<table>
<tr><td>ARCHAEA</td><td><u>Archaean</u>
1.3 billion years (3,800 - 2,500 Ma)
Anaerobic bacterial life, oxygen starts to accumulate in oceans
Oxygen accumulated as by-product of cyanobacteria splitting water to get ATP, then released into atmosphere, marking end of Archean
OVERALL:
Anaerobic forms evolve into aerobic forms (cyanobacteria) → very diverse and successful that have been on the planet for 3.8 billion years.
When morphology was used to classify the loving world it was thought all prokaryotes were the same. But gene sequence studies of the 16S ribosomal subunit shook up the tree of life and the result was prokaryotes were divided in two: The Archea and Bacteria, or Eubacteria as they are sometimes referred to. By the time the proposal of three domains, the third is the Eukaryota, gained acceptance in the 1980's it had also become clear that the Archea and Bacteria Domains included some of the most interesting and complex organisms because of the diversity in their metabolism and horizontal gene transfer, basically gene swapping.</td></tr>
<tr><td>CYANOBACTERIA</td><td>It is the oldest known bacteria that obtains energy through photosynthesis and are thought to have lead to evolution of eukaryotic cells and aerobic respiration
Figure out how to get a high energy proton by splitting water and getting oxygen:
CO2 + H2O + light → (CH2O)n +H2O + O2</td></tr>
<tr><td>DOMAINS</td><td>Highest taxonomic rank of organisms grouped into Eukarya, Bacteria or Archaea
Fundamental difference in how they turned their stored genetic information into functional proteins
Eubacteria
Single celled organisms known as prokaryotes (prokaryotic cells)
Membranes composed of fatty acid chains.
Classified by size, shape, mobility, metabolism
Ex: Streptococcus
Archaea
Single celled organisms (bacteria) that live in extreme environments such as thermal vents found in ocean floors (prokaryotic cells)
Halophiles, methanogens and thermophiles
Membranes composed of hydrocarbon chains
Ex: Sulfolobus (bacteria)
Eukarya
Single celled and multicellular organisms contain complex cells that have organelles and nucleus to contain genetic information.
Single celled, autotrophs and heterotrophs
Classified using morphological characteristics
Ex: E. coli O157:H7, Humans</td></tr>
<tr><td>LINNAEUS'S TAXONOMIC HIERARCHY</td><td>KINGDOMS IN EUKARYA
Animalia
A taxonomic group of eukaryotic organisms (multicellular) that reproduce sexually (sperm and egg)
No cell wall, no chloroplasts, heterotrophs (ingestive), motile
Ex: Sponges, worms, insects, fishes, mammals
Plantae
A taxonomic group of eukaryotic organisms (multicellular) that reproduce asexually and sexually
Cell wall made of chitin, cellulose structure, chloroplasts, autotrophs(absorptive)
Ex: Moss, ferns and flowering plants
Fungi</td></tr>
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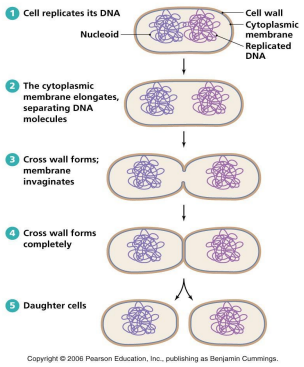
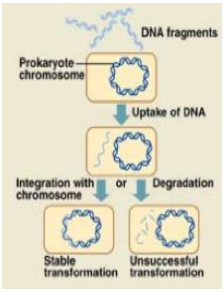
	• A taxonomic group of eukaryotic organisms (some unicellular but most multicellular) that reproduce both asexually and sexually through syncytial spore-producing organisms feeding on organic matter. • Cell wall of chitin, heterotrophs • Ex: Mushrooms and yeasts **Protista** • A taxonomic group of eukaryotic organisms (primarily unicellular, some colonial or multicellular) that reproduce asexually or sexualy. They are usually nonphotosynthetic and classified further into phyla according to their capacity for and means of motility as by pseudopods, flagella or cilia. • Cell wall of cellulose, autotrophs or heterotrophs. • Ex: Ameoba, paramecium, mold **PROTOZOA** • Protozoa are non-phototrophic, unicellular, eukaryotic microorganisms with no cell walls. **ALGAE** • A group of aquatic, photosynthetic, eukaryotic organisms ranging from unicellular to multicellular forms, and generally possess chlorophyll but lack true roots, stems and leaves characteristic of terrestrial plants. ○ Aquatic species food source and provides a good amount of Earth's oxygen **Monera** • A taxonomic group of prokaryotic organisms that reproduce asexually or by fission and have a nutritional mode of absorption, photosynthesis or chemosynthesis • Cell wall composed of peptidoglycan, autotrophs or heterotrophs • Ex: Bacteria, Blue-green algae, primitive pathogens
HETEROTROPHS	• An organism that is unable to synthesize its own organic carbon-based compounds from inorganic sources, hence, feeds on organic matter produced by, or available in, other organisms. **ABSORPTIVE HETEROTROPHS** • An organism that obtains its food by secreting digestive enzymes externally into the environment to break down large food molecules, then absorbing the breakdown products. • Ex: Ex: Fungi, Protists **INGESTIVE HETEROTROPHS** • An organism which secretes enzymes into its environment to ingest organic materials which are then absorbed(digested). • Ex: Humans, mammals
AUTOTROPHS	• An organism that produces complex organic compounds from simple substances in its surrounding, generally using energy from light or inorganic chemical reactions. • Does not depend on other organisms for energy intake (food). • Ex: Plants, algae **What came first heterotrophs or autotrophs?** • Heterotrophs came first and branch into absorptive and ingestive • The prebiotic soup consisted of organic molecules that could break down into energy. • When analyzing the mitochondria (oxygen transport system (ATP)) it proceeds the chloroplast.
PROKARYOTE	• A microscopic single-celled organism that has neither a distinct nucleus or membrane

	bound organelles • Kingdom of Monera • Composed of prokaryotic cells • A member of the kingdom Monera, made of prokaryotic cell. • Ex: Streptococcus
EUKARYOTE	• Multicellular (usually organisms) that contain membrane bound organelles • Wrap DNA around histones • Ex: Animals and plants
AEROBIC	• Organisms that relate to, involve or require free oxygen in order to oxidize glucose for cellular respiration. • Must overcome large volume to surface area ratio by creating body cavity (lungs) (supply and demand) • Ex: Animals
ANAEROBIC	• Organism that relate to, involve or require an absence of free oxygen and metabolize through fermentation of glucose. • Ex: Bacteria, Humans are capable (lactic acid formation)
EXTREMOPHILES	• An organism that thrives in extreme environments (under high pressure and temperature); often form on rocks near the hydrothermal vents. **HALOPHILES** • An organism, especially a microorganism, that grows in or can tolerate saline conditions. • Ex: Halococcus **THERMOPHILES** • A bacterium or other microorganism that grows best at higher than normal temperatures • Ex:Thermus aquaticus **METHANOGENS** • Microorganisms that produce methane as a metabolic byproduct in anoxic conditions • Ex: Methano-bacterium
SURFACE TO VOLUME RATIO	As surface area increases the volume increases by a greater factor • As cell becomes bigger will have more demand for a reaction to occur than material required to supply it. • Supply and demand
BACTERIA CELLS	**NUCLEOTIDE** • The portion within a prokaryotic cell where the genetic material is to be found. **RIBOSOMES** • A body, within a cell or organelle, that attaches to an mRNA molecule and also attaches sequentially to a series of tRNAs matched by their anticodons to the mRNA codons, and assembles into a polypeptide the amino acids carried by the tRNAs. • Translation of messages from DNA to proteins **CAPSULE** • The capsule helps protect bacteria from phagocytosis as well as from desiccation. It also helps them to adhere to surfaces and cells. Hence, it is considered a virulence factor. It is found most commonly among gram-negative bacteria • A polysaccharide layer that lies outside the cell envelope of bacteria • Ex: *Escherichia coli*.

	CAPSID PROTEIN ● Protein coat that packages viruses
CHITIN	● A polysaccharide that contains nitrogen and is present in the cell walls of fungi and exoskeletons of arthropods
FLAGELLUM	● Flagella are used by cells and unicellular organisms for movement, sensation and signal transduction. ● They are long slender extensions of the cell or organism. ● The polymerization of thousands of copies of just one protein form the structure. **FLAGELLAR HOOK** ● Attaches the flagellum to the motor. ● A joint that transmits torque from the motor to the bacterial flagellum and propels the cell when rotated. **FLAGELLAR MOTOR** ● Composed of a series of proteins that due to their amino acid compositions span the plasma membrane to form rings. The number of these rings depend on if the bacteria is gram + or gram - ● Driven by a proton gradient (form of stored energy) ○ Proton moves down the gradient by passing through the opening in the motor proteins. ○ Energy is used to create conformational change in the motor proteins that move the central rotor which spins inside the rings embedded in the plasma membrane
ELECTRON TRANSPORT CHAIN	● A group of compounds that transfer electrons from electron donors to electron receptor via redox reactions coupled w/ the transfer of protons across a membrane to create a proton gradient that derives ATP synthesis **ELECTRON DONOR** ● A molecule that gives or donates electrons from another molecule during a redox reaction. ● Aerobic respiration; produces ATP, water, energy and carbon dioxide **ELECTRON RECEPTOR** ● A molecule that receives or accepts electrons from another molecule; oxidizing agent; reduced
PROTON GRADIENTS	● The product of the electron transport chain used as an intermediate energy source for heat and flagellar rotation; there is a higher concentration of protons outside the inner membrane of mitochondria than inside the membrane; becomes driving force for ATP synthesis.
PEPTIDOGLYCAN	● A polymer composed of amino acids that serves a structural role in the bacterial cell wall, giving structural strength, as well as counteracting the osmotic pressure of the cytoplasm. It is also involved in binary fission during bacterial cell reproduction.
GRAM POSITIVE BACTERIA	● Group of bacteria that tend to retain the primary stain in Gram's method and are no longer stained by the counterstain. That is because they have thick cell walls. The thick cell wall in this group of bacteria is due to the presence of high peptidoglycan that

	crosslink forming the cell wall. They also have lower lipid content compared to those of the gram-negative bacteria. Their thick cell walls resist decolorization when the smear is washed and flooded with the solvent (a mix of alcohol and acetone) after the initial staining. e.g. *Staphylococcus* sp. and *Streptococcus* sp.. • Stain binds to bacteria • Gram-positive bacteria, where the thick layer of peptidoglycan is exposed and can be easily damaged. • Less resistant to antibiotics.
GRAM NEGATIVE BACTERIA	• A group of bacteria that takes the colour of the counterstain in Gram's method. • Have two plasma membranes, with the periplasm between. • The additional outer plasma membrane prevents the staining of the peptidoglycan layer • Bacteria are pathogenic and thus contains endotoxins in outer lipid layer (prevents damage of of peptidoglycan) Ex: *Escherichia coli*, *Salmonella* spp., *Neisseria* spp. • More resistant to antibiotics **PERIPLASM** • A concentrated gel-like matrix in the space between the inner cytoplasmic membrane and the bacterial outer membrane called the periplasmic space in gram-negative bacteria. Can be compared to cytoplasm
PATHOGEN	• An agent causing disease or illness to its host, such as an organism or infectious particle capable of producing a disease in another organism. e.g. influenza, mumps, measles.
ANTIBIOTIC RESISTANCE	• Antibiotic resistance is the ability of a microorganism to withstand the effects of an antibiotic. It is a specific type of drug resistance. Antibiotic resistance evolves naturally via natural selection through random mutation, but it could also be engineered by applying an evolutionary stress on a population.
PENICILLIN	• An antibiotic produced naturally by certain blue molds (now prepared synthetically) • How it works: It blocks the cross-linking reaction in peptidoglycan synthesis and destroys the bacterial cell wall making the bacterium very susceptible to damage.
PLASMID	• Small circular strand of DNA separated from the main genome that duplicate themselves independent of the bacterial cell. • Plasmids initiate conjunction by producing pili, play a role in horizontal gene transfer and implicated in antibiotic resistance and toxin production.
PILLI	• Mechanism that facilitates the longevity of a bacteria • Cytoplasmic bridge that connects 2 bacteria together where those 2 bacteria can now exchange genetic information (not reproduction just facilitates exchange)
ENDOSPORES	• Mechanism that facilitates the longevity of a bacteria • A bacterial cell where all of the machinery has been shut down, almost dehydrated and just need water to come back to life (can shut down under diverse conditions) • Ex: In winter bacteria under frost will go dormant • Ex: Tutacomons tomb

BINARY FISSION	• A type of asexual reproduction common among prokaryotes (haploid) wherein a cell divides giving rise to two cells, each having the potential to grow to the size of the original cell. • The bacterial genome is duplicated, each copy links itself to the cell wall and as the cell divides a copy of the genome ends up in each of the daughter cells. • If plasmid incorporates in the genome of the bacterium the plasmid DNA is replicated at the same time instead of independently. 
CIRCULAR GENOME	• Circular DNA that forms a closed loop and therefore has no free ends. Ex: E.coli
DAUGHTER CELL	• One of the two or more cells formed when a cell undergoes cell division; genetically identical to the parent cell (same # and type of chromosomes)
REVERSE TRANSCRIPTASE	• An enzyme used to catalyze the process of reverse transcription: ○ RNA ---> DNA from a RNA template
ATP SYNTHASE	• An important enzyme that creates the energy storage molecule ATP. ATP is the most commonly used "energy currency" of cells for most organisms. It is formed from ADP and inorganic phosphate (P_i), and needs energy for its formation.
HISTONE	• Highly alkaline proteins found in eukaryotic cell nuclei that package and order DNA into structural units to form chromosomes; contribute to gene regulation.

HORIZONTAL GENE TRANSFER	**CONJUGATION**
	• The temporary joining together of two bacterial cells to transfer genetic material via the plasmid (either as solitary or as part of a chromosome) from the donor cell to the recipient cell.
	• The presence of a fertility gene on the plasmid produces pili on the surface of the cell wall [F-positive (fertility factor) or F-negative (no fertility factor)]
	• If bacterium w/ pilli encounters one w/o, the two become connected and a single strand copy of the plasmid DNA is transferred from the F+ to the F-
	  ○ Plasmid could also incorporate itself into genome of bacterium
	  ○ Why is a plasmid so important?
	  ■ Contains genes for antibiotic resistance and unique metabolic pathways
	• When this modified plasmid starts to replicate it produces pilli on the surface of its host and when conjugation occurs it passes all of the DNA contained in the plasmid to the other cell and the recipient cell receives both plasmid and bacterial DNA; a form of horizontal gene transfer.
	• Ex: Super bugs
	 
	TRANSFORMATION

	• The process of a bacterium to absorb a DNA strand from the external environment and splice it into their own genome, thus acquiring new characteristics
	  ○ If it works: A new gene sequence is inserted and becomes active
	  ○ If it does not: The DNA is degraded and salvaged for it nucleotide building block
	• Key strategy is creating genetic variation in these small organisms
	
	TRANSDUCTION
	• The process of genetic recombination in bacteria in which genes from a host cell (bacterium) are picked up and incorporated into the genome of a bacteriophage and transfers it to another bacterial cell where it is incorporated in the bacterial genome.
	• The virus takes over the host cells' replication, transcription and translation machinery and uses it to replicate its genome and produce the proteins of the viral case encoded in the viral genome
	• Bacteria are simple, but very diverse!

AUTOTROPH	• An organism that uses source of carbon (CO_2) to build required organic compounds generally using energy from light or inorganic chemical reactions. • e.g. Algae, plants **PHOTOAUTOTROPHS (sun)** • Organisms that carry out photosynthesis. Using energy from sunlight form carbon-carbon bonds from carbon dioxide to be used in cellular functions such as biosynthesis and respiration. Ex: aglae **CHEMOORGANOTROPHS (organic carbon)** • Harvest energy contained in existing C-C bonds to build C-C bonds from a carbon dioxide source with high energy organic carbon electrons • Ex: only bacteria **CHEMOLITHOTROPHS (mineral - Fe)** • Oxidizing minerals and using the proton to make energy to build C-C bonds; carbon comes from CO_2 and high energy electrons are from minerals. • Ex: Nitrosospira (only bacteria)
HETEROTROPH	• An organism that is unable to synthesize its own organic carbon-based compounds from inorganic sources, hence, feeds on organic matter produced by, or available in, other organisms. Ex: Animals, Humans **PHOTOHETEROTROPHS (sun)** • Use light for energy to build C-C bonds from liberating them from existing C-C bonds from organic carbon source. • Ex: Rhodospirillum **CHEMOORGANOHETEROTROPHS (organic carbon)** • Organisms that obtain organic carbon as source and use high energy electrons to build C-C bonds by breaking existing ones. • Ex: Herbivores and Carnivores **CHEMOLITHOTROPHIC (minerals used to high energy protons)** • An organism that is able to use organic carbon and high energy electrons from

	minerals to build new C-C bonds, this process is accomplished through oxidation and ATP synthesis.
PHOTOSYNTHESIS	• The process in which an organism converts light energy into chemical energy that can be later released to fuel organism activity. • Ex: Autotrophs have a light dependant (light → ATP → NADP) and light independent (Calvin cycle)
REDOX PAIR	• Conjugate redox pair. An electron donor and its corresponding electron acceptor form, where the electron is passed between 2 compounds and ATP is turned into ADP. • Taking high energy protons, passing them along a proton gradient • Ex: Cu+ (donor) and Cu^{2+} (acceptor) OR Ex:NADH (donor) and NAD+ (acceptor). **REDUCED** • The change in the atomic composition of an atom / molecule by adding hydrogen, removing oxygen, or gaining electrons. **OXIDIZED** • The change in the atomic composition of an atom/molecule by removing hydrogen, adding oxygen, or losing electrons.
LITHOTROPHS	• A diverse group of organisms using inorganic molecules as an energy and electron source such as hydrogen or minerals. Ex: Methanogens
PANDEMIC	• An epidemic of infectious disease that has spread through human populations across a large region. Ex: Bubonic Plague, Influenza
NITROGEN FIXATION	• The conversion of atmospheric nitrogen (N2) into a more usable form by natural means, such as by the conversion of nitrogen gas to ammonia (NH3)by the action of diazotrophs. Ex: *Rhizobia*, *Azospirillum* **NITROGEN CYCLE** • The cycle of turning nitrogen into various biological molecules. • Ammonia being produced by nitrogen fixation in the solid • Ammonia is taken up by the plants (primary producers) • Enters into terrestrial food webs or oceans (enters back into soil through waste)
STROMATOLITES	• A solid structure created by single-celled microbes called cyanobacteria. The cyanobacteria for colonies and trap sediments with their sticky surface coatings. The trapped sediment reacts to calcium carbonate to form limestone.

VIRUS	• A genome surrounded by a protective protein coat (capsid) that is going to steal the synthetic machinery of another cell to survive.
	  ○ Contains the gene required to duplicate the viral genome, manufacture the capsid proteins and assemble the capsid around the copies of the genome, but lack the machinery to do do this.
	  ○ Take over the replication, transcription and translation machinery of another cell.
	• Extremely variable in appearance and their effect (no cell membrane, no ribosomes, no mitochondria, DNA is actually RNA)
	• Replication: Entry → Transcription and viral protein production→ Replication of viral genome → Assembly of virons → Exit → Transmission to new host
	ENVELOPED VIRUS
	• A virus that has a lipid bilayer surrounding the capsid and the genome inside. This lipid bilayer is formed from the plasma membrane of the host

	and during host takeover produce viral proteins embedded in host membrane. ● When they exit cell, the viral proteins pinch off the host membrane to envelope the virus and leaves like a vesicle instead of bursting **NON ENVELOPED VIRUS** ● Viruses without membrane coat that must lyse from host cell to escape
VACCINE	● A harmless variant or non-virulent of a pathogen that when it is introduced into a host stimulates the host's immune system to mount defense against the pathogen. ● When making vaccines: ○ Kill virus and isolate out protein from the protein case and add antagonistic to it. When injected the body recognizes this and the antibodies destroys it.
ANTIBODY	● A highly specific soluble protein molecule in the blood produced in response to and counteracting a specific antigens, binding to antigens to remove them from the body.
ANTIGEN	● A toxin or other foreign substance that induces an immune response in the body, especially the production of antibodies.
BACTERIOPHAGE	● A virus that takes over the bacterial cell and kills them during the lytic phase of the viral life cycle ● Takes over their transcription-translation-replication system for replicating the viruses themselves, eventually lyses ● When virus fails to destroy host DNA, transduction occurs and the virus becomes a carrier for the bacterial transformation.
LYTIC CYCLE	● Viral replication where replicated viruses burst from host cell to infect someone else, unless it is an enveloped virus then the cell will not rupture.
LYSOGENIC CYCLE	● Viral replication where virus blends into host genome and just sit there dormant (latent viral phase) until it is ready to enter the lytic cycle ● Human genome contains about 8% of viral DNA whose ambitions are not known.
PRIONS	● Prions are small proteins that can exist in two configurations; the normal, properly folded form and the misfolded form. ○ If a misfolded version contacts a normal one it converts the normal one into a misfolded prion ○ Misfolded ones have sticky ends that promotes this change and creates lipid vacuole like holes in the brain ○ Essentially replicate themselves (protein first theory) ● Ex: Mad cow disease
VIRONS	● Small pieces of circular RNA that is capable of self replication; plant pathogens ● Interfere with translation of mRNA into protein and shuts down the process. ● In essence, a self-replicating, self-catalytic RNA, thus supporting RNA world theory. ● Ex: Hepatitis D (no vaccine)