

Natural Selection

*Some organisms have **favorable traits** that are well-suited to their immediate environment. Organisms with this advantage are more likely to thrive, reproduce, and pass their traits to future generations than organisms without those favorable traits. This process is known as **natural selection**.*

Favorable Traits

Favorable traits are traits that promote an organism's success in a particular environment. Organisms with favorable traits are more likely to reproduce and pass on their traits than organisms without favorable traits. In this way, the external forces of nature determine, or "select" which traits (or even which types of organisms) will continue to exist in a population.

Favorable traits may include physical traits, such as the body of a sea lion storing extra fat, or they may be instinctive behavioral traits, such as a bird building a nest to protect its young.

If an organism dies before reproducing, then its unique traits will be eliminated from the population. On the other hand, if an organism has favorable traits that allow it to survive and produce many offspring, then its traits will be more numerous within the population.

Natural Selection Occurs Over Time

Genetic variation combined with natural selection allows species to survive by adapting to changes in the environment. If enough significant changes or adaptations occur in the inherited traits of a population, natural selection may result in a new species.

Over time, favorable traits are likely to increase within a population and unfavorable traits are likely to decrease. In this way, natural selection plays an important role in the way species evolve over time. When natural selection results in changes in a species, these changes generally develop gradually, over many generations, rather than suddenly.

The following are sources of genetic variation among living organisms.

- **Mutations**, or changes to an organism's genetic material, are a significant source of genetic variation.
- **Sexual reproduction** results in an offspring that has a combination of genetic material from its parents, which contributes to genetic variation.
- **Meiosis** is the process by which sexually-reproducing organisms produce unique gametes, or sex cells. The unique gamete of one parent can fuse with the unique gamete of another parent to produce a unique offspring, resulting in increased genetic variation.

Natural Selection

Natural selection is a process by which organisms with traits well suited to an environment survive and reproduce at a greater rate than organisms less suited to that environment.

Basic Criteria for Natural Selection

The survival of an organism depends on its ability to sense and respond to the external environment. In all environments, organisms with similar needs compete for the same resources. These two facts fuel the process of natural selection.

Natural selection can occur if the following criteria are met:

1. **Overproduction:**

A species produces more offspring than will survive to maturity.

2. **Genetic Variation:**

The individuals within the species' population are all genetically slightly different from each other.

3. **Struggle to Survive:**

Individuals of the population must struggle to avoid predators and find food and shelter.

4. **Successful Reproduction:**

Individuals that are successful at surviving are able to reproduce and pass on their genes to their offspring.

Results of Natural Selection

Natural selection results in the following phenomena at both the molecular level and the population level:

Diversity

Diversity can refer to either the number of different characteristics present in a population or the number of different species in an area. On the environmental level, diversity creates stability in ecosystems and biomes. This is called *biodiversity*. A community that has biodiversity will not be seriously affected by the extinction of one or two species. On the species level, diversity allows the species to survive in a changing environment.

Humans affect the diversity of a species through the following two processes:

- *Selective breeding*—the breeding of organisms that have a certain desired trait
- *Genetic engineering*—the manipulation of genes that allows scientists to put genes from one organism into another organism

Adaptation

An adaptation is a *structure* or *behavior* that helps an organism survive in its environment long enough to reproduce.

Structural adaptations can include traits that improve the ability to find food, protection, or move from place to place. Most adaptations take long periods of time to develop fully. However, some species are capable of fairly significant change over only a few generations.

Many forms of behavior, including the evasion of predators, the ability to cooperate with other individuals of the same species, and the desire to mate, are governed by traits. Organisms with traits that produce beneficial behaviors are more likely to survive long enough to reproduce. Therefore these traits are more likely to be passed down through the generations and spread throughout a population.

Speciation

Speciation is the process by which two populations of the same species become so different that they can no longer interbreed. Speciation can occur in a few ways, but the end result always increases biodiversity. The following process describes the general steps that occur in most cases of speciation.

1. **Separation**

Different populations of the same species become isolated from one another.

2. **Adaptation**

The separated populations develop different responses, or adaptations, to the different selective pressures found in the newly isolated environments.

3. **Division**

Over a long period of time, the divided populations develop enough changes to their genetic material that they are no longer able to breed with one another.

Speciation can also occur due to a mistake during meiosis, in which too the chromosomes do not separate correctly. The result is an offspring with an extra set or sets of chromosomes, known as *polyploidy*. This is common in plants. In this case reproductive isolation is immediate, even if the individual is not separated from the rest of the population.

Extinction

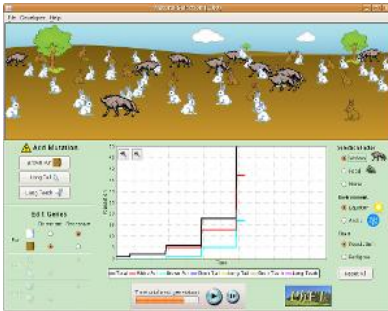
Extinction refers to the process of a species dying out completely. The extinction of a species occurs when environmental changes and adaptive characteristics are insufficient to permit survival.

Phylogeny

A phylogeny illustrates the evolutionary history and development of a species. While natural selection works on the individual level, it eventually affects the species as a whole. Therefore natural selection is one of the main instruments of phylogeny.

Natural Selection

Click on the image below to participate in a simulation in which you explore natural selection by controlling the environment and causing mutations in bunnies.



[PhET Interactive Simulations](http://phet.colorado.edu)
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Genetic Drift & Gene Flow

Genetic drift and gene flow are two mechanisms involved in evolutionary processes.

Genetic Drift

Genetic drift is a change in the allelic frequency within a population due to random chance. It is especially apparent within small breeding populations.

Genetic drift occurs when random chance results in certain alleles being passed on to future generations, while others are passed on at a lower rate, or even lost from the population.

For example, consider a population that has individuals with either brown or blue eyes. Suppose that eye color has no impact on reproductive success. If a random event, such as a natural disaster, resulted in the death of all blue-eyed individuals, then this allele would no longer be present in the population. This is an example of genetic drift because there was no selection involved in the loss of the allele from the population.

The **founder effect** is an extreme example of genetic drift. In this case, a relatively small population with fewer genetic variations becomes reproductively isolated. The result is a new population in which variation remains significantly reduced, and members tend to share many traits with the original founders of the population.

Gene Flow

Gene flow is the transfer of genetic information from one breeding population to another. Gene flow can be an important source of genetic variation when unique genetic information from one population is introduced into a different population.

Gene flow can be caused by many different events. For example, a storm with strong winds could blow pollen from one population of plants to another.