LESSON 1: VIRUS MORPHOLOGY and ANATOMY

Don't let the word "morphology" scare you. It has a simple meaning. It is the study of the shape of something. That's right, scientists could have said "let's look at the shape" but they had to make up a complicated word that uses a Greek word so it would sound more "science-y." Here's the tricky part, though. Most people think "morph" means "to change." That's partly due to television shows like the Mighty Morphin' Power Rangers, who say, "It's morphin' time!" and then change into super-heroes. So now we have to re-educate young people and let them know that "meta" means "change" and "morph" means "shape." For example, when an insect goes through metamorphosis, it changes (meta) shape (morph). Morphology is actually one of the easiest things to study, because it doesn't involve any chemistry. We just look at shapes, often naming them and classifying them into groups.

Viruses come in three basic shapes, although these shapes are not what scientists use to classify viruses. (Classification is done by looking at the genome: the DNA or RNA.) The shape categories virologists use are:

1) RODS (also known as HELICES) The most well-known virus in this group is the Tobacco Mosaic Virus, or TMV. It was the first virus ever discovered. It is a long, thin cylinder, like a drinking straw. The cylinder is made of a long strand of protein curled around and around and around, sort of like twisting a piece of thick wire around a pencil. The shape of the circular wrapping is called a helix. "Helices" is the plural form of the world helix. The TMV's genetic material, RNA, is wrapped up in a helix shape also, and adheres to the inside of the tube.

The rabies virus is usually put into this category, too, although it is a very short cylinder and has a rounded end, making it look like a bullet. The Ebolavirus doesn't fit into any category very well, but it fits into this one better than the others. It is like a long, thin snake. The ends are not open, like the TMV, but are sealed. It might look like a worm, but it's not living and can't move.

2) ICOSAHEDRAL (includes spheres) Most viruses fall into this category. An icosahedron is a 20-sided shape made of triangles. There is a scientific reason why viruses so often take this shape. The virus is made of many individual protein pieces that fit together. It turns out that the icosahedron is the most efficient way for these pieces to come together because it requires the least amount of energy. This is universal pattern that we see everywhere in nature— things try to be at the lowest possible energy level. The smallest icosahedron is made of 60 identical proteins, with three proteins forming a triangle. Bigger icosahedrons will have more proteins, but mostly in multiples of 60 (commonly 180, 240 and). Sometimes the icosahedron will be hiding inside a spherical outer envelope, but even that is likely to based on this same geometry. The glycoprotein spikes sticking out are often, but not always, found at places where the triangles meet.

3) COMPLEX This is a catch-all category for viruses that don't fit into the first two categories. Bacteriophages (or just "phages") attack only bacteria, not plants or animals. They look a bit like lunar modules from the moon landings of the 1970s. The top part is an icosahedron, which can look spherical or oval in some phages. Most phages have names like T2, T4 and T7. The T stands for "type." (The Greek word root "phage" means "to eat.") The things that look like legs are called tail fibers and allow it to stick to the outside of a bacteria cell.

Recently, some really huge viruses have been found. They are far too big to follow icosahedral geometry, so they end up as giant oval shapes. For example, the Pandoravirus looks a bit like a flask with a stopper. The discoverer of this virus was reminded of the Greek myth about Pandora, whose curiosity got the better of her and she opened a flask she was told not to open, and out of the flask came all the evils of the world. In this case, the evil would be the virus's RNA, which invades a tiny ameba and causes it to make more Pandoraviruses.

WHAT IS INSIDE A VIRUS?

Viruses can vary a lot, but the two things they all have in common are 1) a **capsid** made of protein, and 2) a **genome** made of either DNA or RNA. Other structures that might be present are an outer **envelope** made of lipid membrane (stolen from the host cell the virus came out of), spikes and knobs made of **glycoprotein** (sugar-proteins) that allow it to attach to cells, tiny **protein gadgets** that will play a part in the reproduction process, and sometimes a thin layer of protein called the **matrix**, which adheres to the fatty lipid layer and gives it a bit more strength.

WHAT IS PROTEIN?

We keep saying that things are made of protein. Do you remember what protein is made of? The individual building block of protein is the amino acid. Aminos are made of atoms arranged around a central carbon atom. When we want to show al long chain of amino acids, they are usually drawn as circles with a letters written on them. Many aminos strung together form a polypeptide. The long polypeptide chain folds up into a particular shape and we call it a protein.

WHAT IS GENETIC MATERIAL?

Genetic material is either DNA or RNA and both have a "backbone" (the long edge of the ladder) made of alternating sugar and phosphate molecules, and rungs made of "bases." DNA has Adenine, Thymine, Cytosine, and Guanine. RNA replaces Thymine with Uracil (which is very much like thymine). DNA in most cells is always double-sided like a ladder, and RNA is always single-sided. In viruses, DNA and RNA can both be either single or double sided.