

The Biological Species Concept

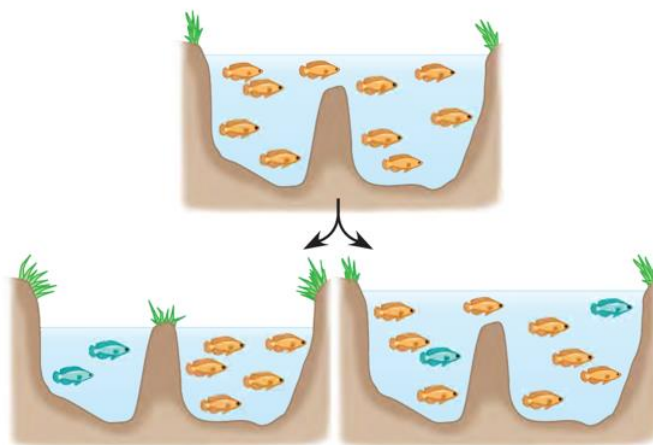
According to this concept, a species is a group of populations whose members have the potential to interbreed in nature and produce viable, fertile offspring—but do not produce viable, fertile offspring with members of other such groups. Thus, the members of a biological species are united by being reproductively compatible, at least potentially. All human beings, for example, belong to the same species.

Given the extraordinary diversity of life on the planet there must be mechanisms for **speciation**: the formation of two species from one original species.

Types of Speciation

Allopatric Speciation

In allopatric speciation (from the Greek *allos*, other, and *patra*, homeland), gene flow is interrupted when a population is divided into geographically isolated subpopulations. For example, the water



(a) **Allopatric speciation.** A population forms a new species while geographically isolated from its parent population.

(b) **Sympatric speciation.** A subset of a population forms a new species without geographic separation.

level in a lake may subside, resulting in two or more smaller lakes that are now home to separated populations).

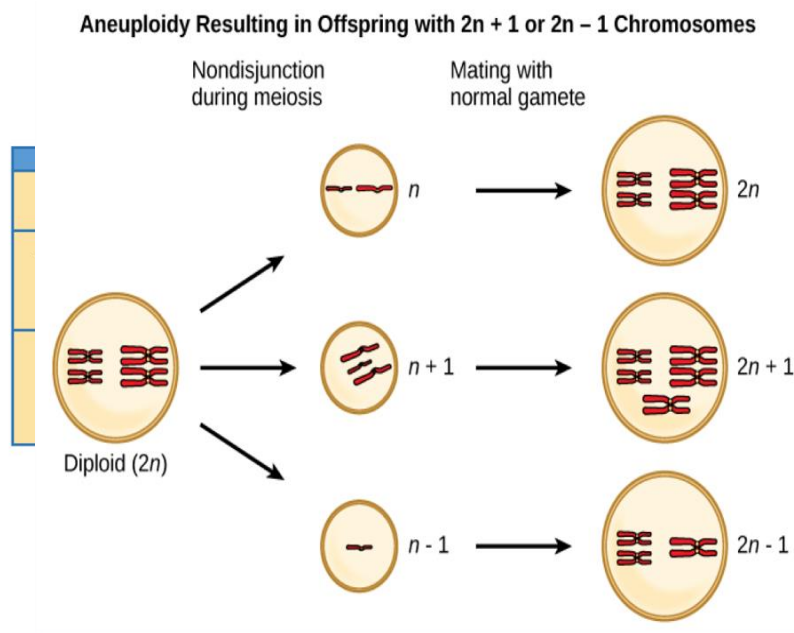
Or a river may change course and divide a population of animals that cannot cross it. Allopatric speciation

can also occur without geologic remodeling, such as when individuals

colonize a remote area and their descendants become geographically isolated from the parent population. During the formation of Arizona's Grand Canyon, squirrels and other small mammals

that had once been part of a single population could no longer contact and reproduce with each other across this new geographic barrier (the canyon), They could no longer interbreed. The squirrel population underwent allopatric speciation. Today, two separate squirrel species inhabit the north and south rims of the canyon. On the other hand, birds and other species that could easily cross this barrier continued to interbreed and were not divided into separate population

Sympatric Speciation



Sympatric speciation occurs when populations of a species that share the same habitat become reproductively isolated from each other. This speciation phenomenon most commonly occurs through polyploidy, in which an offspring or group of offspring will be produced with

twice the normal number of chromosomes. Where a normal individual has two copies of each chromosome (diploidy), these offspring may have four copies (tetraploidy). A tetraploid individual cannot mate with a diploid individual, creating reproductive isolation. Sympatric speciation is rare. It occurs more often among plants than animals, since it is so much easier for plants to self-fertilize than it is for animals. A tetraploidy plant can fertilize itself and create offspring. For a tetraploidy animal to reproduce, it must find another animal of the same species but of opposite sex that has also randomly undergone polyploidy.

Aneuploidy results when the gametes have too many or too few chromosomes due to nondisjunction during meiosis. In the example shown here, the resulting offspring will have $2n+1$ or $2n-1$ chromosome.

Parapatric Speciation

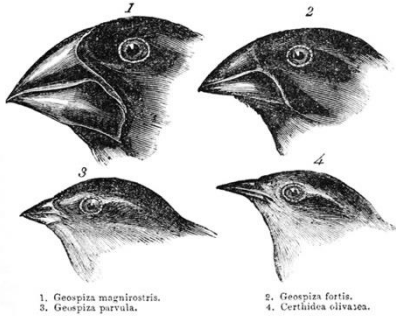
Mode of speciation	New species formed from...	
Allopatric (allo = other, patric = place)	geographically isolated populations	
Peripatric (peri = near, patric = place)	a small population isolated at the edge of a larger population	
Parapatric (para = beside, patric = place)	a continuously distributed population	
Sympatric (sym = same, patric = place)	within the range of the ancestral population	

In parapatric speciation there is no specific extrinsic barrier to gene flow. The population is continuous, but nonetheless, the population does not mate randomly. Individuals are more likely to mate with their geographic neighbors than with individuals in a different part of the population's range. In this mode, divergence may happen because of reduced gene flow within the

population and varying selection pressures across the population's range. We may be observing the first steps of parapatric speciation in the grass species *Anthoxanthum odoratum*. Some of these plants live near mines where the soil has become contaminated with heavy metals. The plants around the mines have experienced natural selection for genotypes that are tolerant of heavy metals. Meanwhile, neighboring plants that don't live in polluted soil have not undergone selection for this trait. The two types of plants are close enough that tolerant and non-tolerant individuals could potentially fertilize each other—so they seem to meet the first requirement of parapatric speciation, that of a continuous population. However, the two types of plants have evolved different flowering times. This change could be the first step in cutting off gene flow entirely between the two groups

Peripatric Speciation - Peripatric speciation is a special version of the allopatric speciation mode and happens when one of the isolated populations has very few individuals.

Adaptive radiation



According to Darwin's Theory of Evolution, living organisms change their physical and anatomical structures over a long period of time for better adaptations to the changing environment. The initiation of the point of evolution was when organisms wanted to exploit a niche and

they were not able to do so with their existing body design or structural component. Organisms started to split and adapt various versions for better survival. **Adaptive radiation is the evolutionary process by which many species originate from one species in an area and radiate to different species.** The phenomenon of adaptive radiation was first observed by Darwin when he travelled to a place called Galapagos Island. There he observed that there were finches with different types of beaks. So, he concluded that all of these finches radiated on the same island from a single ancestor Finch. All of these finches developed beaks according to the kind of food available to them. Hence, they evolved from the conventional seed-eating finches to vegetarian and insectivorous finches. They later came to be known as Darwin's finches.

References

- NCERT Books
- Cambell Biology
- <https://courses.lumenlearning.com/>
- <https://evolution.berkeley.edu/>

[The information, including the figures, are collected from the above references and will be used solely for academic purpose.]