**The Microbial World**

**An Incredible Accident**

In 1928, a Professor of Bacteriology at St. Mary’s Hospital in London made a discovery that changed the course of history in the healthcare world. After returning from a vacation, Alexander Fleming sorted through his various petri dishes that he used to grow and study staphylococcus, a bacteria known to cause various diseases. To his surprise, Fleming noticed something quite unusual in one of his petri dishes. In his other dishes, staphylococcus grew all over the surface to produce several colonies of growth; however, in this one special dish, it appeared as if a mold had worked its way into the dish, and the area surrounding this mold was clear and free of staphylococcus growth. What did this mean? Fleming realized that this area of clearing meant that this mold had the potential to kill bacteria. Although Fleming did not fully understand the implications of his discovery at the time, he discovered a strain of mold that would save lives and cure several diseases. Fleming discovered a mold called *Penicillium notatum* – a strain of mold that secretes the substance penicillin, a well-known antibiotic that is still prescribed today.

**Introduction**

Every time we wash our hands, we are hoping to rid ourselves of bacteria that could be harmful and make us sick. These bacteria are called microorganisms, also known as “microbes.” Microbes are tiny forms of life that are all around us and found basically everywhere – on our books, on our food, in our bodies. These organisms are so tiny that they can only be viewed through a microscope; they are not visible to the naked eye. Often times, we think of microbes as disease-causing organisms that will make us sick, but most of the time this is not this case. Yes, some microbes are responsible for disease – these microorganisms are called **pathogens.** However, less than 1% of bacteria are disease-causing pathogens. Some microbes can actually be helpful and play an important role in our health.

There are several different types of microbes. The six classes broad classes of microbes include bacteria, archaea, fungi, protozoa, viruses, and algae. In this chapter, we will explore some of these different types. Additionally, we will take a look into how these microbes play roles in our health and everyday lives.

**Bacteria**

Our bodies are made of trillions of cells. Bacteria, on the other hand, are organisms made of simply one cell. Bacterial cells are a specific type of cell known as a prokaryotic cell. **Prokaryotes** are single-celled organisms that do not contain a nucleus or membrane-bound organelles. An especially unique characteristic of prokaryotes and of bacteria is the way in which their DNA is arranged. In **eukaryotes,** DNA, which contains the genetic information, is wrapped up inside the nucleus and is stored in several linear arrangements. In prokaryotes, however, DNA is arranged into a single, circular chromosome and is free-floating within the cell.

Scientists typically categorize bacteria according to their shape. The three classified shapes include spherical, rod-shaped, and spiral. Bacterial cells have a rigid cell wall that aids in their protection and function. These rigid cell walls are composed of **peptidoglycan**, a single molecule made of sugars and proteins. Further, bacteria can be classified as either **gram-positive** or **gram-negative** according to their cell walls. **Gram-positive** bacteria have a thick peptidoglycan layer, and **gram-negative** bacteria have a thinner peptidoglycan layer and contain an outer membrane. As we will see later, studying the cell walls of bacteria and classifying bacteria as either gram-negative or gram-positive is important for understanding antibiotics and how they work.

Some bacteria have structures that are specialized to help them move around. A specific example of one of these structures is a **flagellum.** A **flagellum** is a skinny, tail-like structure attached to the cell body that enables the cell to “swim” around. **Flagella** (plural)are often described as “whip-like.” As you can see, bacteria appear to be simple, single-celled organisms, but they can be quite specialized with unique characteristics. Another common morphological structure in bacteria is the **pilus. Pili** (plural) look like little hairs protruding from the cell body. Their function is mainly to attach the cell to a specific structure or to other bacteria.

**Fungi**

Although the word “fungus” does not sound particularly appetizing, humans actually eat different kinds of fungi everyday. Mushrooms are the most familiar kind of edible fungus, but the yeast used to make bread is also a fungus. Fungi are incredibly unique organisms – so unique that they have their own kingdom. Fungus cells are **eukaryotic,** meaning that contain a nucleus and membrane-bound organelles. As compared to bacteria, most fungi are multicellular. A defining characteristic of fungi is that their cell walls are composed of a substance known as **chitin.** The main types of fungi include molds, yeasts, and edible fungi like mushrooms. Fungi obtain their nutrients in similar ways that we do; they must get their food from other organisms. Organisms that cannot synthesize their own food are known as **heterotrophs.**

Similar to bacteria, some fungi can be found naturally growing in our body or on our skin. Fungi are also capable of causing infectious diseases. The diseases caused by fungi are called **mycoses.** A common fungal infection contracted by humans is athlete’s foot. Athlete’s foot is a contagious fungal infection that begins as a scaly, red, and itchy rash near the toes. Fungal infections are often treated with antifungal medicines.

**Viruses**

Viruses are an infectious, parasitic type of microorganism. **Parasites** are organisms that grow in or on other organisms and obtain their nutrients from the organism on which they live. Viruses can be thought of as hijackers. They invade healthy, living cells in order to reproduce and spread. Viruses are unable to reproduce without these invaded host cells. Viruses are neither prokaryotes nor eukaryotes, but they do contain their own genetic material. Their genetic material is protected and contained within a structure known as a **capsid.** Viruses are typically disease-causing. In some cases, the body is able to fight off the viral infection. Viral infections range from the common cold to more serious illnesses like HIV. A problem with viral infections is that they are difficult to treat with medication. Since they are not bacteria, they cannot be treated with antibiotics. A commonly used strategy to prevent viral infections is through vaccinations. Vaccinations “teach” the body to fight off the virus.

**Archaea**

Once classified as bacteria, archaea constitute a specific domain of single-celled microorganisms. It was not until the 1970s that archaea were recognized as their own domain. Archaeal cells are prokaryotic and can morphologically look extremely similar to bacterial cells. However, archaea have a few of their own unique shapes, like square-shaped, and have biochemical processes that are dissimilar from bacteria and other prokaryotes. The archaea that we have currently identified are not pathogenic.

Perhaps the most intriguing characteristic of archaea is their distinct ability to live in the most extreme of environments. Whereas most organisms need oxygen to survive, archaea are able to survive without oxygen, and some types are even poisoned by it. Archaeans have been discovered living in vents of the deep sea at insanely high temperatures and in hot springs, like the hot springs of Yellowstone Park. Archaeans are able to thrive in environments that are deadly to most other kinds of microbes.

**Microbes in Healthcare**

As has been discussed throughout the chapter, many kinds of microbes have the ability to cause disease and illness. Because of this ability, microbes are of utmost importance for scientists, doctors, and infectious disease specialists. A specific area of scientific research called **microbiology** focuses on these tiny organisms that cannot be seen by the naked eye.

**Antibiotics** are drugs that can kill or inhibit bacterial growth. Many kinds of antibiotics work by targeting the cell walls of bacteria. This is why studying and taking a closer look at the cell walls of bacteria is important in our pursuit of combatting bacterial infections. In microbiology and other areas of scientific research, new things are discovered all of the time; that is why it is so important to pay close attention to every detail. Often times, what seems like the smallest discoveries have the largest impact – just like the mold that grew in Alexander Fleming’s lab!

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