

1. Certain human genetic conditions, such as sickle cell anemia, result from single base-pair mutations in DNA.

- (a) Describe how the frequency of an allele coding for a mutant protein may increase in a population over time.

2. Darwin proposed that evolution by natural selection was the basis for the differences that he saw in similar organisms as he traveled and collected specimens in South America and on the Galapagos Islands.

- (a) Explain the theory of evolution by natural selection as presented by Darwin.
- (b) Each of the following relates to an aspect of evolution by natural selection. Explain one of the following.
 - (1) Natural selection and behavior such as kinesis, fixed action pattern, dominance hierarchy, etc.
 - (2) Natural selection and heterozygote advantage.

3. Evolution is one of the unifying themes of biology. Evolution involves change in the frequencies of alleles in a population. For a particular genetic locus in a population, the frequency of the recessive allele (a) is 0.4 and the frequency of the dominant allele (A) is 0.6.

- (a) What is the frequency of each genotype (AA , Aa , aa) in this population? What is the frequency of the dominant phenotype?
- (b) How can the Hardy-Weinberg principle of genetic equilibrium be used to determine whether this population is evolving?
- (c) Identify a particular environmental change and describe how it might alter allelic frequencies in this population. Explain which condition of the Hardy-Weinberg principle would not be met.

4. Scientists use the concept of homology in identifying evolutionary relationships among organisms. Features shared by two groups of organisms are said to be homologous if the similarities reflect shared ancestry. Homology is found in comparisons of structural, molecular, biochemical, developmental, physiological, and behavioral characteristics of organisms. Select TWO of the following hypotheses and explain TWO examples of homology that support each hypothesis.

- (a) Chloroplasts are related to photosynthetic prokaryotes.
- (b) Spiders and insects are closely related.
- (c) Echinoderms (sea stars and their relatives) are closely related to the chordates (the phylum that includes vertebrates).

5. Charles Darwin is considered the father of evolutionary biology. Two of his contributions to the field of evolutionary biology are listed below.

- Occurrence of gradual changes in species
 - Natural selection as a mechanism for evolution
- (a) For each of his contributions listed above, discuss one example of supporting evidence.
 - (b) Darwin's ideas have been enhanced and modified as new knowledge and technologies have become available. Discuss how the Hardy-Weinberg equilibrium has modified biologists' interpretation of Darwin's original contributions