



# Evolution

**Evolution**, in a general sense, means a slow change over time. In biology, evolution means the change in characteristics of organisms over time, which may lead to the creation of a new species. It is a slow process and takes many generations to occur.

A **species** is a group of organisms with similar traits that will naturally reproduce with each other. Individuals in a species do not have to look exactly like each other - all breeds of dogs are a single species! Differences between individuals start with **mutations** in their genes. Mutations randomly occur naturally or may have environmental causes such as exposure to strong radiation or certain chemicals.



Evolution can occur in several ways:

- **Artificial selection** is the method used by animal breeders and farmers to ensure that their stock has the qualities they desire. Most plants and animals raised today are the result of artificial selection.
- **Natural selection** is driven by nature rather than humans. In a group of organisms, some will have characteristics that allow them to survive better in their environment. These individuals will have a better chance to reproduce since they will be healthier and live longer. Individuals without these characteristics, or with characteristics that make it more difficult to survive, will be less healthy or even die sooner. They will reproduce less, and future generations will have more of the 'good' characteristics than the 'bad' ones.
- **Genetic drift**, sometimes called 'accidental evolution', is the evolution of a trait in a group of organisms that gives them no advantage to their survival. One way it could occur is when a large portion of the population is wiped out at random by a disaster. The characteristics in the organisms left alive will be seen more in the next generations, whether or not they have a survival advantage.

Horse breeders want fast, strong horses with long legs. Because of artificial selection, modern breeds of horses are taller than horses from even 100 years ago.

Most Arctic animals have a layer of fat under their skin. Animals without this layer would die from the cold before they were old enough to reproduce and pass on the fat-less characteristic.

An organism's **niche** is the place it occupies in the ecosystem. Where it nests, what it eats, and what time of day it is active are all components of the niche. Usually, only one species will fit into a specific niche. If more than one species tries to fit into a single niche, there is competition for food and space, and the organism better suited to that particular environment would squeeze out the less-suited ones.

When a single species evolves to produce several new species with different characteristics, it is termed **adaptive radiation** or **divergent evolution**. Structures that are similar in the new species (because of their shared ancestry) are called **homologous**. Often, organisms with similar characteristics will develop separately from each other. For example, hedgehogs and porcupines both have spines, but are not directly related to each other. These characteristics are called **analogous**.



There is some debate over whether evolution occurs gradually, with old species fading into new ones (**gradualism**), or whether species remain mostly the same for long periods of time, with a few short bursts of rapid change (**punctuated equilibrium**).

Keep in mind that only characteristics that are **heritable** (part of the organism's genetics) may be passed on to future generations. For example, a plant that naturally has blue flowers will pass this on to its offspring, but a plant that has blue flowers because of a dye in the soil will not pass the blue color to its offspring.



## PRACTICE QUESTIONS

1. Which of these two options describes evolution in a group of beetles during a drought: (a) Food is scarce. Because of the competition for food, all the beetles are smaller than average. (b) The grass they live in is now more brown than green. Since green-coloured beetles are easier to spot, they are eaten by birds, and mostly brown beetles are left.
2. On an island, there are no plants that grow along the ground, but many trees. What kind of animals would you expect to find the most of there? (a) small, armoured animals such as turtles; (b) burrowing animals; (c) small animals that climb; or (d) horse-like animals
3. The canola grown today for its oil was developed at the University of Manitoba by careful breeding of rapeseed plants to remove the foul-tasting erucic acid from the oil (the word canola comes from **C**anadian **o**il **l**ow **a**cid). What method of evolution produced canola?
4. Two kinds of fish in a lake both eat mosquitoes and lay their eggs in the gravel at the bottom of the lake. One type of fish prefers the cooler water in the middle of the lake, while the other prefers the warmer water at the edges. Will these fish be able to exist together?
5. Are a bat's wing and a bee's wing homologous or analogous structures? What about a bat's wing and a human arm?
6. Bactrian camels have two humps, but dromedaries have one. Neither camel has an advantage over the other because of the number of its humps. Which method of evolution likely produced the difference in humps?
7. Antibiotic-resistant bacteria are a problem in hospitals today. There are some types of bacteria that can no longer be treated by the antibiotics currently available. Describe how these bacteria could evolve from a "normal" infection in a person taking antibiotics.



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## SOLUTIONS

1. (b) describes evolution, because the characteristics (brownness) of the beetles will be carried on to the next generations. (a) is not evolution because the size of the beetles was determined by their diet, not their genetics, and their offspring will grow to normal size with sufficient food.
2. Small climbing animals (c) would be best suited to this environment, since most of the food would be up high in the trees, and the other types of animals would be less able to reach it.
3. The method used to produce modern canola is artificial selection, since humans bred the plants to produce desirable qualities, rather than nature selecting those that are best suited for their environment.
4. The fish should be able to exist together because they do not occupy the same niche. Though they have the same food, they feed in different areas, and should not compete with each other.
5. A bat's wing and a bee's wing are analogous structures (same function, evolved separately). A bat's wing and your arm are homologous — both were derived from the limb of a shared ancestor. Compare the bone structures if you like.
6. Genetic drift most likely produced this difference, since it was not caused by human intervention (artificial selection) and it does not make one camel more suited to the desert (natural selection)
7. One possibility: A person is ill and takes some antibiotics. A random mutation has made a few of the bacteria in their body resistant to the antibiotic, so they are not killed as quickly by the drug. The rest of the bacteria are killed quickly, leaving only the resistant ones. If the person does not continue taking the antibiotic, these resistant bacteria will not be killed, and can spread to other people. Any 'normal' bacteria will continue to be killed by the antibiotic, leaving only the resistant ones alive. Starting from a single infection, now an antibiotic-resistant bacterium has formed.

