

Taxonomy Notes

Taxonomy = the classification of organisms

- Created by Linnaeus

Historically, organisms were categorized with 5 Kingdom system:

Kingdom → Phylum → Class → Order →
Family → Genus → Species

- Can remember order better with a phrase, like:

King Philip Came Over From Germany Singing

The five Kingdoms are:

- 1) Animals – eukaryotic, multicellular, heterotrophic, consume their food
- 2) Plants – eukaryotic, multicellular, autotrophic (do photosynthesis)
- 3) Fungi – eukaryotic, multicellular, heterotrophic, absorb their food
- 4) Protista (mostly 1-celled organisms) – eukaryotic, unicellular
- 5) Monera (bacteria) – prokaryotic, unicellular

Now we have a grouping above them: Domains

- Needed because the Monera can be divided into two groups
- 3 Domains: Archaeobacteria, Eubacteria, and Eukarya

"ancient"

extremophiles
(salt, acid,
heat, cold)

Binominal Nomenclature = 2-name naming system

- Uses the Genus and Species names
- Ex. Escherichia coli, Homo sapiens,
Canis lupus, Canis familiaris

To help identify organisms, we use a Dichotomous Key (2-choices) Key

→ Rules

- Genus - always first, capitalized
- Species - always second, NOT capitalized
- italics or underlined

Intro to Evolution Notes

Evolution = process by which species arise, change, and become extinct over time

- Is a Theory = a framework used to help understand the world around us by explaining why something happens
 - Different from a Law = describes a relationship without explaining why

Jean Baptiste Lamarck (1809)

- Developed a theory of evolution with two parts:
 - Those body organs used most to succeed in an environment become larger and stronger while those not used deteriorate.
 - The modifications an organism acquired during its lifetime could be passed along to its offspring.
 - Ex. Giraffes stretched their neck over multiple generations to create the long neck trait

Charles Darwin

- Based on his exploratory travels on the HMS Beagle and the works of others, he developed a theory of evolution
- Galapagos Islands
 - Most animal species on the Galapagos are unique (endemic) to those islands, but resemble species living on the South American mainland.
 - 13 types of finches, although they were similar, were different species.
 - Realized that they diverged based on food preferences
 - Shows in the structure of their beaks
- *The Origin of Species by Means of Natural Selection* (1859)
 - Convinced readers with logic and evidence.
 - How the Theory of Natural Selection works:
 - All species have potential to leave behind way more offspring than they do.

- Environmental resources are limited, leading to a competition for resources, so not all individuals will survive to reproduce.
- Individuals of a population vary in their characteristics and this variation is inheritable.
- Some individuals will inherit traits that are better suited to help them survive in the environment than others, which we refer to as the Survival of the Fittest
 - Fitness = reproductive success of an individual compared to other members of the population
- This unequal ability of individuals to survive and reproduce will lead to a gradual changes in a population, with favorable characteristics accumulating over time.
 - Adaptations = any evolved trait that helps an organism be more suited to its environment
- Ultimately, this process works because it causes a change in allele frequencies
 - An increase or decrease in the occurrence of a particular allele in a population IS evolution
- Changes in allele frequency cause:
 - The creation of a new group, especially a species

Darwin believed in gradualism = Life did not evolve suddenly by quantum leaps, but instead by a gradual accumulation of small changes.

A population is the smallest unit that can evolve

- Population = A group of interbreeding individuals belonging to a particular species and sharing a common geographic area.
- Individuals do NOT evolve

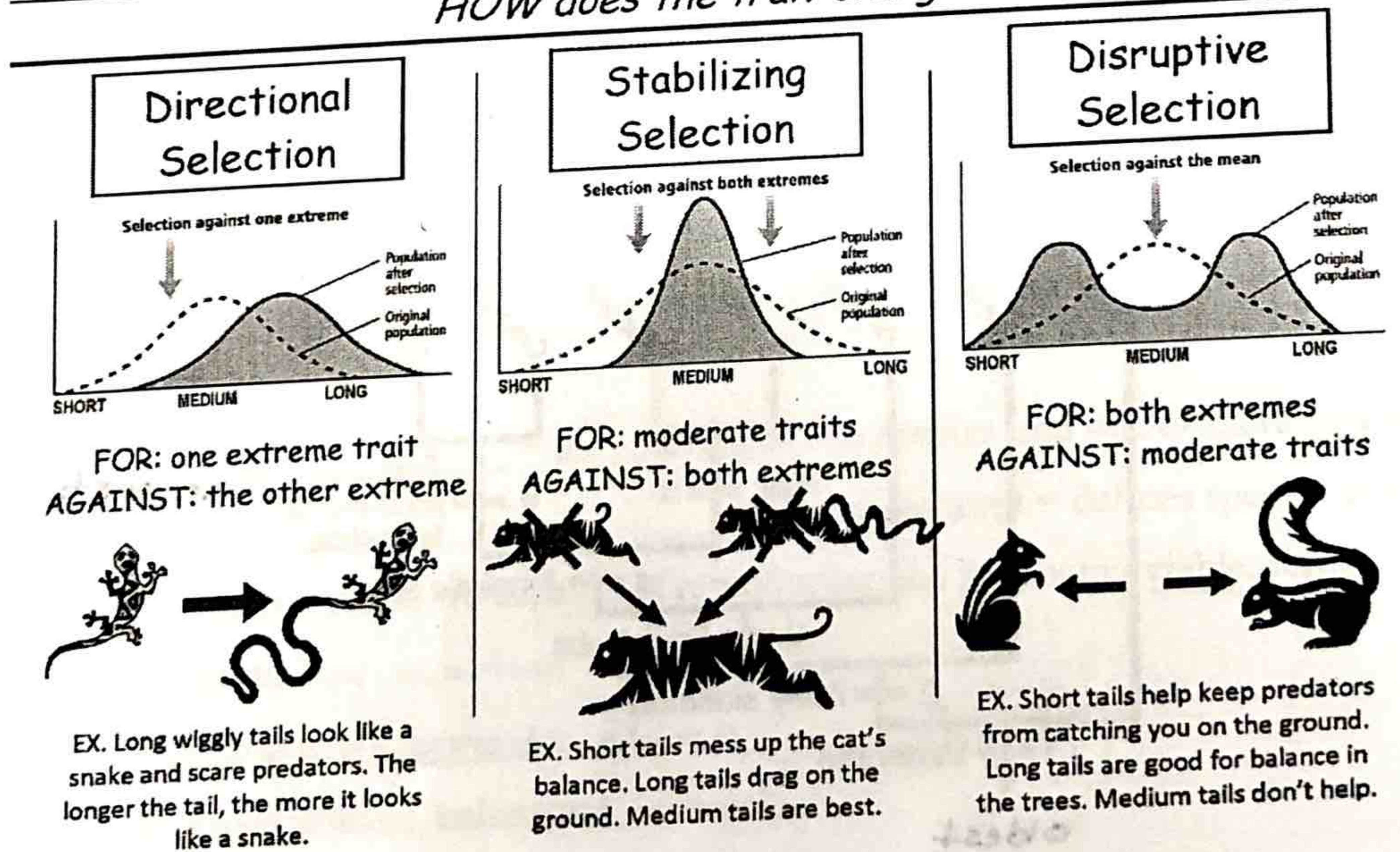
Example: Peppered Moths (Kettlewell)

- 2 forms exist: light and dark
- Prior to Industrial Revolution, the light-colored variant was more common than the dark-colored (only 10 % of population was dark)
- Industrial Revolution led to increase in pollution → left black residue on the tree trunks they rested on (which were normally light in color)
- After this change, dark-colored moths made up a maximum of 94 % of the population
- Now with increased pollution control, the dark-colored moths are back to 15 %.

The Effects of Natural Selection

- Stabilizing Selection = Selects against extremes and favors middle
 - Reduces variation → leads to uniformity
- Directional Selection = Favors one extreme; shifts the frequency curve
- Disruptive Selection = favors extremes over intermediates
- Sexual Selection = leads to differences in the two sexes

HOW does the trait change?

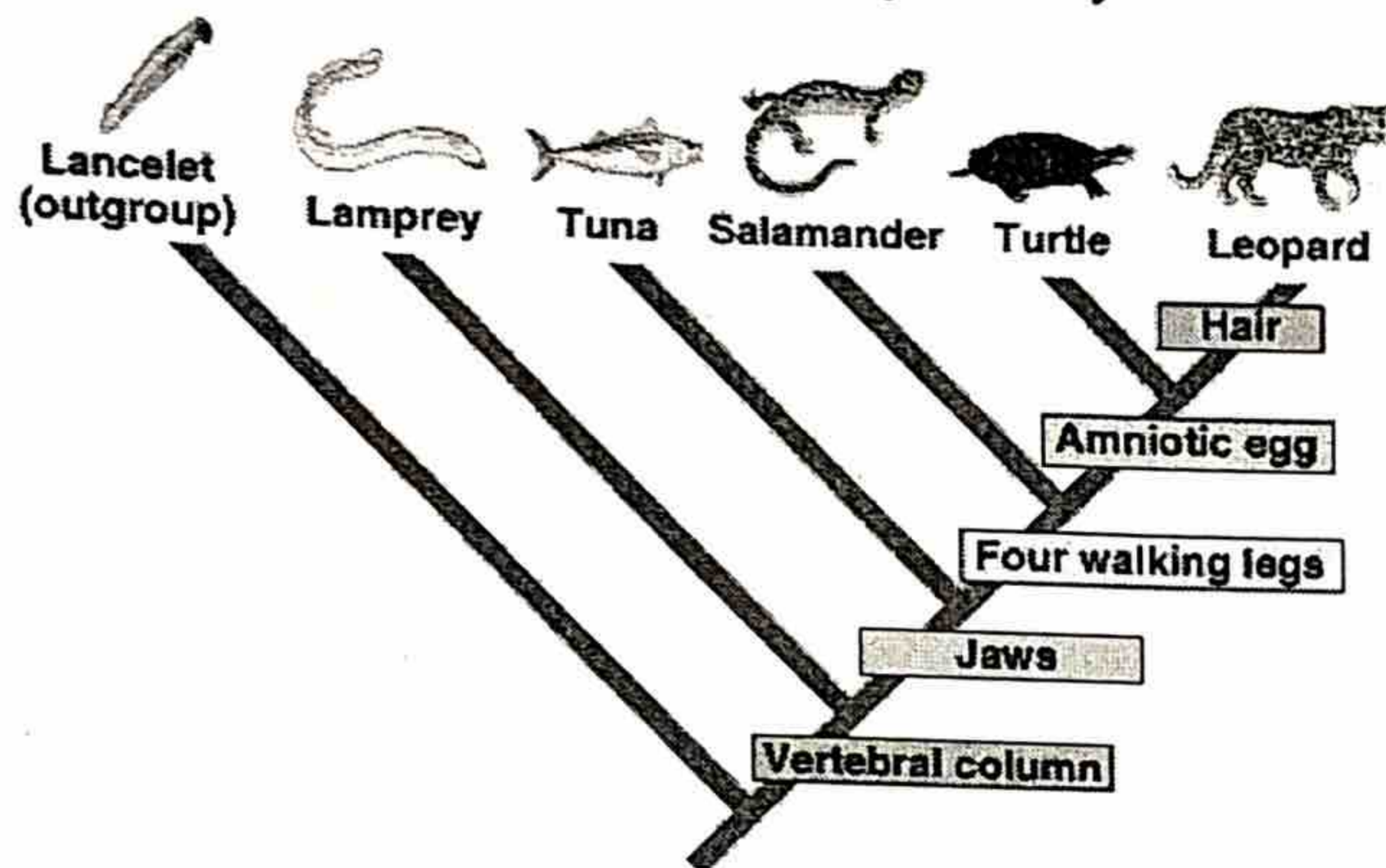


PUNCTUATED EQUILIBRIUM MODEL OF EVOLUTION

Punctuated equilibrium = theory that evolution occurs in spurts of relatively rapid change followed by long periods of no change

- Species undergoing most of their changes as they first separate from the parent species, then show little change
 - Ex. If a species survives for 5 million years and most of its morphological changes occur in the first 50,000 years, the speciation episode occurred in just 1 % of species' lifetime.

Cladogram = diagram of an evolutionary history based on similar/different traits

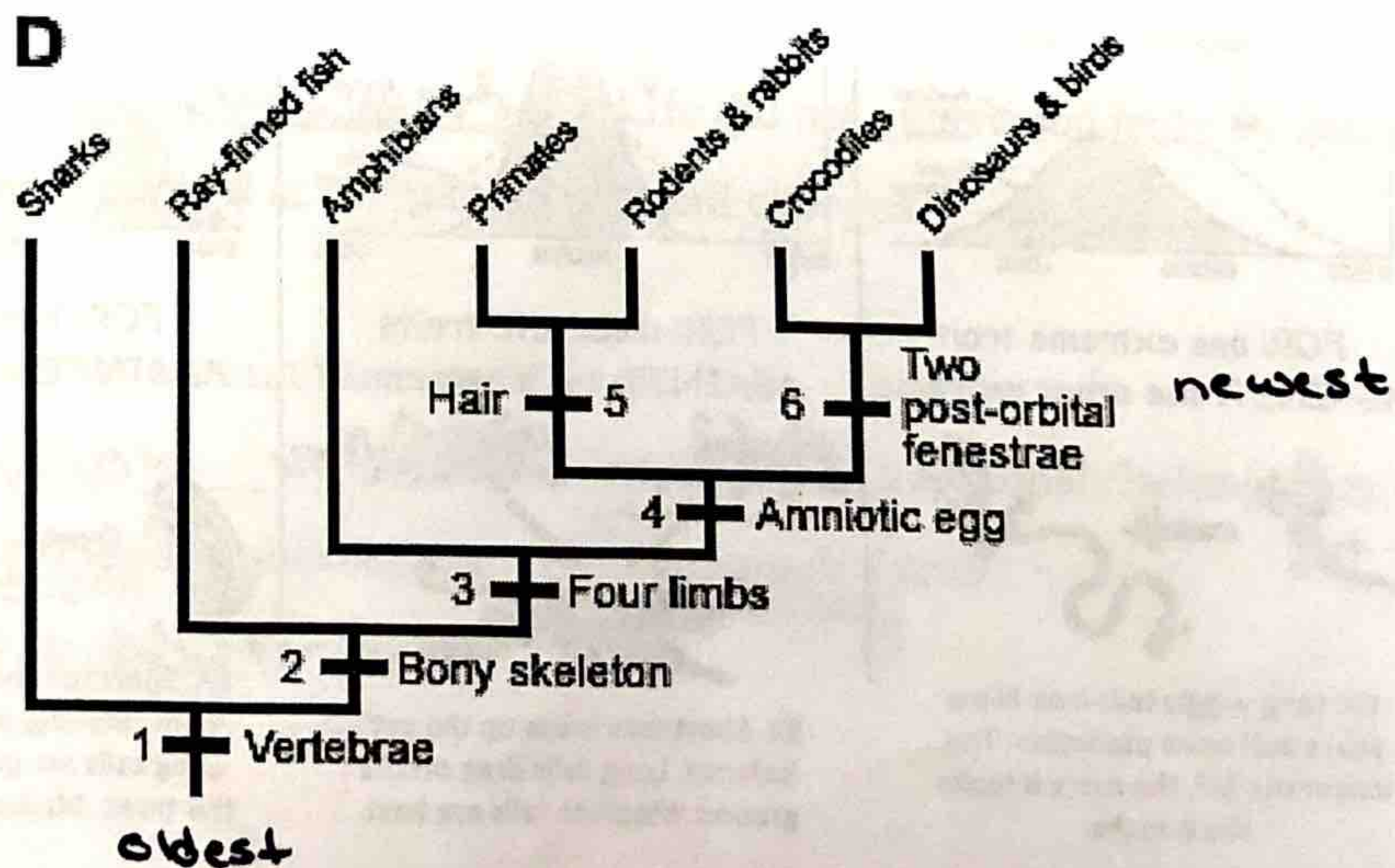


Basically a way to organize organisms based on traits

- Uses outgroups = "One of these things is not like the others"

Phylogenetic Trees

- Take into consideration both (homologous) structures AND time from the fossil record



Speciation and Phylogenetic Trees

Modern Synthesis

Theory integrates natural selection and genetics

micro evolution = a generation-to-generation change in a population's allele or genotype frequencies

Causes of Microevolution

- 1) mutation → A new mutation that is in gametes (sex cells) immediately changes the gene pool
 - If a new mutation increases fitness, it becomes established in the population very quickly
 - Mutation is the original source of all genetic variation.
 - Ex. House flies and resistance to DDT
- 2) Genetic Drift = Changes in the gene pool of a small population due to random chance
 - Causes the frequencies of alleles to "drift" away from the original values.
 - Two special kinds of genetic drift:
 - Bottleneck Effect = when the size of a population is drastically reduced by a natural disaster that kills organisms non-selectively.
 - Founder Effect = when a few individuals colonize a new habitat
 - Ex. Amish community and polydactyly (many digits)
- 3) Natural selection
 - Due to natural selection, genes are passed on to the next generation in different percentages than the generation before.

Speciation = the splitting of one species into two or more new species

Biological Species Concept = defines species as a group of organisms that are capable of reproducing and producing viable, fertile offspring in nature

- Relies on a reproductive BARRIER
- Geographical, behavioral, anatomical

- Temporal isolation = two species breed at different times
- Gametic isolation = Eggs have a receptor for a specific type of sperm. If they don't match, it cannot fertilize the egg
- Hybrid Inviability (Death) = hybrid cannot develop and miscarries
 - Usually due to mismatched chromosome sets
- Hybrid Sterility = hybrids are infertile
 - Ex. the mule is produced by crossing a donkey and a horse
 - Not able to reproduce
- Hybrid Breakdown = the 15+ generation hybrids are fine, but when these hybrids reproduce, the offspring of the next generation are wheat or sterile. (plants)

Reproductive barriers cannot always form

- Heterozygote Advantage = when heterozygous individuals (Aa) have a higher reproductive success than any type of homozygote (AA or aa).
 - Example: Heterozygotes for sickle-cell anemia are resistant to malaria

aa = sickle cell
 Aa = No sickle cell, immune to malaria
 AA = No sickle cell, could catch malaria

MODES OF SPECIATION

Speciation often occurs when the block to gene flow is a geographical barrier that physically isolates the population.

- The two populations are then subjected to different environmental conditions...so their natural selection will be different
 - Ex. Rodent species and the Grand Canyon

Special Case of Allopatric Speciation:

- Adaptive Radiation = the rapid evolution of many species from a single common ancestor.

Some formation of new species happens without the presence of a geographical barrier

- May occur in animals if they become fixed on different resources
 - Ex. The great diversity of cichlid fishes in Lake Victoria is a result of the use of different food sources, Darwin's finches

Divergent Evolution = one species splits into 2+ new species

Convergent Evolution = 2 different species develop a similar trait to deal w/ a similar environment

Co-evolution = when 2 species are in a relationship and influence the evolution (selection) of each other

Evidence of Evolution

1) Fossils = Relics or impressions of organisms from the past preserved in sedimentary rock

- Not just bones, but could be:
 - Insects trapped in Sap (amber)
 - Impressions of dead organisms
 - Animals buried in bogs (tar pits)
 - Footprints
- Fossils become more complex over time
- Oldest fossils are of bacteria estimated to be 3.5 billion years old

Determining the Age of Fossils rock layers

- 1) Relative Dating = younger strata are found on top of older strata
- Fossils found in the same layer are believed to be the same age
- 2) Radiometric Dating = using radioactive decay (radioactive isotopes and their half-life) to determine the age of a fossil

- $C^{14} \rightarrow N^{14}$
- Carbon Dating = uses the $\frac{1}{2}$ -life of $^{14}C \rightarrow 5,730$ years
 - Ex. A sample of a fossil is found to have $\frac{1}{4}$ of the original amount of carbon-14. How old is it?

$$1 \text{ HL} = 50\% = \frac{1}{2} \text{ left} = 5,730 \text{ years}$$

$$2 \text{ HL} = 25\% = \frac{1}{4} \text{ left} = 11,460 \text{ years}$$

Always hoping to find Transition Fossils = represent the intermediate evolutionary forms of life in transition from one type to another

- Ex. Tiktaalik roseae (the fishpod) represents the transition from fish to 4-legged animals (amphibians)

2) Vestigial Structures = structures that are "leftovers" from evolution with little to no use to an organism

- Ex. Pelvic and leg bones in Snakes
- Ex. Human: male nipples and the appendix

3) Homologous Structures = Structures that share a common ancestor

- Ex. Forelimbs of: human, cat, whale, bat (arm)

4) Embryology Patterns = similarities disappear as the organism develops and has had new instructions on how to form added

- Ex. All vertebrate embryos possess gill slits
 - In fish, the gill slits form gills; in humans they form the Eustachian tubes
 - New structures are often modified versions of older ones, and can be seen in embryos

5) Biochemical Evidence (DNA)

- All organisms use the same genetic code → also support common descent
- Similarity in DNA and proteins structures are studied
- The closer two species are, the higher the % of common DNA
- Even distant organisms (ex. bacteria and mammals) have some proteins in common and can be compared with this method.

Found on youtube!

👁️👁️ it!

Crash Course Big History: Human Evolution

- 1) 65 million years ago, when the dinosaurs were eliminated, mammals survived and diverged through (mass extinction / adaptive radiation).
- 2) Which mountain range formed when India crashed into Eurasia? Himalayas / Rockies
- 3) About 25 million years ago, the apes diverged from the (humans / Old World Monkeys).
- 4) T or F: We evolved from monkeys
- 5) T or F: We evolved from chimps
- 6) ALL primates have the following features:
 - (Large / small) brains
 - Eyes on (sides / front) of head
 - (Grasping / reaching) hands
 - Social (parties / hierarchies)
- 7) Humans and chimps share 98.4 % of their DNA
- 8) Because of the shift away from rain forest to savannah, humans needed to run from predators. This led to the development of (spears / bipedalism).
- 9) T or F: Another benefit of bipedalism is that it frees up your hands.
- 10) About 4 million years ago, *australopithecines* evolved. They were short, with slightly larger brains, (carnivores / herbivores), but were not capable of complex language.
- 11) 2.3 million years ago, *Homo habilis* evolved, used (tools / language) and had slightly larger brains.
- 12) *Homo ergaster erectus* evolved 1.9 m.y.a. and had even larger brains. They may have moved to different environments, used tools, and maybe (fire / spears).
- 13) They were also the first to show signs of social (orders / learning) as their tools became more complex.
- 14) Collective learning = the ability of a species to retain (more / less) information with one generation than is lost by the next
- 15) Neanderthals were among the first to develop fire, wooden tools, spears, (clothing / wagons), and improved their tool manufacturing over time.
- 16) Collective learning is important because it allows us to change and adapt without changing our (lives / genes).
- 17) *Homo sapiens* have been around for about 250,000 years.

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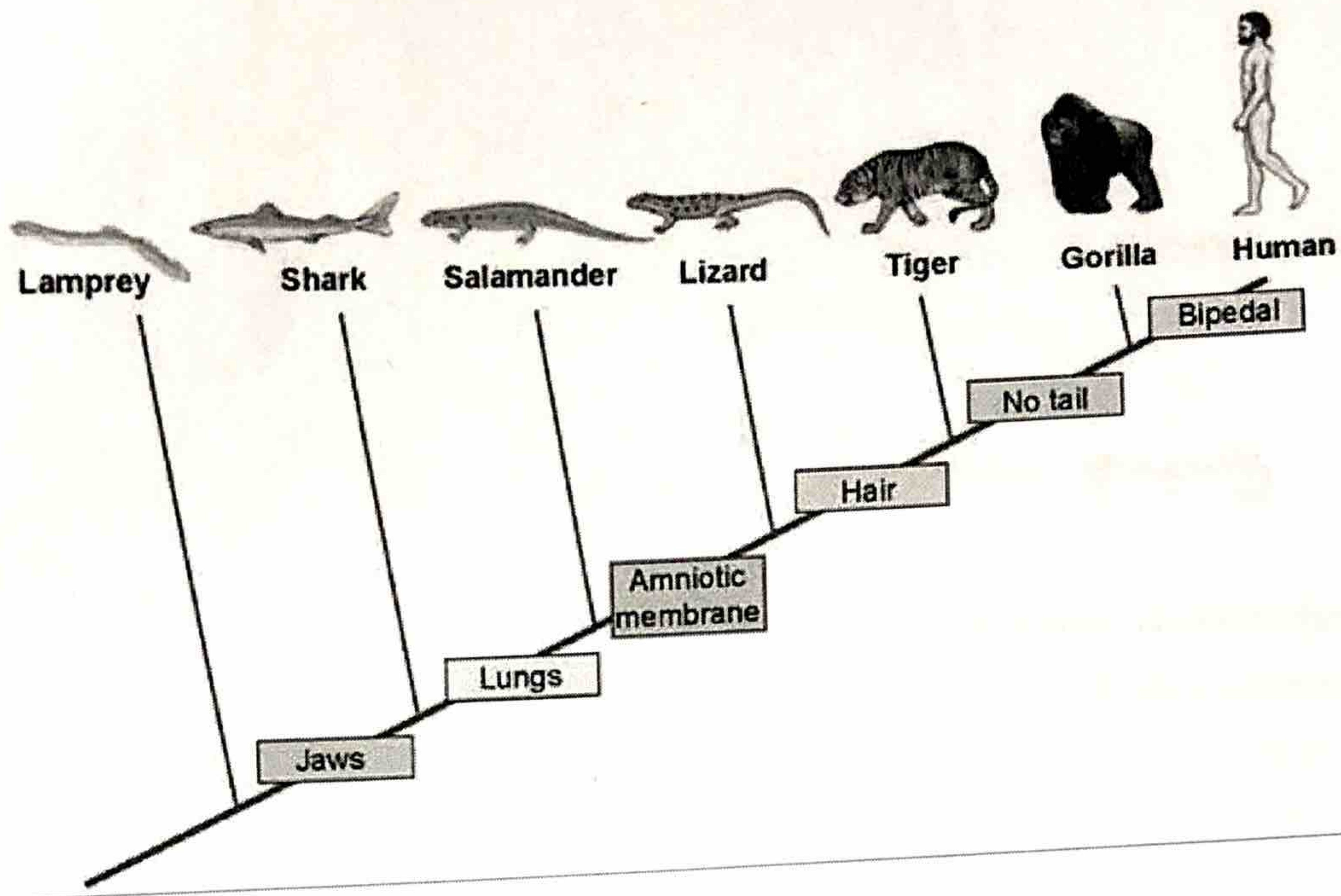
18) (Foragers / serfs) were people that spent their day looking for food.

19) T or F: the average office worker puts in a longer day than a forager

20) 74,000 years ago, a major volcanic eruption caused the human population to be reduced to a few (hundred / thousand). This (increased / decreased) the diversity between us.

Name _____

Cladograms and Phylogenetic Trees



- 1) According to the cladogram, what is the closest relative to the human? **Gorilla**
- 2) From the cladogram, what characteristic separates the gorilla and human from the tiger? **No Tail**
- 3) Which is the least closely related animal to the tiger? **Lamprey**
- 4) What trait makes the lizard and outgroup from the rest? **Hair**
- 5) What trait separates the humans from the gorillas? **Bipedal**
- 6) Which pair is more closely related: **Shark and salamander** OR Shark and lizard?