

Chapter 24: Origin of Species

1-2. What was Darwin’s “mystery of mysteries”? Define speciation.

Darwin’s “mystery of mysteries” was speciation, the process by which one species splits into two or more species.

3. Distinguish between microevolution and macroevolution.

Speciation forms a conceptual bridge between microevolution, changes over time in allele frequencies in a population, and macroevolution, the broad pattern of evolution above the species level.

4. What is the biological species concept?

According to the biological species concept, a species is a 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. Thus, the members of a biological species are united by being reproductively compatible, at least potentially.

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

The absence of gene flow plays a key role in the formation of new species, as well as in keeping them apart once their potential to interbreed has been reduced.

6. What are hybrids?

Hybrids are offspring that result from an interspecific mating.

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

Because biological species are defined in terms of reproductive compatibility, the formation of a new species hinges on reproductive isolation, the existence of biological factors that impede members of two species from interbreeding and producing viable, fertile offspring. Such barriers block gene flow between the species and limit the formation of hybrids. Prezygotic barriers block fertilization from occurring, typically by impeding members of different species from attempting to mate, preventing an attempted mating from being completed successfully, or by hindering fertilization if mating is completed successfully. Postzygotic barriers, such as developmental errors or problems after birth, may contribute to reproductive isolation after the hybrid zygote is formed.

8. Explain each type of isolating mechanism.

<i>Prezygotic Barriers</i>	<i>Explanation</i>	<i>Example</i>
habitat isolation	two species occupy different habitats within the same area, but do not encounter each other, even though they are not isolated by obvious physical barriers	two species of garter snakes occur in the same geographic areas, but one lives mainly in water, while the other is primarily terrestrial
temporal isolation	species breed during different times of the day, different seasons, or different years	though the geographic ranges of the western spotted skunk and the eastern spotted skunk overlap, they mate in summer and winter, respectively
behavioral isolation	courtship rituals and other behaviors unique to a species enable mate recognition, even between closely related species	blue-footed boobies mate only after a courtship display unique to their species, which includes the male’s high-step
mechanical isolation	morphological differences prevent the successful completion of attempted mating	the genital openings of two snails of different species are not aligned
gametic isolation	sperm of one species cannot fertilize the eggs of another species	gametes of red and purple sea urchins cannot fuse easily because proteins on the surfaces of the eggs and sperm bind very poorly to each other
<i>Postzygotic Barriers</i>	<i>Explanation</i>	<i>Example</i>

reduced hybrid viability	genes of different parent species may interact in ways that impair the hybrid's development or survival in its environment	some salamander species live in the same regions and habitats, where they may hybridize, but most hybrids do not complete development
reduced hybrid fertility	hybrids may be vigorous, but are sterile	mules (male donkey + female horse) are sterile
hybrid breakdown	some first-generation hybrids are viable and fertile, but when they mate with either parent species, offspring of the next generation are feeble or sterile	hybrids between strains of cultivated rice are vigorous and fertile, but plants in the next generation that carry too many mutant recessive alleles are small and sterile

9. Name each type of isolating mechanism. ✍

Mechanisms of reproductive isolation include habitat isolation, temporal isolation, behavioral isolation, mechanical isolation, and gametic isolation.

10. Explain and give an example of each main way in which gene flow can be interrupted.

In allopatric speciation, a population forms a new species while geographically isolated from its parent population, as when a river separates a field of blue flowers and a field of red flowers. In sympatric speciation, a subset of a population forms a new species without geographic separation, as when red flowers and blue flowers grow together in the same field.

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

Such a formidable geographic barrier will promote allopatric speciation if it infringes on organisms' mobility. For instance, birds may be less affected by this barrier than snakes.

12. How is sympatric speciation possible?

Although the ongoing gene flow resulting from continued contact makes sympatric speciation less common than allopatric speciation, sympatric speciation can occur if gene flow is reduced to such factors as polyploidy, habitat differentiation, and sexual selection.

13. Explain autopolyploidy. ✍

An autopolyploid is an individual that has more than two chromosome sets that are all derived from a single species. In plants, for example, a failure of cell division could double a cell's chromosome number from diploid ($2n$) to tetraploid ($4n$).

14. Explain allopolyploid speciation. ✍

An infertile hybrid may be able to propagate itself asexually. In subsequent generations, various mechanisms can change a sterile hybrid into a fertile polyploid called an allopolyploid. The allopolyploids are fertile when mating with each other but cannot interbreed with either parent species; thus, they represent a new biological species.

15. Explain what happens in sexual selection, and how this process can drive sympatric speciation.

In sexual selection, (typically) females select males based on their appearance. Research suggests that mate choice based on male breeding coloration is the main reproductive barrier that normally keeps separate the gene pools of closely related sympatric species of cichlids.

16. What are hybrid zones?

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

17-18. Explain the term punctuated equilibria. What is a punctuated pattern? ✍

Punctuated equilibria are periods of apparent evolutionary stasis punctuated by sudden change. In a punctuated pattern, new species change most as they branch from a parent species and then change little for the rest of their existence. Other species diverge from one another much more gradually over time.