulting from ongoing, bidirectional exchanges between heredity and all levels of the environment. For instance, providing a baby with a healthy diet increases brain growth, leading to new connections between nerve cells, which transform gene expression and open the door to new gene–environment exchanges. For example, advanced exploration of objects and interaction with caregivers can further enhance brain growth and gene expression. These ongoing, bidirectional influences foster cognitive and social development.

Although gene–environment interaction and gene–environment correlation also emphasize the relationship between heredity and environment, both concepts grant priority to heredity. In gene–environment interaction, genes affect our responsiveness to particular environments. In gene–environment correlation, children’s genetic makeup causes them to receive, evoke, or seek experiences that actualize their hereditary tendencies. In contrast, the concept of epigenesis does not give priority to either heredity or environment. Instead, it reminds us that development is best understood as a series of complex exchanges between nature and nurture.

CONNECT: Explain how each of the following concepts supports the conclusion that genetic influences on human characteristics are not constant but change over time: somatic mutation (page 52), niche-picking (page 72), and epigenesis (page 73).

Somatic mutation occurs when normal body cells mutate, as happens in many cancers and other diseases. Unlike germline mutation, which occurs only in the cells that give rise to gametes, somatic mutation can take place at any time of life. Perhaps some individuals harbor a genetic susceptibility that causes certain body cells to mutate easily in the presence of triggering events. Somatic mutation provides evidence that individuals do not have a single, permanent genotype; rather, each cell’s genetic makeup can change over time.

Niche-picking—the tendency to actively choose environments that complement our heredity—is not observed in infants or young children, who cannot choose their own environments. Older children, adolescents, and adults, who are increasingly in charge of their environments, can express their preferences through niche-picking. This helps explain why pairs of identical twins reared apart in childhood and later reunited often discover that they share preferences in food, hobbies, and vocations.

Epigenesis refers to development resulting from ongoing, bidirectional exchanges between heredity and all levels of the environment. For example, giving a baby a healthy diet promotes brain growth, which leads to new connections between nerve cells. These, in turn, transform gene expression, opening the door to new gene–environment exchanges (such as advanced exploration of objects and interaction with caregivers), which further enhance brain growth and gene expression. In contrast, harmful environments can dampen gene expression, sometimes so profoundly that later experiences can no longer change characteristics (such as intelligence and personality) that originally were flexible.

APPLY: Bianca’s parents are accomplished musicians. At age 4, Bianca began taking piano lessons. By age 10, she was accompanying the school choir. At age 14, she asked to attend a special music high school. Explain how gene–environment correlation promoted Bianca’s talent. (pp. 72–73)

According to the concept of gene–environment correlation, our genes influence the environments to which we are exposed. That is, children’s heredity plays a role in molding their experiences. Early in her development, Bianca probably experienced a passive correlation. Her parents emphasized musical activities, such as attending concerts and listening to classical music. They also provided her first piano lessons and opportunities for other music-related experiences. Because Bianca was receptive to this abundance of musical stimulation, she undoubtedly prompted positive responses from her parents, who continued to promote her musical development. This is an example of an evocative correlation.

As Bianca grew older, she became more active in choosing her own environments. She decided to accompany the school choir and later asked to attend a special music high school. Bianca’s inherited musical talent led her to engage in niche-picking—to choose activities and environments that complemented her genetic strengths. In these ways, heredity and environment worked together to advance Bianca’s musical endeavors.

REFLECT: What aspects of your own development—for example, interests, hobbies, college major, or vocational choice—are probably due to niche-picking? Explain. (p. 72)

This is an open-ended question with no right or wrong answer.
SUGGESTED READINGS


Mundy, L. (2007). *Everything conceivable: How the science of assisted reproduction is changing our world.* New York: Knopf. A compelling look at reproductive technologies, this book examines current research, as well as controversies, surrounding assisted reproduction. The author also includes personal narratives, myths, and the social consequences of assisted reproduction.

MEDIA MATERIALS

For details on individual video segments that accompany the DVD for *Development Through the Lifespan,* Sixth Edition, please see the DVD Guide for *Explorations in Lifespan Development.* The DVD and DVD Guide are available through your Pearson sales representative.

Additional DVDs that may be useful in your class are listed below. They are not available through your Pearson sales representative, but you can order them directly from the distributors. (See contact information at the end of this manual.)

*Heredity and Environment* (2005, Magna Systems, 29 min.). This program provides a biological explanation of conception, as well as information on such topics as the role of genes, dominant and recessive traits, chromosomal abnormalities, genetic disorders, interactions between nature and nurture, and how the environment shapes the brain.

*Heredity & Environment: Beginnings of Life* (2011, Learning Seed, 38 min.). Describing the structures and chemistry of DNA molecules, this program explains how genes are passed from parents to offspring and how they determine the traits of an individual. It also covers environmental factors inside or outside of the womb that can affect a child’s health later in life, genetic disorders, and the role of counseling and screening to provide health information before or during pregnancy. An educator’s guide is included.

*In the Womb* (2005, National Geographic, 100 min.). Using cutting-edge 3-D and 4-D ultrasound imagery, this program opens a window into the delicate, dark world of the fetus, exploring each trimester of pregnancy in great detail—including a view of a fetoscope operation performed in utero to correct life-threatening complications before birth.

*The Ghost in Your Genes* (2005, Films Media Group/BBCW production, 50 min.). This program examines the emerging science of epigenetics, which studies the relationship between the environment and the expression of genes. With commentary from leading scientists in the field—including geneticist Marcus Pembrey, among the first to observe that dietary stress can produce health problems across generations after it occurs—the program explores a wide variety of clinical evidence for epigenetic inheritance, including an experiment focusing on children born shortly after 9/11.

*The Secret Life of Twins: Identity, Genetics, and Human Development* (2009, Films Media Group, 2-part series, 52 min. each). This series shows how the characteristics of monozygotic twins—their differences as well as their similarities—are leading to new areas of research in medicine, genetics, and psychology. The programs demonstrate that from body type to disease susceptibility to sexual orientation, the life paths that twins follow are both predictable and surprising. The original BBC/TLC title was *The Secret Life of Twins: Unraveling the Secrets of the Self.*
Unlocking the Code: Genetics and Medicine (2011, Films Media Group/Open University, 49 min.). This program looks at several ways in which genetic breakthroughs have improved health-care technology and enriched the study of human physiology. Case studies focus on DNA screening and its benefits—for both parents and children—in identifying hereditary problems, such as Duchenne muscular dystrophy, Huntington disease, and congenital and developmental abnormalities. The film also explores implications for type-2 diabetes, the complex area of multifactorial genetic disorders, and more. A part of the series The Gene Code.

Waiting on the World to Change: Poverty in Camden, New Jersey (2007, Films Media Group, 42 min.). This ABC News program documents the lives of three young residents of Camden, New Jersey, one of the most economically depressed and crime-ridden cities in America. Viewers meet 6-year-old Moochie, who has vowed to get straight A’s in school; Billy Joe, a teenager determined to be the first in his family to graduate from high school; and a 4-year-old named Ivan with one big dream: to escape homelessness and have his own room. A part of the series Camden Chronicles: Children in Urban Poverty.

What Poor Child Is This? Poverty and America’s Children (2011, Films Media Group, 86 min.). This program proposes that with an estimated 12 million American children suffering from economic hardship, even the wealthiest society on Earth cannot escape the poisonous effects of poverty. It examines the causes of child poverty in the United States as well as its impact on children. Citing facts and findings that contradict the American ethos of upward mobility, the film lays bare the sad reality of what financial deprivation is doing to the nation’s young people: eroding family bonds, decreasing literacy, increasing health and addiction risks, raising the specter of mental illness, and putting children disturbingly close to criminal influences. A part of the series Poverty in America.