Summary of Expectations

- Macro-evolution is evolution on a grand scale; a large evolutionary change. (11.1)
- Micro-evolution is the change in the gene frequencies within a population over time. (11.1)
- The Hardy-Weinberg equation is $p^2 + 2pq + q^2 = 1$. (11.2)
- The five conditions required to maintain a population in Hardy-Weinberg equilibrium are random mating, no mutations, isolation, large population size, and no natural selection. (11.2)
- Mutations may provide new alleles in a population and, as a result, may provide the variation required for evolution to occur. (11.3)
- The five causes of micro-evolution are natural selection, gene flow, genetic drift, non-random mating, and mutation. (11.3)
- The bottleneck effect and founder effect lead to genetic drift. (11.3)
- Three ways in which natural selection can affect genetic variation are stabilizing selection, directional selection, and disruptive selection. (11.3)

Language of Biology

Write a sentence including each of the following words or terms. Use any six terms in a concept map to show your understanding of how they are related.

- macro-evolution
- micro-evolution
- mutation
- modern synthesis
- allele
- locus
- homozygous
- heterozygous
- dominant allele
- recessive allele
- genotype
- phenotype
- incomplete dominance
- co-dominant
- population
- polymorphic
- fixed
- electrophoresis
- polymerase chain reaction (PCR)
- diploid
- frequency
- genetic structure
- Hardy-Weinberg principle
- Hardy-Weinberg equilibrium
- genetic drift
- bottleneck effect
- founder effect
- gene flow
- inbreeding
- non-random mating
- assortative mating
- stabilizing selection
- directional selection
- disruptive (diversifying) selection
- sexual dimorphism
- sexual selection

UNDERSTANDING CONCEPTS

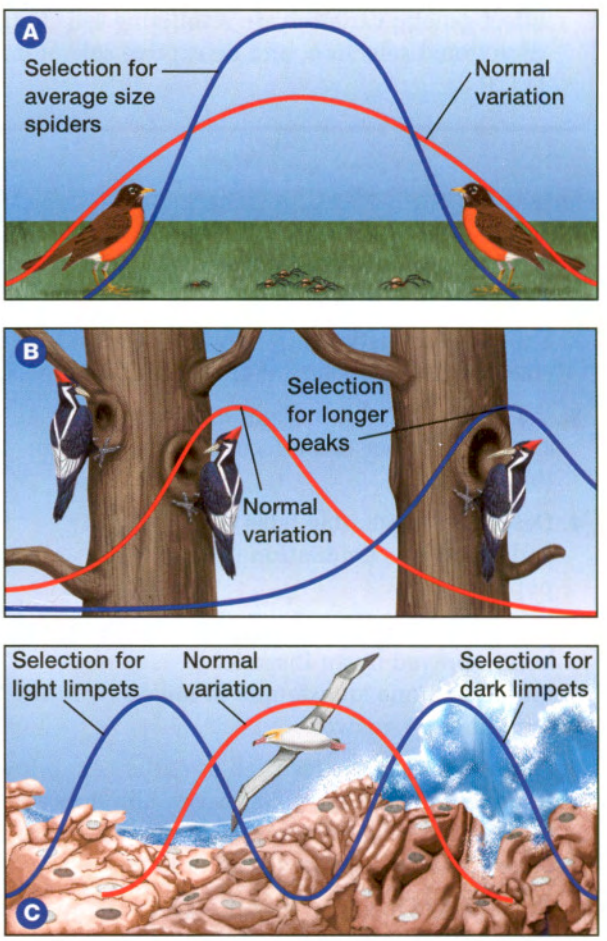
1. Differentiate between (a) dominant and recessive, and (b) gene and allele.
2. Explain the relationship between population size and the frequency of change in gene pools.
3. If a person gets his straight hair permed, explain whether this affects his (a) genotype; (b) phenotype.
4. Describe the possible fates of a mutation and the effects a mutation may have on a population.
5. A fly has a mutation that allows it to survive being sprayed by an insecticide. Is the mutation alone an example of micro-evolution? Explain your answer.
6. Are sex characteristics such as antlers adaptive in any way? Explain your answer and describe how sexual selection may affect the frequency of particular alleles in a population.
7. A species of toad commonly selects mates that are similar in size. How does this behaviour affect micro-evolution?
8. Give five examples of ways in which populations deviate from the Hardy-Weinberg equilibrium.
9. Choose an organism introduced in this unit and explain how two of the five situations that result in micro-evolution affect this population.
10. Describe how the work of Mendel and Darwin were blended to help develop the modern synthesis of the theory of evolution.
11. In pea plants, yellow peas are dominant over green peas. Predict the phenotypes and genotypes of the offspring of a cross between a plant heterozygous for yellow peas (Yy) and a plant homozygous for green peas (yy).
12. Describe the genotype of the parents and offspring in the following situations:
    - **(a)** A black mouse is crossed with a white mouse. There are 16 offspring, of which 75 percent are black and 25 percent are white.
    - **(b)** A bean with speckled seeds is crossed with a bean heterozygous for this characteristic. All offspring have speckled seeds.
    - **(c)** A tall dog and a short dog have two tall pups.

13. If a population has two alleles for a particular locus, B and b, and if the allele frequency of B is 0.7, calculate the frequency of heterozygotes if the population is in Hardy-Weinberg equilibrium.
14. If 16 percent of individuals in a population have a recessive trait, calculate the frequency of the dominant allele in the population. Assume the population is in Hardy-Weinberg equilibrium.
15. Describe three situations that might result in a bottleneck effect in a population.
16. Describe four situations that might result in gene flow in a population.
17. Explain why most mating is *not* random. Give an example of non-random mating in plants and in animals.
18. Describe assortative mating and provide an example.
19. Identify whether each of the following is an example of stabilizing, directional, or disruptive selection.
    (a) a population has only very large and very small snails
    (b) a population of ducks lays eggs of intermediate weight
    (c) in different parts of Africa, the colour pattern of the butterfly *Papilio dardanus* is dramatically different
    (d) most individuals in a population of hummingbirds have long beaks
    (e) a population has only medium-sized spiders
    (f) a population shifts from being primarily black moths to being primarily flecked moths
20. Compare natural selection with sexual selection.

INQUIRY

21. Plan an experiment or model that explains gene flow.
22. Devise a demonstration using coins, poker chips, or another item of your choice to explain how the founder effect works.
23. Create a demonstration, game, or other activity that explains one way in which populations can change over time.
24. The diagrams on the right illustrate different types of natural selection. The red bell-shaped curves indicate a trait's variation in a population. The blue bell-shaped curves indicate the effect of natural selection. Determine the type of selection occurring in each illustration and provide an explanation for how and/or why that type of selection might be occurring.
25. Using the data given below on the peppered moths (which you read about in Chapter 10, section 10.1), create bell-shaped curves that illustrate the natural selection of peppered moths from a polluted environment (in 1959) to a less polluted environment (in 1985 and 1989). Explain what is happening from 1959 to 1989 in the peppered moth population.

Year	In the region near Manchester
1959	9 out of 10 peppered moths were black
1985	5 out of 10 peppered moths were black
1989	3 out of 10 peppered moths were black



COMMUNICATING

26. Create a diagram that shows how non-random mating can increase the frequency of homozygous individuals in a population.

27. Explain the conditions in which a seemingly neutral mutation present in a small portion of a population may become quickly perpetuated in, and advantageous to, the population.

28. Theodosius Dobzhansky, a pioneer in the field of population genetics and one of the architects of the modern synthesis, said "Nothing in biology makes sense except in light of evolution." Explain your understanding of this statement.

29. You are a biologist who has been asked to explain evidence for micro-evolution to a class. Prepare your talk in point form. Provide examples of micro-evolution in action and of ways in which biologists study micro-evolution.

30. Summarize the three ways in which natural selection can shift the traits in a population's gene pool over time. Use diagrams to illustrate your summaries.

31. Scientists have used various types of biochemical and genetic analyses to determine the relatedness among the giant panda, the red panda, bears (such as polar bear, brown bear, black bear), and the raccoon. Results showed that the giant panda has DNA that more closely resembles the DNA of bears, and the red panda has DNA that more closely resembles the DNA of the raccoon. Draw a phylogenetic tree that shows these relationships.

32. You are a doctor who often prescribes antibiotics. Make a list of criteria for your patients explaining why they must take antibiotics only as prescribed.

MAKING CONNECTIONS

33. Why might a plant breeder be interested in knowing how certain traits are inherited?

34. Suppose paleontologists unearth a human skeleton that has been partially mummified and has had some of its hair preserved. What techniques could scientists use to gather more information from this discovery that would add to our understanding of evolutionary history? What are the limitations of the data and the techniques?

35. You are a biologist studying an endangered species of fox. Explain how you might use your understanding of population genetics in your work.

36. Describe different ways in which plant or animal biologists working with endangered species try to enhance genetic variation in populations.

37. What would happen to the conservation efforts if a number of alleles were eliminated from the current whooping crane population?

38. Sickle cell disease is caused by a recessive allele. Explain why the fact that we are diploid organisms keeps this allele at lower frequencies in the population. Imagine that a population of 20 individuals, three of whom carried the recessive allele for sickle cell disease, colonized a deserted island 200 years ago. The descendents of these individuals still live on this island. Predict the incidence of sickle cell disease on the island compared with the incidence of the disease in the human population at large.

39. Do you think that antibiotics should be available without a prescription? Give reasons for your opinion.