Viruses, bacteria, protists & fungi (just the basics!)

- parasites postponed until we discuss them in class.

I. Viruses:

- A virus is a short piece of DNA or RNA, sometimes with some associated enzymes.

- This is then surrounded by a protein coat (capsid) which is then (often) surrounded by a membrane (mostly protein & carbohydrates). This membrane may be made up partially of the membrane of infected cells.

- some RNA viruses are the ones that cause flu, measles, mumps, the common cold, polio, AIDS.

- some DNA viruses cause hepatitis, chicken pox, herpes infections.

- Viruses can be further subdivided - see below.

- The virus can attach to a cell (bacteria, body cell, etc.). Once this happens, the virus will release it's genetic material into the cell. For a typical RNA virus:

- in the case of RNA, a complimentary strand is then made using enzymes from the virus.

- this becomes mRNA that the cell than uses as if it were its own mRNA.

- Brief diversion on genetics: mRNA is RNA that has been transcribed from DNA

- DNA carries genetic information (typically “genes”). This DNA is “transcribed” into mRNA.

- mRNA goes from the nucleus into the cell, where ribosomes read the instructions and make proteins from mRNA.

- proteins control pretty much everything about you:

- structure, control of reactions (enzymes), etc.

- back to viruses: this viral “mRNA” usually makes more viral proteins, but also make new RNA for new viruses.

- the “new” viral RNA gets packed into the viral proteins, and released back outside the cell.

- lots of new viruses can be made in this way.

- the host cell is basically hijacked by the viral genetic material.

- the damage caused by viruses is often a factor of which cells a virus will attack:

- polio attacks nerve cells which can not divide again (once destroyed, your body can't replace them).

- a cold virus attacks cells along the respiratory tract which can rapidly divide again.

- note that the infected cell is not always destroyed. Viruses can behave in many different ways.

- All viruses behave more or less the same way, though the exact mechanism will vary depending on what kind of virus it is and what parts of the organism are infected.

- Viruses typically can only attach to a limited number of recognized molecules on the surfaces of "host" cells.

- The AIDS virus attaches only to certain lymphocytes - the necessary proteins are missing in other body cells (and generally restricted to humans and a few related primates).

- But some viruses (West Nile) are more flexible and can infect many different species.

Classification of viruses:

- Classified in several different ways, and much of this is in flux.

- The main system is based on the type of genetic material. Depending on the source, there are 6 or 7 different classes. For example:

- I Double stranded DNA (dsDNA) viruses

- II Single stranded DNA (ssDNA) viruses

- III Double stranded RNA (dsRNA) viruses

- IV Single stranded RNA (ssRNA) viruses (serves directly as mRNA)

- V Singe stranded RNA (ssRNA) viruses (provide a "template" for making mRNA

- VI Single Stranded RNA (ssRNA) viruses (provide a "template for making DNA)

- (VII) DNA viruses that manufacture DNA.

- within each of these classes there are then families of viruses, usually based on the following:

- Can also be classified using the usual taxonomic system (Kingdom, Phylum, etc.). Sometimes viruses are referred to with one system or the other.

II. Prokaryotes:

- includes heterotrophs and autotrophs

    - heterotrophs - get energy from consuming something else
    - autotrophs - get energy from sources like sun, heat, etc.

- Prokaryotes are divided into two main groups:

    - archaea
    - bacteria

- Come in three basic shapes:

    - cocci - sphere shaped
    - bacillus - rod shaped
    - spirochete - corkscrew shaped

- Some details:

    - archaea: not terribly important in this class. They're unique organisms and often thrive in extreme conditions:

        - different enough in structure and function from typical bacteria that they are generally put into their own taxonomic group (some folks say they're more closely related to eukaryotes than typical bacteria

        - often like extremely salty, hot, or anaerobic conditions are sometimes good places for archaea. Often, these conditions are good enough they can lead to "blooms".

            - more recently have been found in more reasonable conditions as well.

    - bacteria are extremely important:

        - blue-green algae/cyanobacteria - are autotrophs - bacteria that photosynthesize. They are very important (contribute much to oxygen, etc.), but we won't deal with them in this class.

    "Typical" bacteria:

        - they break down leftover biological material (e.g., dead stuff).
        - fix nitrogen (make nitrogen available) for plants (and therefore for us)
        - live together with us:
            - in our gut (breaking down food)
            - in our mouth (preventing fungi from growing (though others do cause cavities))
        - book mentions that there are more prokaryotes in your mouth than the entire human population (both past and present).

    Basic structure of a bacteria:

- Shares plasma membrane with all cells (prokaryotic or eukaryotic)

    - provides a boundary to the cells. Keeps cell contents together, and regulates flow of materials (food, gases, etc.) in and out of the cell.

- Also has ribosomes in common with all cells

    - small structures that make proteins (as determined by genes, which are carried on DNA).

- Do not have a nucleus **[OVERHEAD, fig. 4.3B, p. 55]**

    - the nucleus has DNA in it, so in prokaryotic cells, the DNA is in a nucleoid, a "nucleus-like" region.

    - also do not have "organelles" bounded by membranes.

    - frequently have a cell wall surrounding the cell membrane, and sometimes a capsule that offers even more protection and helps the bacteria stick to things.

    - A few other prokaryotic parts to be aware of:

        pilli - short projections that (like the capsule) help the bacteria stay put.

        flagella - help move the bacteria around.

    - many bacteria have an "endospore". A special "membrane/shell" inside the bacteria that allows the bacteria to survive extreme conditions.

        - this shell is resistant to many physical extremes:

            - boiling, dehydrations, freezing, poisons, etc.

            - many disease causing bacteria will also have an endospore.

        - bacteria with an endospore can remain viable for centuries!

Classification of bacteria:

- Bacteria are difficult to classify. Generally we would like to use DNA to indicate similarities between different bacteria (the more closely the DNA is, the more closely related bacteria would be).

    - This is difficult because bacteria can exchange so much DNA (plasmids or bacteriophages).

    - Still, some parts of the DNA usually are not affected, and so modern

bacteriologists try to work with this or with certain ratios of nucleic acids in order to classify bacteria.

- In the case of disease causing organisms, we are mostly interested in:

- gram staining. A technique invented by Hans Christian Gram.

- Bacteria stain (+) or (-) depending on the structure of various proteins/carbohydrates in their cell walls.

- Usually, Gram (-) bacteria are more dangerous and respond less to antibiotics (structures in their cell walls help expose toxins and help protect them better).

- morphology (basic shape of the bacteria)

- aerobic vs. anaerobic

- some bacteria do not do well in aerobic conditions (in fact, aerobic conditions can often be fatal to the bacteria).

- this can help determine growth patterns and help determine the type of bacteria.

- many antibiotics are also specific for aerobic vs. anaerobic.

- there are obviously many other things we are interested in when looking at pathogenic bacteria, but these are terms you will come across fairly often.

Disease causing bacteria:

- generally, they release toxins (exotoxins), or have toxins in their plasma membranes (endotoxins), that cause serious problems for humans.

- the toxin produced by the bacteria that causes botulism is one of the most toxic substances known (1 gram could kill > 1,000,000 people).

- fortunately botulism toxin degrades rapidly, particularly in open air.

- about half of the diseases humans get are caused by bacteria, including:

- tetanus, anthrax, salmonella, tuberculosis, plague, Lyme disease, etc. Much of the rest of the class will be spent on these.

Protists.

- Protists (and all other groups from here on) are eukaryotes.

- Unlike prokaryotes, the structure of eukaryotes is much more complex. We won't go into the details. But some highlights:

- have a cell membrane & ribosomes

- some (not animals) have a cell wall

- have a nucleus with DNA (chromosomes)

- have membrane bound organelles

- many "parts" of the eukaryotic cell are bound by membranes.

- A very diverse group. Probably should be split up into several groups.

- most are single celled and have mitochondria (for aerobic respiration). Some have chloroplasts (for photosynthesis).

Several major groups (not necessarily a taxonomic breakdown):

1 - Protozoa

- use cilia, flagella, or pseudopodia to move around.

- most are heterotrophs, but some autotrophs are also in this group.

- examples are amoebas, paramecium, euglena, even some diseases like malaria, sleeping sickness and giardia, which is why we need to talk about them.

2 - Slime molds

- are single celled, though some of them can be multicelled during part of their life cycle.

- some can get large

- many feed on bacteria, and live on rotting logs or other rotting material.

3 - Algae (photosynthetic).

- many algal forms are eukaryotes. Some are actually multicelled and can get enormous (giant kelp off the West Coast).

- multicelled green algae are thought to be closely related to plants.

III. Fungi.

The main difference between fungi and plants is that fungi are heterotrophs. They do NOT photosynthesize.

- the generally get their energy from other organisms, by breaking down (usually dead) tissue and absorbing the nutrients they need.

- molds, mushrooms, fungi, are all in this group.

Fungi have thin filaments called hyphae. These weave together to form a mat/network called a mycelium.

- various enzymes are released by the mycelium which digest the needed nutrients, which are then absorbed.

- many fungi have visible reproductive structures (also composed of mycelium). The above ground parts of mushrooms, various fungi you see growing on trees, etc.

Lichen:

- consist of fungi living together with green algae (or sometimes cyanobacteria).

- the fungi gets energy from the algae, the algae gets a place to live (the fungus also provides water and nutrients for the algae).

- these two organisms live together so closely that lichen are usually named and identified as species.

Some fungi are important due to being pests or causing diseases (generally by being parasitic):

- dutch elm disease, corn smut, chestnut blight (wiped out North American Chestnuts)
- Athletes' foot.
- some molds are extremely toxic
- yeast infections
- Coccidioidomycosis can be dangerous enough it was being investigated as a potential biological weapon. Usually it just causes rather mild symptoms. “Valley fever”. In affected areas up to half the population has probably had the disease.

But fungi are also extremely beneficial:

- act as decomposers, getting rid of dead stuff.
- we rely on many for food (mushrooms, truffles).
- we use them to provide flavor (cheese is ripened by fungi).
- lets not forget that yeast is a fungi!
- many are used to make antibiotics (antibiotics were first discovered Penicillin).