Chapter 3 WHYL Answers

The Genetic Code

1. How many pairs of chromosomes and pairs of genes does a person usually have?

A person has 23 pairs of chromosomes and 18,000 to 23,000 genes.

2. What is the relationship among genes, base pairs, and alleles?

Most genes have thousands of precise base pairs arranged in precise triplets, making the 20 types of amino acids needed for development into a human being. The codes for each particular gene can vary, although usually they do not. Some genes have alternate versions of base pairs, with transpositions, deletions, or repetitions of base pairs not found in other versions of the same gene. Each of these variations is called an allele of that gene. Most alleles cause only minor differences (such as the shape of an eyebrow); some seem inconsequential; some are notable (such as the amount of the MAOA enzyme).

The Beginnings of Life

3. In nature, what determines a person's sex, and how can nurture affect that?

Because a female's 23rd pair is XX, every ovum contains either one X or the other—but always an X. And because a male's 23rd pair is XY, half of his sperm carry an X chromosome and half a Y. The X chromosome is bigger and has many more genes, but the Y chromosome has a crucial gene, called SRY, that directs the embryo to make male hormones and organs. Thus, the sex of the zygote depends on which sperm penetrates the ovum—a Y sperm with the SRY gene, creating a boy (XY), or an X sperm, creating a girl (XX).

Chromosomes and genes do not determine behavior. Every male–female difference is influenced by the culture and environment a child is raised within.

4. What are the advantages and disadvantages of being a monozygotic twin?

Monozygotic twins can donate an organ for surgical implantation in their twin with no organ rejection. Establishing a unique identity is a challenge to some monozygotic twins.

5. Why does in vitro fertilization increase the incidence of dizygotic twins?

In this procedure multiple zygotes are implanted and, barring selective reduction, may grow into healthy babies, thus increasing the numbers of multiple births in this country.

From One Cell to Many

6. Why is a person's genotype not usually apparent in the phenotype?

The genotype instigates body and brain formation, but the phenotype (the visible traits and behaviors) depends on many genes and on the environment.

7. What is the difference between an epigenetic characteristic and a multifactorial one?

Epigenetic characteristics refer to environmental factors that affect genes and genetic expression—enhancing, halting, shaping, or altering the expression of genes resulting in a phenotype that may differ markedly from the genotype.

A multifactorial trait is a trait that is affected by many factors, both genetic and environmental expression, that is enhancing, halting, shaping, or altering the expression of genes resulting in a phenotype that may differ markedly from the genotype.

8. Why do polygenic traits suggest that additive genes are more common than dominant–recessive ones?

Polygenetic traits are traits in the phenotype that are determined by many genes. One example is height, which is determined by the interaction of approximately 100 different genes acting together, all contributing a bit to the expression of the trait; in other words, these genes act additively. Hair curliness and skin color are also the result of additive genes. In the case of dominant–recessive genes, the expression of a trait in the phenotype depends on just one gene pair. An example is eye color. The brown-eye gene is dominant, and the blue-eye gene is recessive. The eye color of a child depends solely on the action of these two genes: a child who inherits two brown-eye genes or a brown-eye gene and a blue-eye gene will have brown eyes, whereas a child who inherits two blue-eye genes will have blue eyes. The sheer number of additive traits genes that can contribute to a single trait suggests that additive genes are more common than dominant–recessive ones.

9. What surprises came from the Human Genome Project? Genotype and Phenotype

One of the first surprises was that humans have far fewer than 100,000 genes, the number everyone believed throughout the twentieth century. The total number of genes in a person is between 18,000 and 23,000. Another surprise is that all living creatures share many genes.

10. Regarding heritability, why is it important to know which population at what historical time provided the data?

Heritability is a statistic that indicates only how much of the variation in a particular trait within a particular population in a particular context and era can be traced to genes. Heritability is tied to context, so studying heritability outside of context would not be valid.

11. What nature and nurture reasons make one person an alcoholic and another not?

We now know that biochemistry makes some people more vulnerable to alcoholism and drug use than others, so various proposed cures do not apply equally to everyone. Each person's biochemistry reacts to alcohol, causing sleep, nausea, aggression, joy, relaxation, forgetfulness, sexiness, or tears. How their bodies metabolize alcohol allows some people to "hold their liquor" and therefore abuse alcohol, while others (including many East Asians) sweat and become red-faced after just a few sips, an embarrassing response that may lead to abstinence. Alcoholism is inherited via psychological as well as biochemical tendencies (Macgregor et al., 2009). Some inherited personality traits (a quick temper, sensation seeking, high anxiety) encourage drinking and drugging. Furthermore, certain contexts, such as fraternity parties, make it hard to avoid alcohol; other contexts, such as a church social in a "dry" county, make it hard to swallow anything stronger than lemonade.

12. What nature and nurture reasons make one person nearsighted and another not?

A study of British twins found that the Pax6 gene, which governs eye formation, has many alleles that make people somewhat nearsighted (Hammond et al., 2004). This research found heritability of almost 90 percent, which means that if one monozygotic twin was nearsighted, the other twin was almost always nearsighted, too. Visual problems may also be caused by the environment. Nutrition, age and other confounding variables such as culture and recreational habits may impact those with a genetic vulnerability more intensely than those with no genetic vulnerability.

13. What can be learned from Mickey Mantle's life?

Ignoring the nature-nurture connection can be deadly.

Most of his male relatives were alcoholics and died before middle age, including his father, who died of Hodgkin disease (a form of cancer) at age 39. Mantle became "a notorious alcoholic [because he] believed a family history of early mortality meant he would die young" (Jaffe, 2004, p. 37). He ignored his genetic predisposition to alcoholism. At age 46 Mantle said, "If I knew I was going to live this long, I would have taken better care of myself." He never developed Hodgkin disease, and if he had, chemotherapy developed since his father's death would likely have saved him—an example of environment prevailing over genes.

Chromosomal and Genetic Problems

14. Why does this textbook on normal development include abnormal development?

Studying abnormal development provides us with three things:

1. They provide insight into the complexities of nature and nurture. 2. Knowing their origins helps limit their effects. And , 3. Information combats prejudice: Difference is not always deficit.

15. What usually happens when a zygote has fewer or more than 46 chromosomes?

Usually, each sperm and each ovum have 23 chromosomes, and the zygote they create has 46. However, some gametes have more or less than 23 chromosomes. About 5 to 10 percent of all zygotes have more or less than 46 chromosomes (Brooker, 2009). Far fewer are born, less than 1 percent, primarily because most such zygotes never duplicate, divide, and differentiate. Many of the rest are aborted spontaneously or by choice. Birth itself is hazardous; about 5 percent of stillborn (dead-at-birth) babies have 47 chromosomes (O. J. Miller & Therman, 2001).

Once in about every 200 births, a newborn survives with 45, 47, or, rarely, 48 or 49 chromosomes. Each abnormality leads to a recognizable *syndrome*, a cluster of distinct characteristics that tend to occur together. Usually the cause is three chromosomes (a condition called a *trisomy*) at a particular location instead of the usual two.

16. What are the consequences if a newborn is born with trisomy- 21?

The most common extra-chromosome condition that results in a surviving child is Down syndrome, also called *trisomy-21* because the person has three copies of chromosome 21. Some 300 distinct characteristics can result from the presence of the third chromosome 21. No individual with Down syndrome is identical to another, but most have specific facial characteristics—a thick tongue, round face, slanted eyes—as well as distinctive hands, feet, and fingerprints. Many also have hearing problems, heart abnormalities, muscle weakness, and short stature. They are usually slower to develop intellectually, especially in language (W. I. Cohen, 2005). Their eventual intellect varies: Some are severely retarded; others are of average or even above-average intelligence, partly because of epigenetics and partly because of family support.

17. Why are relatively few genetic conditions dominant?

Severe dominant disorders are rare because children with such disorders rarely live to pass the gene on.

18. Why are a few recessive traits (such as sickle-cell) quite common?

Carriers of sickle-cell die less often from malaria, still prevalent in parts of Africa. Selective adaptation allowed the gene to become widespread because it protected more people (the carriers) than it killed. About 11 percent of Americans with African ancestors are carriers. Similarly, cystic fibrosis is more common among Americans with ancestors from northern Europe; carriers may have been protected from cholera.

19. What are the advantages and disadvantages of genetic testing?

Genetic counseling relieves some worries by providing facts and helping prospective parents discuss sensitive issues. However, counselors must be carefully trained to

communicate clearly, because many people, especially when considering personal and emotional information, misinterpret words such as *risks* and *probability* (O'Doherty, 2006). Even doctors do not always understand.

20. Why do people need genetic counselors, not merely fact sheets about genetic conditions?

The counselor's job is to make sure the person understands the facts and treatment options as well as possible outcomes of not treating. It allows them to understand the difference between probabilities and certainties and to make decisions accordingly.