Chapter 24: The Origin of Species

Overview

What was Darwin's "mystery of mysteries"? 1.

Speciation

2. Define *speciation*.

An evolutionary process in which one species splits into two or more species.

3. Distinguish between *microevolution* and *macroevolution*.

Microevolution is evolutionary change below the species level; change in the allele frequencies in a population over generations.

Macroevolution is evolutionary change above the species level—for example, the origin of new groups of organisms, such as mammals or flowering plants, through a series of speciation events.

Concept 24.1 The biological species concept emphasizes reproductive isolation

4. Use the biological species concept to define *species*.

> A species is a population or group of populations whose members have the potential to interbreed in nature and produce viable, fertile offspring, but do not produce viable, fertile offspring with members of other such groups.

5. What is required for the formation of new species?

> It hinges on reproductive isolation. There are a number of barriers that can prevent gene flow, usually divided into prezygotic barriers and postzygotic barriers.

6. What are *hybrids*?

> Hybrids are offspring that result from the mating of individuals from two different species or from two true-breeding varieties of the same species.

7. Explain the two types of barriers that maintain *reproductive isolation*.

Prezygotic barriers are reproductive barriers that impede mating between species or hinder fertilization if interspecific mating is attempted.

Postzygotic barriers are reproductive barriers that prevent hybrid zygotes produced by two different species from developing into viable, fertile adults.

8. The following charts summarize the various ways that *reproductive isolation* is maintained. Explain and give an example of each type of isolating mechanism.

Prezygotic Reproductive Barriers	Explanation	Example
Habitat isolation	Two species that occupy different habitats within the same area may encounter each other rarely, even though they are not isolated by physical barriers.	One species of frogs lives in the water, and another species is a tree-dweller.
Temporal isolation	Species that breed during different times of the day, different seasons, or different years cannot mix their gametes.	North American eastern spotted skunk breeds in late winter, whereas the western spotted skunk breeds in late summer.
Behavioral isolation	Courtship rituals that attract mates and other behaviors unique to a species are effective reproductive barriers, enabling mate recognition.	Blue-footed boobies of the Galápagos; females respond to the male "flashing" his bright blue feet.
Mechanical isolation	Mating is attempted, but morphological differences prevent its successful completion.	Differing directions of particular snail species' shells prevent complete mating.
Gametic isolation	Sperm of one species may not be able to fertilize the eggs of another species.	Sea urchins species differ in the protein receptors on the egg that will bind the sperm; plant stigmas have specific receptors only to the pollen of the same species.

Postzygotic Reproductive Barriers	Explanation	Example
Reduced hybrid viability	The genes of different parent species may interact in ways that impair the hybrid's development or survival.	Hybrid offspring of salamanders of the genus Ensatina often do not
		complete development or are frail.
Reduced hybrid fertility	Even if hybrids are vigorous, they may be sterile.	The offspring of a donkey and a horse is sterile.
Hybrid breakdown	Some first-generation hybrids are viable and fertile, but when they mate with one another parent species, offspring of the next generation are feeble or sterile.	Strains of cultivated rice

9. The concept of reproductive isolation is essential for an understanding of speciation, so we are going to have you look at it again. Refer to Figure 24.3 in your text, and label the sketch below. Name each type of isolating mechanism.

See pages 490–491 in your text for the labeled figure and mechanisms.

Concept 24.2 Speciation can take place with or without geographic separation

10. Gene flow can be interrupted in two main ways. Explain and give an example of each by labeling and annotating this figure, which shows an ancestral species of fish and then the two modes of speciation.

See page 493 of your text for the labeled figure and examples.

11. What type of speciation is caused by a barrier such as the Grand Canyon?

Allopatric speciation

12. *Sympatric speciation* occurs in populations that live in the same geographic area. How is this possible?

Sympatric speciation can occur if gene flow is reduced by such factors are polyploidy, habitat differentiation, and sexual selection.

13. Your response to question 12 should have listed *polyploidy*, *habitat differentiation*, and *sexual selection*. These are not easy concepts to understand, so let's spend some time with each of them. To begin, use the following figure to explain *autopolyploidy*.

See page 495 in your text for the labeled figure.

Autopolyploidy is a type of polyploidy speciation resulting in an individual that has more than two chromosome sets that are derived from a single species.

14. Now, use this figure to explain allopolyploid speciation

See page 496 in your text for the labeled figure.

Allopolyploid speciation can occur when two different species interbreed and produce hybrid offspring. Most such hybrids are sterile because the set of chromosomes from one species cannot pair during meiosis with the set of chromosomes from the other species. This diagram traces one mechanism that can produce fertile hybrids as new species. The new species has a diploid chromosome number equal to the sum of the diploid chromosome numbers of the two parent species.

15. Before we leave allopatric and sympatric speciation, explain what happens in *sexual selection*, and how this process can drive sympatric speciation.

In sexual selection, individuals with certain inherited characteristics are more likely than other individuals to obtain mates. As in the case of the Lake Victoria cichlids, mate choice based on

male breeding coloration is the main reproductive barrier that normally keeps the gene pools of these two species separate.

Concept 24.3 Hybrid zones provide opportunities to study factors that cause reproductive isolation

16. What are *hybrid zones*?

Hybrid zones are geographic regions in which members of different species meet and mate, producing at least some offspring of mixed ancestry.

Concept 24.4 Speciation can occur rapidly or slowly, and it can result from changes in few or many genes

17. Stephen Jay Gould and Niles Eldredge coined the term *punctuated equilibria*. What is meant by a punctuated pattern?

The term refers to the periods of apparent stasis punctuated by sudden change.

18. Label this figure, and explain how each of the pictures explains speciation.

See page 502 in your text for the labeled figure.

The top part of the figure shows a punctuated pattern, in which new species change most as they branch from a parent species and then change for the rest of their existence.

The lower part of the figure shows gradual speciation, in which species diverge from one another much more gradually over time

Test Your Understanding Answers

Now you should be ready to test your knowledge. Place your answers here:

1. b 2. c 3. c 4. a 5. e 6. d 7. e