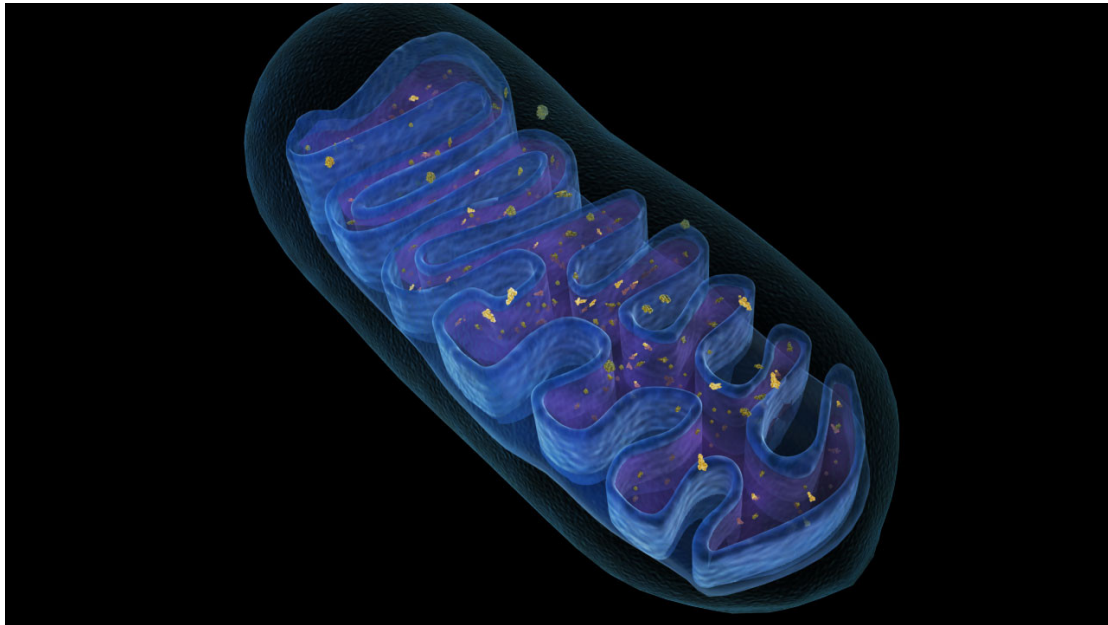


## MITOCHONDRIA / Transport / Taxonomy



**Mitochondria** are the “energy factories” of the cell. It is the mitochondria in cells which require the oxygen we breathe, and they use it in the efficient metabolism of glucose and other molecules to produce energy in the form of ATP. It is these bodies which require the oxygen we breathe. Most of the ATP in a eukaryotic cell is produced by the mitochondria. Mitochondria have a double membrane, and the inner membrane is extensively infolded to form cristae which act to increase the surface area available for enzymatic metabolic reactions which are oriented on membranes. Aerobic respiration is the most efficient and the major energy yielding process, and it takes place in mitochondria.

Convincing evidence suggests that eukaryotic cells are the evolutionary consequence of a symbiotic relationship between an ancient large cell (a so-called ur- karyote) and bacteria that were engulfed by that larger cell but not destroyed. This is the endosymbiont theory for the origin of mitochondria and chloroplasts and other MBO's. Mitochondria and chloroplasts (and some other MBO's) are believed to be evolutionary modifications of ancient engulfed bacteria - this is the endosymbiont theory. Like bacteria, mitochondria and chloroplasts have their own genome, though they are no longer able to live free of the parent cell, and the genome is bacterial in type - a circular chromosome. Mitochondria and chloroplasts also produce their own ribosomes, but these are of bacterial size and structure. The inner membrane of chloroplasts and

mitochondria shares chemical structures and features of bacterial membranes

## Transport

Transport is a critical process in and out of all cells. Nutrients need to be taken in and wastes removed, and this includes gases such as oxygen and carbon dioxide. Transport involves an understanding of the basic features of diffusion and osmosis, which I will mention briefly here but illustrate more deeply in class.

**Diffusion** involves the movement of atoms and molecules across the membrane in response to their concentration gradient, only from an area of high to an area of low concentration.

**Osmosis** is a special case of diffusion where solutes move (diffuse) as described, BUT there is a semi permeable membrane in place - a membrane which has holes (pores) in it which allow some solutes to pass but not others. Think about what this interposition of a semi permeable membrane means in terms of the effect it has on the movement of water as well as the movement of solutes across the membrane. Imagine a long glass tube which we bend into a “U” shape, having glued a semi permeable membrane in place, inside, at the bottom of the “U”. Now we fill the left side of the “U” tube with pure water (no solutes in it), and the right side with the same volume of a 10% solution of sugar. For purposes of illustration here we will assume that water molecules are very tiny and easily cross through the holes in the membrane, but the sugar molecules are too big to cross through the holes in the membrane.

**Facilitated diffusion** across a membrane involves special protein molecules in the membrane that allow movement of specific atoms or molecules across the membrane in response to their concentration gradient, atoms or molecules cannot be accumulated from an area of low concentration to an area of high concentration by this process– facilitated diffusion does not accumulate materials into the cell from where they are in scarcer amounts outside the cell, this is why the cell does NOT expend energy to perform facilitated diffusion.

**Active transport** is the transport of a specific molecule across a cell membrane against its concentration gradient (from an area of low to an

area of higher concentration –you can think of this as an accumulation process in the cell, taking scarce nutrients into the cell and accumulating them) and this DOES require the expenditure of energy in the form of ATP. Generally, a given active transport protein in a cell membrane only transports a given molecule.

**Endocytosis** occurs when a small fragment of cell membrane captures food material from the exterior, pinches off to form a sphere and enters the cell. Exocytosis is the reverse process where small vacuoles from the cytoplasm travel to and then merge with the cell membrane and release material to the cell exterior, such as waste molecules. ONLY eukaryotic cells undertake these processes, and not all eukaryotes do it.

## Taxonomy

Taxonomy is the science of the classification of organisms. Taxonomy is a system of orderly classification of organisms into categories called taxons.

Taxonomy is based on the Linnaean binomial system. The original rationale behind this system is not used now, Carolus Linnaeus (he was Swedish, but he latinized his name) lived in a time centuries ago when it was not appreciated that evolution occurred. He classified organisms mostly according to similar appearance, but this can be misleading, in the absence of evolutionary theory fish and whales are grouped together for instance, because they look alike. The formal binomial naming method created by Linnaeus is still used, but the modern classification rationale is based on evolutionary relatedness.

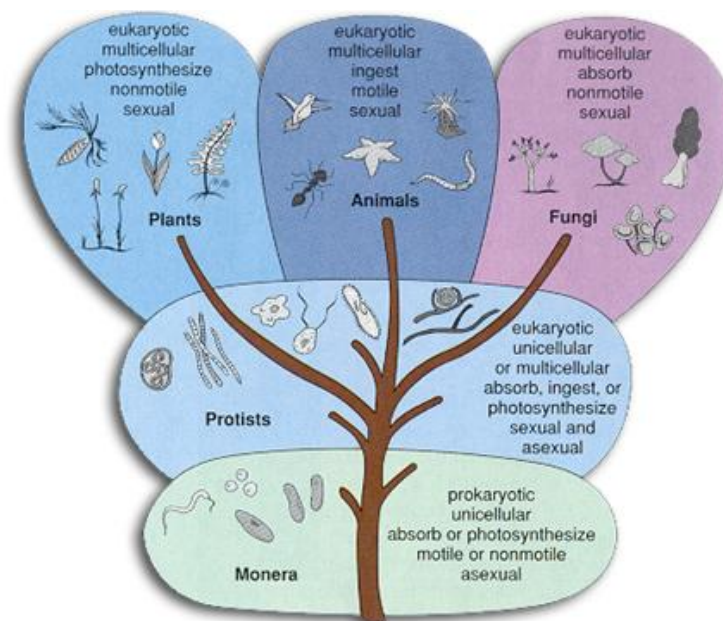
All living cellular things (biological entities other than viruses and prions) have a species and a genus designation, and organisms are placed into groupings that reflect their evolutionary relationships.

For us, *Homo sapiens*, our genus is *Homo* and our species is *sapiens*. Note the correct form used, genus name is underlined and capitalized, species name is not capitalized and is underlined. Alternatively the two words can be separately underlined or can both be entirely capitalized (though this is rarely done). These look like really fussy, picky rules, but this is essential, serious misunderstandings can occur if this convention is

not followed.

*Escherichia coli* is incorrect (not in bold or underlined or italicized). *Escherichia Coli* is incorrect (species epithet “coli” first letter must not be capitalized). *escherichia coli* is incorrect, the term is italicized but the genus must begin with a capital letter. It is acceptable and a usual practice to just use the first letter of the genus of a species **PROVIDING** that in any section of text the entire taxonomic name has **FIRST** been given in full, thus once the name *Escherichia coli* has been given in a written work it can then be referred to as *E. coli*.

The Five Kingdom Classification System; Animalia, Fungi, Plantae, Protista, Monera.



Within each Kingdom each organism is nested into a hierarchical classification of taxons in the order - Kingdom, Phylum-Division, Class, Order, Family, Genus, Species. The order of this list is important (which accounts for use of the term hierarchical), each taxon holds progressively more numbers of taxonomically different organisms as one moves up the list from species level, thus a genus contains a number of species, a family contains a number of genera and thus contains more species than a single genus in that classification since each family contains a number of genera each with their own species.

Taxonomists - those who study the classification of organisms can be a **HIGHLY** argumentative bunch, put two of them together and you may

get three opinions as to how an organism should be classified.

The Prokaryotes (Kingdom Monera) are:

- 1) The eubacteria (so called “true” bacteria - in future lectures, when I use the word bacteria - it refers to the eubacteria unless I state otherwise). Some of the eubacteria cause human disease, and this is why the eubacteria are those bacteria that are of main interest to medical microbiologists.
- 2) The cyanobacteria (so called and improperly referred to as blue-green algae) - common photosynthesising bacteria often noted as the green scum on ponds in summer months.
- 3) The purple photosynthetic bacteria, these perform photosynthesis but they do not use chlorophyll, they use special purple pigments instead, they are found in brine ponds for instance.
- 4) the Archaeobacteria, a group of evolutionarily ancient bacteria which are adapted to living in extreme environments such as high salt, intense cold, high temperature, high acidity etc

ALL the other Kingdoms contain eukaryotic organisms:

## **The Kingdom Protista.**

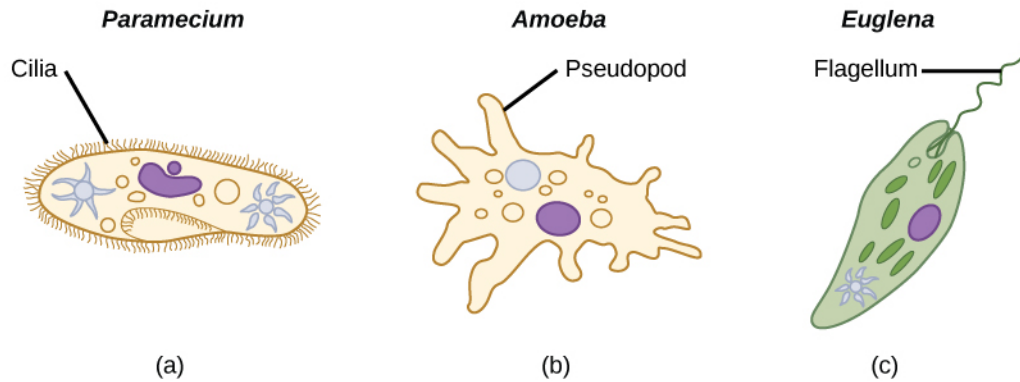
These are a diverse set of organisms

**Algae** - fresh and saltwater, single cells to simple multicellular photosynthesising organisms. Autotrophs, most have cell walls.

**Slime molds**- they are NOT fungi, look like fungi but can also be animal or even plant-like in morphology. Heterotrophs

**Protozoa**, a diverse group of single celled creatures that look and act like animals often, but are not, includes amoeba, paramecia etc, they are heterotrophs (some have autotrophic algae as symbiotic partners).

Some protozoa cause human disease. Some protists have plant and animal-like characteristics and are hard to classify - the Euglenoid protista are Heterotrophic and Autotrophic.



### **The Kingdom Fungi.**

Non photosynthesising single celled to multicellular organisms most of which have cell walls. Heterotrophs.

Includes **yeasts** (which are unicellular) and **mycelial** (filamentous) organisms such as bread mold and the mushroom forming fungi.

Some fungi cause human disease, some are important in food preparation.

### **The Kingdom Plantae – autotrophs.**

Multicellular photosynthesising organisms with cell walls. Trees, shrubs, bushes, grasses, moss, ferns etc.

### **The Kingdom Animalia. – Heterotrophs.**

Complex multicellular organisms of diverse types, no cell walls, showing

Characteristic irritability and movement.

Some cause human disease (parasitic infections, worms etc or act as vectors for other disease causing organisms).

### **Viruses**

Viruses are not classified by using the Binomial naming system and do not belong to any of the five kingdoms.

Viruses are not cellular and are dependent on host cells for their replication. Viruses are classified in two different ways:

1) according to their structure - genetic (DNA or RNA?) and physical (shape etc) – this scheme is favoured by scientists doing fundamental work.

2) according to the type of disease they cause, this scheme is favored by medical workers who need to correlate given viruses with given diseases.