

TOPIC: ALLOPATRIC AND SYMPATRIC SPECIATION

Allopatric and Sympatric Speciation

- ◆ *Recall:* speciation requires reproductive isolation.
- ◆ Broadly, we can say speciation happens in two ways:
 - **Allopatric Speciation:** species evolve in _____ locations (_____ habitual isolation).
 - **Sympatric Speciation:** species evolve in the _____ location (_____ habitual isolation).



PRACTICE

True or False: if false, choose the answer that best corrects the statement.

The difference between allopatric and sympatric speciation is how long it takes for populations to split into separate species.

- a) True.
- b) False; the difference between allopatric and sympatric speciation is if pre- or postzygotic barriers are used to create reproductive isolation.
- c) False; the difference between allopatric and sympatric speciation is how the species respond to recontact in a hybrid zone.
- d) False; the difference between allopatric and sympatric speciation is whether or not it involves a geographical barrier.

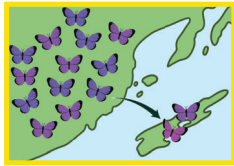
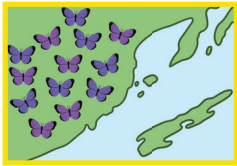
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Allopatric Speciation

◆ **Allopatric Speciation:** diverging populations are _____ isolated (habitual isolation).

▪ **Dispersal:** movement of individuals from one place to another.

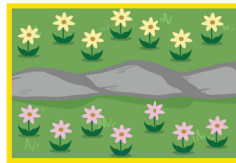
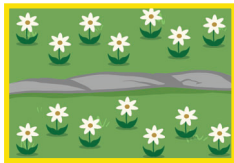
- Individuals _____ & colonize → Reproductive (genetic) isolation → Populations _____.



Populations no longer capable of breeding in the wild.

▪ **Vicariance:** physical _____ of a habitat.

- Event _____ the habitat → Reproductive (genetic) isolation → Populations _____.



Populations no longer capable of breeding in the wild.

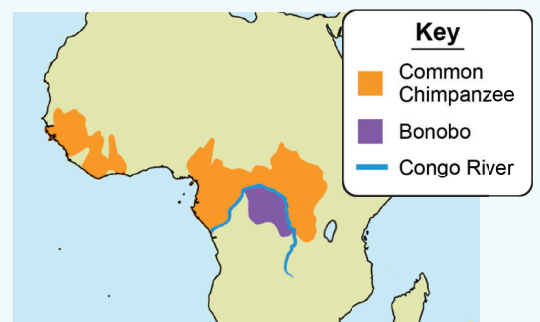
EXAMPLE

The map below shows the ranges of the common chimpanzee (*Pan troglodytes*, orange) and the bonobo (*Pan paniscus*, purple). Also shown on the map is the Congo River. Both species live in similar habitats within the tropical rainforest environment. The two species are thought to have split from a common ancestor approximately 1.5-2.0 million years ago. Use this information and information from the map to answer the following questions.

a. Are these two species sympatric or allopatric? _____

b. What specific type of reproductive isolation do you think likely led to and is most responsible for maintaining the two species? _____

c. If a vicariance event led to the formation of these two species, make a prediction about the age of the Congo River and how bonobos and common chimpanzees ended up on opposite sides of the river.



d. If a dispersal event led to the formation of these two species, make a prediction about the age of the Congo River and how bonobos and common chimpanzees ended up on opposite sides of the river.

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PRACTICE

Which of the following would be most likely to lead to speciation by vicariance?

- a) Volcanoes in the ocean create new islands.
- b) A change in the environment leads to a grassland becoming a forest.
- c) A small group of organisms are washed to sea during a storm and land on a new island.
- d) A change in climate creates a desert that divides a large grassland.

PRACTICE

The organisms of the Galapagos islands have become famous for people studying their processes of speciation.

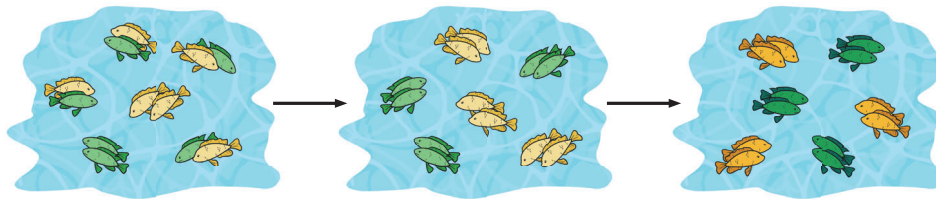
Which statement best describes how speciation most likely occurs on islands like the Galapagos?

- a) Speciation likely occurs through vicariance as the organisms that reached the islands split off from mainland populations.
- b) Speciation likely occurs through dispersal as groups of organisms reach new islands and adapt to local conditions.
- c) Speciation likely occurs through sympatric speciation as organisms diverge in different ecological niches.
- d) Speciation likely occurs through hybridization as new organisms interact with resident organisms on islands.

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Sympatric Speciation

- ◆ **Sympatric Speciation:** new species form in the _____ geographic area.
- ◆ Sympatric speciation can happen through:
 - **Polyploidy:** mutation that results in more than ____ complete sets of chromosomes.
 - More common in _____.
 - **Disruptive Selection:** selection for _____ phenotypes.
 - Requires mechanism for reproductive isolation such as _____ choice &/or microhabitat niches.



PRACTICE

Strong disruptive selection doesn't always create new species. What other requirement must be met for speciation to occur?

- a) There must also be reproductive isolation of the divergent phenotypes for speciation to occur.
- b) There must be no stabilizing or directional selection on other traits for speciation to occur.
- c) There must also be chromosomal differences between the groups for speciation to occur.
- d) There must be random mating in the population for speciation to occur.

PRACTICE

Within the Northeast Pacific, two types of killer whales (*Orcinus orca*) are found. Resident killer whales feed mostly on salmon, while the transient population feeds mostly on marine mammals. While these populations spend a lot of time in the same waters, they do not interbreed, likely because they use different systems of calls to communicate. Some scientists believe that these two populations of orca are undergoing speciation. What type of speciation is occurring, and what type of reproductive barrier do you suspect is reinforcing the speciation?

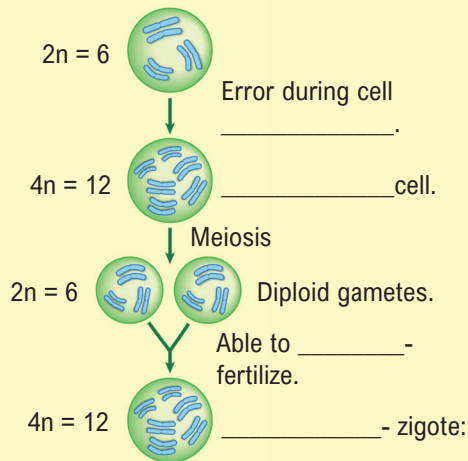
- a) Allopatric speciation with behavioral isolation.
- b) Allopatric speciation with habitual isolation.
- c) Sympatric speciation with behavioral isolation.
- d) Sympatric speciation with habitual isolation.

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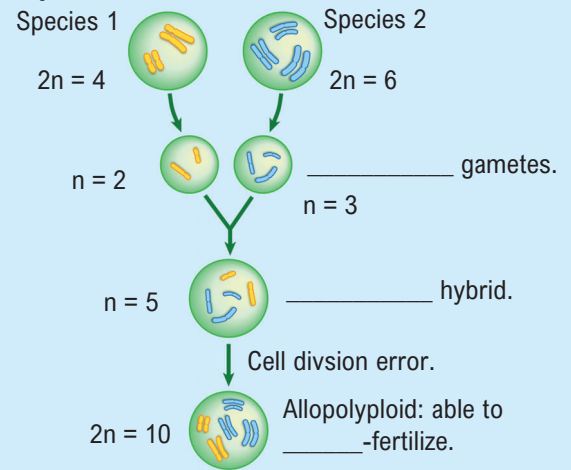
Polyploidy

- ◆ Recall: Polyploidy: having extra _____ of chromosomes.
- ◆ Can create new species in _____ generation.
- ◆ Causes speciation because species with different _____ of chromosomes create sterile hybrids.
- ◆ 2 types of polyploids:

Autopolyploid: Created through cell division error _____ a species (rarer).



Allopolyploid: Created through _____ followed by a cell division error.



EXAMPLE

Plant breeders developed seedless watermelons by creating polyploid plants. Normally, watermelons (*Citrullus lanatus*) are diploid ($2n = 22$). Breeders created watermelons that are tetraploid ($4n = 44$) by treating plants with a known mutagen that prevents the segregation of chromosomes during mitosis, creating cells with twice as many chromosomes. These plants could then be self-fertilized to create the new tetraploid breed. The plants grown from matings between these tetraploid plants and diploid plants are then sterile and, therefore, grow no seeds (and are delicious to eat!).

- As described, are tetraploid watermelons allopolyploids or autopolyploids? _____
- Why do you think that? _____
- Diploid and tetraploid watermelons are typically considered the same species. Based on the information above, however, by what species concept could it be reasonable to consider them different species?

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PRACTICE

Polyploidy creates individuals or gametes with novel numbers of chromosomes. To mate, these individuals must mate with other organisms that are also polyploid. Would this lead to polyploidy being more common in animals or plants, and why?

- a) Animals. Animals tend to have mobile sperm, so the gametes can travel farther to find compatible eggs.
- b) Plants. Many plants can self-fertilize, and gametes from the same plant will have the same number of chromosomes.
- c) Animals. Animal species are more likely to have individuals that are only one sex.
- d) Plants. Plant ovules tend to be larger than animal eggs meaning they can better accommodate the extra DNA.

PRACTICE

What is the difference between autopolyploids and allopolyploids?

- a) Allopolyploids can only reproduce through self-fertilizing, while autopolyploids are able to cross-fertilize.
- b) Allopolyploids are descended from a single species, autopolyploids begin as hybrids between two species.
- c) Autopolyploids are descended from a single species, allopolyploids begin as hybrids between two species.
- d) Autopolyploids can only reproduce through self-fertilizing, while allopolyploids are able to cross-fertilize.