Chapter Preview

Much is determined at the moment of conception, when a sperm and ovum unite to initiate the developmental processes that will culminate in the birth of a new human being. The genetic legacies of the mother and father influence virtually everything about the developing person—including physical attributes, such as gender and appearance, as well as intellectual and personality characteristics. Chapter 3 describes the fusion of the ovum and the sperm and the biological mechanisms by which normal, and sometimes abnormal, chromosomes and genes are transmitted to the developing zygote. The author emphasizes that although the direction a person’s life takes is strongly influenced by heredity, its ultimate course depends on the interaction of many biological and environmental factors—that is, on both nature and nurture.

Chapter 3 also discusses the benefits of genetic counseling for prospective parents who are at risk of giving birth to children with genetic disorders. Chapter 4 continues the discussion by explaining the benefits of prenatal care, which has been greatly facilitated by advances in genetic testing techniques.

What Have You Learned?

The “What Have You Learned?” questions at the end of the text chapter are reprinted here for your convenience in checking students’ understanding of the chapter contents.

1. How many pairs of chromosomes and pairs of genes does a person usually have?
2. What is the relationship between genes, base pairs, and alleles?
3. Why is a person’s genotype not usually apparent in the phenotype?
4. In nature, what determines a person’s sex and how can nurture affect that?
5. What are the advantages and disadvantages of being a monozygotic twin?
6. Why does in vitro fertilization increase the incidence of dizygotic twins?
7. What is the difference between an epigenetic characteristic and a multifactorial one?
8. Why do polygenetic traits suggest that additive genes are more common than dominant–recessive ones?
9. What surprises came from the Human Genome Project?
10. Regarding heritability, why is it important to know which group provided the data?
11. What nature and nurture reasons make one person an alcoholic and another not?
12. What nature and nurture reasons make one person nearsighted and another not?
13. What can be learned from Mickey Mantle’s life?
14. Why does this textbook on normal development include abnormal development?
15. What usually happens when a zygote has fewer or more than 46 chromosomes?
16. What are the consequences if a newborn is born with trisomy-21?
17. Why are relatively few genetic conditions dominant?
18. Why are a few recessive traits (such as sickle cell) quite common?
19. What are the advantages and disadvantages of genetic testing?
20. Why do people need genetic counselors, not merely fact sheets about genetic conditions?

Chapter Guide

➤ “On Your Own” Activities: Developmental Fact or Myth?; Portfolio Assignment
➤ Teaching Tip: Teaching a Large Class
➤ AV: Transitions Throughout the Life Span, Program 3: Nature and Nurture: The Dance of Life
➤ Classroom Activity: What Do Kids Cost?

I. The Genetic Code

Instructional Objective: To explain the basic mechanisms of heredity, and to describe the process of conception, including how sex is determined.

➤ AV: Blueprint for Life; The Developing Child: Conception and Heredity; How Life Begins; Life’s Greatest Miracle; Body Doubles: The Twin Experience; Adoption and Assisted Reproduction: A Look at the Children; The Baby Makers
➤ Classroom Activities: Sociobiology, Culture, and Sex Selection; Classroom Debate: “Resolved: Embryonic Stem Cell Research Should Be Outlawed”
➤ “On Your Own” Activity: Similarities Among Twins: Coincidence or Evidence of Genetic Influence?
➤ Internet Activity: Cloning

1. The work of body cells is done by proteins. Instructions for manufacturing proteins, which are composed of a sequence of amino acids, are stored in molecules of deoxyribonucleic acid (DNA), each of which is a chromosome. These instructions, which are organized into units called genes, are transmitted to cells via four chemical bases: adenine, thiamine, cytosine, and guanine. Some genes come in several slight, normal variations called alleles. The sum total of these genetic instructions for a living organism is the genome.

2. Conception occurs when the male reproductive cell (or sperm) penetrates the membrane of the female reproductive cell (the ovum); they then fuse, and their genetic material combines to form the one-celled zygote. Each human reproductive cell, or gamete, contains 23 chromosomes, half of the 46 of the zygote. This constitutes the organism’s genetic inheritance, or genotype.

3. The 44 chromosomes that are independent of the sex chromosomes are called autosomes. If a gene from one parent is exactly like that from the other parent, the gene pair is said to be homozygous. If the match is not perfect, the gene pair is said to be heterozygous.

4. The 23rd pair of chromosomes, which determines sex, is designated XY in the male and XX in the female. The critical factor in the determination of the zygote’s sex is which sperm reaches the ovum first, a Y sperm, creating a boy, or an X sperm, creating a girl.

5. (text and Thinking Critically) The natural sex ratio at birth is close to 50:50. In times of serious adversity (such as famine), XY embryos are more likely than XXs to be expelled in a spontaneous abortion, or miscarriage. In China between 1990 and 1993, prenatal tests that showed the sex of the child were used and millions of female fetuses were aborted.

6. Within hours, the zygote initiates human development through the processes of duplication and division. Soon after, differentiation begins. Cells begin to specialize, taking different forms and reproducing at various rates. Certain genes also switch on at different times. As a result of these processes, cells change from being stem cells that
are able to produce any type of cell to being able to become only one type of specialized cell.

7. In some pregnancies, a single zygote splits into two separate identical cells that develop into genetically identical, or monozygotic (MZ), twins, who have the potential for developing the same physical appearance and psychological characteristics and the same vulnerability to specific diseases. Dizygotic (DZ), or fraternal, twins begin life as two separate zygotes and share no more genes than any other siblings (about 50 percent).

8. (text and Thinking Critically) Infertile couples may take advantage of assisted reproductive technology (ART) to produce offspring, from the simplest form involving the taking of drugs to more complex methods such as in vitro fertilization (IVF).

II. From One Cell to Many

Instructional Objective: To describe the interaction of genes in influencing physical and psychological characteristics.

- Classroom Activities: Genes for Obesity; Genetic Influences on Taste

1. **Phenotype** refers to the observable characteristics and behaviors of a person.

2. Most traits are polygenic—that is, affected by many genes—and multifactorial—that is, influenced by many factors, including factors in the environment.

3. All human characteristics are epigenetic, which refers to the environmental factors that affect genes and genetic expression.

4. The Human Genome Project is the international effort to map the complete genetic code, completed in 2001. This map has revealed that all living creatures share genes; that the more closely related the organisms, the more genes they share; and that humans have only between 18,000 and 23,000 genes. The regulator genes and the “junk” around the genes are responsible for differences among species.

5. One type of genetic interaction involves additive genes—for example, the various genes underlying height and skin color.

6. Some genes interact in a nonadditive fashion. Genes that have a controlling influence over weaker, recessive genes are called dominant genes. Hundreds of physical characteristics follow this nonadditive dominant-recessive pattern. A person who has a gene in his or her genotype that is not expressed in the phenotype but that can be passed on to the person’s offspring is said to be a carrier of that gene.

7. The recessive genes for some forms of color blindness, many allergies, some learning disabilities, and several diseases are X-linked, meaning that they are located only on the X chromosome. Because males have only one X chromosome, they are more likely than females to manifest these characteristics in their phenotype.

8. Some genes have different effects depending on whether they come from the mother or the father, a phenomenon known as imprinting.

9. The outcome of genetic interaction is complicated because a small deletion, repetition, or transposition in base pairs, for example, may have no effect or may cause problems. Imprinting is another complication.

III. Genotype and Phenotype

Instructional Objective: To discuss the interaction of heredity and environment in determining physical and psychological characteristics.

- AV: The Ecology of Development; Heredity and Environment: Blueprints for a Baby
- Classroom Activity: Shopping for Genes
- “On Your Own” Activities: Calculating Phenotypes and Genotypes; Temperament and Heredity

1. Genes are part of a person’s basic foundation, affecting every aspect of life while determining none. Even traits that show a strong genetic influence are also affected by environment.
2. Most environmental influences on children raised in the same home are not shared.

3. Addiction is a particularly clear example of gene–environment interaction. Some people inherit a biochemical predisposition toward alcoholism and drug addiction. Even so, social influences and individual choices play a critical role in determining whether their genetic susceptibility is actually expressed in alcoholism. Among the personality traits that correlate with abusive drinking are a quick temper, a willingness to take risks, and a high level of anxiety. Two other factors in alcoholism are biological sex and culture. Women become drunk on less alcohol than men do.

4. The percentage of the variation in a trait within a particular population, in a particular context and era, that can be attributed to genes is called its heritability.

5. Age, genes, and culture influence vision. Nearsightedness (myopia) may be caused by maturation or poor nutrition. The alarming increase in the rate of this vision problem among children in some parts of the world has been attributed to the increasing amount of time spent by children in the close study of books and papers. In poorer areas, such as parts of Africa, a deficiency in Vitamin A is a cause of poor vision.

6. On a practical level, knowing that a particular genetic disorder runs in the family can help parents take preventive measures to reduce their children's vulnerability. For instance, if alcoholism is in the genes, parents can keep alcohol away from their home and children.

IV. Chromosomal and Genetic Problems

Instructional Objective: To describe the most common chromosomal and genetic abnormalities and their causes, and to acquaint students with the process and importance of genetic counseling

- AV: Pregnancy After 35; Sickle-Cell Anemia
- Classroom Activities: Should Minors Be Tested for Incurable Genetic Conditions? Classroom Debate: “Resolved: All Prospective Parents at Risk as Carriers of Abnormal Genes Should Be Subjected to Mandatory Genetic Testing”
- Teaching Tip: Genetic Counseling
- Internet Activity: Cystic Fibrosis
- “On Your Own” Activities: Becoming Aware of Serious Genetic Problems; Raising a Child with a Serious Genetic Disorder; Reaching Out
- Critical Thinking Activity: The Genetic Counselor

1. Scientists study genetic and chromosomal abnormalities to gain a fuller appreciation of the complexities of nature–nurture interactions, to increase understanding of how to reduce or limit their harmful consequences, and to foster human understanding.

2. About 5 to 10 percent of all zygotes have too few or too many chromosomes. Most such zygotes do not even begin to develop, and less than 1 percent come to term—usually because a spontaneous abortion occurs. Once in every 200 births, however, a baby is born with a chromosomal abnormality that leads to a recognizable syndrome. The variable that most often correlates with chromosomal abnormalities is the mother’s age.

3. The most common of the extra-chromosome syndromes is Down syndrome (trisomy-21), where victims exhibit distinguishing features of the eyes, face, and tongue. The extra chromosome at site 21 also makes them more susceptible to hearing problems, heart defects, slow intellectual development, muscle weakness, and short stature.

5. About 1 in 500 infants is either missing a sex chromosome or has three or more of them. One such syndrome is Turner syndrome, in which the girl has only one X chromosome (XO). Another is Klinefelter syndrome, in which a boy inherits the XXY pattern.

6. Potentially harmful genes are present in every individual’s genotype. Most of the known genetic disorders are dominant and usually not seriously disabling. Two exceptions are Huntington disease and a rare but severe form of Alzheimer disease.

7. In fragile X syndrome, part of the X chromosome is attached by such a thin string of molecules that it seems about to break off. Although there is considerable variation in its effects, some mental deficiency is common (more so in males than in females).
8. Although most known genetic disorders are dominant, recessive-gene disorders claim many more victims. Among the more common recessive genetic disorders are cystic fibrosis, thalassemia, and sickle-cell anemia.

9. For most of human history, couples at risk for having a child with a genetic problem did not know it. **Genetic counseling** is a means by which couples can learn more about their genes and make informed decisions about childbearing.

10. Genetic counseling is strongly recommended for the following:
    (a) individuals who have a parent, sibling, or child with a genetic condition
    (b) couples who have a history of spontaneous abortion or stillbirth
    (c) couples who are infertile
    (d) couples who are from the same ethnic group, particularly if they are relatives
    (e) women age 35 and older and men over 40.

11. In the United States and many other nations, every newborn is tested for **phenylketonuria (PKU)**, a recessive condition that will result in severe retardation if the common food substance phenylalanine is consumed.