

Q

A

Where do new genes come from?

Jason, from Ohio

Over time, organisms acquire new genes that help them survive in new ways. Arthropods such as insects, crustaceans, and spiders are a great example: their ancestors were probably legless, wormlike aquatic creatures with limited locomotion. At some point in evolution, they developed outgrowths that may have helped them crawl through mud, swim, or cling to rocks. These primitive legs were useful, so evolution favored the animals that had the genes required to make them. This process is called positive selection. Additional new genes eventually caused some animals to create a leg with a joint, which made the limb stronger and more flexible, and so that improvement became favored.

There are two ways an organism can gain new genes to make this kind of progress possible: horizontal gene transfer and gene duplication.

Horizontal gene transfer is common among prokaryotes—single-celled organisms without nuclei, such as bacteria. It occurs when an organism acquires new DNA from its surroundings or another organism. For example, two bacteria can exchange small pieces of DNA in a process known as conjugation. Or, when a virus leaves an infected organism, it may carry some of that organism's DNA with it into a new host. Through this process—called transduction—the second organism can acquire genes from the first.

Single-celled organisms also take up pieces of DNA they encounter in their environs—often loose genetic material from other organisms that have died and released their contents.

This type of gene transfer can occur between different species and has consequences for human health: it is how antibiotic-resistance genes are spread among bacteria.

In gene duplication, a new gene can arise within a cell of a multicellular organism when an error in the cell's replication process makes an extra copy of an existing gene. When two copies of a gene exist, the “spare” copy is able to change its function. Over evolutionary time, the differences between the duplicates may become great.

By combining gene duplication and horizontal gene transfer with other processes, like the random mutations and shuffling of genes that happen when cells copy their genetic material, large-scale evolutionary changes, like the acquisition of limbs, can occur.

Today, arthropods have the most diverse array of limb morphologies of any animal group: they have grasping claws, walking legs, swimming legs, mating appendages, feeding tools, and spear-like hunting appendages, to mention a few. And a single arthropod can have several different types of limbs; lobsters, for example, have walking legs, swimming legs, and claws. Such specialization makes it possible for animals to invade new environments and exploit new resources for survival.

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FOR MORE INFORMATION
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