

## Big Picture

As a population continually adapts to its environment, the accumulation of these adaptations over time makes the organism different enough for it to become its own species. There are many ways to define a species and many ways for a species to form. Organisms must constantly change as the environment changes, so constant speciation is natural and inevitable.

## Key Terms

**Speciation:** The formation of a new species.

**Allopatric Speciation:** When two populations of organisms from the same species are physically separated, each of the two organisms adapts to their respective environments.

**Sympatric Speciation:** When a new species arises even without geographic separation occurring between two populations of the same species.

**Coevolution:** When two species evolve based on their interactions with and effects on one another.

**Gradualism:** A model where evolutionary changes occur at a slow and steady pace.

**Punctuated Equilibrium:** A model where there are long periods of little evolutionary changes and short bursts of rapid changes.

## Species Concepts

There are many things called "species concept" to consider when defining a species. We are only going to look at four, but a species does not need to match all the species concept defined here to be considered a species. However, it should match at least one.

1. Biological species concept: If two organisms can produce fertile offspring, then they are the same species.
2. Morphological species concept: If the two species look like each other, then they are part of the same species.
3. Ecological species concept: This species concept looks at the role of two different organisms within their environment and the ecological niche that they fulfill. For example, if one of the organisms is prey, and the other organism is a predator, then we know that these organisms are obviously not the same species (unless they are cannibalistic, but this is pretty rare) that happen to share an environment.
4. Phylogenetic species concept: This compares the DNA of two organisms to note the similarities and differences to see whether or not the two are the same species.

## Speciation

**Speciation** can occur for several reasons. Geographic separation is important in **allopatric speciation**.

- If members of one species are separated for a long time, they may evolve genetic differences that prevent them from interbreeding.
- Each group had to adapt to their environment. Over time, the adaptations made will make the two organisms different enough to be two different species.
- Example: Let's say we have two populations of squirrels. They are separated by a river. Each side of the river has different environments: one side has trees that yield large nuts, and the other has trees with smaller nuts. The squirrels have to adapt to these environments. Eventually, over time, they have become two different species, with different sized hands and mouths to match with the types of food that they are eating.

Speciation can occur even if two populations are not geographically separated. **Sympatric speciation** can occur due to other types of isolating mechanisms. For example, two populations of the same species may evolve reproductive barriers. The two populations may no longer mate at the same times or may have developed different mating rituals.

**Coevolution** often occurs with species in symbiotic relationships.

- Example: Flowers and insects are a perfect example of coevolution. Flowers need to be pollinated in order to produce more offspring. They rely on pollinators to carry pollen from one flower to another. Flowers eventually evolved to attract insects with bright colors or petals and with nectar for the insects to eat. This encourages the insects to seek out similar flowers and transfer the pollen.

## Timing

Macroevolution can occur slowly or quickly, depending on changes in climate and geologic conditions.

- In the **gradualism** model, there does not need to be some sort of enormous geologic or environmental change for a species to form. Darwin thought that over time, a new species will form gradually.
- In the **punctuated equilibrium** model, there is little evolutionary change for long periods of time. When there is a huge change to the environment, organisms that are not properly adapted to the new environment immediately die off. Individuals that are best suited to the environment will thrive and are likely to form their own species. As a result, there are short periods of rapid speciation.