

## CHAPTER 1 PROBLEM SETS & INSIGHTS

### Solved Problems

S1. A human gene called the *CF* gene (for cystic fibrosis) encodes a protein that functions in the transport of chloride ions across the cell membrane. Most people have two copies of a functional *CF* gene and do not have cystic fibrosis. However, there is a mutant version of the cystic fibrosis gene. If a person has two mutant copies of the gene, he or she develops the disease known as cystic fibrosis. Are the following examples a description of genetics at the molecular, cellular, organismal, or populational level?

- A. People with cystic fibrosis have lung problems due to a buildup of mucus in their lungs.
- B. The mutant *CF* gene encodes a chloride transporter that doesn't transport chloride ions very well.
- C. A defect in the chloride transporter causes a salt imbalance in lung cells.
- D. Scientists have wondered why the mutant cystic fibrosis gene is relatively common. It is the most common mutant gene that causes a severe disease in Caucasians. Usually, mutant genes that cause severe diseases are relatively rare. One explanation why the *CF* gene is so common is that people who have one copy of the functional *CF* gene and one copy of the mutant gene are resistant to diarrheal diseases. Therefore, even though individuals with two mutant copies are very sick, people with one mutant copy and one functional copy are more disease resistant than people with two functional copies of the gene.

**Answer:**

- A. Organismal. This is a description of a trait at the level of an entire individual.
- B. Molecular. This is a description of a gene and the protein it encodes.
- C. Cellular. This is a description of how protein function affects the cell.
- D. Populational. This is a possible explanation why two versions of the gene occur within a population.

S2. Explain the relationship between the following pairs of terms:

- A. RNA and DNA
- B. RNA and transcription
- C. Gene expression and trait
- D. Mutation and allele

**Answer:**

- A. DNA is the genetic material. DNA is used to make RNA. RNA is then used to specify a sequence of amino acids within a protein.
- B. Transcription is a process in which RNA is made using DNA as a template.
- C. Genes are expressed at the molecular level to produce functional proteins. The functioning of proteins within living cells ultimately affects an organism's traits.
- D. Alleles are alternative forms of the same gene. For example, there is a human gene that affects eye color. The gene can exist as a blue allele and a brown allele. The difference between these two alleles is caused by a mutation. Perhaps the brown allele was the first eye color allele in the human population. Within some ancestral person, however, a mutation may have occurred in the eye color gene that converted the brown allele to the blue allele. Now the human population has both the brown allele and the blue allele.

S3. How are genes "passed" from generation to generation?

**Answer:** When a diploid individual makes haploid cells for sexual reproduction, the cells contain half the number of chromosomes. When two haploid cells (e.g., sperm and egg) combine with each other, a zygote is formed that begins the life of a new individual. This zygote has inherited half of its chromosomes (and therefore half of its genes) from each parent. This is how genes are passed from parent to offspring.