What The Heck is a Virus?

~~~~~

Introduction
First, let me tell you what a virus is NOT. A virus is not a bacterium, nor an independently-living organism. A virus cannot survive in the absence of a living cell within which to synthesize copies of itself (replicate). Antibiotics do not harm a virus; it is for this reason that treatment for the "flu" for example, is mainly to help ease the symptoms of the illness rather than to kill the organism which causes the "flu" (*Influenza virus* Please see: What the Heck is the "Flu"?).

Well then, what IS it?
Now, is there a simple explanation which can define what a virus IS? Hmmmm... that's actually a tough question. A virus is not strictly alive.. nor is it strictly dead... A virus has some fundamental information (genes made of DNA or RNA) which allows it to make copies of itself. However, the virus must be *inside* a living cell of some kind before the information can be used. In fact, the information won't be made available unless the virus enters a living cell. It is this entrance of a virus into a cell which is called a viral infection. Too, the virus is very, very small relative to the size of a living cell. Therefore, the information the virus can carry is actually not enough to allow it to make copies (replicate). The virus uses the cell's machinery and some of the cell's enzymes to generate virus parts which are later assembled into thousands of new, mature, infectious virus which can leave the cell to infect other cells. *Poliomyelitis virus* for example, may have over one million copies of its basic genetic information (RNA) inside a single, infected human intestinal mucosal cell.

What does a virus look like?
Moving from the outside to the inside, here are some parts of a virus which are common to many different kinds of viruses: capsid, core, genetic material (DNA or RNA). The capsid is the outer shell of the virus which encloses the genetic material within. The capsid is actually made of many, many identical individual proteins which are assembled very precisely to form the capsid structure. Sometimes there will be a protein core underneath the capsid which also surrounds the genetic material. Some viruses may have an additional covering on the outside called an *envelope*. An envelope is kind of like skin around the outside of the virus. The envelope is actually a lipid bilayer (membrane) with proteins embedded within the membrane. If you examine a baseball, take it apart, you will see how some viruses are assembled. The cover of the baseball (envelope), the tightly-woven thread (capsid), and the rubber core (genetic material) can be used to represent the parts of some viruses.

What do viruses actually do?
All viruses only exist and make more viruses. And with the possible exception of bacterial viruses which kill harmful bacteria, all viruses appear to be harmful because their replication leads to the death of the cell which the virus entered. A virus enters a cell by first attaching to a specific structure on the cell's surface via a specific structure on the
~~~~~

virus surface. Depending on the virus, either the entire virus enters the cell, or perhaps only the genetic material of the virus is injected into the cell. In either case however, the ultimate result of viral infection is the exposure of virus genetic material inside the entered cell. Then, the virus material essentially "takes over" the cell and nothing but viral parts are made, which assemble into many complete viruses. These viruses are mature and leave the cell either by a process called "budding" (just one or a few viruses at a time leave the cell) or by a process called *lysis* (the cellular membrane ruptures and releases all of the virus particles at once).

What things can become infected by a virus
So far, there is not a living thing identified that doesn't have some sort of susceptibility to a particular virus. Plants, animals, bacteria - every living thing, whether multicellular or single-celled, can be infected with a virus specific for the organism. And, within a species, there may be 100 or more different viruses which can infect that species alone. So, whenever viruses are discussed, they are discussed as being either plant, animal or bacterial viruses - which means that an animal virus only infects a certain animal, and a plant virus only infects a particular plant. We say that a virus is *specific* for a particular thing if the virus infects only that thing. So, there are viruses which infect only humans (smallpox), some which infect humans and one or two additional kinds of animals (influenza), some which infect only a particular kind of plant (tobacco mosaic virus), and some which infect only a particular species of bacteria (lambda bacteriophage which infects *E. coli*).

How many kinds of viruses are there?
Viruses come in all shapes and sizes and have an enormous array of different kinds of organization of basic genetic material within them. And, it is the arrangement and type of genetic material which is the method used for sub-classification of a given group of viruses. For example, the animal virus group can be sub-divided into the following sub-groups: double-stranded DNA; single-stranded DNA; double-stranded RNA; single-stranded RNA, and, retroviruses (a very unique kind of single-stranded RNA virus). An example of a human double-stranded DNA virus is *Epstein-Barr* virus (EBV). An example of a human single-stranded RNA virus is *Influenza virus*, Type A). An example of a human retrovirus is *Human Immunodeficiency virus* (HIV). As you can see, unlike humans, the arrangement and kind of genetic material within viruses can be very diverse. However, for all viruses, regardless of the kind or arrangement of genetic material, the virus is capable of replicating within a living cell and can produce progeny (offspring) which are usually absolutely identical to the original virus. You may wish to take a look at David Sander's information about viruses. Please see: David Sander's Complete Virology Information, Tulane

Do viruses change
Sometimes during the process of viral replication, mutations occur. If the mutation is harmful, the new virus particle might no longer be functional (infectious). However, because a given virus can generate many,. many copies of itself, even if 200,000 particles are no good, 100 might still be just fine. Further, some mutations don't lead to harm to the virus, but instead lead to a functional but now brand-new *strain* of virus (*Influenza virus* can do this; consequently, there are several different strains of this virus which have to be

identified each year in order to make a vaccine against the particular strain which might cause the "flu").

What protects things against viral infection?
Humans are protected in a couple of ways. First, if a particular virus infects one or more cells of a given tissue in our body, the infection leads to the synthesis and secretion of substances called *interferons*. Interferons are proteins and may be designated as alpha, beta, or gamma interferon). These proteins interact with adjacent cells which help adjacent cells become more resistant to infection by the virus. Sometimes, this resistance isn't quite good enough to prevent the spread of the virus to more and more cells, and we begin to feel sick (we are now experiencing a disease caused by the viral infection). Now however, the body's immune system takes over and begins to fight the infection by killing the virus on the outside of the cells, and kills the infected cells, too. The killing of the infected cells prevents the spread of the virus, since as was stated above, a virus requires a living cell in order for the virus to be able to replicate. Eventually, the virus will be completely removed, and we'll get over the illness. HIV is an exception to this situation because HIV infects cells of the immune system which are necessary to kill the infected cells. So, although HIV does not itself directly cause the condition known as AIDS, the eventual death of immune cells due to infection with HIV allows other infections to harm a person.

Recently, there have been agents designed in the laboratory and isolated from natural sources which are being used to fight certain viral infections. These agents are not called antibiotics however, since they are effective only for viruses and have not been isolated from other organisms capable of killing a virus. So far, no agents have been identified which are secreted by a cell which actually kills a virus. You may be familiar with the drug called *Acyclovir* which is used to inhibit the replication of *Herpesvirus*; and, AZT and HIV protease inhibitors which are used to inhibit the replication of HIV.

Plants are protected from certain viruses by substances which coat leaves and stems and "closing-off" systems which generate a walled-off area within the plant at the source of the infection. Bacteria can be protected from bacterial-specific viruses through the action of enzymes inside the bacterium's cell. However, if a bacterial virus (called a bacteriophage) infects one cell, usually within a very short time, all of the bacterial cells will be killed. If there are no other bacterial cells of that particular species around for that particular virus, however, the virus will die, too.