6.1.1

# Prokaryotic Morphology and Reproduction

Prokaryotic cells can be identified by one of four shapes:

Cocci – spherical

Bacilli – cylindrical or rod shaped

Spiral – twisted rod

Vibrio – shaped like a comma

Prokaryotes reproduce through a process called asexual reproduction, primarily through a process called **binary fission** (the division of a single entity into two parts). The process results into two daughter cells with identical DNA, each being a clone to the parent cells. The reproductive rates are very high with cells doubling every 1-3 hours or 20 min in comes species like *E. coli*. In addition, the high reproductive rates come with a high error rate when it comes to copying the DNA. This high error rate is referred to has **mutation**. Most of the time mutation causes high rates of death, but every once and while, a mutation proves beneficial to the organism (more fit), improving its survival. In this case, the new "mutated" bacteria outcompete the other less adapted bacteria and a new strain takes over. Sounds just like an X-men movie! Growth is regulated by the conditions of growth such as nutrient supply, space, predation, and competition with other organisms. If conditions are bad, some prokaryotes can from endospores, which are extremely tough desiccated shells full of DNA, ribosomes and dipicolinic acid, the latter being necessary to maintain dormancy. These endospores can survive very difficult conditions such as extreme temperatures, pH, and even UV exposure for decades. When conditions return to optimal, the endospores will rehydrate and start growing again.

With no defined nucleus, the DNA is still found in given areas or regions called the **nucleoid.** DNA is organized into a single circular chromosome. Additionally, some pieces of shorter circular DNA called **plasmids** exist in bacteria cells, these plasmids often contain genes that improve survival (i.e., antibiotic resistance). Thus, with high mutation rates and unique plasmids that both improve survival rates, its no wonder that bacteria and humans exist in a kind of "arms race" to see who can defeat the other first!

The most important part of any reproductive process is the transfer of DNA and in prokaryotes have developed three unique ways to transfer DNA: **transduction**, **conjugation**, and **transformation**.

Transduction is defined as the process through which foreign DNA is introduced into a cell. Transduction does not require physical contact, instead DNA is transferred between bacteria by viruses called **bacteriophages**. Like humans, bacteria also share viruses, and these viruses can take over some of the DNA machinery turning the cells into mini virus production factories. The discovery that bacteriophages can insert "foreign" DNA into bacterial DNA led to the new discipline called genetic engineering.

Conjugation is the process that uses pili to pull two bacteria together and exchange plasmids. This allows unique genes to be transferred from on bacterium to another. The first plasmid discovered was named the fertility factor (F-sex factor or F-plasmid). Scientists now understand what gives the F-factor its unique property to be transferred and have since

used that property to insert different genes into bacteria. For example, the gene for human insulin was inserted into a genetically modified plasmid and then conjugated into a bacteria cell which then began to divide rapidly and produce human insulin!

Transformation is a “built-in” mechanism that some bacteria have that allows them to incorporate DNA from the outside. This typically happens when bacteria experience starvation and are thus “looking” for ways to increase their survival. Taking in foreign DNA comes with all kinds of risk, but, like mutation, every once a while the attempt works, giving a new advantage to the bacteria.

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