Cellular Respiration

Cellular respiration is made up of 3 distinct phases;
-Glycolysis
-The Krebs Cycle
-The Electron Transport Chain

Glycolysis takes place in the cells cytoplasm outside of the mitochondria.
The Krebs Cycle and The Electron Transport Chain however take place within the mitochondria

$$6O_2+C_6H_{12}O_6 \Rightarrow 6CO_2+6H_2O+\text{Energy}$$

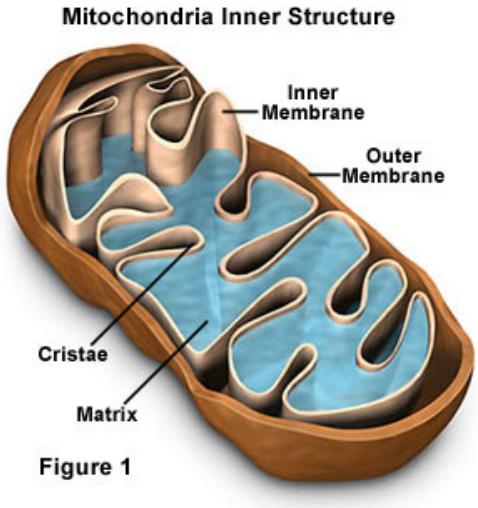
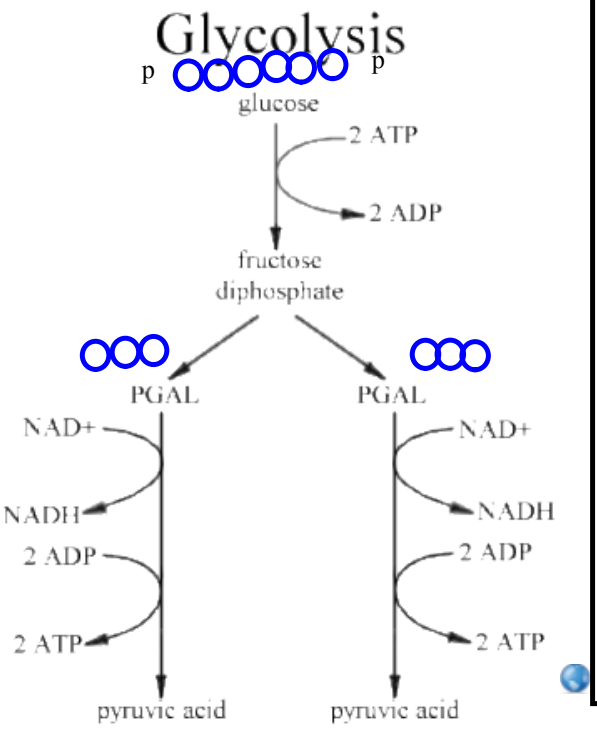


Figure 1

Return to Kreb's Cycle



Glycolysis-the splitting of glucose. Two phosphate groups are bonded to a glucose molecule. The energy comes from the breakdown of two molecules of ATP into ADP. This increase in energy causes the molecule to split into 2 molecules of Phosphoglyceraldehyde(PGAL), a three carbon sugar. PGAL is then oxidized by the loss of 2 hydrogen atoms and is changed into pyruvic acid. This releases energy which is used to produce 4 ATP. The hydrogen removed from PGAL is accepted by NAD+ forming NADH .

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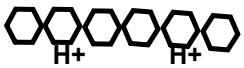
Questions 1-6

A P PP



APPP

NAD+

NADH

NAD+

NADH

APP

APP

Pyruvate =$C_3H_4O_3$

P

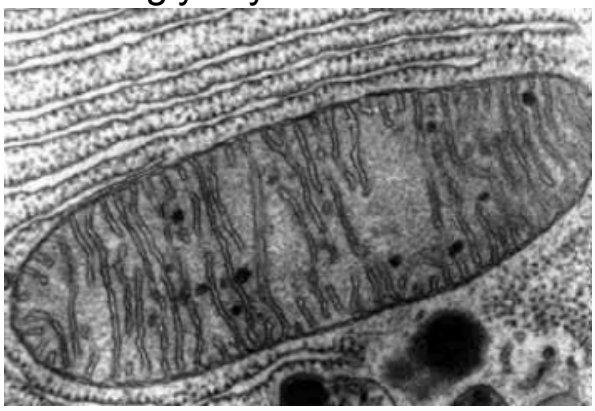
P

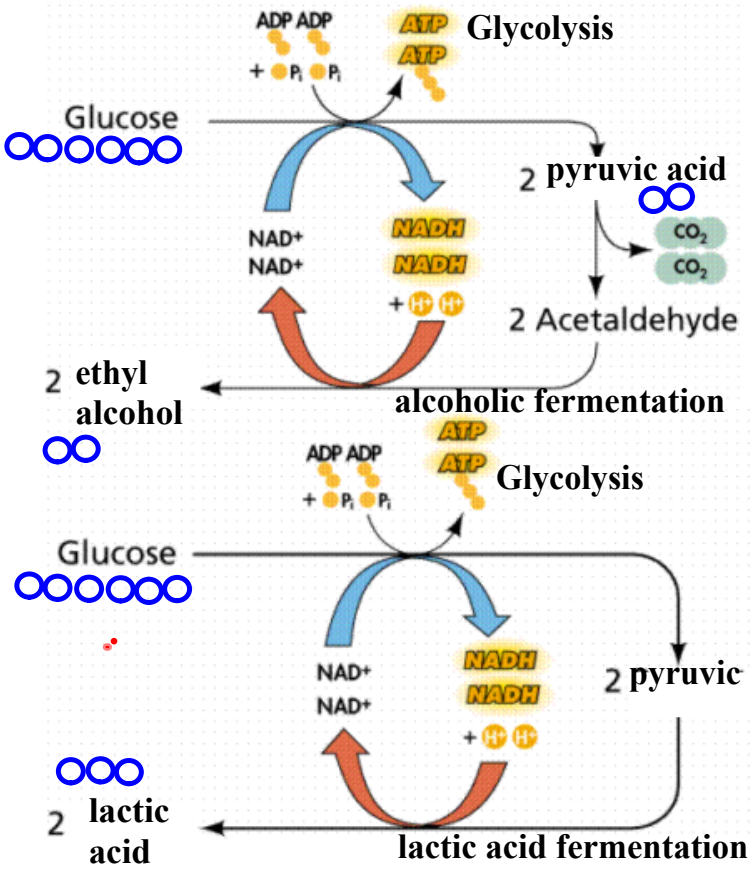
Glycolysis

Glycolysis does not realease a lot of energy, but because it takes place in the cytoplasm and because it does NOT require Oxygen then cells can produce a lot of it.

So much in fact that these cells can run out of available NAD+ and thus can not continue glycolysis

What could a cell do to Produce or free up more NAD+?



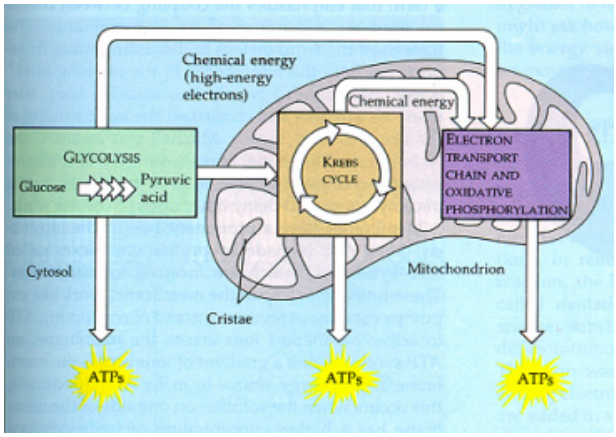


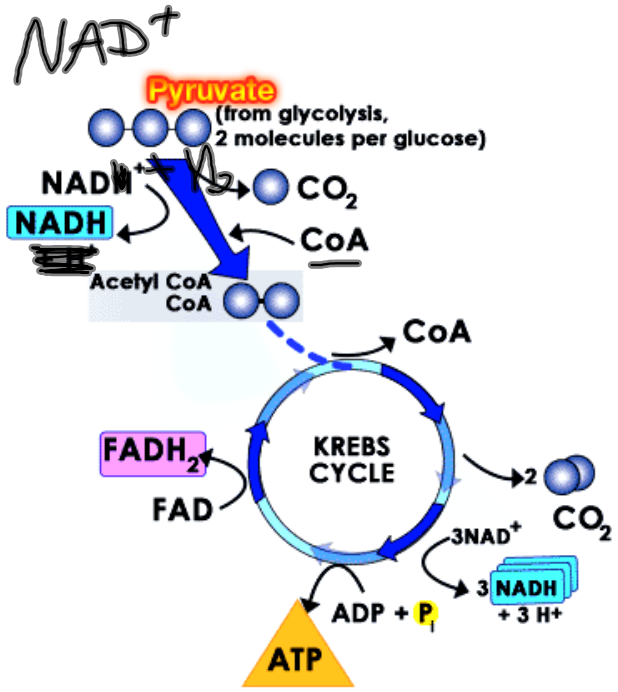
One of 2 possibilities: ***Anaerobic respiration*** takes place in the absence of oxygen. In animal cells, glucose is broken down into lactic acid, while in other cells such as yeast, the final product is alcohol. During both processes, only two molecules of ATP are produced.

But What happends when O_2 is present?

The 2nd and perfered option would be *Aerobic respiration,* which requires oxygen and involves the complete oxidation of glucose.

As glucose moves through Glycolysis, the Kreb's cycle and the Electron Transport Chain, 36 molecules of ATP are gained.

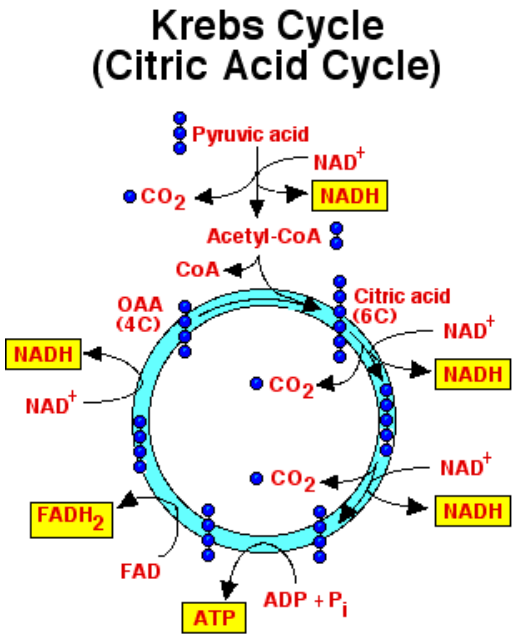




Glycolysis Link

Kreb's Cycle

The Kreb's cycle takes place in the cellular matrix.
Pyruvate breaks down into Acetyl CoA, which enters the Kreb's cycle and yields 3 molecules of CO_2 and 6 pairs of hydrogen atoms. The hydrogen atoms are picked up by NAD+ and FAD.
Most of the energy removed is carried by these hydrogen.



The products of the Krebs cycle are: 1 ATP, 1 $FADH_2$, $3CO_2$ and 4NADH

Keep in mind that 1 glucose produces 2 pyruvic acid molecules

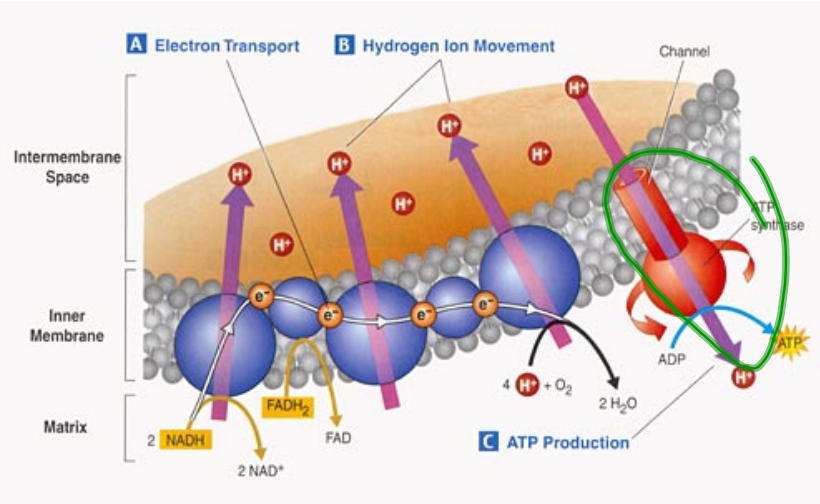
Where does the CO_2 go?

When the Krebs cycle is finished there are many high energy electron carriers

http://www.youtube.com/watch?v=aCypoN3X7KQ

Electron Transport Chain

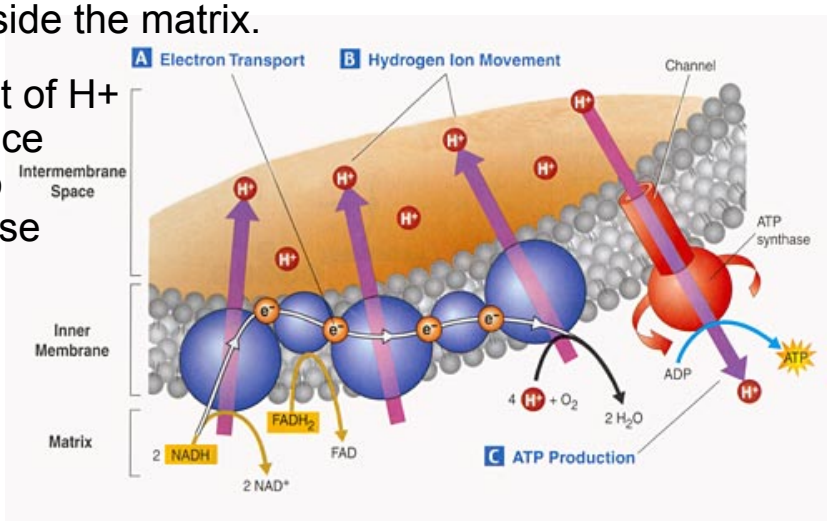
This is a series of electron carriers on the inner membrane of the mitochondria. $NADH_2$ and $FADH_2$ deliver hydrogen to the electron transport chain. The hydrogen(H_2) is split into hydrogen ions(H+) and electrons(e-). As the electrons pass from one electron carrier to the next, they release energy and ATP is formed. At the end of the chain, electrons, ions, and free oxygen combine to form water molecules.

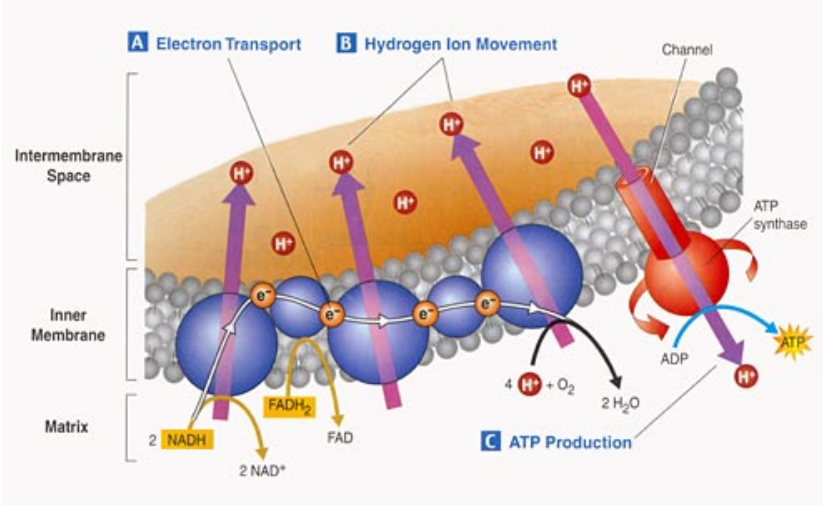


So basically the electron transport chain takes the high energy electrons from the krebs cycle and uses them to convert ADP into ATP.

It uses carrier proteins to pass electrons along the inner membrane, each time being used to actively transport H+ into the intermembrane space making it positively charged. This continues until an Oxygen molecule accepts the left over protons and electrons inside the matrix.

At this point there are a lot of H+ in the intermembrane space and the only place for it to go is through ATP Synthase This is where most ATP is generated.

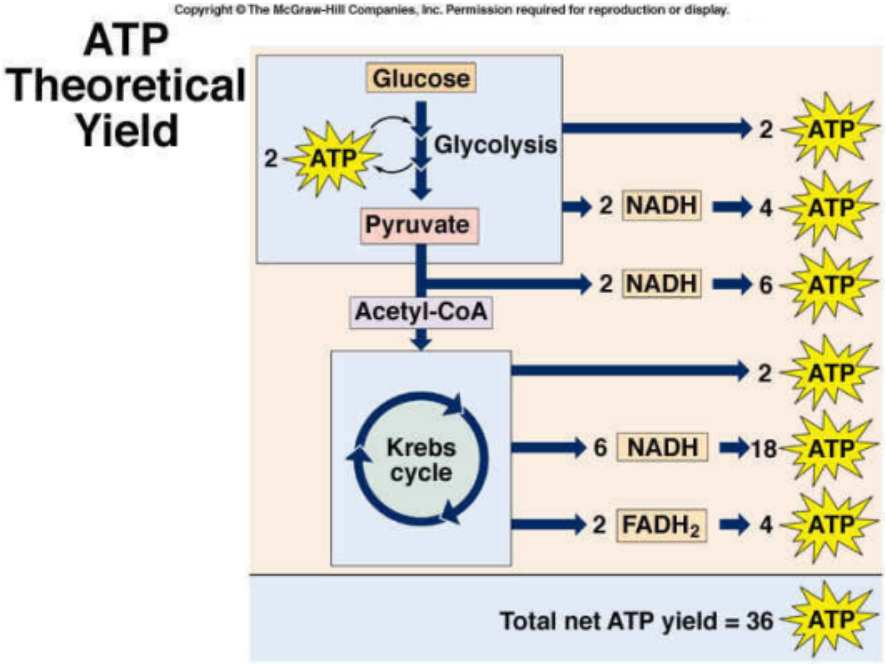




Does this look familiar?

How is this different from the light dependent phase of photosynthesis?

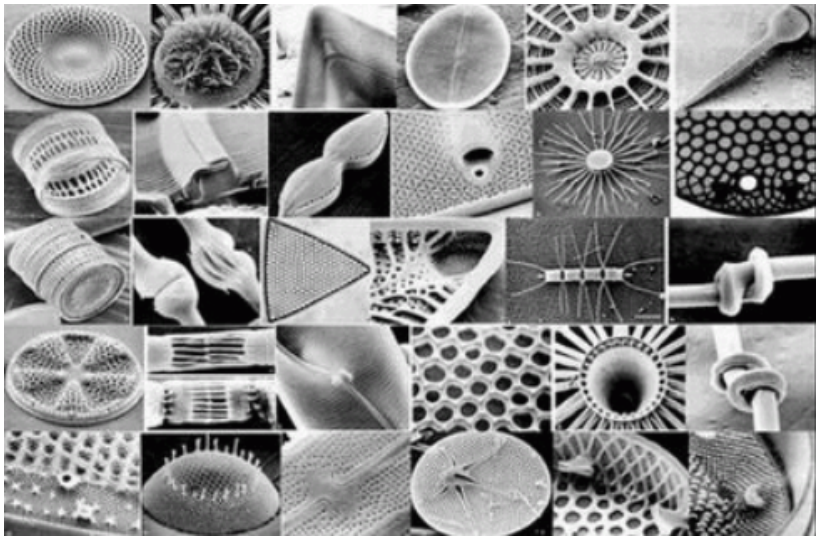
So for the whole process we have:



and a lot of heat

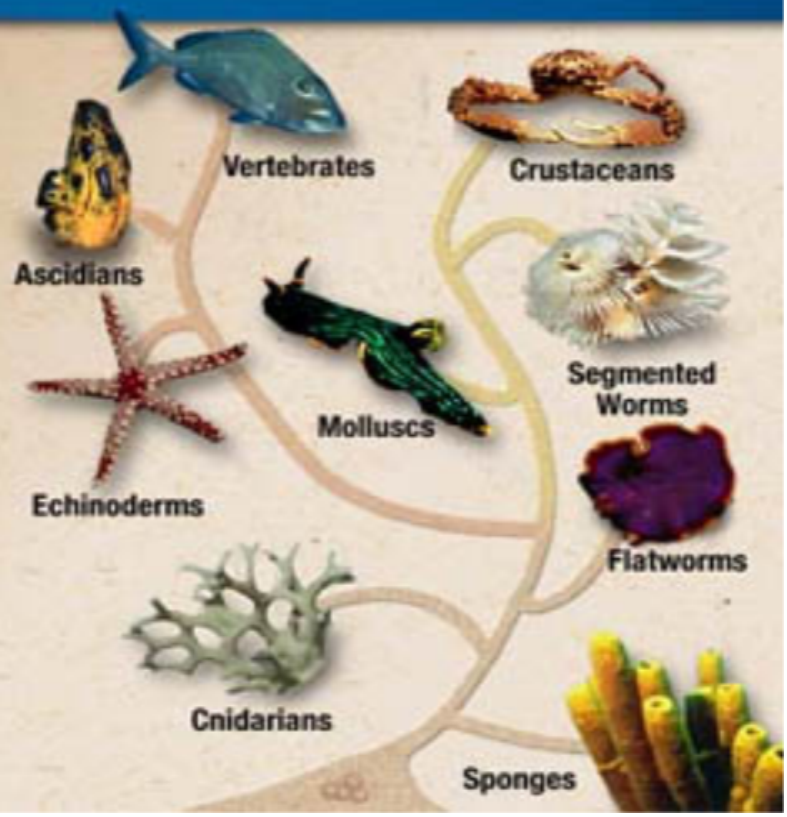
Taxonomy

There are millions of organisms on this planet, the majority of which are microscopic. How would you organize them?

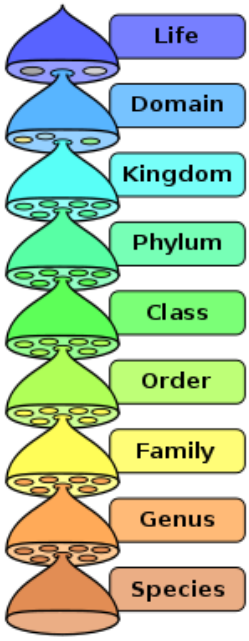


TAXONOMY

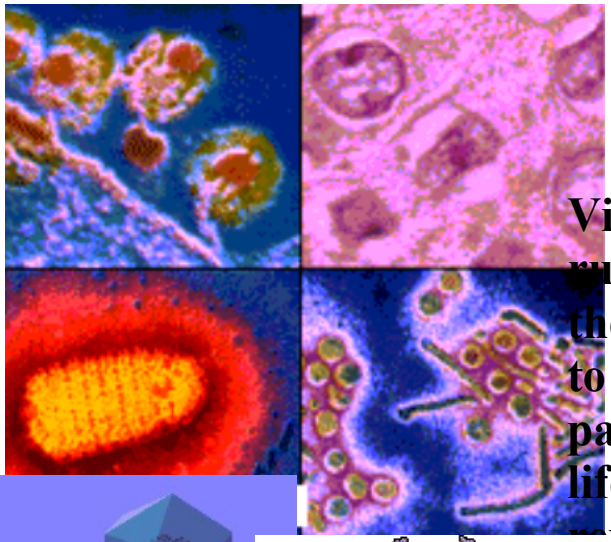
Taxonomy is the science by which organisms are placed into categories based on their structural similarities and evolutionary relationships.

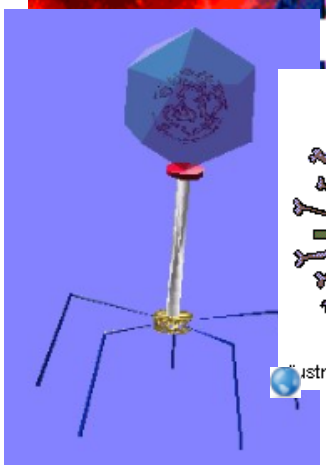


Kind professors can't
often fail good students



King Phillip came over from Greece Saturday.

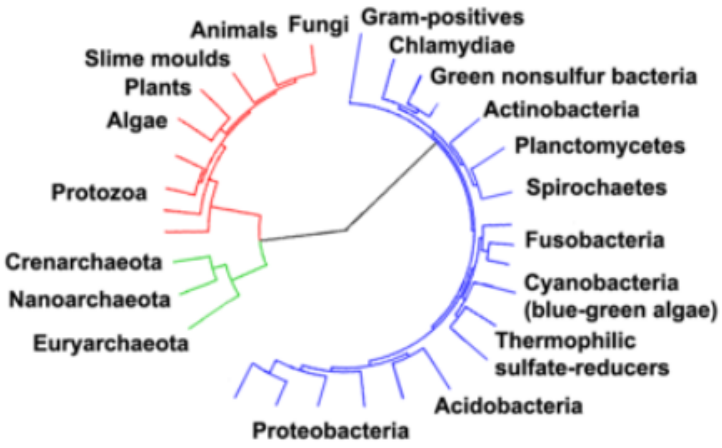




Life or Not

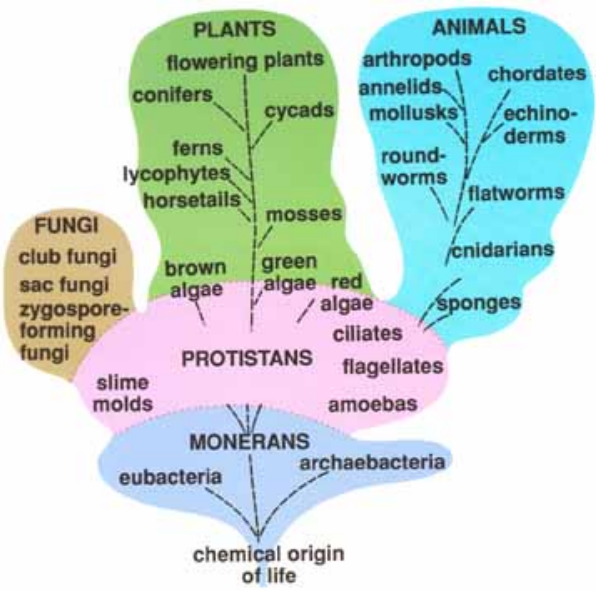
Viruses are the exception to the rule. They do not fit into any of the kingdoms. They are said not to be alive and are merely particles. Outside the cell, it is lifeless. Once it invades a cell, it reproduces. The virus has a protective coat called the capsid (5% of the virus). It also contains nucleic acid (genetic material) on the inner core. They take several different forms (fig 18.6). Most viruses are selective and only enter specific hosts.

There are 3 Domains: Eukarya, Prokarya (Bacteria) and Archea.



The old 5 Kingdoms are: Monera, Protista, Fungi, Anamalia and Plantae

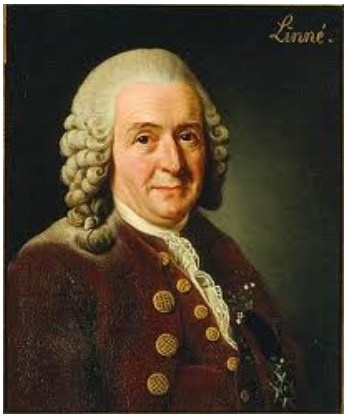
The old 5 kingdoms divides unicellular prokaryotes (monera eukaryotes (protista). The oth kingdoms are eukaryotic and a based on nutrient acquisition.



Modified version of Whittaker's five-kingdom system of classification.

The next groups: phylum, class, order, family, genus, and species are progressively more specific

We will probably only look at genus and species



Organisms are classified
to make it easier to study
the diversity of life
by grouping organisms
based on genetic, structural
or reproductive characteristics

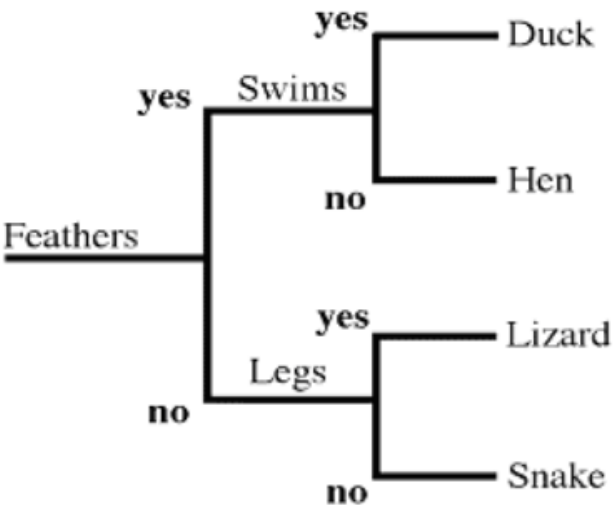
Early efforts were poor to say the least

Then came Carolus Linnaeus who though of a way to group organisms into a hierarchy, which has several levels. Each organisms was assigned two names which were very specific; genus and species. This naming system was called...

The most specific name an organism can have is its <u>scientific name.</u> This is where the term <u>binomial nomenclature</u> is from, it refers to the genus and species names. The genus is a category that includes very closely related organisms that do not usually interbreed. The species is a category limited to naturally interbreeding living things.

- **Western bluebird (*Sialia mexicana*)**
- **Eastern bluebird (*Sialia sialis)***
- **Mountain bluebird (*Sialia currucoides*)**

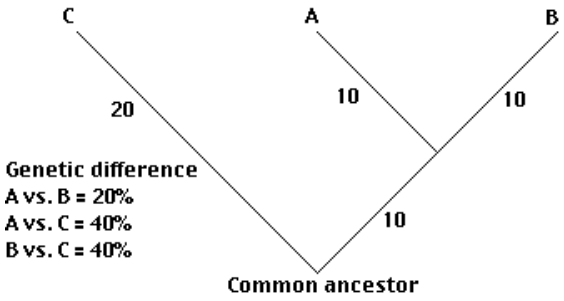
These names show that they are closely related.
These names must be <u>underlined</u> or *italicized*.
The Genus is capitalized, while the species is not.

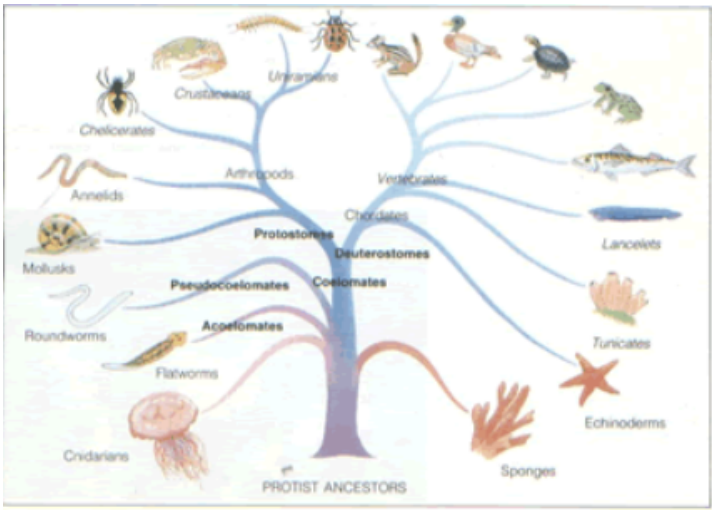


Dichotomous keys are two part keys that are used to identify living things. By following the descriptions correctly, you can identify the species.

Molecular Clocks

Overtime organisms charge as a result of natural selection and random mutations. The idea is that those changes occur regularly overtime, so a comparison of how different the genes are is a good indicator of how long ago the organisms have been separated.





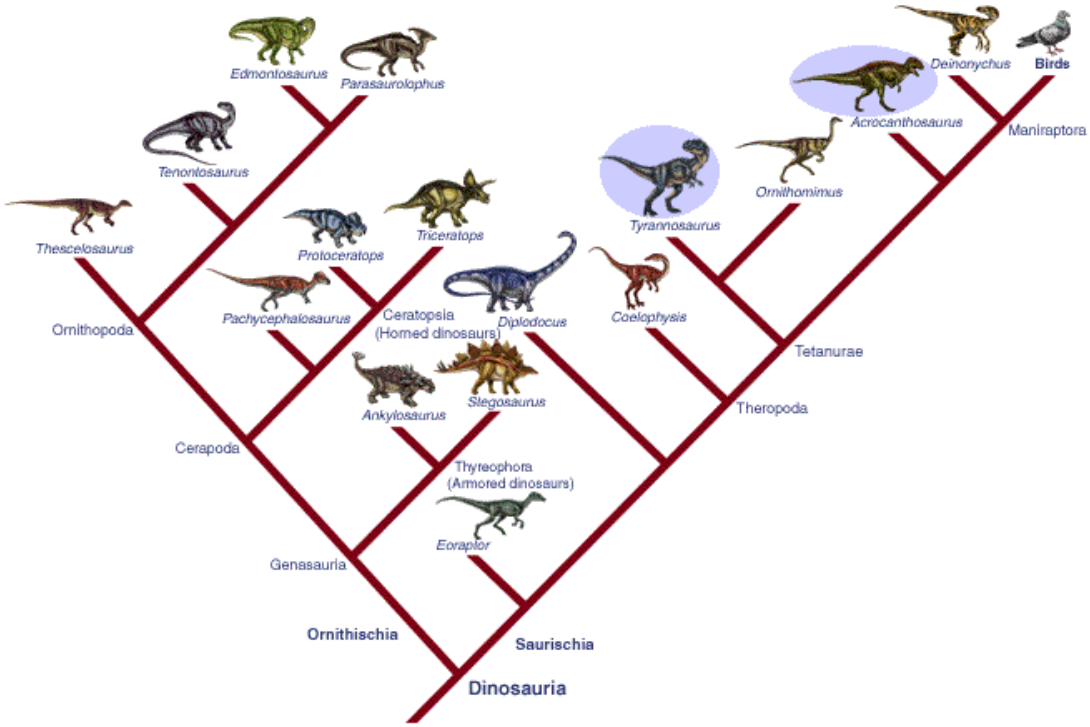
It is understood that organisms change. <u>Phylogeny</u> is the study of the evolutionary history of living things. A phylogenetic tree represents relationships. It is the precursor to a cladogram.

Cladograms

Cladograms show evolutionary relationships, but can also be used to show morphologies and branches that follow certain traits.

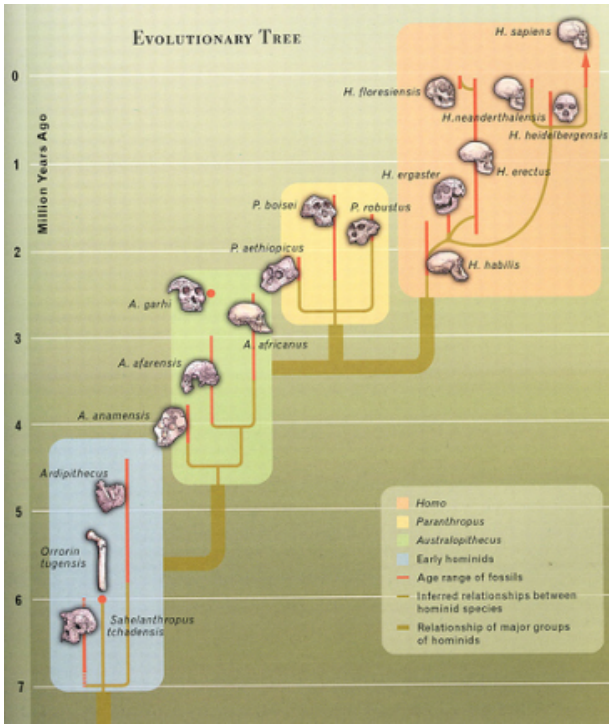
The traits that researchers look at are only new and innovative ones that appear in newer species but not older lineages. These are also called derived characteristics.

Cladograms


Edmontosaurus
Parasaurolophus
Tenontosaurus
Thescelosaurus
Protoceratops
Triceratops
Pachycephalosaurus
Ceratopsia
(Horned dinosaurs)
Diplodocus
Ornithopoda
Ankylosaurus
Stegosaurus
Cerapoda
Thyreophora
(Armored dinosaurs)
Eoraptor
Genasauria
Ornithischia
Saurischia
Dinosauria
Tyrannosaurus
Coelophysis
Ornithomimus
Acrocanthosaurus
Deinonychus
Birds
Maniraptora
Tetanurae
Theropoda

So for humans

Life	Life
Domain	Eukarya
Kingdom	Anamalia
Phylum	Chordata
Class	Mammalia
Order	Primates
Family	Hominidae
Genus	Homo
Species	sapiens



In Class Assignment
Bellwork
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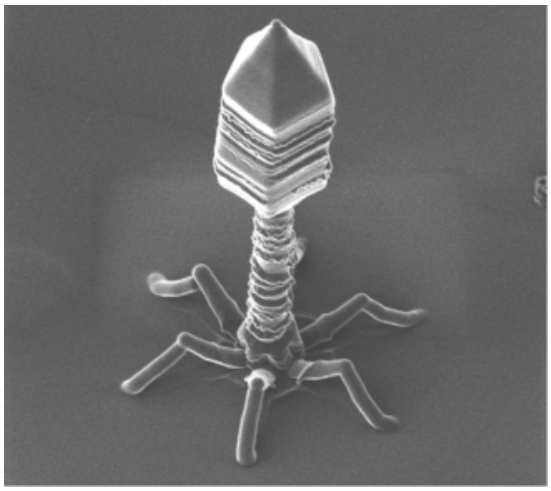
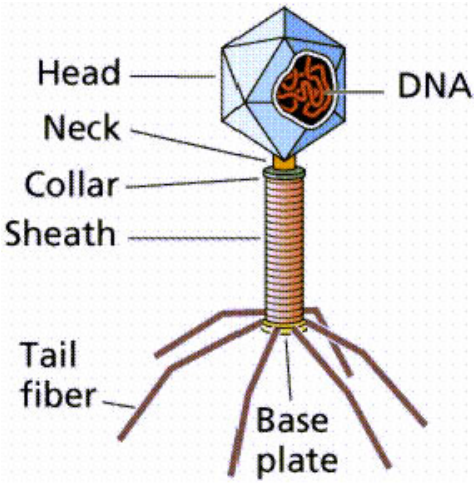
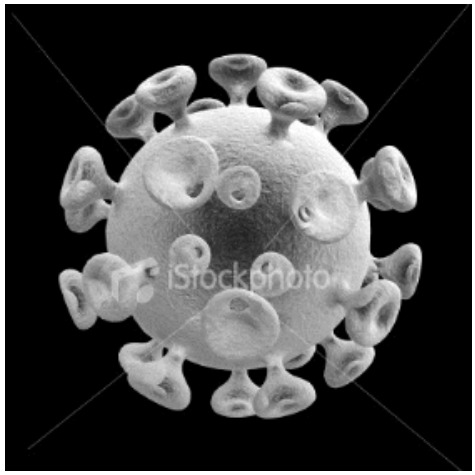
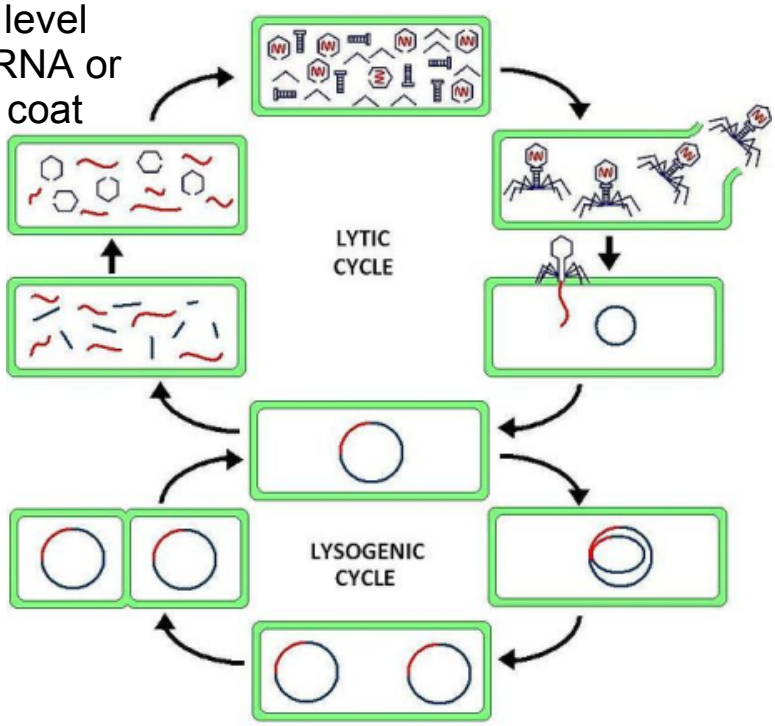
Viruses







Viruses walk the line between abiotic and biotic. At their most basic level they consist of nucleic acids (RNA or DNA) surrounded by a protein coat called a capsid.



They exist in an inert state until coming in contact with a host
Replicate 1 of 2 ways lysogenic or lytic life cycle

The lytic cycle of viruses is probably the most destructive stage from the hosts viewpoint

When the virus makes contact with the cell it penetrates it and injects its genetic material

When the genetic material is inside the host cell it uses the cells organelle and enzymes to replicate its genetic material and then its structural proteins

The final stage is when the virus directs the release of enzymes which cause a cell to increase liquid uptake or burst

http://www.youtube.com/watch?v=Rpj0emEGShQ

http://www.youtube.com/watch?v=lrYlZJiuf18&feature=fvsr

The other possible mode of reproduction of a virus is the lysogenic life cycle

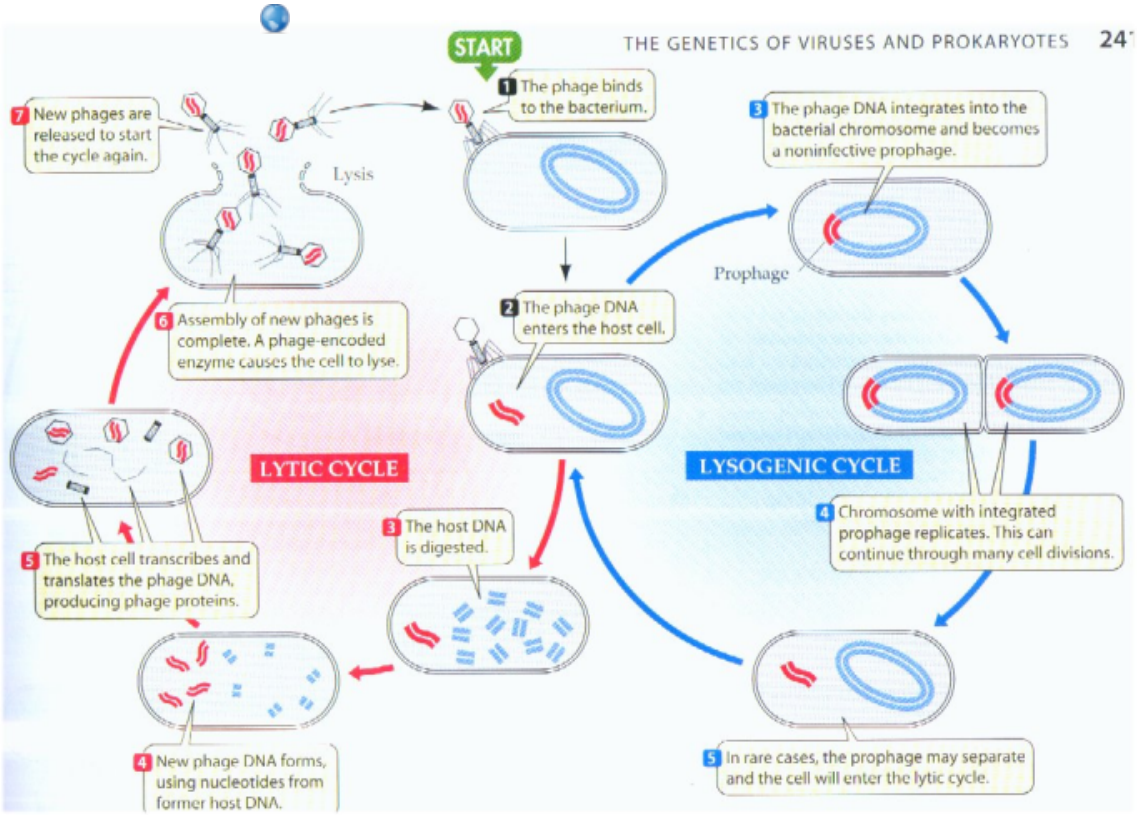
The virus penetrates the cell and injects its genetic material

After this the virus' genetic material (prophage) inserts itself into the hosts DNA

The virus' genetic material stays in the host and is even replicated when cells divide

These viruses can stay dormant or become active entering the lytic lifecycle at any time.

Look for diagram on page 481



Retroviruses, Viroids and Prions

Viruses that contain RNA as their genetic information and are called retroviruses.

Reverse transcriptase creates a DNA copy of viral RNA

The DNA copy of a retroviruses' RNA is inserted into the DNA of the host cell, much like a prophage. Retroviruses may remain dormant for varying lengths of time before becoming active.

Viroids are single-stranded RNA, with no capsid

Prions are proteins with no capsid, DNA or RNA. They cause normal proteins to become folded like prions

Vaccines

Prompt the body to recognize surface proteins on a virus, making you immune by giving you immune system something to look for...Like a wanted poster

Taxonomy

Carolus Linnaeus came up with binomial nomenclature and a hierarchy to group organisms taxonomically.

Taxonomy groups organisms based on structural similarities & evolutionary relationships

Binomial Nomenclature gives *Genus* and *species* name based on reproduction

Organisms are clustered into a variety of taxonomic groups; Domain,Kingdom,Phylum,Class,Order,Family,Genus,Species

There are 3 Domains: Eukarya, Prokarya (Bacteria) and Archea

The Kingdom level has been traditionally divided into 5 catagories: Monera, Protista, Plantae, Anamalia and Fungi

Currently we are use a 6 kingdom system: Eubacteria, Archaebacteria, Protista, Plantae, Anamalia and Fungi

Phylogeny is the study of evolutionary relationships and history

Cladograms are used to show these relationships based on morphologies and new traits (derived characteristics)

Dichotomous Keys are also used to identify species based on structural similarities

Molecular clocks are also used to categorize animals based on mutations and related genes/organisms

Convergent and Divergent Evolution

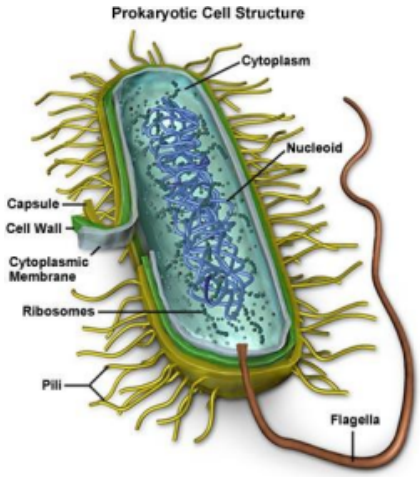
Viruses- between life and death, lysogenic and lytic lifecycle, retroviruses

So...Linnaeus gave us a nice broad catagory to catagorize the major groups of animals

The 5 Kingdoms:

- Monera (now Eubacteria and Archeabacteria)
- Protista (Eukaryotes)
- Animalia
- Plantae
- Fungi

Since the kingdom monera was made before molecular data was available it basically looks at Prokaryotes and Archeans

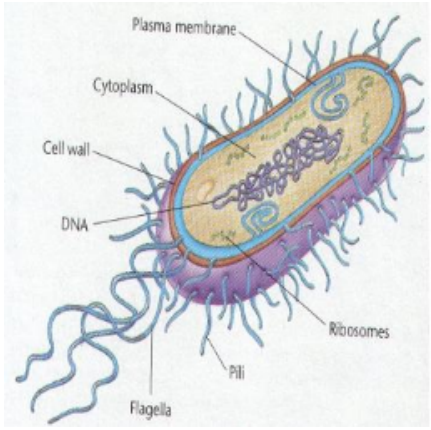


Prokaryotes lack a nucleus

So in general they refer to both bacteria and archea, although they are generally not considered to be the same taxonomically

MICROORGANISMS

Some microorganisms are pathogenic, but many are harmless and actually help the environment. Bacteria are largely responsible for the breakdown of organic matter left behind as plants and animals die. The bacteria is able to decompose the organism releasing nutrients such as oxygen and nitrogen back into the environment.



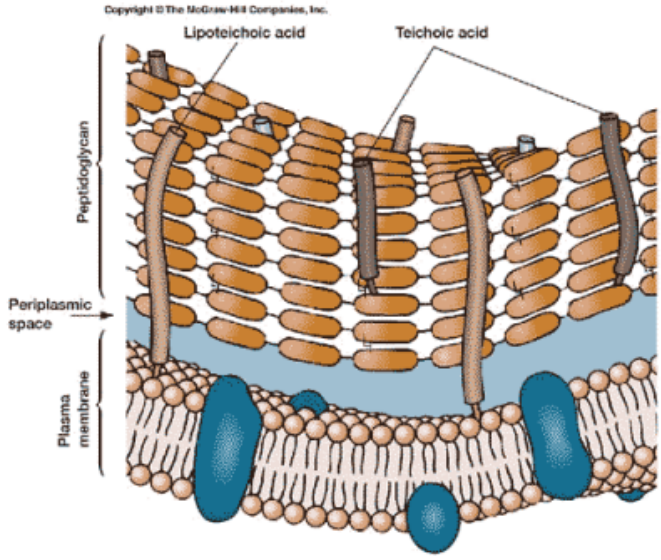
Archaebacteria

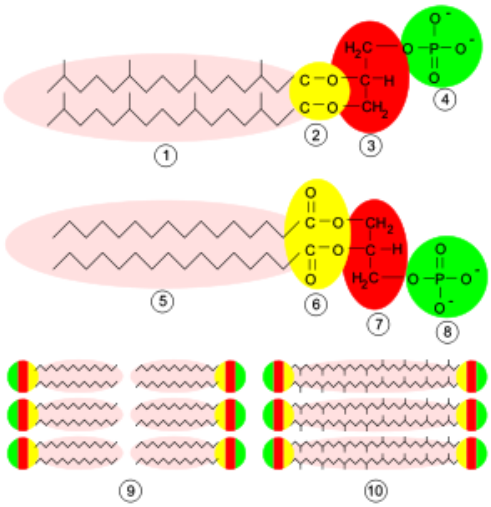
Archaebacteria lack peptidoglycan in their cell walls, have different membrane proteins and have DNA that has much more common with eukaryotes than it does with bacteria

Many archaebacteria are extremeophiles

Live in high salt, high acid, anoxic/anaerobic, and high temperature conditions/environments.

Archaebacteria lack the peptidoglycan of Eubacteria and also have different membrane lipids. Also, the DNA sequences of key Archaebacterial genes are far closer to those of Eukaryotes than that of Eubacteria





Membrane structures. **Top**: an archaeal phospholipid, **1** isoprene sidechain, **2** ether linkage, **3** L-glycerol, **4** phosphate. **Middle**: a bacterial and eukaryotic phospholipid: **5** fatty acid, **6** ester linkage, **7** D-glycerol, **8** phosphate moieties. **Bottom**: **9** lipid bilayer of bacteria and eukaryotes, **10** lipid monolayer of some archaea.

Archeans are very different than bacteria or eukarya, although if you look at the niches they inhabit you begin to see a lot of overlap with bacteria.

Prokaryotes

Prokaryotes are identified by genetic analysis as well as based on morphology.

Currently their diversity is so great that we can't classify them easily based on genetics so we use different characteristic such as shape, structure of their cell walls, locomotion, energy/nutrient acquisition.

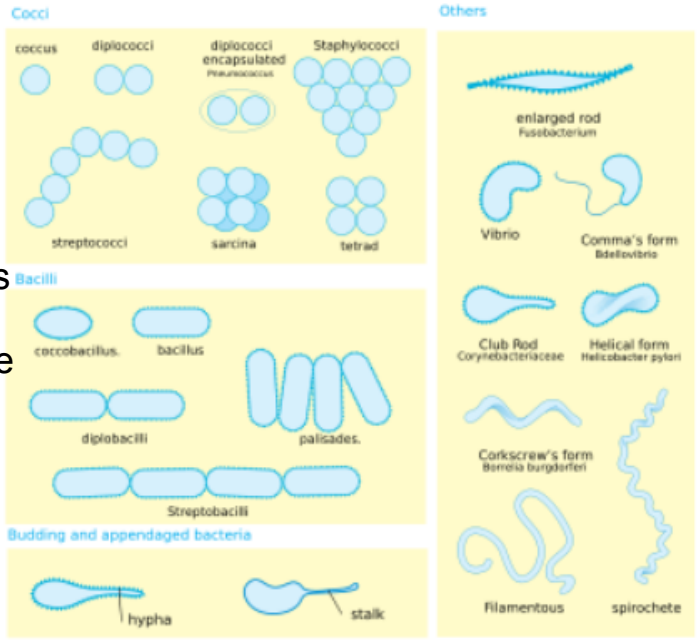
Prokaryotes are very small and it's very difficult to do a genetic analysis on all types, so many are classified by their shape.

Shape

Bacilli are rod shaped bacteria

Cocci are round or spherical shapes

Spirilla is a twisted, elongated shape



Prokaryotes

Metabolism is basically divided into Autotrophs and Heterotrophs

Autotrophs make their own food and heterotrophs have to get it from elsewhere

We need O_2 to release energy in our food, some organisms don't need it and some find it toxic. Because of this we classify organisms based on these characteristics
Obligate aerobes-O2 is required for survival
Obligate anaerobes-O_2 is toxic
Facultative anaerobes-Can survive in either

Prokaryotes

Locomotion is usually classified based on the presence of either a flagella or cilia.
Many of the prokaryotes move in other unique ways as well. Some use gas bubbles as floats, some rotate like a propeller to move and some just don't move at all

http://www.youtube.com/watch?v=6p9e0oolbmE

Growth and Reproduction

Binary Fission- Genetic material doubles, then splits as does organism

Conjugation- form a bridge between two prokaryotes and move genes back and forth, done to increase diversity and resistance.

Budding occurs when a clone forms on the outer surface and breaks off.

Endospores- When conditions become difficult some bacteria can form an endospore, which basically encloses the cell and protects it from the outside environment. Meanwhile the cells metabolism shuts down. When conditions become favorable again the spore opens and the bacteria becomes active again

Bacillus anthrax

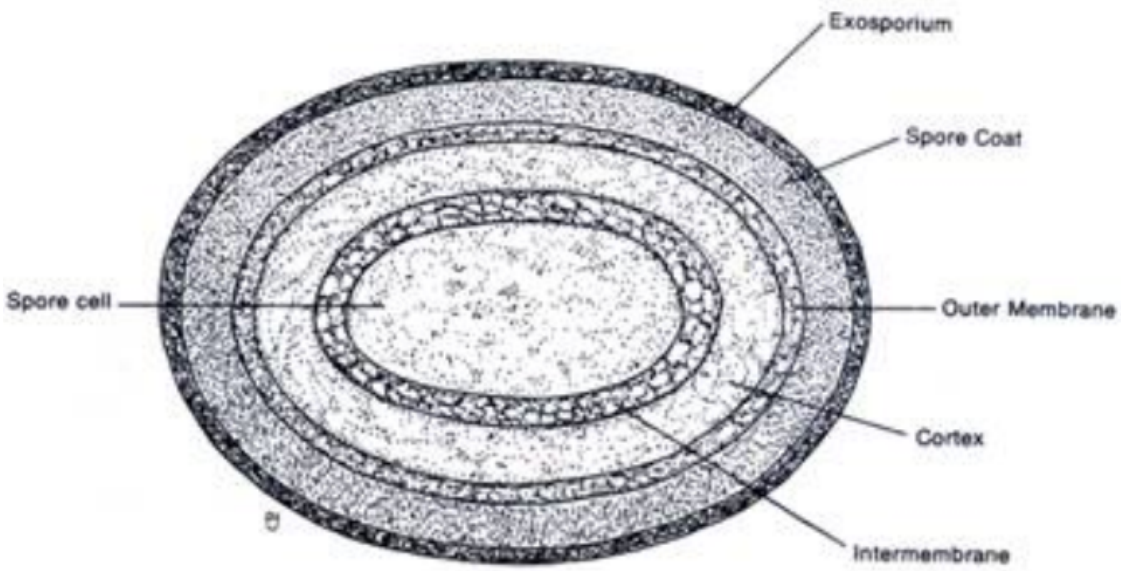


Fig. 8.1. Endospore

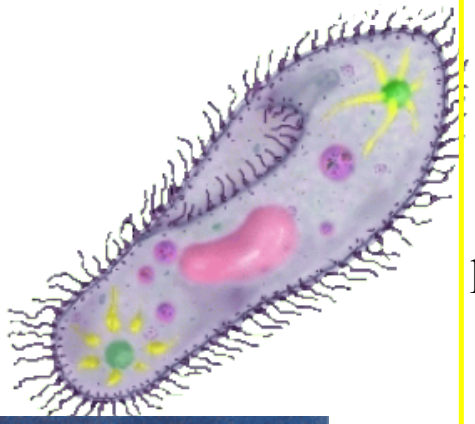
Bacteria may form endospores. *Endospores* are a formation of a thick wall to protect the cell when conditions are not favorable. This helps make bacteria very resilient.

Prokaryotes

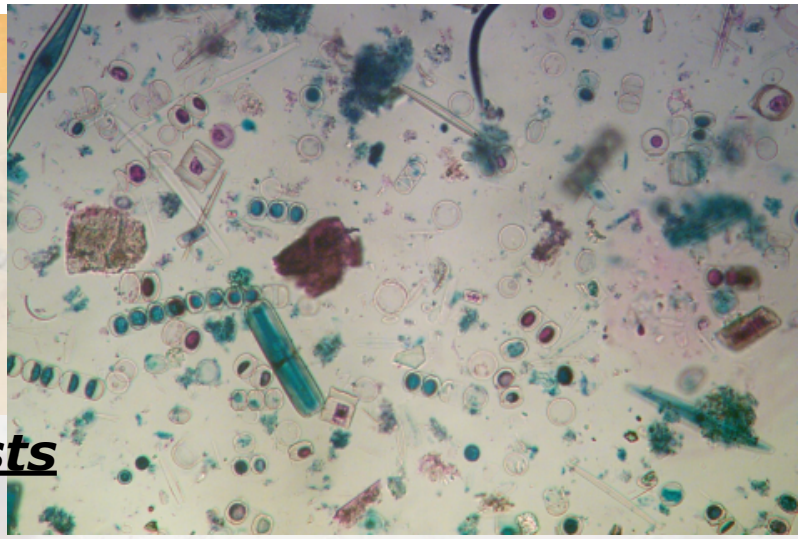
Bacteria and Archea both provide a valuable service to humans in a great many ways.

Many bacteria and archea are useful as decomposers, primary producers and digestion.

Both are also extremely important in industries such as mining, petroleum clean up, medicine, industrial chemistry and forensics.



Protists are more advanced than monerans. They have a membrane bound nucleus and organelles such as ribosomes and mitochondria. Most protists are unicellular and are found in fresh or salt water. Zooplankton are animal-like protists that are an important part of the foodchain. Zooplankton are heterotrophs. *Phytoplankton* are plantlike protists and they make up a significant portion of oxygen on Earth. Phytoplankton are autotrophs.

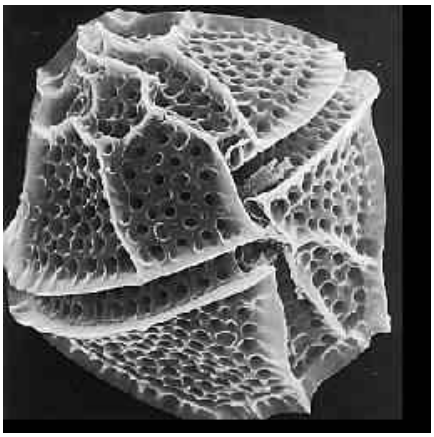


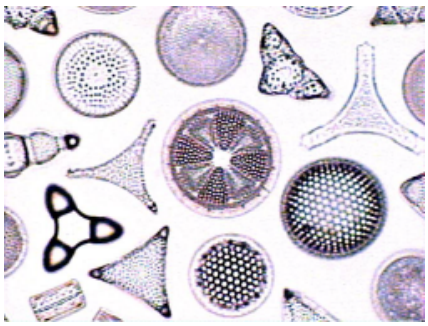
3 Types of Protists

Plantlike Protists-these have usually been associated with algae. These organisms all contain chlorophyll and are able to produce their own food. They make up a large portion of Phytoplankton.

The plant-like protists are divided into four basic groups:

-euglenoids
-dinoflagellates
-diatoms
-and algae.

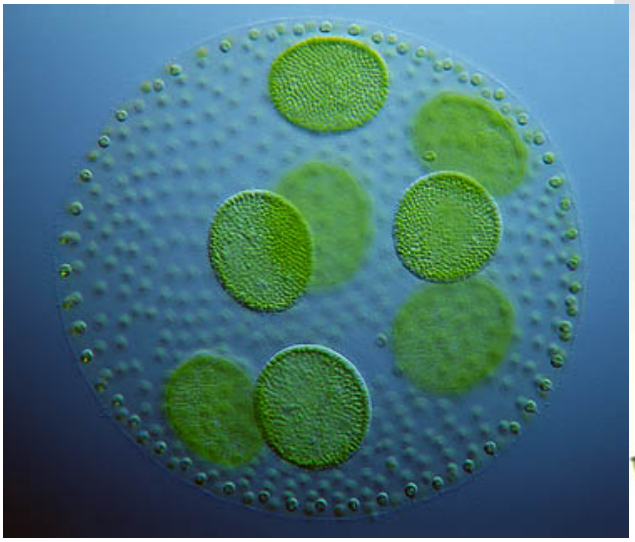




Alexandrium, Dinophysis, Prorocentrum and Pseudonitzschia off the coast of Maine

Green Algae

Closely related to land plants
Many use the same photosynthetic pigments
Live in fresh, salt and brackish water
Mostly unicellular

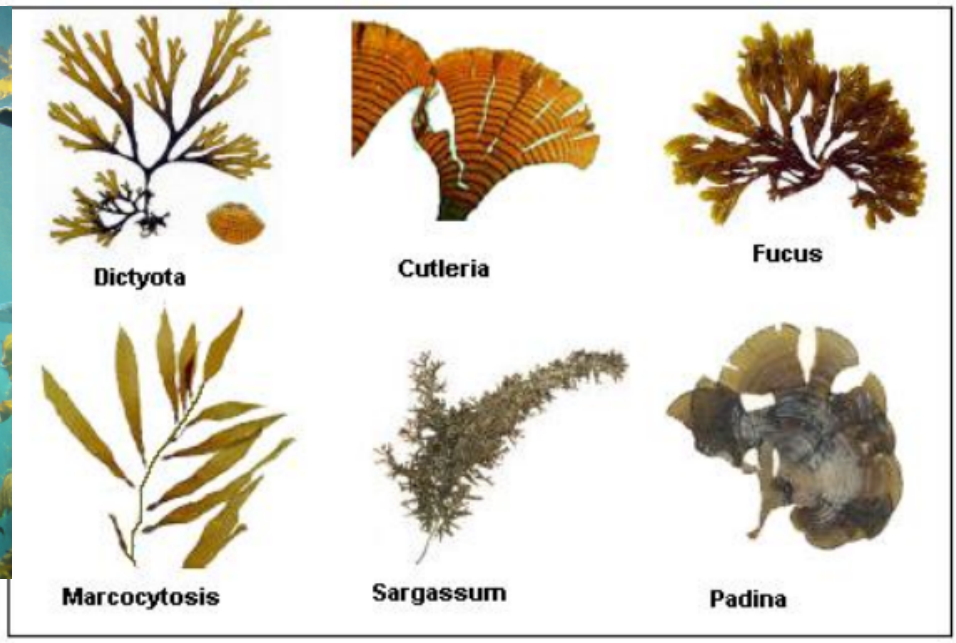


Red Algae

Many form large multicellular assemblages called seaweed.
Often harvested for carageen, a thickener used in ice cream, shampoo, tooth paste, etc
Live in deeper in salt water environments.

Brown Algae

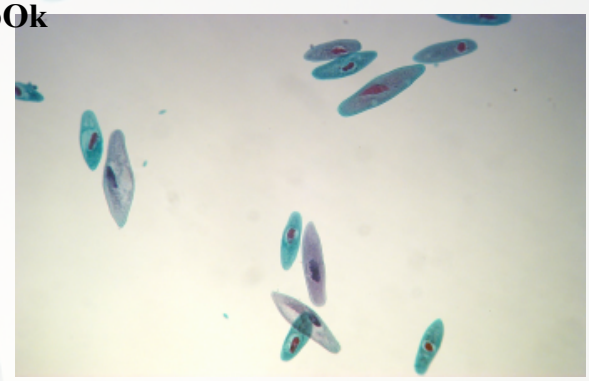
Are the largest type of algae, form large kelp forests in some environments
Mostly found in marine environments
Consist of a holdfast, blade and air bladders



Animal-like Protists-are known as protozoans and are heterotrophs.

http://www.youtube.com/watch?v=-zsdYOgTbOk

Generally eat other protists, bacteria and other microbes for food. They are either free-living or parasitic.



Fungus-like Protists

These protists are heterotrophs with cell walls. They reproduce by forming spores. All are able to move at some point in their lives.

There are 3 Main types
- -water molds
- -downy mildews
- -and slime molds.

Fungilike Protists

These protists are often referred to as slime molds. They prefer cool shady places and are usually found under fallen leaves or rotting logs.

http://www.youtube.com/watch?v=bkVhLJLG7ug

1. What are the 3 Domains? Give 2 characteristic for each

2. Which domain are Acheabacteria part of?

3. What domain are Eubacteria part of?

4. What domain are Protista part of?

5. What types of environments do Archeans live in?

6. What are the 3 main shapes of prokaryotes?

7.What is Binary Fission?

8. What is Conjugation?

9. What is an endospore?

10. What are the 2 ways prokaryotes obtain energy?

11. What do you call an organism that lives in an aerobic environment?

12. What do you call an organism that lives in an anaerobic environment?

13. What do you call an organism that lives in either environment?

14. What are the 3 main groups of protists? How are they classified?

15. What are the 3 types of plant like protists?

16. How are fungi-like protists like and dislike Fungi?

17. What causes Red Tides