# MICROBES

### VIDEO TRANSCRIPT

They are the oldest form of life on earth. Without them, plants could not grow. Garbage would not decay. We would not have oxygen to breathe and we would not be able to digest food. There are more of them on your hand right now than there are people in the world. We cannot seem them, yet we humans would not be able to survive without microbes.

Microbes are single-celled organisms so tiny that hundreds of thousands could fit on a period at the end of a sentence. To put this into perspective, this means that a tiny period could hold as many bacteria as there are people living in the entire city of Boston!

Microbes are the oldest form of life on earth dating back to about 3.5 billion years ago. This far back in time, we find a population of microbes that were the last universal common ancestors (LUCA) of all life on earth. From this common ancestor arose three domains by which we classify all of life: bacteria, archaea, and eukarya. All of the microbes in these domains contain a cell membrane, DNA, and RNA and ribosomes to help synthesize proteins from their DNA code. Now, although at first glance microbes may look similar, microbes are incredibly diverse.  So diverse that the last time many of them shared a common ancestor was 3.5 billion years ago!

To examine these differences, let’s first look at the domain bacteria:

Like archaea and eukarya, bacteria have a cell membrane, but unique to their domain, bacteria have a cell wall made up of peptidoglycan. Interestingly many bacteria produce antibiotics to kill other bacteria that might be competing for resources. We actually get the majority of our antibiotics to fight bacteria from other bacteria. When people think of bacteria they think of “germs”. While this can sometimes be the case, there are more bacteria in our bodies than human cells, and they help us digest food and provide us with nutrients we would not be able to get otherwise.

Bacteria also have many other benefits. *Lactobacillus* is the bacteria responsible for making your yogurt. Without the bacteria rhizobia, plants couldn’t take in the nitrogen they need to survive. Cyanobacteria live in the oceans and produce a large portion of the oxygen in our atmosphere by photosynthesis.

The next domain, archaea, may look like bacteria, but by examining their ribosomal RNA, archaea were shown to be more closely related to eukarya—the domain humans are in. It was once thought that archaea were only found in extreme environments. And although some archaea can flourish at below-freezing temperatures, above boiling temperatures, and in extremely salty conditions, archaea are found everywhere from your gut, to oceans, and most other places that you will find microbes.

Microbes within the final domain, eukarya, have a nucleus and organelles.

Microbes such as algae, protists, and fungi fall into this domain. We use fungi for fermentation to make bread, beer, and wine. Remember that bacteria can produce antibiotics to kill other bacteria? Well, fungi also produce antibiotics. In fact, the first antibiotic used in medicine, penicillin, was taken from fungi. Eukaryotic protists benefit humans by helping our guts, purifying drinking water, and producing atmospheric oxygen. However, some eukaryotes also have a dark side and can cause disease just like bacteria. For instance, the disease malaria is caused by a eukaryote and can be transmitted by mosquitoes.

Life in the domains bacteria and archaea consist of microbes—that is, they are one celled organisms. However, not all organisms in eukarya are microbes, and are instead multicellular. For instance, although there are unicellular fungi, such as yeast, other fungi such as mushrooms consist of many cells. Plants are another example of multicellular eukaryotes, and animals fall into this category too.

Both bacteria and archaea can obtain energy from a multitude of sources such as sunlight, deep sea vents, sugar, sulfur, hydrogen, vinegar, and iron. Most eukaryotic microbes gain energy from more familiar sources such as sunlight and sugars, and can even prey on smaller bacteria and archaea.

Microbes are microscopic, but play a BIG role in our world. They are an incredible group of organisms. Dead plants and animals decay after dying because microbes break them down allowing nitrogen, carbon, and oxygen to be recycled back into the ecosystem. Although plants usually get the credit, cyanobacteria from the domain bacteria and algae from the domain eukarya together produce about 75% of the oxygen in our planet’s atmosphere!

They have evolved to live in just about every place on earth - from 100 meters below the ocean floor, to hundreds of feet in the air, to Antarctica, to volcanoes, to inside of you! Understanding microbes has large implications for the environment and for human health. We humans would not be able to survive without them.