BIOLOGY:PRE DARWINIAN

Ages of Sand	Proposed by Douglas Adam 1. The telescope (1608) that allowed us to observe our universe/solar planet (associated to scientific revolution). 2. The microscope (1670's) that allowed us to see the cell and its details 3. Computer chip (1960's) access to computational strength to analyze data and answer unanswerable questions 4. Fiber Optic cables (1980's) allowed scientists all over the world to communicate and share their research = "free knowledge" and work together global scale problems

400BCE - 450CE	***Greek & Roman Ages***
Hippocrates	First person to catalog medicine and human anatomy and make it available for everyone else (*Hippocratic Corpus*)
Aristotle	Student of Plato known for being the first person to categorize the living world (The Great Chain of Being - humans underneath god aka *Scala Naturae*) - *Great Chain of Being* - Gods - Humans - quadruped oviparous - cetations - ovipara - malacia - crustaceans - entoma - anything in shells - (jellyfish & sponges) - higher plants - lower plants - inanimate world
Theophrastus	"Father of Taxonomy" catalogued plants based on their reproductive structure (9/10 copies survived) - Importance: Medicine, Food, and Fiber (structural elements & cotton)
Essentialism	Prominent belief, until the scientific revolution, that the reason why child looks like parents is because of this "essence" given by the Gods that tells them what to be. Basically their explanation for genetics.

450 - 16th century	***Medieval Ages & Byzantium's Golden Age***
Medieval Ages	Early Middle Ages (Dark Ages), High Middle Ages (infrastructure booming), Late Middle Ages (Black Plague) Special Creation (Ussher) - Pattern - Species don't change because each species created Oct 23, 4004 BCE (the species are not old) - Process "God"
Byzantium	Al-Dinawari - Cataloged plants during Constantine's golden age (17th - 19th) added much more plants which combined Theophrastus along with middle eastern plants. Alhazen - First to described scientific method that is still used today Al-Jahiz - "Book of Animals" proposed struggle for existence, food chain and evolution (natural selection)

	Avicenna - Advanced the natural sciences by summarizing Greek, Indian and Muslim medication Ibn Al-Baitar - a pharmaceutical catalogue of medicinal plants that once translated into Latin was in use until the 18th and 19th centuries. (depended on type of disease along with its cure)
Scientific Method	1. Observation 2. Statement of problem 3. Formulation of hypothesis 4. Testing of hypothesis using experimentation 5. Analysis of experimental results 6. Interpretation of data and formulation of conclusion 7. Publication of findings

16th -18th century	***Renaissance & Scientific Revolution (Physical Science was more popular)***
Harvey	Circulatory System (Physiology) - How heart pumps, pulmonary and body
Linnaeus	Linnaean Taxonomy - Looked for commonality in animals and grouped them together (hierarchical system[1]) creating his own "Systema Naturae" Binomial Nomenclature - first word was the Genus (Latin noun) the second the species epithet (adjective)
Linnaean Taxonomy	Kingdom (Animalia[2]/Plantae) > Phylum > Class > Order > Family > Genus > Species "King Peter Came Over For Great Sex"
Van Leeuwenhoek	First Microscope - Lead to the discovery of new life form which lead to a change of philosophy (**Ussher's)
Vesalius	Father of Anatomy - Anatomically perfect along with the skeletal/muscular system's details (how they work)

Taxonomy	***the science that identifies, names, and classifies new species***
Folk	Information is passed down verbally
Artificial	arrangement that is based on superficial or arbitrary attributions. It is constructed rather than based on discoveries
Mechanical	based on the physical characteristics of the organisms that being classified (not based on biology or relatedness instead they are put into nested categories)
Natural (Evolutionary)	Organization of taxon based on ancestral origins in other words based on evolutionary history
Phylogenetic (cladistic) taxonomy	classification of organisms based on their assumed evolutionary histories and relationship

Physical Sciences	***Natural Sciences***
Physicalists - “with the exceptions of humans all living things are machines”. Descartes	Vitalists - Physical and chemical laws apply but living things have a vital force (essence - explanation for biodiversity)
Inanimate objects - Uniform behaviour (uniformity in observation)	Animate objects - Many variables (average effect)
Physical and Chemical LAWS	More than physical and chemical laws (Genetics)
Universal - because they work with inanimate object and it exists in the universe - One falsification = theory elimination	Not Universal - only theories based on earth think: we can't have genetic law because not all life in universe has been examined - One falsification ≠ theory elimination
Empirical Observation - Technique: experiments	Historical Narratives - Technique:“stories”
Deduction - General to every circumstance - Allows application of theories to specific observation	Induction - Specific to general - Based on numerous research (best assumption) - Used to form hypotheses/theories

<u>Proximate Cause</u> (Physical Sciences - like biology) - “HOW” - Manipulation changes something and predictable - Here and Now - SCENARIO: KNEE JERK - HIT KNEE->JERKS	<u>Ultimate Cause</u> (Natural sciences - like biology) - “WHY” - Variable (probabilistic) - Evolutionary past - SCENARIO: KNEE JERK - YJERK? SYSTEM INVOLVE REFLEX

Scientific Terms	*prediction>hypothesis>theory>law>fact*
Control	a set of individuals that will not be subject to the treatment.
Fact	The hierarchy is hypothesis to theory to fact to law
Hypothesis	An idea of how something works/behaves formed from examining the existing scientific literature or from observations of the natural world. A tentative explanation can be tested by further investigation. *It must be falsifiable*. <u>Null hypothesis</u> - hypothesis that there is no significant difference between specified populations, any observed difference being due to sampling or experimental error.
Prediction	statement about what the researcher expects to happen to one variable if another variable changes. (drives the experimentally)
Sample Error	error in a statistical analysis arising from the unrepresentativeness (of the population) of the sample taken. Real true number because insufficient data.

Theory	An explanation or model that explains events in the natural world and makes predictions on how they will occur. Based on broad range of observation backed up by multiple hypothesis and it is very unlikely for it to be contradicted and is regarded as established truths.

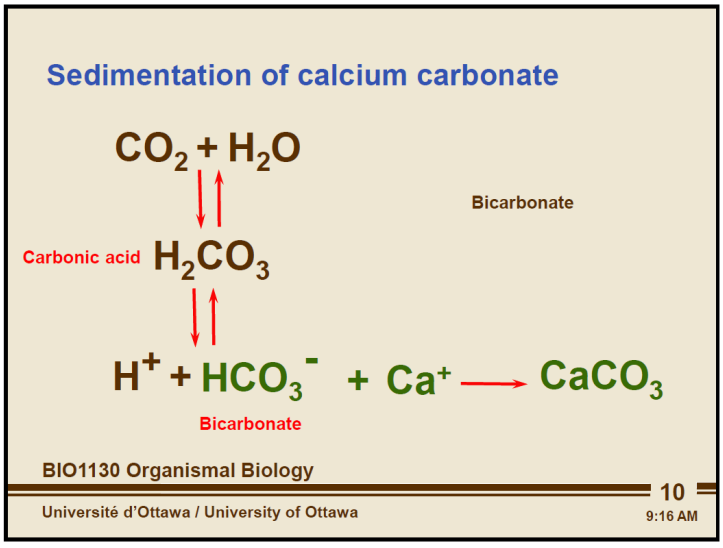
Scientific Method	Distribution of Scientific Facts
Scientific Literature	Primary - Scientist did the work + published data is all there Secondary - Experts in the field review literature by many primary then summarize info with all data Tertiary - Didn't do the science/doesn't review literature that is there but has reliability/ability to synthesize secondary (no data+ no full reference)

Random Terms	
Biogeography	Studies of the world distribution of plants and animals
Classification	An arrangement of organisms into hierarchical groups that reflect their relatedness.
Industrial melanism (of tree bark)	"Pepper Moth". Fitness of moths decreased if visible against tree so. White most against black trees their population decreased.
Organicist	Vital force replaced by genetic program and the importance of emergence (swarm behaviour)
Taxon	(plural. TAXA) any of the taxonomic categories such as phylum or subspecies

DARWINIAN

Pre- Darwin	note** essentialism still prominent as well as church's impact.
Erasmus Darwin	- Grandfather of Charles Darwin - Believed that animals did not all appear at the same time instead he suggested evolution through his poem "Temple of Nature"
Cuvier	- Developed the "catastrophism"[4] theory which suggests that dramatic changes in the environment led to change of animals in that area. (think dinosaurs a dramatic change lead to disappearance of dino and appearance of new species) - Founder of comparative biology/anatomy[8] and coined the term EXTINCTION - Added the rank phylum to Linnaean taxonomy
Leclerc (Buffon)	- Some animals must have changed through time rendering other bodily parts useless aka Vestigial Structures[3]. However he had no explanation for <u>how</u>. - Earth was 70,000 years old and not 6,000. - Animals were all created in the poles[7] and changed to fit environment as it gets closer to warmer area (equator). The new environment altered the essence. - Found science of Biogeography "Conceived by nature, changed through time" also think Morphology

Lamarck[5]	The one that offered the mechanism or the "how" part for Leclerc's theory. He believed that bodily parts that were useful became stronger/more developed. Meanwhile, body parts that were rendered useless has atrophied from the lack of use. He then also stated that the changes were inherited by offspring and further development of the useful body parts continued while the not so useful parts simply stopped functioning. Infusoria - simplest life form and as generation goes by it develops complexity environment changes this to match where they are - Satisfy cuvier (extinction) and satisfy lyell (takes long time)and everyone else - Essence modified slowly becoming different organism overtime FAULTS IN THEORY - Fail to recognize that the cell that changes during one's lifetime are somatic cells and the cells that are passed down to next generation uses germ cells (ones used for creating sperm and egg) which are "tucked away" --- cannot be touched because its use for reproduction and it allows continuation of gene (continuation to look same). "Use it or Lose it", "Perfecting Principle"
Lyell	- Countered Cuvier's theory of catastrophism and instead believe uniformity theory where the change was more gradual and took a longer amount of time **theory was foreed by observing strata or layers of sedimentary rock - According to his theory, age of the planet should be considerably longer than the 70,000 years because of the the amount of time for lines in rock sediments to form.

Plate tectonics	Plates of planet is constantly moving because of earth's rising magma - This is basis of continental drift - Original continent was called *Pangea* (all , "Mother earth"/land)
Carbon Cycle	 Carbon dioxide in air and carbon in water SPONTANEOUSLY react creating carbonic acid. Then, the carbonic acid separates to H^+ and bicarbonate and bicarbonate forms a bond with positively charged ion (insoluble salt) and it precipitates -- rain of molecular dust falling on ocean all the time .... SEDIMENTARY ROCK (animal fossil bottom are buried in sediment)

Transformation **Lamarck	Transmutation

- Based on environment "essence itself is changing" overtime - Finalism - essence has inherent program that tells itself to transform overtime and stop	- MAJOR and ABRUPT changes in essence - Ex. chicken egg suddenly produces fox

Darwin	
5 Concepts	1.No constancy species 2.Common ancestry 3.Multiplication of species 4.Natural Selection 5.Gradual Change Faults to theory - No mechanism. No idea what he was changing and how much change needs to occur to create a new species

No Constancy of Species	Species change over time proven by
	- Fossils
	  - Petrified wood
	  - Amber (insects)
	  - Permafrost
	  - Shale (invertebrate) sedimentary mud/clay
	- Extinction
	- Transformational Forms
	  - Archaeopteryx lithographica (reptile to bird)
	  - Puijila darwini (land to sea)

Common ancestry	Proofs
	- Comparative anatomy/morphology
	  - Divergent evolution (Homology)
	  - Convergent evolution (Homoplasy)
	- Comparative embryology
	  - Early stages of different vertebrate embryos are very similar (presence of gill slits and tails) only difference is their
	- Vestigial Structures (present but not in use)
	  - Ex. goose bump (attacked then fur rises or for cold fur rises-insulation) and nictitating membrane (protect from damage) in aquatic animals.
	- Biogeography
	- Molecules

Multiplication of Species	how new species arise; or what biologists refer to as speciation
Gradual Change	
Natural Selection Darwinian Fitness	Characteristics that better enable organisms to adapt to <u>specific environmental</u> pressures will tend to increase in succeeding generations in a population. Organisms with those characteristics are better able to survive and can reproduce in greater numbers than those without the characteristics. Next generation is subjected to the same process of selection, these favourable traits will become even more common. (Think of antibiotics video) Descent with Modification - Biological evolution also known as the evolutionary alteration and diversification of ancestral species. - occurs in groups of organisms rather than in individuals

Convergent Evolution	Divergent Evolution
- The evolution of similar adaptations in distantly related organisms that occupy similar environments *Homoplasy* - Characteristics shared by a set of species, often because they live in similar environments, but not present in their common ancestor; often the product of convergent evolution.	- A process whereby natural selection or genetic drift causes populations to become more different over time. *Homology* - characters that are similar in their evolutionary history but not necessarily their function. - reflect underlying genetic similarities, and can indicate common ancestry and genetic relatedness.

Pasteur	Germ Theory (ROLE OF DISEASES?) Debunk spontaneous generation
Schleiden & Schwann	Cell Theory - Basic unit, individual cell have all characteristics of life, all cell come from division of other cells
Mendel	Provided the mechanism for Darwin Law of Segregation Law of independent assortment

MODERN THEORY: SPECIATION AND CLADISTICS

Species	*Various species concepts in Modern Theory*
Morphospecies	The grouping of species based on morphological similarities and ignore other differences such as DNA and inability to reproduce between individuals
Biological Species	Defines species as groups of interbreeding populations that are reproductively isolated from populations of other species in nature (unable to breed with different specie) ● Cannot be applied to species that are asexual reproduction, extinct or geographically separated populations

Phylogenetic Species	- Defines species by their unique derived features and common ancestry
	- Species is any population that forms independent branch on the phylogeny (monophyletic)
	- Reproductive isolation is mirrored by genetic distance
	
	Related words
	- Phylogeny
	  - evolutionary history of a group of organisms
	- Phylogenetic Trees
	  - Constructed using systematics (think: Taxonomy is method of systematics)
	  - Each branch point is a divergence of evolutionary lineages from common ancestor
	- Derived Characters
	  - A new version of a trait found in the most recent common ancestor of a group

Speciation	Process of species formation. It is also described as the evolution of reproductive isolation between populations.
Allopatric	Speciation that occurs because the species was separated geographically(can be by hurricanes too) Vicariance - Geographical separation (mountain/river)
Sympatric	Speciation that occurs in the same habitat. It can arise from - Natural Selection - Sexual Selection - Polyploidy - genetic condition of having more than two sets of chromosomes - Autopolyploidy - polyploidy same species

Parapatric	Speciation that occurs when adjacent population evolve into distinct species while maintaining contact along a common border also known as Hybrid Zone
	
	Ring Species - series of geographically neighboring population that are closely related
	
	Hybrid zone has three possible outcomes
	- Reinforcement (new species)
	  - Occurs when hybrids are less fit than parental species
	  - Also indicates that two subspecies are in the process of speciation
	- Fusion (no new species)
	  - Occurs when hybrids are as fit as parental species and two can become one

Isolating Mechanisms	*Considered to be macroevolution*

Reproductive	Any biological characteristics that prevents the gene pools of two species from mixing
	- Prezygotic Isolation Mechanism
	  - Ecological (different habitats)
	  - Temporal (different breeding times)
	  - Behavioural (different courtship behaviour)
	  - Mechanical (cannot physically mate)
	  - Gametic (incompatibility between sperm/egg of other)
	- Postzygotic Isolation Mechanism
	  - Hybrid inviability (zygote forms but cannot mature to organism)
	  - Hybrid sterility (hybrid cannot produce offspring)
	  - Hybrid breakdown (hybrid offspring has reduced viability/fertility)
	**the two are not mutually exclusive;both may operate simultaneously

Cladistics	
Henning	Entomologist and founder of phylogenetic systematics
Cladistics	An approach to systematics that uses shared derived characters to infer the phylogenetic relationships and evolutionary history of groups of organisms. In other word: field of biology that creates phylogenetic trees
Cladistic Useful Terms	Autapomorphy - Derived character only present in one group

	Apomorphy - Derived character within group Synapomorphy - Derived character shared between groups Plesiomorphy - Ancestral or primitive character within group Symplesiomorphy - Ancestral or Primitive character shared between groups Outgroup - Species/ group that does not have the same common ancestor as ingroup - The one that has the LOWEST score in doing cladogram
Cladogram	Monophyletic (Clade) - includes the ancestral species and all of descendants Paraphyletic - Includes ancestral species and some of the descendants Polyphyletic - No ancestral species just the descendant
KISS principle Occam's Razor Parsimony	Simplest explanation is likely to be right

Punctuated Equilibrium (Sudden change)	Gradual Change
Cladogenesis (Splitting)	Anagenesis (changing)

Random Words	
Advanced Characters	Character of species that has differed and become better than their ancestor
Character Polarity	Order of evolution or each character
Sister Group	Groups of organisms that share an immediate common ancestor