## What are microbes?

# The good, the bad, and the microscopic.

Life on earth began around 3.8 billion years ago with single celled prokaryotic organisms eventually leading to the evolution of humans about 200,000 years ago. Microbes are microscopic organisms that cannot be seen by the naked eye. The term microbe is general term rather than taxonomic one. Under the umbrella of the term many forms of life exist such as archea, viruses, bacteria, and fungi. The human body is home to many microbes with the main three being bacteria, fungi, and viruses. They can be both helpful and harmful. Specific microorganisms can create toxic algae blooms while others can aid us in digestion, soil replenishment, and even cleaning up oil spills.

## History

Understanding microbes and their interactions with the environment is essential to understanding how ecosystems function and how infectious diseases spread. In 1546, prior to the development of the microscope the study of microbiology was founded by Girolamo Fracastro when he suggested the theory of contagious diseases. In 1665, the first microscope was invented by Robert Hooke. Because of this, Hooke was the first person to have a close up view of a cell. In 1798, Edward Jenner helped develop a vaccine for smallpox. In 1861, Louis Pasture, known as the father of medical microbiology; coined the terms “aerobic”, “anaerobic”, and “microbiology” through describing the growth of yeast at the edges of sugar in and out of the presence of oxygen. Lord Joseph Lister can be considered the father of antiseptic surgery leading to the development of listerine. Robert Koch demonstrated the role of bacteria and in 1887 Richard Petri developed the petri dish used for solid cultures. In 1929, Alexander Fleming published the effects of penicillin drastically changing the way we view modern medicine and introducing things such as antibiotics and vaccines.

## C. Types of Microbes

### Bacteria are microscopic single celled organisms without any nucleus. Their cell walls are made of peptidoglycan. Which is a substance made of amino acids and sugars forming a mesh layer around the plasma membrane. They are believed to be direct descendants of the earliest organisms with fossil records dating back to 3.5 billion years ago. Bacterial cells are much smaller than our own cells with few being larger. Some are even as small as a virus cell. Bacteria do not have membrane bound organelles such as mitochondria and the endoplasmic reticulum. The large and diverse group of prokaryotes offers a wide array of shapes, sizes, and functions. The three main shapes being Spherical (cocci), Rod (bacilli), and Spiral (spirilla).

### Initially classified as bacteria, archea are void of a nucleus and have a unique lipid membrane. They can look similar to bacteria with a smaller size and shape. Archea too lack organelles and live in similar settings as bacteria. Although the group archea are best known for the few members living in extreme environments such as hot springs and salt lakes.

### Fungi, commonly known as molds, mushrooms, and yeasts, have no nucleus. Although they do possess membrane bound organelles such as mitochondria and a cell membrane composed of chitin. Unlike most plants, fungi are heterotrophs and cannot make their own food. They live as small singular cells ranging between the size of our cells and a bacterial cell. Mushrooms and molds are actively fruiting colonies of fungi that live as long microscopic fibers. Fungi are essential decomposers in most ecosystems. Some species of fungi even live harmlessly in/on the human body (mostly yeasts).

What did the algae say about the mushroom?

He’s a Fun(gi)!

### Protists can be either single celled or multicellular, containing a nucleus and membrane bound organelles. Multicelluar protists live in colonies without specialization of cells. This category of microorganisms is more defined by what they are lacking than what they have, making them a very diverse group. Due to this they have a variety of ways to move including amoeboid action, cilia, and flagella. Some are autotrophs, using chloroplasts to make their food while others are heterotrophs and consume decaying matter. Some parasitic protists can cause life threatening diseases such as malaria.

### Viruses are microscopic subdivisions made of nucleic acids, proteins, and occasionally lipids. Since the ability to reproduce is necessary for life, some consider viruses to be non-living due to their inability to procreate independently. Viruses instead reproduce by infecting a host cell and “hijacking” its machinery. They are often specialized to infect a specific host and cell type within said host. For example, HIV is a virus that infects the immune cells in primates. Viruses not only infect our bodies’ cells but our microbiome inhabitants as well.

### Microscopic plants and animals are also included in the microbe category. Most microscopic plants are considered to be amongst “green algae” and have membrane bound compartments with an outer membrane and cell wall. They are autotrophs and can produce their own food as well as serving as a significant food source for many creatures. Algae also release oxygen which is essential for animal life. Some animals like salamanders even place algae in their eggs as a symbiotic union benefiting both parties. Microscopic animals however are multicellular with specialized cell functions and nuclei. Unlike algae they cannot produce their own food. Most species of microscopic animals are from arthropoda (insects), crustecea (crustaceans), and rotifers (multicellular aquatic organisms). Mites, for example, are one type of microscopic animal that live on our bodies. They are arachnids similar to ticks that live in tight spaces such as hair follicles.

##  Where do they live?

Microbes can live in almost every environment on earth reaching from 20 miles below the earths surface to 20 miles above living at temperatures -20 C and below 0 C to boiling hot temperatures such as in geysers and ocean vents. They are considered extremeophiles due to the environments they can inhabit. Soils, oceans, plants, frozen seas, animals, roots, compost piles, toxic wastes, rocks and many other evironments are all habitats microorganisms can occupy. As a result of this ability to live in extreme places microbes have developed a way to “breathe” substances other than oxygen such as iron, nitric acid, arsenic, sulfuric acid, and uranium.

## What they eat

Due to their expansive reaches, microbes have very diverse diets. They thrive on a wide range of food from dead organic matter to oil and toxic wastes. The two main categories of diet for microbes are those who are autotrophs meaning they make their own food, and heterotrophs who have to find and consume their food. Without heterotrohic microbes the globe would be filled with corpses. Bacteria decompose animal waste, dead organisms, and plant litter to attain nutrients they recycle it as well. Through the decomposition processes employed by bacteria chemicals such as phosphorus, nitrogen, and carbon can be released back into the atmosphere. Simply put, next time you see a vegetable rot you are actually watching microbes at work. Not only do they eat and recycle matter, they serve as food for other organisms as well. For example in the great salt lakes microbes feed the brine shrimp that inhabit the lake. Those shrimp are then ate by millions of migratory birds. Without microorganisms such as those ate by the brine shrimp basic ecological functions would be drastically effected.

## Microbial influence on our bodies

### Microbes have a huge impact on human health as well. With over 100 trillion cells living in/on us this symbiotic relationship provides us with a wide array of benefits ranging from aiding in digestion to protecting us against pathogens. The microbiome contains taxa including archea, bacteria, viruses, and eukaryotic microbes with over 1000 species of bacteria alone. 90% of our microbiome can be categorized by six phyla: *Bacteroides, Verrucomicrobiota, Fuseobacteria, Actinobacteria, Proteobacteria, and Firmicutes.* Irregularities can lead to diseases such as obesity, autoimmunity, and metabolic syndromes. Microbes also provide us protection against pathogens through competitive exclusion and synthesis of antimicrobial elements. The present microbes in our bodies compete for residence against pathogens helping keep unwanted individuals out. The effects of microbial influence on our bodies is still widely unknown due to the nature of their size and the inability to study them up until around 150 years ago. With the recent boom in technology we can now study in depth the role microorganisms play in our health opening up a new world of medicine.

**Section Vocabulary and Definitions**

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| Word | Definition |
| Prokaryote | Microscopic single celled organism lacking nucleus and specialized organelles |
| Eukaryote | Any organism containing specialized organelles, membrane bound nucleus, and division by mitosis or meiosis. |
| Antibiotic | Medicine that destroys or inhibits growth of microorganisms |
| Microbiome | Microorganisms in a specific environment (such as the body of part of it)  |
| Vaccine | Substance used to stimulate the synthesis of antibodies and provide immunity against diseases, prepared from a contributory agent of the disease. Acts as an antigen without provoking disease  |
| Microbe | Term referring collectively to microscopic organisms. May exists as a colony of cells or single celled life form  |

**Chapter review questions:**

1. Name one prokaryote mentioned in this chapter.
2. Who invented the first microscope?
3. Name one autotroph and one heterotroph.

**Review answers**

1. Bacteria
2. Robert Hooke
3. Algae and Fungi

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