17: PROKARYOTES (part 2)

The word ***motility*** means movement. Bacteria motility is most commonly the result of one or more flagella, but there are also a few other ways they can move, such as making internal air bubbles that float them to the surface if they are in water. Some bacteria, that don't live in water, can glide using a slippery slime make of sugars (polysaccharides). Scientists speculate that the slime is extruded out the back and acts as a very slow jet engine causing an equal and opposite reaction that propels the bacteria forward, albeit extremely slowly.

Most often, bacteria rely on flagella for movement. Flagella are made of microtubules. At the base, where it attaches to the cell wall, there is a tiny protein gadget motor that spins the flagella around at speeds up to 200 rotations per second. Flagella are similar to cilia, a feature often found on unicellular protozoans but also found on some human cells. Cilia beat back and forth, creating a coordinated waving motion. Flagella beat in circles, acting more like an outboard motor.

Some bacteria have only one flagellum. The cell can still move backward and forward, however, because the direction of the flagellum's rotation can be reversed. Other bacteria have a clump of flagella instead of just one. Some have a flagella at each end. Perhaps the strangest arrangement is the all-over look, where there are so many flagella that the bacteria starts to look hairy. Bacteria with multiple flagella can spread them out and vibrate them in such a way that they do a "tumbling" motion, which helps them to turn and go in a different direction. Spirochetes have an inner flagellum, set between an inner and outer membrane. This geometry allows the spirochete to flex and twist, allowing it to "swim" through soft body tissue such as skin and cartilage. Whatever type of motility a bacteria has, it is used to go toward sources of food and away from things that would harm them.

Bacteria can be classified several ways. One is by shape, as we have seen. This is important for some purposes, but not for applying antibiotic medicines. When you need to get rid of harmful bacteria in your body, you must know which medicines will be most effective. ***Pathologists*** (doctors who study diseases) want to know about the bacteria's biochemistry. The most important testing procedure is called the ***Gram stain***. The results of this test will give you information about a bacteria's outer coating. Some bacteria have a thick layer of peptidoglycan, as we saw in the previous drawing. These bacteria will turn purple when the Gram stain method is applied. The peptidoglycan layer will soak up a lot of purple stain. Bacteria that turn purple with Gram staining are called ***Gram positive***.

Other bacteria have a much thinner peptidoglycan layer and have an additional outer membrane. These bacteria don't have enough peptidoglycan to turn purple, but will hold a reddish-pink stain. Bacteria that turn pink with Gram staining are called Gram negative. The names "Gram positive" and "Gram negative" don't mean "good" and "bad." There are good and bad bacteria in both categories. And from the bacteria's point of view, they are just trying to survive, which to them is always good.

Gram negative bacteria also usually have an additional feature that causes problems for their hosts. They have toxic sugars sticking up from their outer membrane. These toxins can be a problem even if the bacteria has died. In fact, if you kill off these bacteria too rapidly your body can be overwhelmed with trying to get rid of all the toxins. Your liver can only process toxins at a certain rate. The sick feeling (fever, aches, nausea) you get from an overload of these toxins is called the ***Herxheimer reaction***.

Some bacteria have yet another outer layer called a ***capsule***. The capsule is made of sugars (polysaccharides) and is very soft and sticky; it is often called the ***slime layer***. Having a slime layer is a big advantage for a bacteria. It prevents the cell from drying out, it helps it to stick to surfaces, and it makes it much harder for our immune cells to eat and digest it.

The archaea used to be classified as bacteria. Basically they are bacteria. They look and act like bacteria. The only reason they now get their own kingdom is because of some minor differences. Regular bacteria are now called ***eubacteria***, *(yu-bacteria)* meaning "true" bacteria. Here are some differences between archaea and eubacteria:

1) The protein structure of archaea RNA polymerase (the thing that makes mRNA) is slightly different from eubacteria.

2) The archaea ribosome has a slightly different structure and can't read eubacteria DNA code that tells where to start.

3) The phospholipids in the archaea plasma membrane have their fatty acids attached differently. This difference makes it possible to have a molecule with heads on both ends, so that there is no need for two molecules to make a bilayer. (Imagine joining the tails of all those phospholipids in our bilayer pictures.) This makes a very tough plasma membrane—one that can survive extreme conditions such as boiling hot or extremely salty.

4) Archaea cell walls are not made of peptidoglycan. Their walls are made of sugars, proteins and various combinations of those, sometimes looking very much like peptidoglycan, but not close enough for chemists to use the term "peptidoglycan."

5) Archaea DNA is wound around little spools made of protein balls called ***histones***. Plant and animal cells also have their DNA wound on histone spools. Eubacteria do not have histones.

For better or for worse, depending upon the situation, archaea will react differently to antibiotics than eubacteria will. We've seen how two types of antibiotics work: erythromycin and penicillin. Erythromycin attacks bacterial ribosomes at their P site, and penicillin attacks peptidoglycan cell walls. Archaea are not susceptible to either of these medicines because their ribosomes and cell walls are different from those of eubacteria.