BIO1130-Organismal Biology Key Terms

Predarwinian-Darwin

Ages of sand	• Douglas Adams: divides modern science into four ages of understanding • All related to various forms of sand/silica/glass • Telescope-cosmology->Microscope->cell theory->Silica-based chip->computer->Fiber optic->Internet
Al-Dinawari	• Islamic Golden Age • Islamic botanist who wrote the Book of Plants, covered over 400 plants • Explained favorable growing conditions, plant development, classification
Alhazen	• Islamic Golden Age • Islamic scientist who coined the scientific method: Systemic approach to linking theory and observation
Al-Jahiz	• Islamic Golden Age • Islamic zoologist who translated Greek science • Book of animals describes various ways of behaviour, communication, survival • First to propose natural selection
Avicenna	• Islamic scholar, physician during Golden Age • Book of Cure: Summarized Greek, Indian and Muslim medicine
Al-Baitar	• Islamic Golden Age • Islamic physician and botanist, interested in medicinal plants • Made a huge pharmacopeia of medicinal plants and how to make use of them
Middle Ages	• From 5 to 16th century, a period of stagnated scientific development due to feudalism and diseases • A brief revival during the High Ages when roads and buildings were back until the Black Plague hit • Islamic world flourished, their Golden Era
Aristotle	• Major Ancient Greek Philosopher, zoologist • Focused on the living world and set out to classify the tings in it • Scala Naturae: Organized everything he could see according to value (gods at the top) • Wrote a long list of animals called the history of animals
Theophrastus	• Aristotle's student, botanist who wrote 10 books on plants based on how they reproduce, and instructions how to use them • Almost 100% accurate • Father of taxonomy

Hippocrates	• Practically invented "Wikipedia", collected every doctor's note into a single edition • Hippocratic Corpus covered diseases, speculation, diagnosis, ethics…
Essentialism	• Plato thought the soul of a species made it what it is, works well with creationism • Discouraged scientific studying of biological origins • Until Darwin refuted the idea of unchanging things
Special creation	• Theological stance that all organisms were thrown by God onto Earth one day and never changed after since • Refuted by Darwin • Bishop Usher calculated a date of arrival
Scala naturae	• Created by Aristotle: Great chain of being that classifies according to value • Essence is passed from one generation to another • Church added heaven and hell
Vitalist	• Idea that living things are different from inanimate things because they have a soul • Life cannot be explained by material forces alone
Classification	• Organize things you collect into various groups based on shared traits • Every living thing conscious or not, classifies food, friend, foe • Humans however bother to record these classification systems to make it easier for others to identity things
Taxonomy	• Applying a set of criteria to put things into groups for classification • Rules vary across the world for the same set of objects or animals • Keep track of things so changes can be noticed more easily
Folk taxonomy	• Earliest form of taxonomy when information was passed down verbally • Centered around daily life and only what was important to living • Leads to confusion when cultures clashed
Artificial taxonomy	• Replaced folk taxonomy due to limitations of human memory • First used by Aristotle and Theophrastus • Translated and passed around the world until the list grew ridiculously long • Classifies based on appearance, not names
Hierarchical system	• Putting categories into hierarchies ranging from the biggest difference to the most subtle • Each level (called a taxon) contained an implicit criteria to fit in that category
Mechanical/Linnaean taxonomy	• Carl Linnaeus • Reduces the great detail of artificial taxonomy into two words fot each

	organism called a binomen • Official and universal language for taxonomy
Binomial nomenclature	• Coined by Linnaeus • Two part name system: *Genus species*
Van Leeuwenhoek	• Invented the best microscope of his days • One lense can magnify over 200 times • Father of microbiology: Observed the first organisms that he called "animalcules"
Vesalius	• Physician who upheld the importance of anatomy in medicine • Drew various sketches of body positions
Historical narrative	• Writing history in a storylike manner • A sound argument that applied universally to a group of organisms • Non mathematical law, use logic to explain observed facts
Natural sciences	• Vitalists: Divides line between animate and inanimate • Holistic: Believes the whole is more valuable than the parts added together---emergence • Open to multiple interpretations that is time-place specific • Use induction as method
Physical sciences	• Physicalist: Divides line between humans and machines • Everything can be explained with physiochemical laws • Reductionist view: Explaining the whole using its parts • Allows for no exception • Deduction as method
Theory	• The soundest explanation for an observed phenomenon with supportive evidence • Has withstood the test of time, very slight chance of being wrong but not much
Law	• Must work universally for all places • Biologists are limited to earth, so they cannot have laws • Mendel's law is an exception, but only works under specific conditions
Deduction	• Premise accepted as truth, then go from general to specific
Induction	• Observing patterns over time then making out general formula
Hypothesis	• Baby theory, just a proposal of possible causations but must withstand the test of time to verify that it is indeed the cause • If this were to change…then something would happen
Logical prediction	• Scientific prediction based on logic and reliable evidence • Not predicting the future, but explaining the effect of a variable

Chronological prediction	• Pop science like Tarot • Literally predicting the future without means to explain it
Scientific method	• Evidence-based way of answering a question • Research->develop possible explanations->test hypothesis->see if results fit model->when causation proved, publish results • Links theory to observation
Fact	• An observation confirmed so many times that it is pointless to keep proving
Proximate cause	• "How" aspect of a question • Deals with immediate forces at work • Ex. The animal ran because it sensed danger
Ultimate cause	• "Why" aspect of a question • Deals with underlying causes • Ex. The animal ran away because evolutionary mechanisms prompt it to do so in face of danger
Empirical observation	• Determined from data collected through strict experiment • Has to be verifiable through repeated testing, and every trial must yield same results
Sampling error	• Unreliable sample at work • If experiment is replicated, results or outcomes should be similar for each trial
Primary reference	• Author of the work wrote it themselves • First hand data with every fact referenced to previous studies, and peer-reviewed by experts of the same field • Key source of every scientific fact
Secondary reference	• Written by experts in the field who didn't do the experiment • Still peer-reviewed, but mostly a summary of other people's work, references everything
Tertiary reference	• Written by non-experts who don't reference everything either • Still peer-reviewed, but not as strict • Ex. Textbook
Industrial melanism	• Pepper moths acquire darker color in response to darker environment • Significant because it directly demonstrates evolution: A shift in the frequency of alleles in a population • Indicted different fitness levels competing
Extinction	• A major, recent, sharp loss of a species
Leclerc	• Coined the idea of changing species • Father of biogeography

	• Observed felines of different morphological traits in different environments
Erasmus Darwin	• Translated Linnaeus into accessible English • Authored Zoonomia (laws of organic life) that mentioned marine origins • Believed microbes came from ocean then moved up land and grew bigger
Cuvier	• Catastrophic theory that tried to explain mass extinctions • Coined mass extinction • Father of comparative morphology
Lyell	• Examined rock layers from around the world and found their composition share the same sequences: rock cycle • Father of geographical stratigraphy: Created a geographical time scale that was longer than described in the Bible • Rock cycle explains the change in fossils
Uniformitarian theory	• Idea that Earth was shaped by geographic processes gradually taking turns over millennium, and the process continues even to our day • Perfected by understanding of plate tectonics
Catastrophic theory	• Idea that Earth was shaped by sudden disasters never seen before • Survivors of the catastrophe live on to become a new generation
Continental drift	• Precursor of plate tectonics: Attempt to explain the symmetrical distribution of similar animals found across different continents • Proposed by Alfred Wagener • Lateral movement of continental masses away from or toward each other
Lamarck	• Attempted to explain how species changed into their present form ever since Eden • Simple life become more complex as their traits and body parts which they use to strive in an environment develop better than other traits or parts • Parents then pass on acquired traits to offspring
Constancy of species	• Species don't change after created
Alfred Wallace	• Proposed fitness of an organism as getting to pass on more copies of its genes, which is impacted by a changing environment • As advantageous traits change, allele frequency in a gene pool also change since those with advantageous alleles get to live longer to reproduce
Biogeography	• The study of geographic distribution of animals and plants throughout space and time
Charles Darwin	• Applied uniformitarianism, artificial selection and Lamarck's ideas to

	evolution • Provided purely physical and natural explanations as to how species cane to change • No constancy of species and common ancestry was accepted
Natural selection	• Idea that organisms with traits better suited to the environment will reproduce more and pass those traits on to offspring, promoting the preservation of those traits
Fitness	• Measure of a competing gene's contribution to the gene pool based on how many copies it successfully passed down relative to other competing genes • An individual's ability to reproduce as many offspring that survive to reproduction age
Fossil records	• Remains or impression of animals inside rocks for preservation • Proved extinction and showed transition via natural selection • Provided missing links to the interrelativity of species
Transitional forms	• Intermediate states between ancestor and descendant • Proved no constancy of species
Comparative morphology	• Comparing structural based homologous traits in species that shored a common ancestor, similar components indicate blood lineage • By analyzing structural details we can infer what happened to cause this change
Homology/divergent evolution	• Species have different modified traits according to environmental needs • Share common ancestor • Ex. Horse feet and human feet
Analogy/convergent evolution	• Species share similar traits • But they are not related • Ex. Insect wings and bat wings

Microevolution

Louis Pasteur	• Proposed germ theory
Germ theory	• Life originated as a sort of living plasma spontaneously • Became basis for cell theory
Schleiden/Schwann/Cell theory	• Schleiden(plant) and Schwann(animal) found all things share a basic unit that contained membrane and kernel • 1. All organisms are made of one or more cells • 2. A cell is the basic structural and functional unit of an organism • 3. All cells come from pre-existing cells
Mendel	• Breeding peas he discovered the laws of heritability

	• 1, Law of segregation of characters • 2. Law of independent assortment
Biological species	• Groups of organisms only capable of breeding with each other • Problem being single cell and extinct animals cannot breed
Morphological species	• Groups of organisms based on shared traits • Problem being confusing divergence with convergence, and hard to pick which traits should be based on
Anagenesis	• A species change its appearance overtime and replaces its ancestor • Ancestor extinct
Cladogenesis	• Separate two groups of the same species that can co exist quite peacefully
Allopatric	• Separate species geographically so they cannot interbreed
Sympatric	• Species not physically isolated but have contact barriers
Parapatric	• Species adjacent to one another, in region of contact there is a hybrid ring • Creates subspecies
Subspecies	• Taxon beneath species • Different enough but can still interbreed
Reinforcement	• One outcome of subspecies coming into secondary contact with each other, where the two lineage differences are reinforced by the survival disadvantage of hybrid offspring • Eventually hybrid disappears and speciation is complete
Fusion	• One outcome of secondary contact, where genetic differences are again wiped out
Reproduce isolating mechanism	• Ecological: Environment difference prevents breeding • Temporal: Mating season difference prevents breeding • Behavioral: Signal to mate not shared, prevents breeding • Mechanical: Morphological differences prevent breeding • Gametic: Gametes cannot fuse together • Post zygotic • Hybrid inviability: Hybrid unable to survive, die young or cannot reproduce
Phylogenetic species	• Species classified based not on sex or appearance but on the degree of evolutionary history they share • Can be applied to any group, living, asexual • Tree branches incorporate both morphological and biological definitions: No gene flow, look different

Cladogram	• Divided into two groups, one stays at the bottom and the other inherits a derived trait • Emphasizes similarities rather than difference
Plesiomorphy	• Ancestral trait that is retained
Apomorphy	• Derived trait
Autopomorphy	• Trait that defines a species
Synapomorphy	• Shared derived trait but not exclusive to species
Symplesiomorphy	• Shared ancestral trait that is retained
Monophyletic taxon	• Includes both ancestor and all its descendants on a clade • Best way of classification
Polyphyletic taxon	• Only the descendants but no ancestor
Paraphyletic taxon	• Ancestor and part of its descendants
Modern Synthesis	• Unifies theory of evolution with Mendelian genetics put together by Huxley • Explains both microevolution and macroevolution that lead to speciation
Microevolution	• Evolutionary changes in allele frequency in a population due to genetic differences over time that produces different phenotypes • Ex. Mutation, chromosome recombination
Allele	• A member of a gene pair that occupies a locus on a homologous chromosome, each coding for a trait • Can be dominant or recessive or have several versions • Genetic recombination accounts for the great variability of genotypes
Gene pool	• Sum of all alleles at all gene loci of all individuals in a population
Genotype frequency	• % of individuals in a population possessing each genotype
Allele frequency	• Relative abundance of each allele in a sample population's gene pool • P and q are used to represent dominant and recessive
Hardy-Weinberg principle	• Proposed by Hardy and Weinberg independently • Under specified conditions, the allele frequency not genotype frequency should change over generations---genetic equilibrium is reached • 1. No mutation 2. No migration/gene flow 3. Population is large/no gene drift 4. No natural selection 5. Random mating • If not met, microevolution may occur, indicated by a shift in allele frequency
Adaptive radiation	• Describes a population that are adaptively specialized to a certain

	habitat and food source.
Allopolyploid	• An organism gets chromosomes from different species (Meiosis). The resulting offspring is usually infertile and bears several genetic conditions. • Ex. Plants crossing over
Autopolyploid	• An organism has multiple sets of chromosomes that are derived from one species due to errors in meiosis. • Usually only seen in plants because plants can survive well with more than natural set of chromosomes
Beneficial mutation	• Mutation in the genome that produces a beneficial affects on the organism in a way that increases its Darwinian fitness and the chance of its mutation being passed on • Dramatically affects the genetic diversity of a population but are rare and can cause long term adaptation.
Bottleneck effect	• Large population suffers a catastrophe and only a few survive • The resulting population that springs back will have a high percentage of survivor's genes
Chromosomal inversion	• A form of chromosomal mutation when there occurs a break in two pieces of a chromosome and the portion of the chromosomes is then inverted. The cut the chromosome may occur in the middle of a gene and cause the gene to lose its functionality so that it is no longer expressed. No mutation would occur if the cut rearranges the gene sequence.
Chromosomal mutation	• A change that occurs at the chromosomal. This causes abnormalities due to a change in the chromosomal DNA. • Missing, extra, or irregular piece • Down Syndrome have 3 chromosomes when others have two
Chromosomal translocation	• A chunk of one chromosome gets moved to another
Crossing over	• During gamete fusion some of the parents chromosomes exchange genes • Allow for more diversity due to recombination
Deleterious mutation	• Harmful mutation that reduces an organism's fitness • If mutation occurs in the part of the DNA squene that does code for protein cause be deleterious • Can cause errors in the protein sequences. Can make protein able to partially function or not function at all • Sickle cell anemia, (red blood cells don't fold properly)
Diploid	• Two sets of homologous chromosomes • Advantageous because one protects the other, harmful mutations can be covered • In eukaryotes

Directional selection	• When one allele is favoured over another, causes the graph to shift and favour the side of one extreme over the other. • Bell curve is remained but mean is used more to the extreme • can be caused by natural selection
Disruptive selection	• When extreme phenotypes are selected for and the intermediates are selected against • Leads to speciation
Female choice	• Females choose mating partner • Males must prove their fitness to pass down genes • Ex. In some birds males who sing louder are determined to be more healthy and therefore more attractive
Frameshift mutation	• When gene sequence changes, because a nucleotide is added or taken away • Can alter entire sequence unless three consecutive frameshift happens
Point mutation	• Gene sequence changes due to one nucleic acid replaced by another • Another amino acid can form
Punnett square	• The process/ technique that Mendel used to determine the genotype and phenotype of the next generation
Stabilizing selection	• Moderate traits between two extremes are favored • Bell curve becomes narrower but mean does not change
Triploid	• An organism has three sets of homologous chromosomes

Hadean

Adhesion	• Cohesion property allows water to be adhesive and bond to other polar substances • Example: water up a straw, vascular system of plants, transpiration
Archaean eon	• Between 3800 to 2500 MA • Rise of anaerobic bacterial life (archaea) in ocean • Oxygen accumulated as by-product of cyanobacteria splitting water to get ATP, then released into atmosphere, marking the end of Archean eon
Bio monomers	• Smallest unit of macromolecules • Can form polymers through polymerization • Organic molecules formed by Miller-Urey Apparatus (methane), hydrothermal vents (superheated water from extreme pressure can make building blocks of life, turn inorganic matter into organic), or having interstellar origins
Biopolymers	• The macromolecules: Carbs, proteins (amino acid), lipids, nucleic acids (nucleotides) • Clay hypothesis: Solid surfaces like clays may have provided the environment necessary for polymers (whether proteins or RNA first) to form, whereas in aqueous environments chains would break down after

	reaching a certain length • They allow for precise orientation needed for monomers to line up
Building phase of the earth	•After big bang, how solar system was created (see bio web note) •Earth being constantly bombed by meteorites, volcanic activity, continuous heating and cooling of the planet
Carbon	•Most abundant building block of life, formed by dying stars •Special and versatile in the capacity to form four bonds, allowing for common forms of molecules
Cenozoic	•Age of the mammals, when larger animals began to be seen •65 million years ago •Other two are Mesozoic and Paleozoic
Central dogma	•Fundamental aspect of life, its growth and replication •Explains how information is transferred in the cell: DNA-(transcription)>RNA-(translation)>proteins •DNA alone can code for all the processes in a cell
Chemical evolution	•How inorganic molecules became organic and more complex through homegrown chemical processes •Contributed to life forming in the Hadean Eon
Cohesion	•Hydrogen bonding: Uneven charges create the characteristically polar nature of water molecules •Water molecules attract each other in all directions, but near the surface the intermolecular forces are stronger, stickier •They are therefore very hard to separate, like a bag of magnets
Crystal lattice of water	•H-bonding between water molecules, when a central molecule creates a symmetrical, 3D, tetrahedral structure with four other molecules •Bond angle of 109.5 degree •Observed in ice, lowers its density (from 4 degree), causing it to float and protecting aquatic life beneath
Emergence	•A molecule in its own does not have some form of ability, but when molecules work together, new properties emerge •Complex higher system emerge from many simple interactions that do not possess the special properties in their own
Eras	•Subdivisions within major Eons in Earth's History •Contains subdivisions called periods •For example, we're in the Cenozoic Era within the Phanerozoic Eon
Eukaryote	•Unicellular or multicellular organisms whose cell/cells have a membrane

	bound nucleus containing genetic materials •One of the three domains
Mesozoic	•251-65MA •Great explosion of multicellular life on land: Appearance of herbivore and omnivore vertebrates •Flowering plants that use insects to spread gametes dominated the earth •Ends with dinosaur extinction
Evaporation	•When liquid shifts into gas phase, absorbing heat •Mechanism of animals to carry away extra heat through sweat evaporation •Created primordial atmosphere that contained organic molecules (See podcast atmosphere section)
Geological timescale	•Presented by Lyell in uniformitarian theory as each rock layer described different time periods in earth's history •Divided into four eons (Hadean, Archaean, Proterozoic, Phanerozoic)
Goldilocks zone	•Habitable region around a star that allows liquid water to exist, fundamental to life •Ideal temperatures: Cannot be too close for evaporating, but not too far for freezing •Earth allows all three forms of water to exist
Greenhouse gases	•Gases like CO2, CH4, H2O that hold heat in the atmosphere in the form of infrared radiation •Earth traps just enough heat for organisms to live •Earth cooled down when lime deposits formed
Hadean eon	•4500-3800 MA •Violent formation of the solar system and planets •Set the stages for life, but ends with the actual appearance of life forms
Hydrogen bond	•Non-covalent bond that is almost ionic, due to unequal sharing of electrons between hydrogen and elements like FNO
Hydrophilic	•Polar molecules create bond with water •Ex: Lipid head of cell membrane is hydrophilic and can bond with water, creating a water film surrounding the surface
Hydrophobic	•Non-polar molecules that lack any affinity to water molecules •Ex. Fatty acid tail of cell membrane
Hydrothermal vents	•Alternative hypothesis to carbon compounds forming in atmosphere or extraterrestrial origins •They can be formed at deep sea vents, results of volcanic activity •Superheated water under high pressure contained rich building blocks of life

	including amino acids and nucleotides
Interstellar organic compounds	• Alternate hypothesis to atmosphere or deep sea vents regarding the origin of carbon compounds • Meteorites that impacted the earth contained many biologically important molecules including amino acids and nucleotides
Interstellar space dust	• When solar system was formed, intense heat and pressure gathered most of the dust cloud and hydrogen gas into the sun • The rest formed the planets including Earth
Late heavy bombardment	• During late Hadean Eon • Moving planets disturb surrounding asteroid belt, shooting things towards either the center or the outside • Planets' orbits expanded • Jupiter and Saturn's harmonic pull and push on asteroid belt caused pieces of the asteroid belt to either be pulled towards the center or shot outside • Also kicked Neptune to the outer ring • As a result inner planets like Earth suffered heavy bombardment, until Jupiter and Saturn became protective scavengers for incoming meteorites, bringing stability
Liposome	• Lipid bilayer vesicle encloses a water droplet • Very similar to cell membrane, selectively permeable, may have resembled photobionts before development of cells • Important for origin of life because membrane allows metabolic reactions to take place in an semi-isolated environment with different concentrations than outside
Micelles	• Monolayer version of liposome, one spherical layer of phospholipids that traps a lipid droplet
Miller-Urey experiment	• Simulate the Hadean conditions where complex molecules arise through abiotic processes in a reducing atmosphere, before the origin of life • Repeated heating and cooling cycles of water and chemicals reacted with carbon to form basic building blocks of life • Since it also produced components of nucleic acids, it formed the basis of DNA that is essential for Central Dogma to make life
Nice model	• Scenario for evolution of the Solar System • Seeks to explain late heavy bombardment, migration of planets, asteroid belt
Nonpolar compound	• Compound whose atom's electronegativity's difference is very low • Hydrophobic: Does not form bond with polar compounds, so they separate in layers • Ex. Accounts for plasma membrane, liposomes, micelles formation

Paleozoic	•543-251MA •Starting with Cambrian explosion, a rich diversity of multicellular ancestral types then diversity began decreasing •Two phases: In ocean heterotrophic invertebrate animals feed on algae, on land first insects feed on first plants
Panspermia	•Central dogma states there must be a DNA->RNA->protein system for life to grow and replicate itself •Instead of arising abiotic ally on Earth, the system may have been introduced to Earth by a simple life form from outer space •Maybe from Mars in a meteorite
Periods	•Smaller time frames within an era within a period •Ex. Jurassic period within Mesozoic era within Phanerozoic eon
Phanerozoic eon	•543MA-present •Appearance of multicellular heterotrophic organisms •Divided into three eras: Paleozoic, Mesozoic, Cenozoic
Prebiotic soup	•Operon-Haldane hypothesis states the reducing atmosphere in early Earth contributed to formation of complex organic molecules that are the building blocks of life (amino acids, nucleotides) •Overtime these molecules concentrate forming a nutritious “soup”, but no life has occurred yet because the amino acids and nucleotides are not macromolecules, and not proteins or RNA
Prokaryote	•Organism whose genetic material is not enclosed by membrane •Consists exclusively of eubacteria and archaea •Probably fused together to form eukaryotes
Proteins first hypothesis	•Alternative to RNA world: If proteins did come first, it would have to replicate itself to be considered living •A protein was found to be able to duplicate fellow proteins •However protein catalysts are long chains and need clay to orient them
Proterozoic eon	•2500MA-543MA •Marked by appearance of aerobic single cell eukaryotes (Protista) in oxygen world •Unicellular algae become photosynthetic primary producers in ocean •No multicellular life yet
Protocells	•Primordial Earth: A group of abiotic ally produced molecules surrounded by a lipid sphere, precursor of a cell •Membrane system and genetic info system must have evolved at the same time to create the first ‘living’ cell •Clay hypothesis: Besides forming amino acid chains, clay also help form lipid vesicles, and clay particles can catalyze reactions inside membrane

Reducing atmosphere	•Molecules in early atmosphere possessed a lot of hydrogens and electrons •Ready to react with other molecules, at last forming biological building blocks (Nucleotides, amino acids, sugars) •Fundamental for explaining the Operon-Haldane hypothesis/Miller-Urey experiment
Reverse transcriptase	•How RNA can come first then turns into DNA, explains RNA world •Reverse central dogma •Nowadays an enzyme used by virus to replicate itself within host cell
Ribozymes	•RNA molecules that catalyzes its own synthesis •Can fold 3D like proteins •Answered the central dogma question concerning origin of life: Early life may have existed in an RNA world, where RNA not only carries information (nucleotide sequence) but also replicate itself (3D folding) •However DNA is better at info storage, and proteins are better catalysts, so the organisms that have DNA->RNA->proteins are at evolutionary advantage over RNA by itself •The self-sufficient spirit of ribozymes survive in ribosomes
RNA world	•Where early life may have existed, with RNA serving as info storage, info carrier and replicating catalyst all at once •Eventually RNA passed info storage to DNA and catalyst to proteins->central dogma
Specific heat	•The amount of heat needed to increase the temperature of a given quantity of a substance, associated with bond strength •Ex. Accounts for sweat's effective ability to bring away heat from body simply by vaporizing
Spontaneous origins	•Obsolete thought on origin of life that believed life can arise by non-living things •Different from abiogenesis because spontaneous origins believed it's still ongoing, whereas abiogenesis/primordial soup stated this is now impossible, the conditions of earth have changed irreversibly
Stabilizing phase of the earth	•After building phase of Earth meteorites stopped bombing Earth that could cause global damage •Habitable zone: Right temperature of Earth allowed surface cooling to form a crust, from which volcanic gases emitted, while water vapour cooled down to form the ocean •The right gravitational field held on to escaping gases, resulting in early atmosphere that had no oxygen
Surface tension	•Measure of the strength of bonds at the surface of a liquid •Stronger bonds at the surface gives elastic properties and makes it more

	resistant to separation, or "stickier" to each other •Ex. Insects exploit the strong hydrogen bonding at water surface to walk on water
Surfactant	•Chemical agent capable of reducing surface tension of a liquid •Ex. detergent
Vesicles	•Small fluid filled, membrane-bound sac found in the cytoplasm of a living cell •Used for nutrient and waste transport
Volcanic outgassing	•Hadean eon, volcanic activities release gas from Earth's molten center core •Formed the atmosphere when gases cooled, but early atmosphere contained no oxygen •Water vapor when cooled, formed the ocean

Archean

Absorptive heterotroph	• Organisms who receive nutrients from external environment by secreting enzymes to digest their food first, then absorb them in • As opposed to ingestive, where the food is first taken in then digested • Used by fungi
Aerobic	· Type of respiration where an organism requires oxygen to perform cellular Respiration. · Humans breathe oxygen to provide the final electron acceptor for the electrons that are removed from food, and pass down an electron transport chain to make ATP via aerobic respiration. · Some prokaryotes use oxygen as a final electron acceptor also, which makes them and humans aerobes.
Algae	· A diverse group of photosynthetic organisms that aren't plants. · Classified under the kingdom Protista · Eukaryotic (they're DNA is enclosed within a nucleus) *Extra stuff found online that might be useful:*

	· Algae provides a good amount Earth's oxygen, · They are the food base for almost all aquatic life, · They are a source of crude oil, and they provide food, pharmaceutical, and industrial products for humans.
Anaerobic	· Type of respiration where a prokaryotic organism does not require oxygen to live. (In fact strict anaerobes require an oxygen-free environment to survive.) · Obligate anaerobes are poisoned by oxygen and survive by fermentation. This is where organic molecules are the final electron acceptors, or by anaerobic respiration. They're strict anaerobes. · Facultative anaerobes use O2 when it is present, but under anaerobic conditions, they live like obligate anaerobes. · Anaerobic respiration can also involve other inorganic molecules, such as nitrate or sulfate, as the final electron acceptors. Only prokaryotic organisms are capable of this type of respiration.
Animalia	· Taxonomic group that includes all living and extinct animals. · A classification from Linnaeus' taxonomic hierarchy.
Antibody	· A highly specific soluble protein molecule that circulates in the blood and lymph, recognizing and binding to antigens and clearing them from the body.
Antigen	· A foreign molecule that triggers an adaptive immunity

	response. · Macromolecules; most are large proteins (including glycoproteins and lipoproteins) or polysaccharides. · They may be exogenous, which means that they enter the body from the environment · Or endogenous which means that they are generated within the body. · Example: E. Coli
Antibiotic resistance	· And antibiotic is a natural or synthetic substance that kills or inhibits the growth of bacteria and other macromolecules. · Because the bacteria have the capability to survive in extreme conditions, even with antibiotics, few bacteria may survive. They survive because they developed an Antibiotic Resistance. · The antibiotic resistance is a valuable trait so the bacteria will be multiplied through reproduction (binary reproduction or horizontal gene transfer). · Some bacteria may become what are known as “Super-bugs”. Super-bugs are not only resistant to antibiotics, but they can simply pass the trait to another bacteria (they don’t need to undergo the reproduction process). · There are various mechanisms by which bacteria resist antibiotics . For example, some bacteria are able to pump antibiotics out of the cell using membrane-bound pumps. They can also produce molecules that bind to the antibiotic or enzymes that break down the antibiotic, rendering it ineffective against its target. Alternatively, a simple mutation can result in a change in the structure of the antibiotic’s target, so that the antibiotic cannot bind to it. Finally, bacteria can develop new enzymes or pathways that

	are not inhibited by the antibiotic. · Bacteria can develop resistance through mutations, but they can also acquire resistance via horizontal gene transfer (e.g., plasmid transfer). Taking antibiotics routinely in mild doses, or failing to complete a prescribed dosage, contributes to the spread of resistance by selecting strains that can survive in the presence of the drug.
Archaea	• Single-celled prokaryote • Circular chromosome protected with histones • Complex RNA polymerase makes proteins, and the primary amino acid used is methionine
ATP synthase	• Proton gradient builds up then falls back through ATP synthase, changing its shape • Converts ADP to ATP energy molecule
Autotroph	• Source of carbon to build required organic molecules comes from CO2 • Builds C-C bonds from consumed molecules of CO2
Bacteria(Eubacteria)	• Single-celled prokaryote, outnumber any other organisms • Circular chromosome not protected with histones • Simple RNA polymerase makes proteins, and the primary amino acid used is formylmethionine • Extremely great metabolic diversity, uses various combinations of electron donors and electron acceptors
Bacterial flagellum	• How a bacteria swings, flagellum consists of 23 proteins identical in all bacteria • Proteins form rings in the membrane(s) and in the peptidoglycan layer, sealing motor protein and shaft • Moves by proton-motor protein-flagellar hook-filament interaction
Bacteriophage	• Viruses that prey on bacteria • By taking over their transcription-translation-replication system for replicating the viruses themselves, eventually cell lyses • When virus fails to destroy host DNA, transduction occurs and the virus becomes a carrier for bacterial transformation
Binary fission	• Like mitosis but no lining up of chromosomes • With the large number of bacteria there is bound to be an unfixed mutation during DNA replication • They can pass mutation onto offspring

Capsule	• Dormant bacteria's extra protection
Chemolithoheterotroph	• Builds new C-C bonds by breaking down existing C-C bonds and liberating carbons • Obtains energy to build the bonds from oxidizing minerals
Chemolithotrophs	• Oxidizing minerals and using the proton to make energy so you can build C-C bonds • But the carbon itself comes from CO2 • Only found in bacteria
Chemoorganoheterotrophs	• Builds new C-C bonds by breaking down existing C-C bonds to get carbon • Harvests energy contained in existing C-C bonds to re-stitch the carbons together
Chemoorganotrophs	• Harvests energy contained in existing C-C bonds to build C-C bonds • But the carbon itself comes from CO2 • Only found in bacteria
Chitin	· A polysaccharide that contains nitrogen and is present in the cell walls of fungi and the exoskeletons of arthropods.
Circular genome	· This is the usual shape of the genome within a bacteria · Genome is the entire collection of DNA sequence for a living organism.
Conjugation	· In bacteria, the process by which a copy of a part of the DNA of a donor cell, moves through the cytoplasmic bridge into the recipient cell where genetic recombination can occur. In ciliate protozoans, a process of sexual reproduction in which individuals of the same species temporarily couple and exchange genetic material. · Two bacteria cells contact each other by a long tubular structure called a sex pilus and then form a cytoplasmic bridge. Once DNA from one cell enters the other, genetic recombination can occur. This unidirectional transfer of a part of the chromosome is kind of like a sexual reproduction in prokaryotic organisms.
Cyanobacteria	· A phylum of bacteria that obtain their energy though photosynthesis · Aquatic bacteria
Daughter cell	· The result of a parents cell dividing itself into two or more identical parts; cell division In prokaryotes: binary fission · Eukaryotes: Mitosis & Meiosis (where the 2 daughter cells are then split in half again to form gametes)
Domains	· In protein structure, a distinct, large structural subdivision produced in many proteins by the folding of the amino acid chain. · In systematics, the highest taxonomic category; a group of cellular organisms with characteristics that set it apart as a major branch of the

	evolutionary tree.
Electron donor	· A chemical entity that donates electrons to another compound. · It is a reducing agent, so by donating electrons, it is oxidized in the process.
Electroreceptor	· A compound that receives or accepts an electron from another compound. · An example For both Donor and Acceptor where this occurs is during oxidative phosphorylation in cellular respiration, and photosystem 1 and 2 in photosynthesis.
Electron transport chain	· Series of protein complexes in mitochondria, or chloroplasts, which pass electrons between the complexes. It involves a series of oxidation and reduction reactions that pass the electron to oxygen to form water and ATP · Located at the plasma membrane
Endospore	• Specialized cell wall in bacteria besides the peptidoglycan • Protects the bacteria from adverse conditions, while the cell inside goes dormant and can be easily dispersed around the world, might carrying diseases with them • Ex. Killed the Tutankhamen archaeologists after a long sleep
Enveloped virus	• Virus whose genetic material and protein coat are surrounded by phospholipid membrane coat, which they steal from host cell • During host takeover they also produce viral proteins embedded in host membrane • Budding: Then when they exit host cell, the viral proteins pinch off host membrane to envelope the virus, and it leaves like a vesicle instead of bursting
Eukaryote	• Not in the archaea or eubacteria domain • Have a true nuclei: Genetic material enclosed by membrane, looks like a kernel • A derived trait, May have evolved later by several prokaryotes fusing into a cell
Extremophiles	• Archaea, can live in all sorts of extreme environments without going dormant (heat, saline), found in deep sea vents, glaciers • Cannot study them properly because we cannot duplicate their living conditions in lab • Since they have the best hopes of surviving radiation in space travel, might be the clue to panspermia
Flagellar hook	• Spins as shaft gets turned by motor protein by flowing protons
Flagellar motor	• Works like ATP synthase, smallest motor in living world • Protons get pumped outside membrane, and they can flow down the conc. gradient back to cell only through the motor protein • Each time a proton flows through, motor protein changes conformation, in turn displacing the shaft, after shaft returns to original shape the cycle

	starts over • Repeated cycles brings the flagellar hook rotating, as well as the whip-like filament embedded inside, generating motion
Fungi	• Multicellular eukaryote absorptive heterotrophs • Cell walls made of chitin • Saprophytic, feed on the dead and decaying
Gram-negative bacteria	• Two membrane separated by a peptidoglycan layer • Outer membrane plays an active process in regulating exchange (therefore cannot be stained) • Extremely diverse in their surface proteins, serve as fingerprint identification
Gram-Positive bacteria	• Thick peptidoglycan layer protecting cell membrane • Can be killed with penicillin which interferes with its peptidoglycan wall, making the cell swell and burst
Halophiles	-Extremophile archaea that love salty environments
Heterotroph	• Consumes then breaks down existing C-C bonds, and uses the liberated carbon to build its own required organic molecules • Evolved before autotrophs, huge advantage in the primordial soup
Histones	• Wraps and concentrates DNA by electrical attraction
Horizontal gene transfer	• Another way to pass genetic variation besides reproduction • Plasmids travel through pili into neighbor bacteria (conjugation), replicates itself • Recipient is thus changed in genetics, can then do the same thing to other bacteria • Ex. Accounts for antibiotic resistance quickly spreading throughout population • Includes transformation (taking DNA from environment) and transduction (bacteriophage as accidental DNA carrier)
Ingestive heterotroph	• Organisms who receive nutrients from external environment by taking in food and digest them inside the body • As opposed to absorptive, where the food is first broken down by enzymes then taken in by the organism • Used by animals
Lysogenic cycle	• Viral replication where virus blends into host genome and just sit there dormant until it is ready to enter the lytic cycle • Human genome contains 8-10% of viral DNA whose ambitions we have no idea of
Lytic cycle	• Viral replication where replicated viruses burst from host cell to infect

	someone else • Unless it's an enveloped virus then the host cell won't rupture
Monera	• Inclusive category that fitted in all the prokaryotes, before eubacteria and archaea were distinguished • Until people stated sequencing their RNA strands • Eubacteria and archaea carry out the central dogma (DNA replication, transcription, translation) in drastically different ways
Nitrogen fixation	• Only bacteria can convert N2 gas into nitrogenous compounds that are released into soil, taken by vegetation, then enter terrestrial food web, eventually to be recycled • Nitrogen is essential to all three components of the central dogma: DNA, RNA(nucleic acid), protein(amino acid), but organisms cannot directly use N2 from air • Ex. Nitrogen fertilizers can leak into water bodies, creating bacteria bloom and depriving water of oxygen, destroying ecosystem
Non-enveloped virus	-Virus without a membrane coat -Must lyse from host cell to escape
Nucleoid	• Inside prokaryotes instead of a membrane-bound nuclei • Region where DNA wraps around histones, but no membrane cover
Pandemic	• Large scale infection that has spread across multiple continents • Ex. Spanish flu
Peptidoglycan	• Layer of proteins and carbohydrates that gives bacteria cells its rigidity • Allows bacteria to preserve its shape against osmotic pressure changes
Photo heterotrophs	• Uses light energy to build C-C bonds • Obtains carbon by liberating them from existing C-C bonds
Pilli	• How horizontal gene transfer occurs • Directed by plasmid, on the surface of bacteria to help them exchange genetic materials
Plantae	• Multicellular eukaryote photoautotrophs • Cell wall made of cellulose
Plasmid	• A way to share genetic material between bacteria, transferred through pili then replicates itself in recipient cell • Ex. Recombinant DNA work: take fragments of DNA of organisms you want to study, put them inside bacteria plasmid to be amplified, then re-collect them • As it migrates among hosts, helps to mix up DNA further, bringing some of original host DNA to the next cell

Prions	• Not virus, not bacteria, not even nucleotide, just extremely stable and ambitious proteins • Extremely sticky, "aberrant" proteins form unstoppable plaques that continually expand and convert other proteins into aberrant • In essence, replicates itself, thus supporting protein first theory • Interferes with nerve operation, Ex. Mad cow disease
Prokaryote	• Single celled organisms without a nuclei, DNA not wrapped in a membrane • Evolved before eukaryote • Consists of solely eubacteria and archaea
Protista	• Single cell eukaryotes • Ancestors of multicellular eukaryotes • Consists of protozoans and algae
Redox pair	• Fundamental to any biological energy supply, couples an electron donor and a receptor to trap energy • Remove an excited electron from donor either by light(photo-), chemical bonds(chemoorgano-) or ionized inorganic materials(chemolitho-) • Attach high energy electron to a proton, proton then transfer energy to receptor molecule which goes to mitochondria to make ATP • Initial donor and final receptor both result in new products • Ex. Cyanobacteria (classical photoautotroph) was so successful because it used ocean water as its electron donor, and directly responsible for oxidizing the planet, setting stage for all aerobic life
Reduced	• Added electron
Reverse transcriptase	• Used by RNA virus during replication • Turns RNA into DNA when infecting and taking over host cell's transcription-translation-replication system • Supports RNA world theory
Stromatolites	• Cyanobacteria that form biofilm colony on surface, successive generations grow on top of dead older generations, creating layers
Surface-volume ratio	• As cell gets larger, surface supply cannot catch up with the metabolic demands of a fast growing volume • Thus aiming for maximum surface area: More contact with environment means more simple diffusion of nutrient/waste • With regards to minimum cell volume: Smaller cell means less biochemical activity • Smallest bacteria has ideal surface to volume ratio, sparing cellular complexity
Transduction	• Method to overthrow an alpha bacteria predator tyrant for ecosystem stability • Viruses called bacteriophages prey on bacteria cell by taking over their transcription-translation-replication system for replicating the viruses

	themselves, eventually cell lyses • Sometimes a strand of host DNA gets packaged inside virus, who then migrate to another host, and by injecting its DNA from original host transforms the new one
Transformation	• Bacteria randomly incorporates into their genome pieces of DNA from the environment • Since there is no protective second chromosome, any effect the DNA piece might have will be expressed right away, whether for better or worse (no carriers) • In most of evolutionary history (billions of years), bacteria gene variation occurs through simple transformation
Vaccine	• Antigenic reaction to proteins that has been previously injected • Destroys coat proteins associated with the virus • Ex. Spanish flu extremely lethal, also because viruses mutate their coat proteins quickly so the same vaccines won't recognize it
Viroid	• Small circular pieces of RNA found in plants • Invading viroid sets down MRNA translation to replicate itself, and shuts the cell's own processes down • In essence, a self-replicating self-catalytic RNA, thus supporting RNA first theory • Ex. Hepatitis D, vaccines won't stop it
Virus	• Minimalist organisms that does not even meet all criteria of life • Basically a strand of genetic material inside protein casing • Replicates by injecting own genetic material inside host, disable all host's central dogma related processes, but uses the exact same mechanisms to make new copies of itself, eventually exiting (like raising own family inside house of a family you murdered) • May be surrounded by phospholipid bilayer(enveloped) membrane or not(no enveloped) • RNA viruses can do reverse transcription • More complicated if infecting eukaryote cell

Proterozoic Eon:

1)9+2 Organization	-the organizational pattern that results in the creation of microtubules from the centrioles -The 9+2 part comes from the fact that the microtubules is made of 9 "doubles" around 1 central tubule
2)Alternation of Generations	-The regular alternation of mode of reproduction in the life cycle of an organism, such as the alternation between diploid (sporophyte) and haploid (gametophyte) phases in plants.

	-The occurrence of two or more forms differently produced in the life cycle of a plant or animal usually involving the regular alternation of a sexual with an asexual generation -ex. Plants are prime examples of this
3)Amoeboid movement	-the alternative mode of movement besides using flagella -used by amoebozoa -features actin and myosin changing the shape of the cytoplasm to destroy and recreate the hyaline cap, making the fixed volume of the protist move forward
4)Asexual Reproduction	-Any mode of reproduction in which a single individual gives rise to offspring without fusion of gametes, that is, without genetic input from another individual. See also vegetative reproduction.
5)Autotroph	-a photosynthetic organisms that takes carbon from inorganic compounds such as co2 to make sugar molecules -also uses light in the process of creating energy for itself
6)Eubacteria	-one of the three main domains dividing all life -main characteristic: the existence of a nucleus -most related to the archaea domain -came last in evolution due to high amount of complexity
7)Bacteriophage	-viruses carrying bacterial DNA -can destroy the host bacteria via the lytic cycle or lie dormant in the lysogenic cycle
8)Basal Body	-a synonym for centrioles and centrosomes -specifically used when the centriole is at the base of a cilia or flagella in a cell
9)Bikont	-a state characterized as having two flagella -one of the main division of all living things (how many flagella do you have?)
10) Cellular Division of Labour	-In eukaryote cells -Each organelle has its own role that contributes to overall cell survival
11)Cellular Gliding	-the type of movement that describes the first primitive form of motion
12)Centriole	-an important organelle in the cell responsible for moving around chromosomes during mitosis and maintaining the cell architecture
13)Centrosomes	-A cylindrical structure consisting of nine triplets of microtubules in the centrosomes of most animal cells. - the centriole-containing region of clear cytoplasm adjacent to the cell nucleus
14)Chloroplast	-organelle in photosynthetic cells used to create sugar molecules using light -contain chlorophyll which is not only essential for photosynthesis but gives plants green pigment
15)Choanoflagellate	-the ancestor of all animals -an opisthokont (means the flagella is in the back)

	-also the flagellated cell in sponges that help filter feed through the water
16)Cilia	-tiny hair like structures in the plasma membrane of ciliates that allow movement and feeding -made by the centrioles within the cell -can result in complex movement in the cell due the fact that the cilia do not all move in same direction
17)Cirrus	-a slender usually flexible animal appendage or projection: as -a fused group of cilia functioning like a limb on some protozoans
18)Contractile Vacuole	-vacuole within protists cell that collects water only to propel out to keep the cell from bursting
19)Crossing Over	-a source of genetic variation within meiosis in which the parental dna on nearby chromosomes swap places -very important for the sake of biodiversity in eukaryotes
20)Cytoskeleton	-The interconnected system of protein fibres and tubes that extends throughout the cytoplasm of a eukaryotic cell. -formed by the centrioles of the cell
21)Diploid	-An organism or cell with two copies of each type of chromosome in its nucleus. -a characteristic that is alternated within the “alternation of generations” -having two haploid sets of homologous chromosomes -a single cell, individual, or generation characterized by the diploid chromosome number
22)Diplontic	-the life cycle characterized by spending the majority of time as a diploid organism -a characteristic of animalse -key difference from the other two types of life cycles is that gametes are created from diploid cells through meiosis
23)Dyenin molecular motor	-One of the three molecular motors that move along microtubules to cause them to move in flagellar, ciliary movement -also help in organizing the cell architecture -burn atp to twist at every step to move from one polarized end to another
24)Ectoplasm	-the outer relatively rigid granule-free layer of the cytoplasm usually held to be a gel reversibly convertible to a sol
25)Endomembrane System	-In eukaryotes, a collection of interrelated internal membranous sacs that divide a cell into functional and structural compartments. -three main components: the nuclear envelope, the ER (both rough and smooth) and the golgi apparatus -created by invaginations of the plasma membrane in the evolution of protists -creates a system of surface area for complex processes in the cell to occur without disturbing a large part of the cell such as organizing and packaging proteins

26)Endoplasm	-the inner relatively fluid part of the cytoplasm
27)Endosymbiosis	A symbiotic association in which one symbiont or partner lives inside the other. -two subdivisions: primary and secondary symbiosis -explains how the mitochondria and the chloroplast came about to be in the cell today -caused by the fact that the cell gained the ability of movement through the creation of the flagella -occurred because the host did not fully digest the ingested organisms
28)Eukarya	-one of the three main domains of life characterized mainly by the existence of nucleus in the cell -closest relative is an archaea -evolved from different classifications of protists
29)Flagellum	- long, threadlike, cellular appendage responsible for movement; found in both prokaryotes and eukaryotes, but with different structures and modes of locomotion. -in prokaryotes, the driving motor is embedded in the plasma membrane -in eukaryotes, it is created from microtubules and molecular motors (dyenin and kynein) moving up down the alternating sides of the microtubules -gave the first cell its primary mode of movement to lead to the endosymbiosis -one of hte major ways of dividing all the living organisms in the living world (unikont or bikont)
30)Formylmethione	-the first amino acid coded for in prokaryotes in the process of translation
31)Gametocyte	-a cell (as of a protozoan causing malaria) that divides to produce gametes
32)Gametophyte	-a stage in the “alternation of generations” -lead to the fertilization and sources of variation that lead into the next generations - the haploid multicellular individual or generation of a plant with alternation of generations that begins with a haploid spore, produces gametes by mitotic division, and ends with fertilization producing a diploid zygote and that constitutes the visibly dominant form in mosses and algae, exists as an independent plant body in ferns and their relatives, and is reduced to a microscopic or rudimentary state in seed plants -An individual of the haploid generation produced when a spore germinates and grows directly by mitotic divisions in organisms that undergo alternation of generations.
33)Haploid	-An organism or cell with only one copy of each type of chromosome in its nuclei. -having the gametic number of chromosomes typically including one of each pair of homologous chromosomes -a stage of the “alternation of generations” -except for animals, can exist as an organism (i.e,haploid form of plants)
34)Haplontic	-the life cycle in which organisms spend the majority of life as haploids -a characteristic of the kingdom fungi

	-gametes are created through mitosis
35)Heterotrophs	-An organism that acquires energy and nutrients by eating other organisms or their remains. -requiring complex organic compounds of nitrogen and carbon (as that obtained from plant or animal matter) for metabolic synthesis
36)Histone proteins	-any of various simple water-soluble proteins that are rich in the basic amino acids lysine and arginine and are complexed with DNA in the nucleosomes of eukaryotic chromatin -positively charged -protects and stores the dna in the nucleus -allows humans to contain a large genome within a small space
37)Host	-the organisms that ingests or holds within the invading organimss -ex. bacteria and bacteriophage -the events of symbiosis in which the bacteria served as host for small bacteria formed a relationship that shaped all of earth's biodiversity today -a living animal or plant on or in which a parasite lives**b :** the larger, stronger, or dominant member of a commensal or symbiotic pair**c :** an individual into which a tissue, part, or embryo is transplanted from another
38)Kynesin molecular motor	-one of the molecular motors that move along microtubules to cause the cellular movement, rearranging chromosomes in meiosis and mitosis, and designing the cellular architecture -walk toward the positive end of the microtubule
39)Macronucleus	-In ciliophorans, a single large nucleus that develops from a micronucleus but loses all genes except those required for basic "housekeeping" functions of the cell and for ribosomal RNAs. -a relatively large densely staining nucleus of most ciliate protozoans that is derived from micronuclei and controls various nonreproductive functions
40)Malaria	-a protozoan parasite that transfers from human to human via fruitflies? -complex life cycle (explained in slides) -
41)Meiosis	-the division of diploid cells to haploid progeny, consisting of two sequential rounds of nuclear and cellular division. -assisted by microtubules and molecular motors -important process involved in the creation of genetic variations (via random assortement and crossing over)
42)Merozite	-a sporozoan trophozoite produced by schizogony that is capable of initiating a new sexual or asexual cycle of development
43)Metachronal wave	-describes the type of movements that ciliates use -the cilia go through a power stroke, then the recovery stroke is 90 degrees to the power stroke (against the body) -allows to go forward more then backward each stroke

44)Methionine	-the primary “intiator” amino acid coded for in the process of translation using ribosomes, trna and mrna -a key characteristic that links the eukarya and archaea domains
45)Micronucleus	-also created from the single large nucleus, the small nucleus of the two within the cilia -a minute nucleus; *specifically* **:** one that is primarily concerned with reproductive and genetic functions in most ciliated protozoans -this structure allows for the ciliate dna to stay pristine and undamaged (mutation) from outside environments (due to the fact that its sole purpose is for reproduction)
46)Microtubules	-any of the minute tubules in eukaryotic cytoplasm that are composed of the protein tubulin and form an important component of the cytoskeleton, mitotic spindle, cilia, and flagella -A cytoskeletal component formed by the polymerization of tubulin into rigid, hollow rods about 25 nm in diameter. -created from the centrosomes within the cell -allowed the eukaryote cells to essentially develop to become larger than the prokaryotes -allowed for the cell to have a more efficient way of distributing nutrients beside diffusion
47)Mitochondria	-the powerhouse organelle gained by eukaryote cells through a primary endosymbiosis -orginates from bacteria due (the proof is the size, shape, circular dna, ribosomal sequence and use of binary fission) -creates ATP for the cell to undergo important life processes
48)Mitosis	-process in which a parent cell (diploid/ haploid) will duplicate itself into order to create two identical daughter cells -steps; Interphase, PMAT, Cytokinesis
49)Molecular motors	-motors that walk along the microtubules; use ATP to cause confirmational changes that cause the motors to walk -have a carrying structure to help transport vesicles -aid the microtubules in cell division, the cell architecture, and intracellular transport -Three types: Kinesin, Dyenin and Myosin
50)Myosin molecular motor	-an example of a molecular motor; this specifically walks on actin fibers to cause amoeboid motion
51)Nuclear envelope	-caused the invagination of the plasma membrane from both sides around the nucleoid -isolated ⅔ of the Central Dogma inside the nucleus -contains pores to communicate with the cytoplasm
52)Operon Genes	-A cluster of prokaryotic genes and the DNA sequences involved in their

	regulation. -a group of closely linked genes that produces a single messenger RNA molecule in transcription and that consists of structural genes and regulating elements (as an operator and promoter)
53)Pandemic	-occurring over a wide geographic area and affecting an exceptionally high proportion of the population <*pandemic* malaria> -an outbreak of a disease that occurs over a wide geographic area and affects an exceptionally high proportion of the population **:** a pandemic outbreak of a disease
54)Parasite	-an organism living in, with, or on another organism in parasitism -example parasite: flukes and flatworms -the organisms that it lives on is being harmed, hence the relationship parasitism
55)Peptidoglycan	-A polymeric substance formed from a polysaccharide backbone tied together by short polypeptides, which is the primary structural molecule of bacterial cell walls. -a polymer that is composed of polysaccharide and peptide chains and is found especially in bacterial cell walls —called also *mucopeptide, murein*
56)Pericentriolar Material	-Mass of protein that make up the centrosome surrounding the two centrioles -Responsible for microtubular nucleation
57)Phagocytosis	-the engulfing and usually the destruction of particulate matter by phagocytes -used by the immune system/lymphatic system to kill infectious foreign agents
58)Phytoplankton	-Microscopic, free-flowing aquatic plants and protists. -umbrella term for green algae and cyanobacteria=the primary productivity of the oceans that the first animals fed on -still prevalent today in the oceans
59)Pinocytosis	-bulk phase endocytosis -the uptake of fluid and dissolved substances by a cell by invagination and pinching off of the cell membrane
60)Planar Flagellar Beat	-Flagella beats in wavelike pattern
61)Plankton	-the passively floating or weakly swimming usually minute animal and plant life of a body of water
62)Plasmodium	-a motile multinucleate mass of protoplasm resulting from fusion of uninucleate amoeboid cells; *also* **:** an organism (as a stage of a slime mold) that consists of such a structure
63)Plastid	-any of various cytoplasmic organelles (as an amyloplast or chloroplast) of photosynthetic cells that serve in many cases as centers of special metabolic activities -also gained through primary endosymbiosis in earlier cell -proof is shared with the mitochondria and also the fact that it contains

	peptidoglycan in its walls
64)Polygenomic Classification	-Phylogenetic classification for polyploids
65)Primary Consumer	-A herbivore, a member of the second trophic level. -example: crustacea -in the oceans primary consumers mostly fed off algae and other phytoplankton
66)Primary Endosymbiosis	-symbiosis in which a symbiont dwells within the body of its symbiotic partner -In the model for the origin of plastids in eukaryotes, the first event in which a eukaryotic cell engulfed a photosynthetic cyanobacterium. -reason why eukaryote cells have mitochondria and plastids (endosymbiosis between a small bacteria and a larger protist)
67)Primary Producers	-main example in the oceans- unicellular algae and other phytoplankton -on land-multicellular plants -An autotroph, usually a photosynthetic organism, a member of the first trophic level. -
68)Proterozoic	-of, relating to, or being the eon of geologic time or the corresponding segment of rocks that includes the interval between the Archean and Phanerozoic eons, exceeds in length all of subsequent geologic time, and is marked by rocks that contain fossils indicating the first appearance of eukaryotic organisms (as algae)
69)Protista	-one of the major kingdoms classifying all life on earth -ancestral kingdom to fungi and animalia -any of a diverse taxonomic group and especially a kingdom (Protista syn. Protoctista) of eukaryotic organisms that are unicellular and sometimes colonial or less often multicellular and that typically include the protozoans, most algae, and often some fungi (as slime molds)
70)Pseudopod (pseudopodium)	-used in amoeboid movement -a temporary protrusion or retractile process of the cytoplasm of a cell that functions (as in an amoeba) especially in a locomotor or food gathering capacity -created through interactions of the actin fibers and myosin motors with the endo and ectoplasm layers of the protist
71)Reverse Transcriptase	-used by HIV to turn RNA into DNA (first viewed in this virus) -An enzyme that uses RNA as a template to make a DNA copy of the retrotransposon. Reverse transcriptase is used to make DNA copies of RNA in test tube reactions.
72)RNA polymerase (simple and complex)	-any of a group of enzymes that promote the synthesis of RNA using DNA or RNA as a template
73)Saprophytic	-obtaining food by absorbing dissolved organic material; *especially* **:** obtaining nourishment from the products of organic breakdown and decay

	-a key characteristic of the kingdom fungi
74)Secondary Endosymbiosis	-In the model for the origin of plastids in eukaryotes, the second event, in which a nonphotosynthetic eukaryote engulfed a photosynthetic eukaryote. -
75)Sexual Reproduction	-The mode of reproduction in which male and female parents produce offspring through the union of egg and sperm generated by meiosis. -
76)Spiral Flagellar Beat	-Flagella motion moving in a spiral direction, as opposed to planar
77)Spore	-haploid product created through endosymbiosis in fungal and plant life cycles -creates gametes through mitosis -A haploid reproductive structure, usually a single cell, that can develop into a new individual without fusing with another cell; found in plants, fungi, and certain protists. -a primitive usually unicellular often environmentally resistant dormant or reproductive body produced by plants, fungi, and some microorganisms and capable of development into a new individual either directly or after fusion with another spore
78)Sporophyte	-An individual of the diploid generation produced through fertilization in organisms that undergo alternation of generations; it produces haploid spores. -the diploid multicellular individual or generation of a plant with alternation of generations that begins from a diploid zygote and produces haploid spores by meiotic division
79)Sporozite	- usually motile infective form of somesporozoans that is a product of sporogony and initiates an asexual cycle in the new host
80)Supergroup	-
81)Trophozoite	-a protozoan of a vegetative form as distinguished from one of a reproductive or resting form
82)Tubulin (tubulin dimers)	-the proteins used by centrioles to create microtubules -made out of two carbohydrate sub units (hence the word “dimer”) -a globular protein that polymerizes to form microtubules
83)Zooplankton	-Small, usually microscopic, animals that float in aquatic habitats. -plankton composed of animals
84)Zygote	-a fertilized egg, formed from the fusion of a male (sperm) and female (egg) -usually diploid -grows through mitosis into an organism

Phanerozoic-Paleozoic Era

Cambrian and Ordovician

Snowball earth

- Theory that Earth froze at least once before Cambrian explosion (550MA)
- Terrestrial rocks reflect more than absorb solar energy
- Appearance of aerobic photosynthesizing organisms and O2 shifted atmospheric CH4 to less insulating CO2 that also got depleted when rain erosions brought CO2 incorporating minerals into the ocean
- Planet becomes unable to trap solar energy and freezes
- Developing multicellular life at this point got on hold until Earth thaws again---Cambrian explosion

Slushball earth

- Like snowball earth but less severe
- Same impact on multicellular life

Doushantuo fossils

- 590-565MA, before Cambrian
- Fossilized embryos of multicellular life

Ediacaran fossils

- 580-542MA, Fossils of the Ediacaran period in Newfoundland
- Impression of oldest multicellular life on earth, the proto animals
- Makes Cambrian explosion less dramatic, however no burrowers and everything sat on biofilm layer

Ediacaran period

- Last period in Proterozoic Eon
- Before Cambrian Explosion
- Ediacaran fossils show evidence of proto animals

Cambrian explosion

- 550MA
- Huge burst of multicellular biodiversity, including the ancestors of invertebrate animals that appeared all at once
- However there is evidence of multicellular life even before Cambrian, that probably got on hold when snowball earth happened

Cambrian period

- 550-488MA

- Massive explosion of marine invertebrates

Cambrian burrowers

- One explanation for Cambrian explosion
- Molluscs and Annelids, first burrowing Cambrian invertebrates broke through the formerly impenetrable biofilm layer sitting at ocean bottom
- Advantage of feeding (on what no one else exploited), anchorage (one end rooted in substrate layer, the other munching), protection (dig inside to hide)
- Whole new food source opened up a whole new world

Cambrian shelled arms race

- One explanation for Cambrian explosion
- Besides burrowing, you can also become bigger to escape predation and swallow smaller prey
- Shelled animals like Molluscs and Arthropods competition in size lead to increased biodiversity
- Less selective pressure kept the not so successful body plan around until competition arises, leading to mass extinction

Homeotic genes/Hox genes

- Real explanation for the Cambrian explosion of diverse body plans, for they only appeared since Cambrian
- Genes that regulate body developmental pattern in the embryo, by encoding transcription factors that signaled which structures are turned on and off in different locations
- Same pattern across all cells from generation to generation
- Multiple sets of homeotic genes allowed for more experiments while keeping original function (like second set of chromosomes)

Homeotic mutants

- Homeotic genes regulate body development patterns
- Taking a cell that received a certain homeotic signal to specialize, and put it somewhere else in the growing embryo
- The organism ends up having structures in the wrong locations
- Ex. Mutant fruit fly with legs where the antenna is supposed to be

Paleozoic era

- Geological Era in the Phanerozoic Eon
- 550-250MA
- Cambrian explosion of biodiversity---appearance of marine invertebrates, primitive fish, first land plants and insects

- Ends with Permian Mass Extinction

Burgess Shale fossils

- Fossil records of the Cambrian explosion
- Exquisite preservation of soft bodied invertebrates that typically should not fossilize
- Includes all the major animal phylas we know today, plus some unclassified

Cambrian swimmers

- Primitive chordate fishes

Ordovician period

- 488-443MA
- Diverse marine invertebrates

End Ordovician extinction

- Second largest mass extinction after the Permian, at the end of Ordovician
- Happened as glacier activity caused sea levels to drop, destroying ecosystems that resided on continental shelves
- 60% species were wiped out, including many of the bizarre animals in the Burgess shales
- Many of its survivors have the body plan we know and love today

Choanocytes-Porifera

Choanocyte (Choanoflagellate)

- Common ancestor of animals and fungi, sits at ocean bottom
- Collar of microvilli surrounds central unikont flagellum, captures particulate food in water current created by beating flagellum
- Choanocyte colonies precede sponges, but no cell-cell communication and no specialization

Colonial choanoflagellate

- Choanocytes get together to collectively pump water
- More effective than individual cells added: Emergence
- Predecessor of sponges

Assymetric body plan

- Sponges
- Does not have an oral-aboral axis through which a line drawn can divide the organism into identical halves

Porifera/Sponges

- Simplest life form that appeared before Cambrian, only multicellular life form without tissues
- Choanocytes create aquiferous pumping system sending water current through porocytes covering the surface, bringing in nutrients (filter feeding)
- Totipotent cells can become any other type of specialized cell
- Asymmetrical body plan, sessile

Aquiferous system

- Feeding, pumping system of sponges
- Beating flagellum of choanocytes brings water current into spongocoel that contains particulate food, captured by microvilli
- Water leaves with wastes through osculum

Spongocoel

- Large central cavity of sponges, lined by choanoderm
- Water enters though pores covering the surface, bringing nutrients
- Exits through osculum, carrying away waste

Choanoderm

- Inner layer of cells, not tissues, that lines the spongocoel
- Cells glued together by collagen, no cell-cell communication
- Made of choanocytes that create unidirectional current flow through microvilli, capture particulate food

Mesohyl

- Gelatinous layer that glues together outer pinocoderm and inner choanoderm in sponges
- Contains supporting spicules made of spongin

Pinacoderm (Pinacocyte)

- Layer of cells, not tissues, that form the outer wall of sponge
- Cells glued together by collagen, no cell-cell communication
- Made of pinacocytes

Totipotent cells

- Sponge plasticity
- Every cell is a sort of stem cell that even after specialization, can despecialize again to become any other type of cell if needed
- Ex. Choanocyte becomes sperm, amoebocyte becomes egg during reproduction

Amoebocyte (Archeocyte)

- Specialized cell in sponges that function as internal circulatory agents
- Totipotent, can turn into an egg during reproduction season

Cnidaria

Gap (Septate) junctions

- Adjacent cells linked by connexon channels that open and close, controlling chemical signals to pass through
- Essential for cell-cell communication that distinguishes true tissue from cell layers

Blastula

- A stage in embryonic development before gastrulation occurs, embryo is just a hollow ball with one cell layer
- Becomes gastrula when gut folds in at blastopore

Blastopore

- Opening where the gut folds in during embryonic development
- After another opening forms at the opposite end, blastopore may become mouth (protostome) or anus (deuterostome)

Gastrulation

- During embryonic development, part of a blastula receives signal to grow inward, creating a pocket-like archenteron cavity for digestion
- Blastula goes from hollow ball of cells to two layers: diplobastic

Gastrula

- Forms from blastula after gastrulation when an endoderm is created by punching in the ectoderm
- Is now diploblastic, the outer ectoderm and inner endoderm surrounding digestive cavity, the gut

Archenteron (Enteron)

- A primitive, undeveloped gut surrounded by endoderm, formed during gastrulation
- Develops into digestive cavity of all modifications

Incomplete gut

- In diploblastic organisms and flatworms there is only one opening, the mouth that also functions as anus

Diploblastic

- Gastrulation forms two layers of tissue, ectoderm (epidermis) and endoderm (gastrodermis) during embryonic development
- Incomplete gut

- Cnidaria

Ectoderm

- Outmost layer of a developing embryo

Endoderm

- Innermost layer of a developing embryo
- Lines digestive cavity, may or may not be lined by mesoderm

Radial symmetry

- Found in Radiata like Cnidaria, before cephalization occurs
- Draw a line across oral-aboral axis, no matter drawn in which direction the body can always be divided into identical halves
- Not necessarily mean diploblastic

Cnidaria

- True tissue: Diploblastic with incomplete gut (coelenteron), radially symmetrical
- Have cnidocytes, specialized cells that discharge nematocyst stingers to capture prey
- Dimorphic life cycle: Alternates between sessile polyp and motile medusa
- Epitheliomusculature with antagonistic contractile myonemes and fluid filled gut creates hydrostatic skeleton

Cnidocil

•On cnidocyte cell that triggers discharge of nematocyst

Cnidocyte

•Specialized stinging cell that arms and captures prey for Cnidaria

•When triggered by cnidocil, discharges nematocyst with poison or barbed thread

•May be stolen by platyhelminthes as defense strategy

Epitheliomusculature/Epidermis

- Ectoderm of Cnidaria, contains nerve net and contractile myonemes
- Myonemes line ectoderm and endoderm in antagonistic sets, longitudinal and circular, that take turn contracting
- Works with the fluid in gastrovascular cavity to create hydrostatic skeleton: Organism returns to original form after changing shape

Mesoglea

- Found between outer epidermis and inner gastrodermis in Cnidaria
- Like mesohyl in sponge but thicker, glues together tissues

- Medusa: the elasticity of mesoglea works with inner circular myonemes to swim by changing diameter, forcing water in and out

Gastrodermis

- Endoderm of Cnidaria, lines the gastrovascular cavity
- Separated from ectoderm by mesoglea NOT mesoderm

Hydrostatic skeleton

- Fluid filled space does not change in volume, so shape must change as one set of muscle contracts
- When combined with antagonistic set of muscles, organism can return to original form after changing shape, which is essentially the function of a skeleton
- Contraction of one set of muscle returns the other set to original length
- Seen in Cnidaria, Annelida, Nematoda, Echinodermata, invertebrates before true skeleton developed

Medusa

l Derived body plan of Cnidaria, motile

- When reproduction, fertilized egg becomes planula that lands to enter sessile polyp stage
- Requires only one circular set of myonemes combined with elastic mesoglea to propell itself through water, by repeatedly forcing water in and out of its body

Oral-aboral axis,

- Axis from the blastopore to its opposite end
- The number of dividing planes that can be drawn across it determines symmetry

Polyp

l Ancestral body plan of Cnidaria, Medusa flipped upside down

- Grown from free-swimming planula larva (comes from Medusa)
- Sessile with epidermis, mesoglea, gastrodermis surrounding incomplete gut that is directed up, with a circle of cnidocytes armed tentacles around it
- Gastrovascular cavities of polyps may attach to form colonies

Gastrozooid

•Specialized polyp in a polyp colony whose function is feeding

Gonozooid

•Specialized polyp in a polyp colony whose function is reproduce

Corals

- Appeared (650MA) before Cambrian (550MA) indicating the long time presence of Cnidarians
- Coral reefs built from little interconnected polyps that secrete a protective hard case shelter
- Most biodiverse habitats, like the ocean's rainforest. Prominent around the equator, create and maintain large diversity of organisms that come to live under their rooftop
- Coral bleaching as result of global warming

Reefs

- Built together by corals and bryozoa in the Ordovician oceans

Bilateria

Triploblastic

- Three layers of tissue, precedes bilateral symmetry because cephalization only occurs with advanced movement and navigation that requires mesoderm
- However Ctenophores have triploblasty but not bilateral symmetry
- Mesoderm may proliferate from between ectoderm and endoderm then split to form coelom (schizocoel) or proliferate from enteroderm with coelom inside (enterocoel)

Mesoderm

- Between ectoderm and endoderm
- Provides advanced movement, essential for cephalization and bilateral symmetry
- Accompanies the coelom

Coelomate (Eucoelomate)

- Animals with a fully functioning coelom that split or pouched from mesoderm
- Fluid inside body cavity acts as hydrostatic skeleton independent of digestive cavity
- Can also function as circulatory fluid for nutrient transport
- Provides space to expand for organs when needed
- Musculature lining digestive organs let them move food through the tract

Schizocoel

- Found in Trochozoa
- Mesoderm proliferates from between ectoderm and endoderm then splits to form the coelomic cavity

Enterocoel

- Mesoderm proliferates from endoderm, with coelom pouch inside

Complete gut

- In most Bilateria triploblasty accompanies complete digestive tract with mouth and anus
- Opening where gut is punched in during gastrulation is called blastopore
- Blastopore forms mouth then Protostome, forms anus then Deuterostome

Cephalization

- Drifting of an organism's sensory organs to one end of the body in the direction it navigates, forming the head

Bilateral symmetry

- Occurs only after triploblasty, as mesoderm provides advanced movement and navigation
- Cephalization moves all sensory organs to one end of the body
- Only one line can be drawn across the oral-aboral axis that divides the body into identical halves

Bilateria-Protostoma-Platyzoa

Protostome

- During embryonic development in triploblastic organisms the gut folds in at blastopore, then another opening forms at the opposite end
- Protostome is when blastopore becomes mouth

Radial cleavage

- Embryo development stage when four cells become eight, the divided cells directly pile on those four cells
- As opposed to spiral cleavage
- Once thought to define deuterostomes

Spiral cleavage (Spiralia),

- Embryo development stage when four cells become eight, the divided cells sit on the clefts between those four cells
- As opposed to radial cleavage
- Once thought to define protostomes
- Seen in Platyzoa and Lophotrochozoa

Platyzoa/Platyhelminthes

- Loss of coelom as result of miniaturization so they can flatten
- Moves by muscular motion or cilia gliding across substrate, ventral mouth picks up food with pharynx and sends it to branched gut

- Incomplete gut is a derived trait, gut branches throughout body
- No metanephridia, no circulatory system, but simple diffusion compensates for all this, with increased surface-volume ratio

Miniaturization

- The art of doing most with the least materials, high surface-volume ratio
- Make body so small and flat that simple diffusion is enough for nutrient distribution, gas exchange and waste deposal
- Coelom or mesoderm that gets in the way are removed (Flatworms, Nematoda)

Acoelomate

- Animals who do not have a secondary body cavity (coelom) that provides circulatory system and hydrostatic skeleton, apart from digestive cavity
- Mesoderm does not split to form coelom; remains a solid mass
- Seen in platyhelminthes where minimization makes simple diffusion enough for nutrient transport, but not in more complicated animals

Fluke life-cycle

- Parasitic life cycle of flatworms
- Miracidium hatch from eggs buried in fecal materials to invade a gastropod host, where it morphs into sporocyst containing more baby larvae, the redia, that contain even more larva with tails, the cercadia
- As free-swimming Cercaria larva, passes to vertebrate host, eventually settling in human liver
- Phenomenal because humans arrived so much later than Platyhelminthes

Larval Amplification

- How flukes multiply their numbers just in larval stage
- Miracidium->gastropod host->Sporocyst
- Sporocyst->many baby redia larvae
- Redia->more baby cercadia swimming larvae

Hermaphrodite (Hermaphrodism)

- Organism has both male and female reproductive organs, doubles the chance of finding a mate to pass down genes
- Extensive measures are taken to prevent self-fertilization, ensuring genetic recombination
- Sperm production and exchange happens first, passed from seminal vesicles to the mating partner's seminal receptacles
- After a while the egg matures and fertilization occurs when egg passes by seminal receptacle containing the partner's sperm

- Seen in flatworms and snails

Seminal receptacle

- After sperm exchange the partner's sperm is stored in the seminal receptacle and waits for own egg to mature

Seminal vesicle

- Before sperm exchange the sperm is stored here, separate from maturing egg to prevent self-fertilization
- Sperm transferred by sperm duct from secreting testes

Protostoma-Lophotrochozoa-Lophophorate

Lophotrochozoa

- Only group that lacks morphological similarities besides molecular data to unite them
- Things in this group either have a lophophore feeding structure plus U-shaped gut or a trochophora larval stage

Lophophore

- Double ring of hollow ciliated tentacles around the oral opening of Lophophorates
- Traps and moves particulate food down a continuous mucous stream all the way to the mouth
- Great for suspension feeding

Bryozoa/Moss animals

- Sessile, sits at bottom of the ocean with U-shaped gut
- Suspension feeders: Lophophore tentacles hollowed and covered in cilia, traps food and pass them down to the mouth
- Grow by budding, can form reefs

U-shaped gut

- Mouth and anus on the same side, bent gut
- Water current brings in food and brings away waste in the same direction

Lophotrochozoa-Trochozoa-Mollusca

Trochophore

- Larvae stage that defines Trochozoa with cilia propelling them through water, as well as food into the mouth
- Ultimately settles down and undergo metamophorsis ex. Mollusca, Aneelida

Trochozoa

- Trochophore larvae stage

- Mesoderm and coelom formed by schizocoel
- Dorsal heart and pericardial cavity

Mollusc

- Teeth-on-tongue radula provides huge feeding advantage as organisms scrape organic material (biofilm) off substrate
- Body consists of two distinct regions: Organs protected by dorsal mantle that secretes protective calcareous shell that even when pulled down, leaves a mantle cavity for filter feeding and waste removal…..
- And ventral ciliated muscular foot that propels organism forward while under protection of shell, and carries the whole body with it
- Adaptive radiation: Same basic structure that provide great feeding, movement, defense advantage modified in a huge variety of ways

Radula

- Razor-like tongue, biological scraper with teeth
- Great for substrate feeding

Deposit (Substrate) feeders

- Organism that feeds on organic materials in sediment layers on top of which they live
- As opposed to filter feeding that captures particulate food in moving water currents
- Includes Mollusca (w/ radula) and Annelida (burrowing)

Ciliated ventral muscular foot

- Tread-like locomotion device that carries with it the entire body cavity containing major organs, mantle, and shell (like a tank)
- Wave of contractions propels the body to glide forward
- Protected by dorsal mantle
-

Adaptive radiation

- A shared set of distinct characteristics that have been diversely modified in response to selective pressure
- Seen in Mollusca, a tremendous array of body plans across different classes, but all based on the same basic structures
- Principle of homology

Mollusca-Bivalve

Bivalve (Clams)

- Radula gone
- Filter feeds (suspension feeder) by burrowing into substrate and pumping water through mantle cavity

Filter feeding

- Getting food by filtering organic material particles in water
- Seen in aquatic organisms, such as clams

Mollusca-Gastropod

Gastropod (Snails)

- Trochozoa, most abundant of Mollusca
- Torsion: Body twists and retreats into spiral shell for protection
- Elegant hermaphrodites that stab partner with dart to make them more feminine
- Asymmetric body plan

Mollusca-Cephalopod

Cephalopod (Squids and Octapods)

- Most complex and intelligent of Mollusca
- Closed circulatory system
- Elongated body and loss of shell ** was watching the lecture & I'm pretty sure they still have their shells!
- Dorsal head close to muscular foot that are modified into tentacles

Trochozoa-Annelida

Annelida

- First burrowers + substrate feeders, helped by four (beta-chitin) setal bundles to anchor the earthworm
- Metamerization creates identical segments with coelomic fluid hydrostatically isolated, so individual segment changes don't affect one another
- Have a complete digestive tract but needs closed circulatory system to distribute nutrients

Setae (Setal hairs)

- Tiny hairs of Annelids, arranged in bundles of four, helps anchor earthworm while burrowing
- Contraction of longitudinal muscles make setal hairs pop out, grip nearby walls
- Single seta and a pair on each side of earthworm

Metamere (Metamerization)/Segmentation

- Segmented body plan, serially identical units in an earthworm that repeat down its length

- Each segment hydrostatically isolated from its neighbor; can independently change shape via circular and longitudinal muscles
- Closed circulatory system needed to distribute nutrients, as segments were isolated

Protostoma-Ecdysozoa-Nematoda

Ecdysozoa

- Moulted protein cuticle replaces surface cilia
- Cuticle made of collagen or chitin
- Special cleavage pattern, neither spiral or radial
- Grow by ecdysis (moulting)

Ecdysis

- Moulting growth pattern
- New, unpolymerized cuticle is laid beneath the old one, polymerized and fixed only after escape
- Organism inflates itself to escape, rips open old cuticle and wriggles its way out
- Size and weight don’t change together

Cuticle

- Non-living outer layer secreted by underlying epidermis
- Can be rigid or flexible
- Can’t be enlarged once polymerized and fixed, so growing animal must discard the old shell for a newer and bigger one via ecdysis/moulting, hence the name

Nematoda (Round worm)

- Bilateral Ecdysozoa with collagenous cuticle and cylindrical body
- One layer of longitudinal muscle, muscles on both sides take turns contracting, creating whiplike motion that lets them weave through soil to feed
- Pseudocoelomate: Result of miniaturization, getting advantage of coelom with less tissue. No muscle lining gut, food moves when body moves
- No motor neurons needed, muscle extensions connects nervous to muscle system
- Amoeboid sperm that doesn't swim
- Epitheliomuscular pharynx that when pharyngeal muscles contract, quickly pulls open triangular space and sucking force that draws food in

Collagen

- Cell glue for Animalia, though does not imply tissue
- Cuticle of Nematoda, as opposed to chitin

Pseudocoelomate

- Animals with a partial coelom: fluid filled cavity similar to coelom, but lack the lining musculature around digestive organs (hence only one layer of muscle)
- Organism must physically move around to move food through tract
- Seen in Nematoda

Pharynx

- Cavity at back of the mouth, opens to esophagus
- Part of both digestive and respiratory system

Triradiate pharynx

- Nematode pharynx organization that is Y-shaped when closed

- When pharyngeal muscles contract, rapid opening of triangular space generates suction force to pull food in

Amoeboid sperm

- Reproductive strategy of Nematoda
- Male pass amoeboid sperm to female, internal fertilization occurs

Ecdysozoa-Panarthropoda-Onychophora

Chitin

- Like collagen, strands of reinforcing fibers embedded inside protein matrix armor
- Common in invertebrates and fungi, but only ecdysozoans get alpha-chitin cuticle

Onycophora (Velvet worm)

- Nocturnal predators, use secretion from slime glands contained by oral papillae to catch prey
- Sheet-like body musculature under flexible chitin cuticle that are part of its hydrostatic skeleton (in addition to an exoskeleton), much like other soft bodied vertebrates
- Simple, unarticulated limbs in comparison to Arthropoda

Oral papilla

- Major feeding and defensive strategy for Onycophorans
- Contains slime glands that shoot out milky secretion
- Can capture prey 30cm away

Panarthropoda-Arthropoda

Arthropod (Arthropoda)

- Articulated joints with rigid plates on appendages that allows it to bend in more than one direction

- Rigid exoskeleton makes hydrostatic skeleton and circular/longitudinal muscle impossible
- Instead banded muscles control joint flexing, each attached to a piece of cuticle, creating the segmented limbs
- Compound eye made of countless tiny visual fields that are put into one picture

Epicuticle

- Outermost part of the cuticle
- Reduce water loss and block foreign substances

Procuticle

- Lies directly above the secreting epidermis
- Contains a mesh of protein matrix and reinforcing chitin fibers

Exoskeleton

- Arthropod's protective armor against predators and water loss
- Surface for banded muscle attachment
- Sensory interface with environment

Yolk sac

- Extra embryonic membrane in an amniotic egg that contains nutrients for the developing embryo
- Found across vertebrates, except in mammals it gets replaced by placenta

Endoskeleton

- Internal bone or cartilage framework
- Anchors muscle, helps return to original shape after contraction
- Found in vertebrates

Tagma (Tagmatization)

- Taking metamerization a step further
- Fusion of adjacent metamere segments into larger units with specialized functions
- Unlike annelids, arthropods have appendages on either side of their tagma

Ingestive heterotrophy

- Source of carbon comes from breaking down existing C-C bonds
- Food containing C-C bonds are first taken into body then digested by enzymes
- All Animalia, meaning anyone who taps into a new food source is more fit

Larva

- Active immature form of an insect from hatching until it becomes chrysalis

- Body growth done through ecdysis

Trilobite

- Fourth Arthropod group
- Abundant in Cambrian and survived into Ordovician but now extinct

Insecta

- Great majority of Arthropods and in fact 85% of animal species
- Terrestrial, only family of Tracheata that can open and close its spiracles, connected to trachea that supplies air directly to tissue

Crustacean

- Only group of marine Arthropods
- Tagmatization fuses similar segments into one tagma whose appendages take on specialized functions (eg. Feeding, defense)
- Special limb movements create food-bringing water current, at the same time sifting food into the mouth, effectively combined locomotion and feeding in one swim motion
- Microscopic species (zooplankton) are herbivores that feed on primary productivity of marine environments, their abundance playing huge part in food chain

Primary producers

- Autotrophs that make their own and other organisms' food by stitching inorganic CO_2 molecules to form organic building blocks
- At base of food chain, constantly introducing organic materials for heterotrophs to feed on

Phytoplankton

- Photosynthesizing microscopic organisms that inhabit upper sunlit layer of ocean
- At base of marine food chain
- Fed upon by zooplankton

Primary consumers/Herbivores

- Heterotrophic herbivores that feed on primary productivity
- Second lowest on food chain, just above photosynthesizing organisms
- Food source for secondary consumers/carnivores

Zooplankton

- Microscopic crustacean very effective at swimming/feeding at same time
- Mass captures algae and primary productivity in the ocean, as result dominates
- Food source for most of marine life at the basis of consumer food chain

Deutrsostoma-Echinodermata

Deuterostome

- During embryonic development in triploblastic organisms the gut folds in at blastopore, then another opening forms at the opposite end
- Deuterostome is when blastopore becomes anus

Echinodermata

- Five arms equipped with tube feet for locomotion, anchor and suction feeding on Molluscs
- Pentaradial symmetry as adults, bilateral as larva
- Coelom modified into water vascular system that forms extensions throughout the body including tube feet, like tiny tube-like hydrostatic skeletons
- Mutable connective tissue allows starfish to freely switch between rigid and flexible

Tube feet

- Small isolated hydrostatic skeletons
- Sessile ancestors used for suspension feeding, as tube feet and mouth were pointed up to trap falling food and pass them into the mouth
- Nowadays they flip upside down, tube feet are used for locomotion
- Suction to anchor on substrate, also pry clam shells open

Pentamerous symmetry

- In starfish this occurs only as adults, they still have bilateral larva
- Due to ancestral feeding strategy

Water vascular system

- Modified coelomic cavity that acts like hydrostatic skeleton extending throughout the body including the tube feet

Mutable connective tissue

- Innervated connective tissue between starfish plates that can receive signals to be either rigid or soft

Sarah A.

Phanerozoic PART B Silurian and Devonian (DONE)

IMPORTANT HE SAID THIS WOULD BE ON THE EXAM…. Not sure if it's true but just in case know the difference between pinocytosis and phagocytosis :)

Silurian Period

- 443-416 Ma period during paleozoic
- Jawless fish diversify
- First jawed fish, arthropods, and terrestrial vascular plants

Devonian Period

- 416-359 Ma during the Paleozoic time period
- Terrestrial vascular plants diversify
- Lignin causes the plants to stay straight and makes some of its parts indigestible so insects can't eat them and it fossilizes and can be seen today filled with carbon
- Fungi, invertebrates, amphibians colonize land
- First insects and seed plants (not flowering plants)
- Major glaciation at the end of period, mass extinction (mostly marine life)

Chordate

- A phylum of animals that have a notochord, a dorsal central nervous system, post anal tail and gill clefts during some time in their development

· Ex. Humans and other vertebrates

Pharyngeal Gill

- Slits inside the mouth
- Fish perfected pumping of water, gill covers pull away as mouth cavity contracts and pulls water out, gill covers come back when mouth opens and expands gill cavity
- Water empties through gills

· Ex. Cephalochordata, Gnathostomata

Dorsal Hollow Nerve Cord

- A hollow cord dorsal to the notochord
- Unique to Chordates, made of ectoderm, other animal phyla have ventral tubes

· Later modified into the central nervous system which is composed of the brain and spinal cord

Endostyle

- Unique to Chordates
- When water gets into the mouth the endostyle traps the food
- At the base of the pharynx the endostyle cells scrunch up mucus to make a sheet of it so when water comes in the mouth it goes across the mucus sheet and the food accumulates on it, the sheet moves upwards and mucus bag filled with food is scrunched and passed to the digestive system
- Highly efficient filter feeder

· Ex. In cephalochordata

Notochord

- Ex. In Chordates, urochordata, cephalochordata,
- Allows new motion of swimming that is tadpole like
- Cartalagynyst caletal element, has flexibility to bend

· Muscle blocks on one side and contracts and makes the notochord bend, the muscles are down the length of the organism

Post Anal Tail

- Post-Anal Tail: All Chordates have this, extension that runs after anal opening, only in embryonic stage for humans and others

· Heterocercal Tail: Ex. in chondrichthyes, The tip of the vertebral column faces upwards extending into the dorsal lobe of the tail fin

Vertebrata

Craniata

- Branch that has a tripartite brain and cranium (protective bony structure around the brain), axial skeleton with vertebrae
- Remains as disks in vertebrae but notochord is not the same as the spinal and skeletal structure
- Would be named this if they werent named vertebrae
- Vertebrates diverged from cephalochordates (lancelets), which had previously diverged from urochordates (tunicates)

Axial Skeleton

- Part of Vertebrata

· Consists of the bones of the skull and vertebral column

Pteromyzontida

Agnatha

- part of the branch Pteromyzontida (lampreys): unique feeding structure with circular suction and keratinized teeth, tongue covered in teeth
- Known as the jawless fish who can't close their mouths
- Examples: Hagfish and Lamprey

- Lamprey are small covered in bony plates and have no fish scales, sinks teeth into surface of another body its tongue tears their tissue and creates wound and places something so that the body cannot heal and constantly feeds on damaged tissue and pus, water goes through its gills, and have similar breeding cycles as salmon
- Lampreys are fluid feeders
- Mixini section of vertebrate phylogeny (Hagfish)

Gnathostomata

- Branch on vertebrate phylogeny, autopomorphies, Animalia Chordata Craniata
- Special characteristics include genome duplication (Hox genes), hinged jaw development, and paired fins

· Ex. Tetrapods, , Armoured fish

Genome Duplication

- Plants duplicate their own genomes
- Genomes that are duplicated..hehe
- Vertebrate phylogeny: Gnathostomata

· Homeotic hox genes

Hox Genes

- Homeotic (structure determining) genes of the embryo specify what each segment will become after metamorphosis
- They encode transcription factors that regulate the expression of genes responsible for the development of adult structures
- Each homeotic gene has a region called a homeobox that is key to its function
- Hox genes are present in all animal phyla and control the development of segments/regions of the body and are arranged in order in the genome
- Ex. In flies, cells have been moved into another region so from the middle to the front and the appendage became a walking leg instead of an antenna so genome was turned off except that particular part
- This lead to the idea that these sets of transcription factors (missing genes of system) lead to the creation patterning system encoded by genes (bilateral symmetry)
- Ensured that from the generation to the next the embryo had the same pattern

· Ex. Gnathostomata had it

Gill Arches

- Vertebrate Phylogeny: Gnathostomata
- Enhancement of gill respiration

· When the mouth shuts water goes through slits

Jaw

- Gnathostomata: The jaw was not created as a feeding structure, there was a bony structure that made sure the opening stays open, bones began to grow from outwards and downwards from dorsal and ventral side, so jaw stayed open
- Chondrichthyes: Jaw became more complex it began to have teeth and was advantage for feeding, food can be sent directly to the digestive system if you can open and shut with teeth and water comes out pharynx Ex. Sharks bite into prey then shake to rip them, their teeth usually fall out when this happens and regrow
- Jaw of shark is not attached to skull
- Evolution of jaw was originally enhancement of respiration

Cartilaginous/Chondrichthyes Fish

- Chondrichthyes introduced this along with placoid scales, heterocercal tail, and a unique upper jaw bone
- Known for the cartilage type of skeleton, softer and more flexible in bone
- Cartilage gives less body mass, density is close to waters which gives less work to prevent sinking (this is from the oil produced in their liver that oils the cartilage)
- Ex. Sharks

Placoid Scales

- Introduced in Chondrichthyes along with: Cartilage skeleton, heterocercal tail, and unique upper jaw bone
- solve the problem of moving through a medium
- Water moves across scales and creates laminar flow
- Shark's skin have bumps from the scales and so when water flows over the surface it turns into turbulence and breaks the interaction between the two smooth surfaces and decreases resistance on the skin surface
- More repulsive force out of it, prevents adhesion of water flowing by the body

· Sharks teeth are made out of same material so have similar mechanism

- Shark scales point backwards

Heterocercal Tail

- Ex. In chondrichthyes like sharks
- The tip of the vertebral column faces upwards extending into the dorsal lobe of the tail fin
- dorsal lobe is much larger than the ventral lobe

Neutral Buoyancy

- When the animal stops it neither sinks nor floats
- Cartilaginous skeleton allows this to occur

· Ex. In sharks

Mermaids Purse

- Egg is in a mermaid purse
- It's made of keratin and is very hard to break down as it seals and protects the egg
- The egg is developed inside the purse and when it matures it knows how to digest it

· Ex. Sharks have this

Placental Nutrition

- Babies complete embryonic development in the mother's uterus and the placenta nourishes it until they reach advanced stage of development

· Sharks produce only one baby so that all of the nutrients can go to that baby instead of having many and they all get a certain fraction

Pectoral Girdle

- A skeletal support to which the front or upper limbs of a vertebrate are attached

· Ex. In Chondrichthyes

Pectoral Fin

- Pair of fins situated just behind the head in fish, help to control the direction of movement during locomotion
- Appendicular supports the appendages (fins)
- Articulated

· Ex. In Chondrichthyes

Pelvic Girdle

- Bony or cartilaginous structure in vertebrates attached to and supporting the hind limbs or fins

· Ex. In Chondrichthyes

Pelvic Fin

- Pair of fins attached to the pelvic girdle of fish that help to control the direction of movement during locomotion
- Articulated

· Ex. In Chondrichthyes

Actinopterygii

Bony Fish

- Bony skeleton replaces cartilage
- Introduced by Actinopterygli (fish group)
- This group also got swim bladder, modification of the jaw for suction feeding
- Most bony fish have eight copies of genome

· This structure allows them to move and twist, they have rapid tail movement, can easily sense vibrations (locate prey & run from predators)

Swim Bladder

- Introduced in Symplesiomorphies with the characteristics teeth embedded in Jaw and bony skeleton instead of cartilage
- Actinopterygii branch has it along with fins supported by bony rays and jaw suited for suction feeding
- It's an internal sac of air sitting in the digestive system, closely ties to the circulatory system
- Helps fish control their buoyancy, the oxygen gas fills the sac as the fish sinks and gets compressed and empties as the fish is rises, it empties into the bladder
- Helps them stay at certain water depth without having to waste so much energy in swimming

· Cartilaginous fish DONT have it

Suction Feeding

- Actinopterygii branch has it along with swim bladder and fins supported by bony rays

· Used by fish to open and extend the mouth to quickly swallow the prey before it senses it

Ray Finned Fish

- Introduced in Actinopterygii Vertebrate phylogeny along with: swim bladder and suction feeding

· Have tiny bones in fins that allow them to fan out their fins and give support

Opercula Gill

- Fish perfected the pumping of water
- Hard bony flap that covers and protects the gills
- Flaps pull away as mouth cavity contracts and pulls water out of cavity, then Flaps come back as the mouth open and expands the gill cavities

· Ex. In Actinopterygii

Symplesiomorphies

Lobed Finned Fish/Sarcoptergii

- Used to go through water walking on limbs and that movement lead towards the creation of amphibians
- Muscle and bone tissues

Tetrapod

- First four limbed vertebrates and their descendents
- Evolution of tetrapod stance
- Lobe finned fish used to use limbs to walk and push themselves to get their heads out of the water to inhale oxygen if the water lacked it
- These movements lead us towards amphibians

Buccal Force Respiration

- Introduced in amphibians, they did not fully transition from water to land
- They're descendants of the lung fish, they have lungs
- Inflate lungs in three different ways, push air into lungs and gulp it then close their mouth and cavities and push into lungs till they're full (done 2-3 times) and empty by contracting body walls to squeeze lung and force air out

Plantae

Cellulase Rosettes

- In plantae
- Characteristic feature of cellulose synthase in higher plants
- Moves within plasma membrane by microtubules and motors, embedded in membrane is rosette and underneath is microtubule motor tracks with motors under and they drag it across membrane and string out cellulose behind it
- Cluster of cellulase molecules in groups of six

Cell Plate

- Part of cell division in plants
- forms between two chromosome sets in a dividing cell by cytokinesis
- involved in forming the wall between two new daughter cells

Cellulose Fibril

- Made of 36 cellulose molecules

- In tough walls that enclose plant cells
- Formed in parallel lines on top of eachother

Micrfibril

- Formed by cellulose molecules ionic interactions
- Very small fibril composed of cellulose and glycoproteins

Cellulose Synthase

- Makes cellulose
- Incorporated into genome of plant cells

· This molecule takes glucose units and puts them together to make cellulase molecules that cluster together as rosettes

Phagmoplast Cell Division

- In Plantae cell division
- Plant cell specific structure that forms during late cytokinesis

· scaffold for cell plate assembly and subsequent formation of a new cell wall separating the two daughter cells

Plasmodesmata

- In Plantae
- Cytoplasmic connections between adjacent cells

· Allow solutes such as amino acids and sugars to move from one cell to another

Alternation of Generations

- A type of life cycle in which organisms fluctuate between diploid and haploid stages
- Plantae undergo both diploid and haploid phases

· Diploid structure (sporophyte) makes spores through asexual division (meiosis), spores make the haploid structure (gametophyte) and this structure makes haploid gametes

Stomatophyta

Stomata

- In plant phylogeny branch of Stomatophyta, along with determinate meristem
- Tiny openings in leaves
- Open and close to allow the intake of oxygen and release of carbon dioxide
- Consist of guard cells

- Water loss can occur by this (tranpiration)

Guard Cells

- Plant Phylogeny: Stomatophyta
- Transition to land and water conservation method
- Surround the stoma
- Help regulate the opening and closing of stomata to control the plants transpiration
- Cell can be isotonic to all surrounding tissues when ions pump into the cell so pores close because flexible cell wall bulges out

· If we take out ions from the guard cells they become less salty, less pressured and cell will go back to its original shape and its pores will open

Determinate

- Meristem cells are specialized based cells that can differentiate into any tissue ex. they can form vascular tissues, etc. Its fate is to set to a certain structure
- Type of meristem (the other is indeterminate) introduced in Stomataphyta Plant phylogeny with stomata

· Animals grow to a certain size and then their growth slowly or dramatically stops

Tracheophyta

Indeterminate

- Type of meristem (the other is determinate)
- Plant phylogeny Tracheophyta have it as well as a secondary wall out of lignin, tracheary cells, sieve elements, and long lived sporophyte
- Plants grow throughout their lives they don't stop
- Flowers, leaves, fruits can stop but roots and tips of shoots continue to grow under influence of plant hormones
- They have indeterminate growth because it helps give plants flexibility based on factors such as light, temp, water, nutrients which gives benefits for adaptation

· Ex. If incoming light direction changes plants can shift gears and grow in that direction

Primary Wall

- In Plantae
- Plant cells have primary cell walls that surround the plasma membrane and cell contents
- The "skeleton" of the plant giving support for its body, strong, flexible, semipermeable

· Made of microfibrils of cellulose and proteins

Secondary Wall

- Plant phylogeny: Tracheophyta has this along with Indeterminate meristem, long lived sporophyte, sieve elements, and tracheary cells (They have lignified secondary cell walls)
- When cell reaches final size it produces a secondary cell wall that contains lignin which makes cellulose not make contact with water inside that cell
- Water is then repelled away from it

· Sieve tube elements DON'T have secondary cell walls

Lignin

- Responsible for holding plants up and is indigestible
- Plants use this to create so much biomass so when they die nothing decomposes them, it becomes fossilized
- Secondary cell wall is made of it

· It is toxic and hydrophobic

Lignase

- Can break down lignin

· Ex. Bacterial and Fungal Lignase

Sieve Elements

- Plant phylogeny: Tracheophyta has this along with Indeterminate meristem, long lived sporophyte, lignified secondary cell walls, and tracheary cells
- Sieve cells are called phloem, no secondary cell walls
- Have plates that connect them to each other up the plant(Cytoplasmic)
- Every sieve cell have companion cells associated with it, these two cells work together to make the phloem function
- Companion cell at the top of the plant takes glucose from source cell and gives it to the sieve cell
- The sugar and salt concentration rises in that cell, so water diffuses into the sieve cell to dilute it, cell walls don't allow the plant cells to swell, so pressure squeezes the contents to the sieve plate and food goes down

· The companion cells at the bottom pump glucose into storage so they build pressure at the top of the plant and decrease it at the bottom

Sieve Plates

- The end parts of the sieve tube cells (that are connected side by side and make up the phloem)
- The sieve cells and sieve tubes are in charge of food transportation in the phloem

· Cytoplasmic connection

Companion Cell

- Every sieve cell has a companion cell
- Companion cells are located at the top of a plant
- Takes glucose from source cell through itself and into the sieve cell

· The companion cell also takes sugar out of the sieve plant and pumps it into storage to decrease pressure at the bottom of the plant

Rhizoids

- A modified hypha that anchors a fungus to its substrate and absorbs moisture
- Picks up water that moves to the cytoplasmic cell to supply the whole plant

· Has two regions, one in photosynthetic and the other is where storage is for glucose

Vessel Elements

- One of the cell types found in Xylem
- Broad and have side walls thickened by lignin over most of the surface area

· Cell walls are broken down to provide connection with the cells below and above them

Thallus

- Ex. in Liverworts
- Consist of clusters of cell that form a thallus (leaf like structure) and archegonium and antheridium grow out of the thallus
- Small pores are in the thallus that are always open

· Liverworts rely on rain drop to splash sperm under the umbrella of the archegonia to fertilize

Tracheids

- To be able to do their function these cells are dead
- Cells elongate end to end connected to each other through plasmodesmata and once fully mature the cell dies and cytoplasm disappears and the microscopic tube in bundles make the plant rigid and each year larger plants add more of these bundles

· Help transport water and provides structural support

Fertilization

Internal Fertilization

- Can occur in birds, mammals, fish, reptiles, and invertebrates (like some arthropods, some molluscs etc)
- Sperm released by the male close to or inside the entrance to the female's reproductive tract and sperm swim till they reach egg and fertilize it
- When the male's sex organ is in the female's sex organ

· Ex. Male sharks and rays use pelvic fins to chanel sperm to female's cloaca

Gemma Cups

- Asexual reproduction that mainly occurs in liverworts and mosses
- Liverworts must live in moist environments
- Recombination of two individuals is very rare so asexual reproduction is important

· Plant makes little plant tissues discs inside cups called gemmae (like a mini copy of the plant) and as it rains water carries these away from the parental plant far enough to grow on its own

Splash Fertilization

- (photo in slide) ex. The spots in the right one are where the eggs are, when water splashes up it carries sperm, rain falls on plants, water hits splash cup, the water droplets bounce in the air sperm is in them and then it allows sperm to travel down into the egg to fertilize it
- even though it's highly unlikely to get sperm from another liverwort plant, you can self fertilize your own

· you don't get all advantages of meiosis and genetic variation but it allows your species to survive overtime

Water Pathways

Apoplastic

- Pathway for the movement of water into roots
- Water moves through nonliving region's (network of adjoining cell walls and tissue air spaces)

· When it reaches the endodermis (inner most layer of cortex) it must pass through the cytoplasm of endodermal cells and enter the symplastic pathway

Symplastic

- Pathway for the movement of water into roots
- Water passes into and through living cells

· Root hairs take up water and water diffuses through the cytoplasm and passes from one living cell to the next through plasmodesmata

Root

- Two different types of pathways allow water and minerals to travel through the root epidermis to get to the xylem either through interconnected cytoplasm of living cells or through cell walls and intercellular spaces
- The two pathways are Symplastic and Apoplastic (mostly) pathways
- When the roots lead the water to the xylem the water and minerals are then taken through the entire plant

· The water and minerals in soil lead to the roots

Sporophyte

- In plant phylogeny
- Part of moss anatomy
- Releases spores
- Is the diploid multicellular stage

· Develops from the zygote produced by haploid egg fertilized by haploid sperm so it has two sets of chromosomes

Sporangia

- Produce asexual spores by mitosis
- Single celled or multicellular

· Ex. Algae, Liverworts, Moss, and Ferns have it

Spore

- Produced by sporangia, give rise to gametophyte
- Reproductive cell that can develop into a new individual without reproducing with another cell (asexual), reproductive agent of asexual reproduction
- Differ from gametes
- Ex. Algae, Liverworts, Moss, and Ferns have it

· They travel by wind, water, etc.

Megaspore

- Type of spore present in heterosporous plants (the other is microspore)

· Germinates into female gametophyte that produces egg cells

Gametophyte

- Haploid individuals that come from the germination of spores

- At maturity the nuclei of some cells in gametophytes develop into female (egg) or male (sperm) gametophytes
- They all tend to be genetically identical because they arise through mitosis not meiosis

Gametangia

- Protective organ that produces gametes
- Made by Bryophyte gametophytes
- Archegonia is the organ that protects the eggs
- Antheridia is the organ that protects the sperm

Antheridia

- Liverwort Life Cycle: Spores germinate and male and female gametophyte that have gametangia that produce gametes
- A haploid structure producing male gametes (sperm) in plants
- Ex. Liverworts have umbrella structure that have archegonia and flat like structures that have antheridia

Archegonia

- Liverwort Life Cycle: Spores germinate and male and female gametophyte that have gametangia that produce gametes
- A haploid structure producing female gametes (eggs) in plants
- Waits for sperm to help form zygote
- Ex. Liverworts have umbrella structure that have archegonia and flat like structures that have antheridia

Heterosporous

- Production of two types of spores differing in size and sex
- Produce two morphologically distinct sporangia that create two different types of spores (mega vs micro) that turn into female and male gametes

Homosporous

- Production of spores of one kind only that are not differentiated by sex
- Produces one sporangium and then single type of spore

Phanerozoic

abdomen	⅓ major tagma on an insect. consist of 11-13 segments, and is the section where all of the functions of the body occur. Abdomen can be

	expanded via cuticle plates if needed.
absorptive heterotroph	organisms secreting enzymes to the outside environment in order to break down organic material which will then be absorbed
amphibia	-possess lungs (are the descendants of lung fish) -use buccal force respiration -have non-waterproof external surfaces, -have poison glands as a defence against predators that will release the poison through the skin
anoxia	Lack of oxygen in water. Occurs as a result of the end-devonian mass extinction, where plants are decomposing and dumping their organic wastes into the ocean which will then be decomposed by bacteria. This bacterial decomposition is what causes the depletion of the oxygen levels in the ocean & results in the death of the coral and bryozoan reefs, as well as the armoured jawless fishes
arbuscular mycorrhizal fungi	fungi invading and living inside plant cells (he talked VERY briefly about this - this was all I got!)
background extinction	extinction as a result of the normal lifecycle of a species (approximately 10 million years). occurs as a result of things such as climate change, diseases, loss of habitats etc..
basidium	the structure produced by the basidiomycetous fungi after sexual reproduction, in which spores are formed at the tips of the projecting stalks
basidyomycoda	phylum of fungi containing mushrooms, self fungi & more. reproduce via basidia
buccal force respiration	the amphibians push air into the lungs by gulping it into their mouthes and buccal cavity and pushing it into their lungs when it comes time to empty the lungs, the body wall is contracted and air is forced out
carboniferous period	The diversification of plants begins here. There are some insects on land (feeding on the spores and leafy tissue of the plants) however the animals have not yet dominated land. The pangea is now formed and is one single land mass. As a result of the diversification of plants occurring during this period, we see a lot of similarity between the plant species around the world
coal forest	Occurs in the carboniferous period. Consists of horestails, club mosses and tree ferns. Horsetails were one of the earliest vascular plants, and although today they are rather small, their variants during this period grew up to 40 to 50 feet high with diameters between 6 and 7 feet wide. The club mosses were also extremely large during this period but once again are now small species. The tree ferns are the ancestors to the ferns we have today, but during this period were

	very tall (resembling palm trees). Plants during this time period were extremely tall as they were reaching for sun in order to perform photosynthesis. These plants cannot be broken down because of the presence of lignin and will give us the carbon/coal reserves we have today
compound eye	set of optics units with its own optic lense on every unit you don't see individual elements but you see the culmination of all the elements that are present each optic unit has 1 level of colour they all become integrated into a bigger and bigger picture putting it together results in a visual mosaic more pixels —> much clearer visual interpretation of whats surrounding you how arthropods see the world
dikaryotic cell (n+n)	part of the fungal life cycle when 2 different types of fungi mate (called pluses and minuses) a septal wall will separate 2 nuclei and then the cytoplasms will fuse the result is a cell with 2 haploid nuclei in it
ectomycorrhizial fungi	a fungal/hyphae relationship, where fungal mycelia have wrapped themselves around the root the fungi provide minerals and nutrients (they are decomposers) and the root provide the fungi with glucose + sugar greatly support the plant in its ability to grow & thrive see slide 30 for diagram
epicuticle	part of the exoskeleton a thin, waxy protective & waterproof layer covering the surface of some plants and insects.
flood basalts	places where the Earths crusts rips apart for hundreds of miles along a direction, the molten magma starts to flow up (thousands of feet hight) lots are located where there are fracture points/narrow points in the planet they are very much associated with the pulling apart of the continents (i.e. pulling apart of south america + africa) we only know of one recorded in history in the late 1700s in iceland results in elevated CO_2 levels - a cause of mass extinctions
frond	used to describe the leaves of certain ferns & palm trees
gas hydrates	In the deep waters where archaea and methanogens are living - methane is pumped out as a byproduct the pressure causes the methane to compress and becomes near liquid methane (a crystallized matrix with ice) if the ocean were to warm or ocean levels were to drop, the pressure would cause the methane to bubble out of the water into the atmosphere as methane - an affective greenhouse gas

gymnosperms (conifer)	dominating tree plant in the Carboniferous , have separate male and female gametophytes - (cones on the bottom = male gametophyte (distinguished by orange/yellow color) and female cones on top of the trees).
heterokaryotic	cells where two or more genetically unique nuclei share one cytoplasm
heterosporous	production of two different shaped and sized spores (male and female)
homosporous	producing only a single kind of spores
hyphae	fine, branching tubes that make up the body of a multicellular fungus
karyogamy	proceeds the dikaryote stage of fungi (n+n), the two nuclei will fuse to become one and then will immediately undergo meiosis to return to haploid state
leptosporangia	The perfected mechanism of launching spores. These are present in ferns. (see slide 11 diagram). It is essentially a mass of spores surrounded by a series of cells around the outside. Say these cells are box shaped and we have two adjacent to one and other. All sides except those facing the spores (the bottom) are made of thick cell wall. The ones facing the spores are thin. When water is removed, the volume of these boxed shaped cells decrease and the thinner side caves inwards. This causes the adjacent cell walls to move closer together and causes the entire structure to bend backwards. The tension will then become so high that the membrane will burst, the elasticity built up will cause the structure to spring forward and will release the spores.
lichen	a symbiotic relationship between a fungus and a cyanobacterium photobiont wrap around the mycelia lichen protects the photobiont while it produces sugar can become dormant by drying out if the environment is not favourable
macrosporangia (macrospores)	Macrospores come from macrosporangia and create the female gametophyte plants that will produce eggs
marine anoxia	warming causes Earth's temperature to go up , as water warms O2 solubility goes down as a result oceans became anoxic - a cause of mass extinction
mass extinction	-50% + of the biodiversity disappears

microsporangia (microspores)	Microspores come from microsporangia & produce the male gametophyte plants which will produce eggs
mucus gland	the mechanism used by amphibians in order to keep their skin moist for respiration
mutualism	a relationship where both participants benefit. example: fungi are always in a mutual relationship with plant roots. the enzymes secreted by the fungi can dissolve minerals and provide plants with more nutrients, while the plants can produce glucose for the fungi to feed on.
mycelium	a network of branching hyphae that constitutes the body of a multicellular fungi. how the fungi absorb nutrients, water, etc..
omnivores	Eats both plant and meat ex. Humans
pangea	the single land mass that existed during the perimian and triassic periods
permian period	One of the biggest mass extinctions will occur here, where over 95% of the biodiversity will disappear. The Earth essentially gets 'scrubbed clean of most of the living forms that exist, and the organisms today are the descendants of the survivors from this extinction
photobiont	the photosynthetic component of lichen. usually green algae or cyanobacterium
plasmogamy	see dikaryotic cell
poison glands	-used by amphibians as a method of protection from predators -one of the most deadly poisons in the world produced by these glands
pollen	the product of the male cones in conifers (male gametophytes). Inside microsporangium there is a spore mother cell. This will undergo meiosis and will produce 4 product cells: generative & tube cells: the male gametophyte stage (haploid). prothalial & wing cells: waterproof the pollen & allow it to move through the wind (respectively) These four cells form the male gametophyte pollen
pollen tube	An outgrowth of a pollen grain, which transports the male gametes to the ovule. It will only grow if the pollen grain is compatible with the female tissue. In angiosperms, the pollen grain is deposited on the stigma and the pollen tube grows down through the style and into the ovule.

procuticle	the inner layer of the cuticle of an insect (endocuticle)
reptalia	have diapsid skulls (two holes for temporal fenestra) keratinized scales or feathers keratinized cells: dead epidermal cells and filled and crosslinked with keratin protein to form scales crushing jaws
retinular cell	sensory elements of the compound eye, each ratinula cell extends basally as an axon which passes thru the basal lamina of the optic lobe
seed	The structure in angiosperms and gymnosperms that develops from the ovule after fertilization. The seed contains the embryo and nutritive tissue, either as endosperm or food stored in the cotyledons.
seed coat	protective covering of the seed, the '3rd' generation (grandparent) of the 3 generations within a seed
spermatophore	a waterproof package used by some insects to pass sperm internally (used in internal fertilization)
spindle pole body	structure on the wall of the nucleus that organizes microtubules
strobila (cones)	two types: male cone: inside the production of male gametophyte occurs (the microsporangia) - distinguished by their red/yellow/orange coloration. inside the microsporangia there is a spore mother cell that will undergo meiosis and there will be lots of mitotic divisions which will result in pollen be female cone: megaspore cells are sitting inside megasporangium. the megaspore cell will undergo meiosis and make 4 products, but only 1 will be retained and then will become the egg cell.
tube cell	the cell in a pollen grain that will give rise to the pollen tube
visual mosaic	see compound eye

Mesozoic:

Albumen	-Water soluble protein -clear liquid contained within an egg
Amniote animals	-lay eggs -tetrapods
Anapsid	-type of skull found in reptiles -seen only in turtles nowadays

	-Behind opening of skull-solid and lacks openings
Angiosperm	-A flowering plant. Its egg-containing ovules mature into seeds within protected chambers called ovaries.
Anther	-The pollen-bearing part of a stamen
Allantois	-One of the extraembryonic membranes found in the amniote animals -contains the metabolic wastes created by the developing embryo -involved in gas exchange and is important in forming the placenta in placental mammals
Central Cell	-the cell in the center of the archegonium whose division produces the egg and usually also the ventral canal cell
Carpel	-reproductive organ of a flower -Supports ovule
Co-evolution	-evolution of genetically based, reciprocal adaptations in two or more species that interact closely in the same ecological setting
Cretaceous	-derived from the Latin "creta" -geologic period and system from 145 ± 4 to 66 million years ago.
Diapsid	-skull of some reptiles and all birds -two temporal openings behind the orbits in the skull
Double fertilization	-characteristic feature of sexual reproduction in flowering plants -In the embryo sac, one sperm nucleus unites with the egg to form a diploid zygote -the embryo develops, and another unites with two polar nuclei to form the primary endosperm nucleus.
Endosperm	-Nutritive tissue inside the seeds of flowering plants.
Endospory	-The development of a gametophyte within the confines of the spore -essential innovation toward the evolution of seeds, but this feature also arose in seedless plants. In bryophytes, spores may begin to divide prior to dispersal and germination, but always -develop into a free-living gametophyte.
Extant	-Species, or groups of animals, that are still living today -Not extinct
Extinct	-Animals that existed in the past but are no longer living species
Fruit	-A mature ovary, often with accessory parts, from a flower.
Jurassic	-The Jurassic is a geologic period and system that extends from 201.3± 0.6 Ma to 145± 4 Ma -end of the Triassic to the beginning of the Cretaceous

K/T (K/P) boundary	-defines the end of the Mesozoic Era, estimated at around 66 Ma -*K* is the traditional abbreviation for the Cretaceous Period, -*Pg* is the abbreviation for the Paleogene Period -marks the end of the Cretaceous Period, the last period of the Mesozoic Era -marks the beginning of the Paleogene Period of the Cenozoic Era

Keratin (Beta and Alpha)	Beta-used as waterproof layer in reptiles
Keratinized skin	-flat, dead -no nucleus -filled with protein called Keratin which makes our skin waterproof
Megasprorangium	-plant structure in which megaspores are formed, such as those of the female cones of pines
Megaspore	-A plant spore that develops into a female gametophyte; usually larger than a microspore
Mesozoic	-Middle Life" Era -life diversified rapidly -giant reptiles, dinosaurs and other monstrous beasts roamed the Earth -The period, which spans from about 252 million years ago to about 66 million years ago -also known as the age of reptiles or the age of dinosaurs
Microsporangium	-sporangium that produces spores that give rise to male gametophytes.
Microspore	-A plant spore from which a male gametophyte develops; usually smaller than a megaspore.
Micropyle	-A small opening at one end of an ovule -pollen tube passes prior to fertilization.
Nectar	-sugar-rich liquid produced by plants in glands called nectaries -either within the flowers with which it attracts pollinating animals, or by extrafloral nectaries, -provide a nutrient source to animal mutualists -antiherbivore protection.
Omithischia	-Ornithischia or Predentata is an extinct order of beaked, herbivorous dinosaurs.
Oviaparious	-Animals that lay eggs
Ovary	-Female reproductive organ -produces eggs

Ovule	-In plants, the structure in a carpel in which a female gametophyte develops and fertilization takes place
Pangea	-supercontinent that existed during the late Paleozoic and early Mesozoic eras
Pericarp	-Fruit Wall
Plesiosaurs	-order or clade of Mesozoic marine reptiles -belonging to Sauropterygia -Plesiosaurs first appeared in the latest Triassic Period -about 205 million years ago
Pole Cell	
Pollen	-fine to coarse powder containing the microgametophytes of seed plants, which produce the male gametes
Pollen tube	-A tube that grows from a germinating pollen grain through the tissues of a carpel and carries the sperm cells to the ovary.
Pollination	-The transfer of pollen to a flower's reproductive parts by air currents or on the bodies of animal pollinators
Pterosaurs	-flying reptiles...
Saurischia	-one of the two basic divisions of dinosaurs -Harry Seeley classified dinosaurs into 2 orders -based on their hip structure
Sauropods	-dinosaurs -very long necks, long tails, small heads and four thick, pillar-like legs.
Stamen	-A "male" reproductive organ in flowers, consisting of an anther (pollen producer) and a slender filament.
Stigma	-The receptive end of a carpel where deposited pollen germinates.
Synapsid	-Vertebrate skull of the mammals and the extinct mammal-like reptiles -There is only one temporal opening behind the orbits in the skull
Synergid	-one of two small cells that lie inside the embryo
Temporal fenestra	- large holes in the side of the skull
Theropods	-group of saurischian dinosaurs - carnivorous, some evolved herbivory, omnivory, piscivory, and insectivory.
Tube nucleus	-the one of the two nuclei formed by mitotic division
Vertebrate	-comprise any species of animals within the subphylum Vertebrata -represent the overwhelming majority of the phylum Chordata

Cenozoic:

Alpha Keratin	-coiled-coil -strong, inextensible, insoluble and chemically inert -found in hair, wool, horn, and tails
Amniote animals	-Divided into 3 superclasses (Synapside, Diapsida and Anapsida) -Based on number of openings on skull
Apocrine sweat gland	-sweat gland -composed of a coiled secretory portion located at the junction of the dermis and subcutaneous fat, -from which a straight portion inserts and secretes into the infundibular portion of the hair follicle
Barb	-various ray-finned fish species in a non-phylogenetic group
Barbule	-filament projecting from the barb of a feather
Deciduous teeth	-otherwise known as baby teeth, temporary teeth, milk teeth, and now more commonly primary teeth, are the -first set of teeth in the growth development of humans and other diphyodont mammals.
Eccrine sweat gland	-Glands that produce material using exocytosis -example-Sweat glands which produce watery secretion
Endothermy	-Ability to generate body heat
Great Apes	-Also know as Hominidae -taxonomic family of primates -includes seven extant species -orangutan, Gorilla, chimpanzee and the human
Heterodont dentition	-Jaw which contains different teeth -All specialized for different functions
Macroevolution	-studies on change that occur at or above the level of species
Mammary gland	-Milk producing -Characteristic of mammals
Oviparous	-Eggs laid by female -Embryo develops and hatches outside of female
Placenta	-placenta, a flat cake -An exchange surface between an unborn fetus and mother's

	uterine wall. -Blood between fetus and maternal remain separate Nutrients, metabolic waste and gases are exchanged
Pneumatized Bone	-bone which contains many spaces -found in birds, creates bones which are light and strong
Sebaceous gland	-epidermal gland cell -produces oils to maintain hairs
Sternal keel	-sternum in birds modified -Source of attachment for flight muscles
Viviparous	-Animals which fertilize eggs -Development occurs within female -Receives nutrients from parent