Chapter 7 • Lesson 35

Natural Selection

Key Words • species • evolution • natural selection • adaptation • phenotype • fitness • gene pool

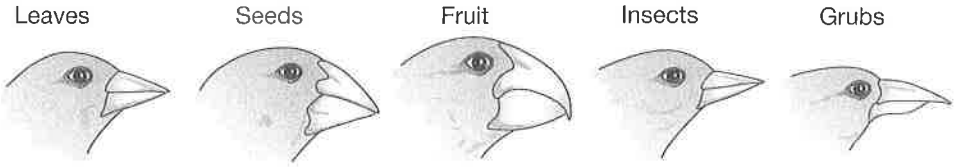
Getting the Idea

A **species** is a group of similar organisms that can breed and produce fertile offspring. The species that exist on Earth today are not the same species that existed 100 million, 10 million, or even 1 million years ago. In 1859, Charles Darwin, a British naturalist, published *On the Origin of Species by Means of Natural Selection.* In his book, Darwin proposed an explanation of how species change.

Natural Selection

The change in species over time, from the earliest forms of life to the wide range of organisms that exist today, is called **evolution**. Scientists today think that evolution has occurred at least partly through natural selection. **Natural selection** is the process by which organisms with favorable variations for their environment survive and reproduce, passing those variations on to the next generation.

Any organism must obtain resources from its environment to survive. Traits that increase an organism's chance of survival tend to become more common in a population. Such a feature is called an **adaptation**. Adaptations can be structural (related to an organism's form), functional (related to the way its body works), or behavioral. Darwin discovered the finches shown below during his voyage to the Galápagos Islands. The birds developed from a species that came to the islands from South America. The differences in their beak shapes show how they became adapted to the food sources available on each island.



Beak shapes in Galápagos Islands finches vary according to the type of food the finches eat.

How Natural Selection Works

Four key principles of natural selection include overproduction of offspring, competition for limited resources, variation, and differences in fitness.

Overproduction of Offspring

An oak tree produces thousands of acorns in its lifetime, and a spider may lay hundreds of eggs at a time. However, not all of these offspring survive to adulthood. Most are consumed by predators or do not manage to find a suitable place to grow. Relatively few survive to reproduce. Almost all organisms produce more offspring than can grow to adulthood.

Limited Resources in the Environment

The amount of space, food, water, shelter, and other resources in nature is limited. Organisms that share an environment must compete for these resources.

Variation within a Population

A *population* consists of the members of a single species that share an environment. Organisms in a population differ from each other in how well they can obtain resources from the environment and avoid *predation*, or the preying of one animal on others. Some of the variation is genetic variation, which is inherited, while some is due to affects of the environment.

Differences in Fitness

Recall that a **phenotype** is the form of a trait that an organism displays. Some phenotypes are better than others at helping an organism get resources and survive in its environment. If a phenotype that makes an organism successful results from its genes, the variation can be passed on to offspring. Organisms with traits better suited to their environment tend to produce more offspring than do other organisms in the same population. The ability of an organism to survive and reproduce in its environment is called its **fitness**. Traits that increase an organism's fitness are more likely to be passed on to the next generation. In this way, the traits of a population may change as the environment changes.

Natural Selection and Genes

Natural selection depends on variation in phenotypes. It acts on phenotype, not genotype. However, phenotype is the result of genotype, as you learned in Lesson 32. Traits are determined, at least partly, by genes. Therefore, natural selection can change the gene pool of a population.

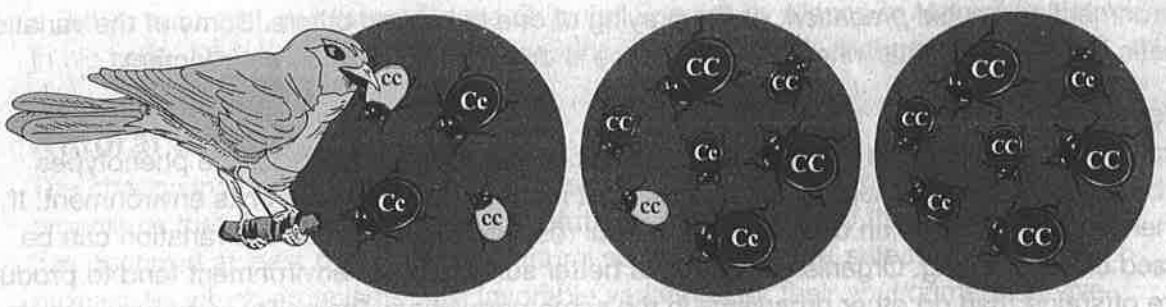
A population's **gene pool** includes all the alleles carried by members of the population, whether or not the alleles are expressed. Suppose that an allele, *t*, results in a helpful trait that allows the organism to better survive in its environment. This organism will be more likely to have offspring, and those offspring are more likely to inherit the helpful allele. Over time, the allele becomes more common, while other alleles (such as *T*) become less common. In this way, natural selection changes the population's gene pool.

In order for natural selection to work, there must be genetic variation in a population. Suppose there is only one allele *T* for a gene, so that each individual has the genotype *TT*. Natural selection cannot act on this gene because there is no variation to select. Recall from Lesson 33 that meiosis and sexual reproduction increase genetic variation. When gametes form, variation arises from independent assortment and crossing-over. Some variations also arise from mutations, or changes in DNA. A variety of genotypes and phenotypes in a population makes it more likely that some members of the population will survive and reproduce in a variety of different environmental conditions.

Examples of Natural Selection

Pesticide resistance is an example of natural selection. People have developed chemicals called pesticides to kill insects. *Resistance* is an organism's ability to withstand a harmful agent. Occasionally, some insects in a population have an allele that enables them to survive a pesticide. Because these organisms have greater fitness, they pass the allele that makes them pesticide-resistant to the next generation of insects. Over several generations, this trait can spread to many or all members of the insect population.

Many adaptations relate to finding food, escaping predators, and reproducing in specific environments. For example, the light-colored beetles below are spotted by predators more easily against the dark background. Because the dark phenotype helps beetles survive and reproduce in this environment, the allele for dark color passes to the next generation more often.



First generation Second generation Third generation

Natural selection does not eliminate every harmful allele from a population. Consider the allele that causes sickle-cell anemia, a disorder in which red blood cells are misshapen. People with two alleles for the sickle-cell gene (*SS*) experience pain, fatigue, and a shorter life span. Heterozygous people (AS) experience few symptoms, but they are less likely to be infected with malaria, a deadly disease. The sickle-cell allele is commonly found in populations that live where malaria is a problem. Although an allele may be harmful or lethal, it can persist in a population because heterozygous individuals are either more fit or not harmed by it.

Discussion Question

Fitness depends on an organism's environment. Give an example of a trait that would be favorable in one environment and unfavorable in another. How would natural selection affect the frequency of this trait if the environment changed?

Lesson Review

1. Which of these is **not** a principle of natural selection?

   A. More offspring are produced than will survive to reproduce.

   B. A phenotype that increases an organism's fitness tends to occur more frequently in subsequent generations.

   C. Organisms must compete for resources in their environment.

   D. Species with less variety are more likely to survive environmental change.

2. Which is the **best** definition of fitness?

   A. the ability to inherit dominant alleles

   B. the ability to pass on traits to offspring

   C. the ability to survive in an environment

3. A farmer plants a field of true-breeding corn plants. The plants are genetically very similar. What is a disadvantage of this similarity?

   A. The plants cannot pass on their traits to the next generation.

   B. The plants' phenotypes will be influenced by the environment.

   C. The plants are less likely to survive a change in the environment.

   D. The plants are more likely to develop a gene pool with recessive traits.

4. A disorder causes members of a mammal species to die soon after birth. The disorder is caused by inheriting two matching alleles for the disorder. What is **likely** to happen to this allele over time?

   A. It will disappear from the population because it decreases fitness.

   B. It will persist at the same frequency because natural selection cannot act on it.

   C. It will increase in the population because it allows parents to have more offspring.

   D. It will remain in the population because heterozygous individuals are not affected.