

## Cell Types

Cells can be divided into two large categories: **prokaryotic cells** and **eukaryotic cells**. Prokaryotic cells (bacteria) were the first cell type to evolve on Earth 3.5 billion years ago. They are simpler in structure and smaller in size. Prokaryotic cells lack **organelles**, which are specialized internal structures that perform specific functions (we will learn a lot more about organelles a bit later). Though all cells must contain DNA, prokaryotic cells do not house their DNA within a membrane-bound nucleus. Instead, bacterial DNA is condensed within a specific region called a **nucleoid**. Prokaryotic cells must undergo metabolic processes and create energy, so they have many enzymes needed to “run” their cellular reactions. Enzymes are made of proteins, and proteins are made by the bacterial **ribosomes** floating around inside. Some bacteria are motile (meaning they can move) and do so by using whip-like structures called **flagella** or smaller, hair-like projections called **cilia**. And, of course, a bacterial cell is surrounded by a cell membrane, plus an extra outside layer called a **cell wall**.

Though prokaryotic cells are simple cells, that does not mean they are at a disadvantage. On the contrary, their simplicity allows them to quickly reproduce. Furthermore, quick reproduction can introduce genetic mistakes (mutations), which create variation in a population. If you combine those two qualities a quickly growing population of cells, many of which have newly introduced genetic mutations you create perfect conditions for evolution to occur!

Healthy soil is rife with bacteria, and a single teaspoon can contain anywhere from 100 million to *one billion* bacteria! Bacteria are key in the food industry, such as fermentation of yogurt and cheese, and most importantly, bacteria keep us healthy. Bacteria provide us with antibiotics, and by colonizing our skin and digestive tract. One major downside to their super-fast evolution, however, is their penchant to become resistant to the antibiotics that are supposed to stop their growth. This occurs because a random mutation will enable a bacterial cell to survive in the presence of an

antibiotic chemical that would otherwise kill it; this lone, lucky survivor quickly reproduces and creates offspring, all with that same, lucky, antibiotic-busting mutation.

If prokaryotic cells are the small and simple types, eukaryotic cells are their larger and more complex cousins. The animals, fungi, protists, and plants are all composed of eukaryotic cells. Though it may seem straightforward to use the presence of cells as the defining characteristic of “life,” there is more to it. A living organism must also be able to reproduce and create progeny, and it must have a heritable genetic code (DNA). A living organism uses materials and undergoes metabolic processes, and it requires energy to survive. A living entity strives to maintain constant internal conditions (referred to as **homeostasis**) and responds to its environment. And finally, all living things evolve.

What, then, about viruses? These little guys are composed of only nucleic acid (sometimes DNA, sometimes RNA) surrounded by a protein coat. There is no self-derived phospholipid bilayer, no cytoplasm, no organelles. If you have ever come down with a bad cold, the seasonal flu, or something more exotic such as measles, you have definitely felt the wrath of those tiny little viral particles populating your body. A rhinovirus (the common cold) is inhaled, invades specific cells lining the respiratory tract, and once inside the cell, replicate themselves to such high numbers the cell essentially explodes. The virus does, indeed, reproduce and create more progeny viruses, but it cannot do so without first invading and taking over a cell that important building block of all life.

*Laskey et al.,2024*