Great moments in evolution

Myths and Misconceptions

- https://www.youtube.com/watch?v=mZt1Gn0R22Q

(4:53)

The Theory of Evolution

- Change over time.
  - People used to think that species did not change.

DARWIN WAS NOT THE PERSON TO COME UP WITH EVOLUTION

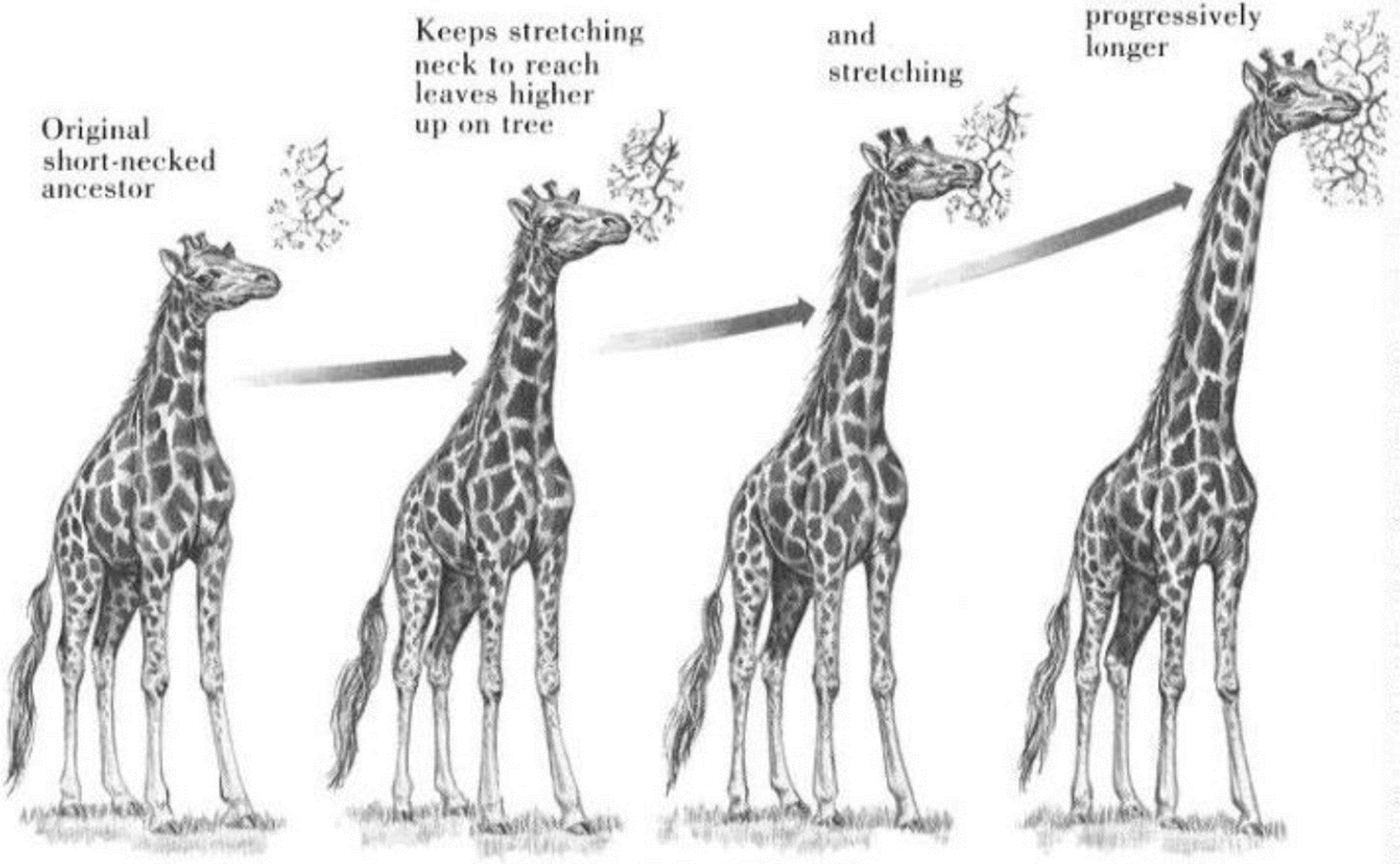
MANY scientists came up with the idea that species change They just didn't know **how**

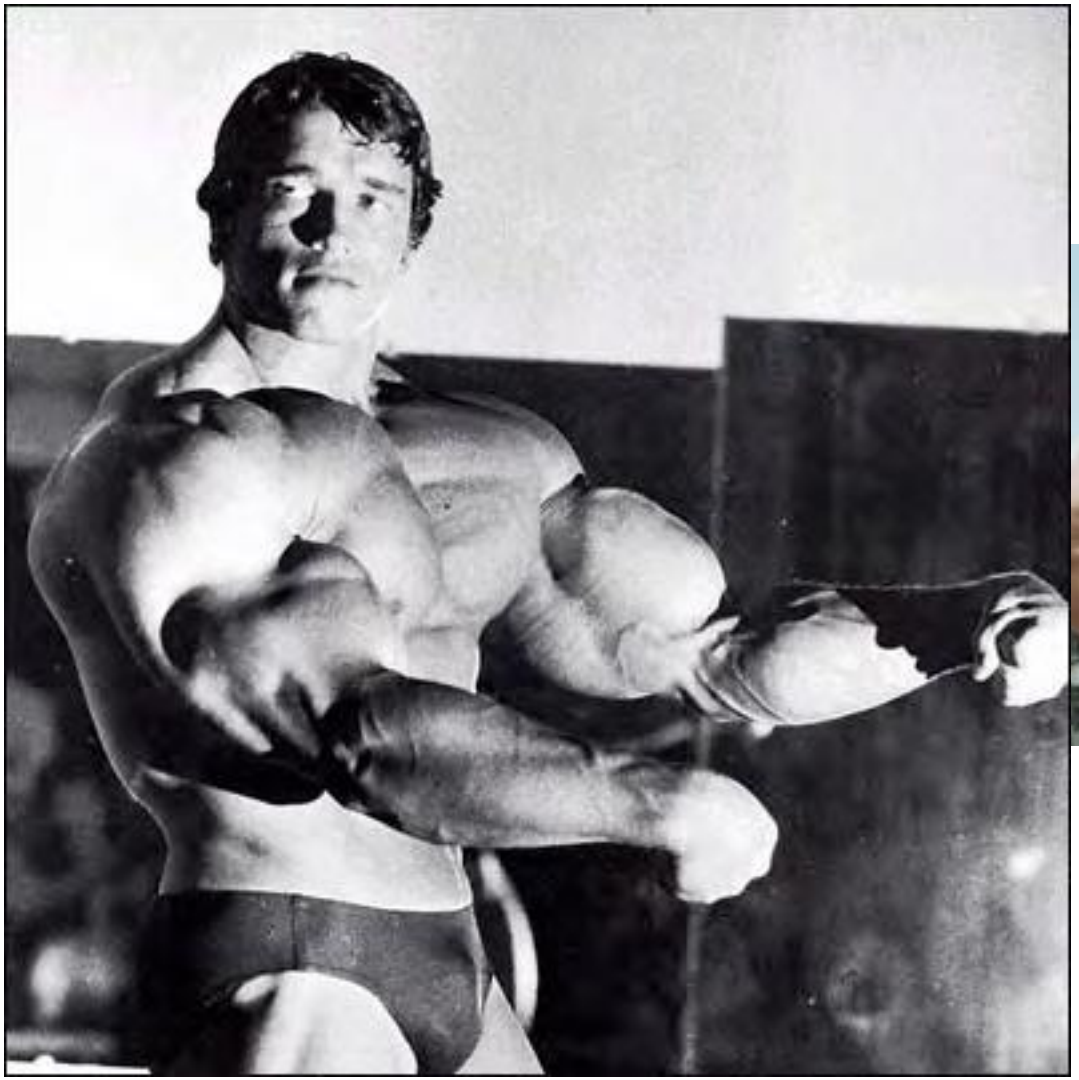
John Baptiste Lamarck

- French Biologist (1744-1829)
- Knew species changed, just had the wrong mechanism

- Lamarckian Inheritance
  - Use and disuse of acquired characters

LAMARCK'S GIRAFFE





So, according to Lamarck – this guy uses his muscles all the time and when he had children . . .

with this woman, she had a hard time giving birth to their big muscled little babies that came out ready to pump some iron!

But, they were normal size.

Lamarck's mechanism was wrong…or this woman would have had kids with no arm!

Darwin's Natural Selection is the correct mechanism

ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

1859

Natural Selection: Darwin's mechanism

- We can break it down into **5** facts & **3** conclusions.

Fact 1: **High reproductive potential**

The Duggar Family- 19
Kids and counting

Sultan Ishmael the Blood thirsty of Morocco fathered 800 children

Fact 2: **Constant Population Size**

Populations maintain and stay the same size

Fact 3: **Natural Resources are Limited**

- There's only so much food, shelter, habitat available to living organisms

Fact 4: **Variation- differences in one species**

Compare the stripes on the Zebra

Fact 5: **Variation is inherited**

- **Variation is passed on from parent to offspring.** Darwin knew this and he didn't know anything about Genetics.

Conclusion 1: **Struggle for Existence**

- Not all acorns or rabbits produced will survive!

- Conclusion 2: **Natural Selection= Survival of the Fittest** (the organism that can best reproduce)
  - Those individuals that survive better than the others, will pass on their genes to the offspring.

- Conclusion 3: **EVOLUTION- species change over time**

Note on Natural Selection

- Evolution does not occur in individuals.
- Natural selection acts on the phenotypes of individuals which survive and reproduce in a population.
- So, evolution acts directly on the populations as a whole.
- Individuals do NOT evolve, populations DO!
- Variation is the raw material for evolution.

Look at your chart: Mechanisms of Evolution (How it happens)

So, what is a simple definition of Natural Selection?

Individuals that are best able to survive and reproduce pass on traits to their offspring.

https://www.youtube.com/watch?v=0SCjhI86grU (9:18)

RECAP

Populations are variable

Natural Selection

Some individuals survive better & reproduce more than others

The next generation is more like the survivors

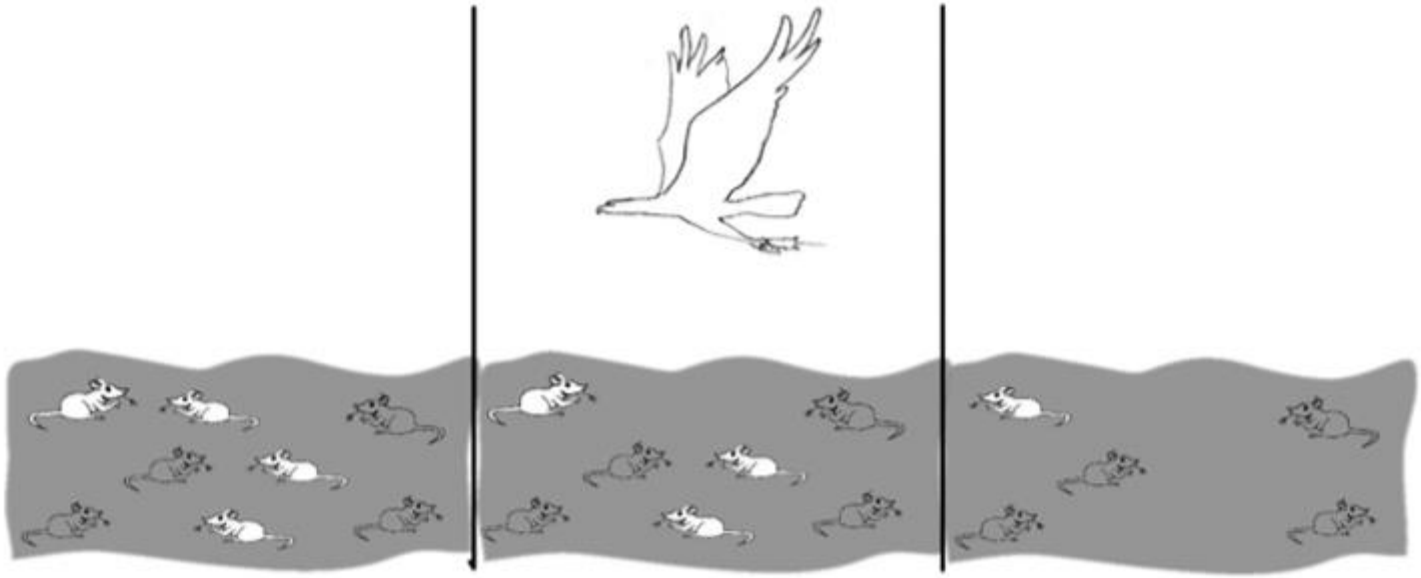
Result: the population changes = **evolution**

Who is more “FIT”?

- https://www.youtube.com/watch?v=OEqsgwyvtqc cuttlefish mating (1:36)

Mechanisms of Evolution

- Natural Selection
- Mutations
- Gene Flow
- Genetic Drift
- Isolating Mechanisms
  - Behavioral
  - Geographical



Natural Selection

Genetic variations and different phenotypes exist in a population

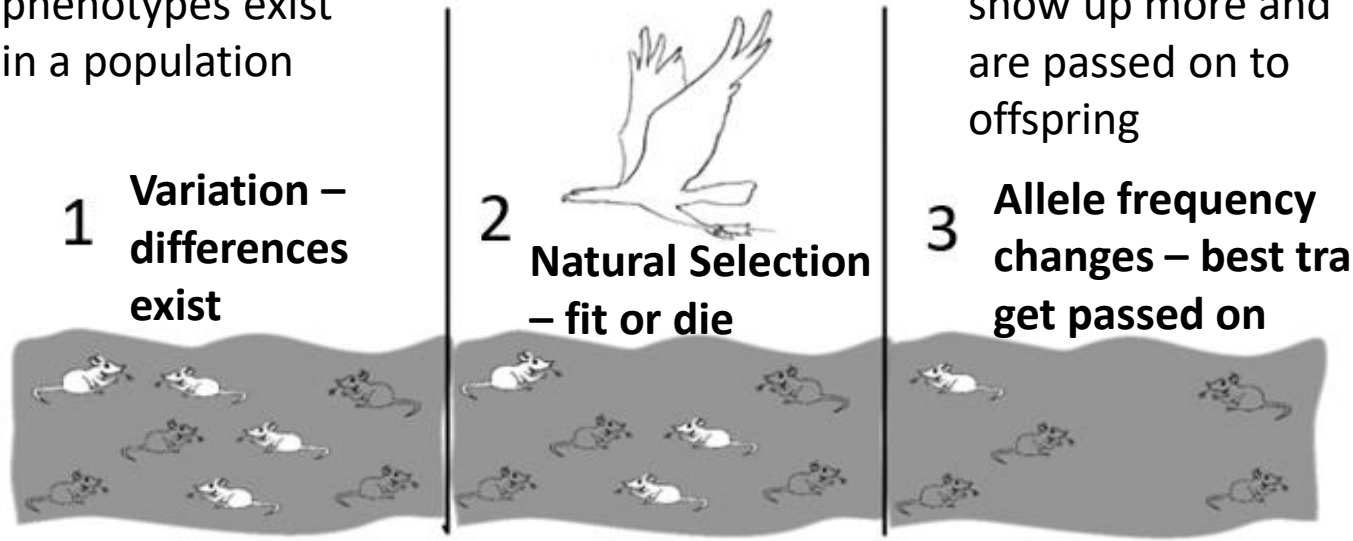
Those less fit or less adapted die

The adaptations that allow for fitness show up more and are passed on to offspring

1 **Variation – differences exist**

2 **Natural Selection – fit or die**

3 **Allele frequency changes – best traits get passed on**



Adaptations

Fitness

Differential Reproductive Success

- The ability of an organism to compete successfully for resources, survive predation, resist disease and live to adulthood allows that organism to reproduce.

Heritable Characteristics

- These improve survivability and reproductive potential.
- Example:
  - Camouflage
    - Lizards changing color to camouflage
    - Octopus changing color and shape
  - Mimicry
    - Monarch and Viceroy butterfly

Adaptations

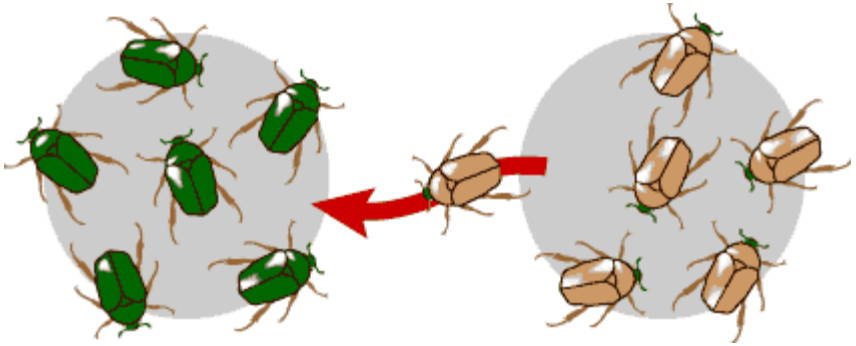
- A genetic change that allows organisms to survive natural selection in their habitat.
- Adaptations lead to change in species.
- Examples:
  - Beak shapes on birds
  - Thorns on stems of flowers
  - Mimicking a poisonous animal or plant (fly mimics wasp)

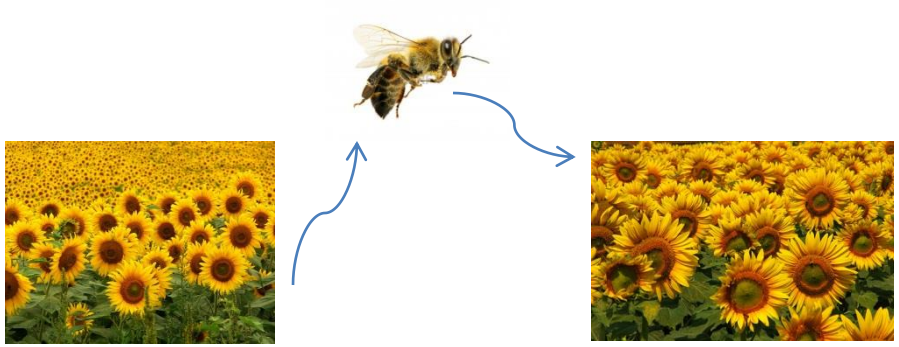
Mutations

- If a mutation benefits the survival of a population it will become a common trait
- If a mutation is detrimental to the population, it will not become a common trait.
- Alleles only increase if the mutation is beneficial.
- **VERY RARE**

Gene Flow

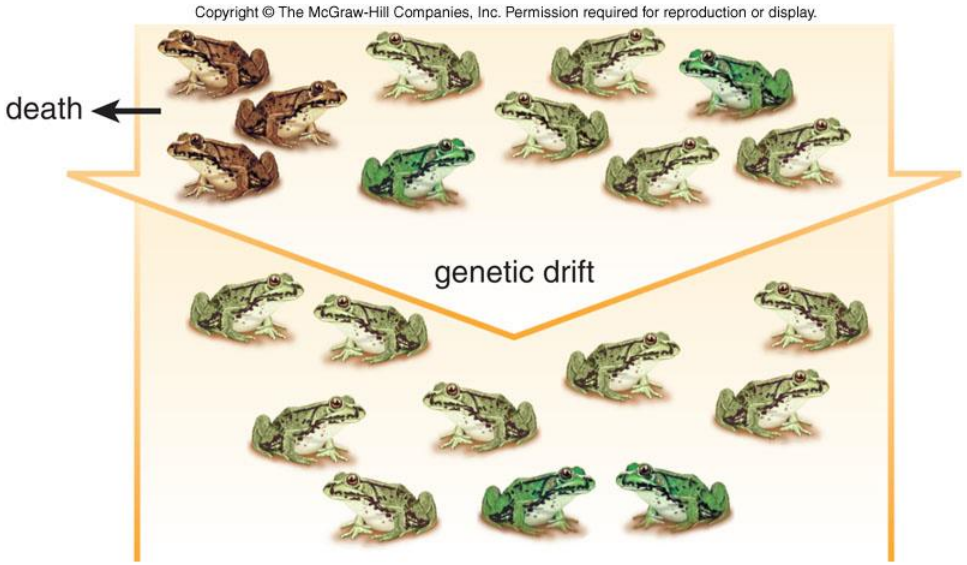
- The transfer of alleles from one population to another.
- Example:
  - An individual leaves one population and travels to another and reproduces with the new population.
  - An animal carries pollen from one population of flowers to a different population of flowers



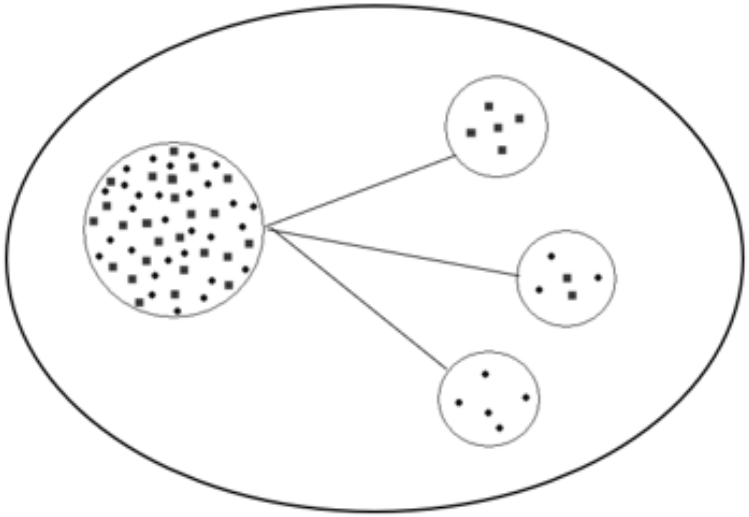


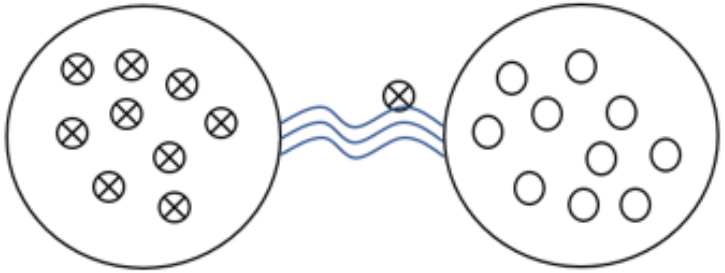
Genetic Drift

- The change of frequency of alleles in one population in a certain area.
- Example:
  - In a population of frogs living in a swamp, those with lighter skin survive longer – the light skin allele will increase throughout the population of these frogs.

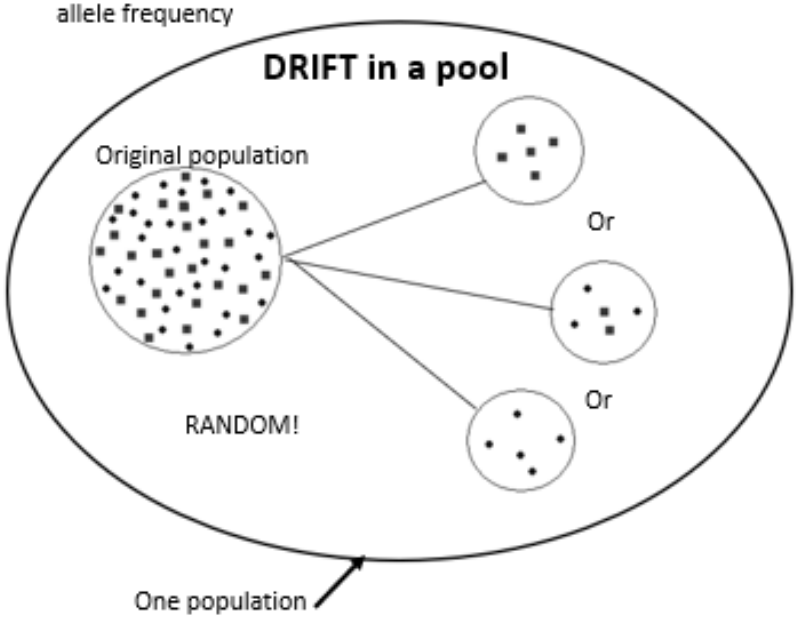


Genetic Drift & Gene Flow

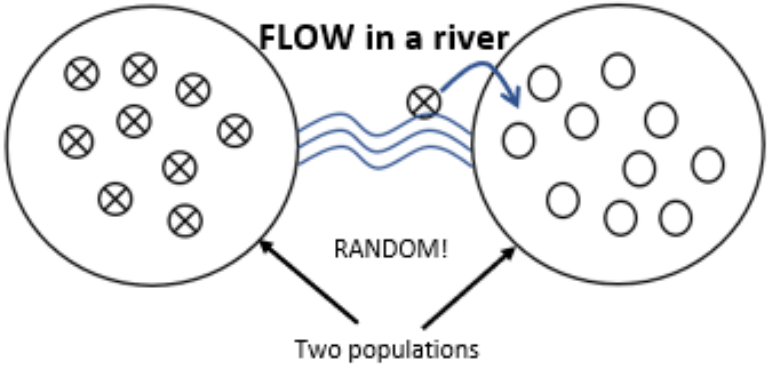




Genetic DRIFT – random change within one population of allele frequency



Gene FLOW – random change from one population to another, allele frequency changes



Behavioral Isolation

- Reproduction does not occur due to some type of behavior
- Example – the male peacock spider displays his colors and dances to attract a female, if a female peacock spider does not respond or recognize this dance ritual, she will not mate with him.

Temporal/Reproductive Isolation

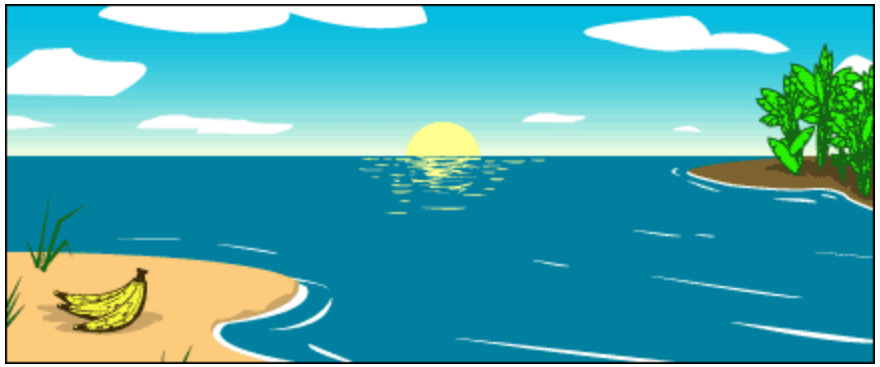
- Reproduction doesn't occur between species because they mate at different times.
- Example; Spring Field Cricket and the Fall Field Cricket

(a) Spring field cricket (*Gryllus veletis*)

(b) Fall field cricket (*Gryllus pennsylvanicus*)

Biogeography- Geographic Isolation

- Populations are separated by water or land and evolve differently increasing biodiversity.
- Examples:
  - Darwin's finches on islands separated by water
  - Population of squirrels separated by a canyon
  - Population of rabbits separated by a river



Abert Squirrel . . .

Abert squirrels make their homes on the South Rim of the Grand Canyon and in some of southern Arizona mountains. Their cousins, Kaibab squirrels, live only north of the Canyon on the Kaibab Plateau, and they don't venture anywhere else. The Abert and Kaibab squirrels were **ONE** species before the Grand Canyon gorge split their habitat, so they have a lot in common, but enough differences for each to now be a separate species.

Biogeography- Geographic Distribution

- When a population is split into two separate populations in two different habitats and each group evolves differently to survive.

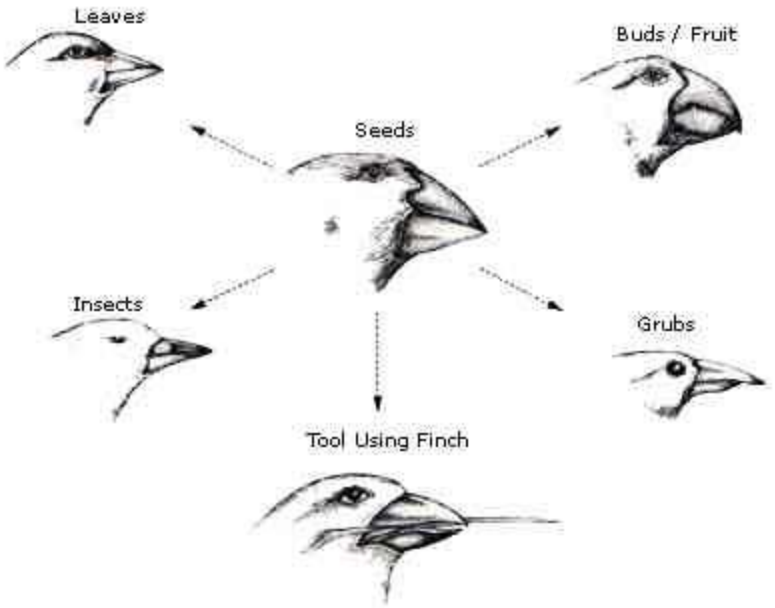
Alligators lack salt glands of crocodiles; the Chinese (Asian) and Amerian species had separated no later than 14 mya

Evidence of Evolution

Darwin's 2nd Contribution

Morphologies

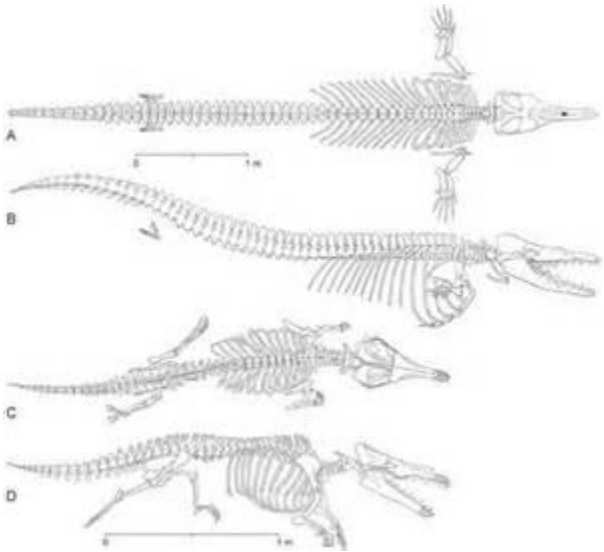
- The form and structure of organisms' traits depending on their environment.
- Example:
  - Finches have different beak shapes for the function of eating different food items

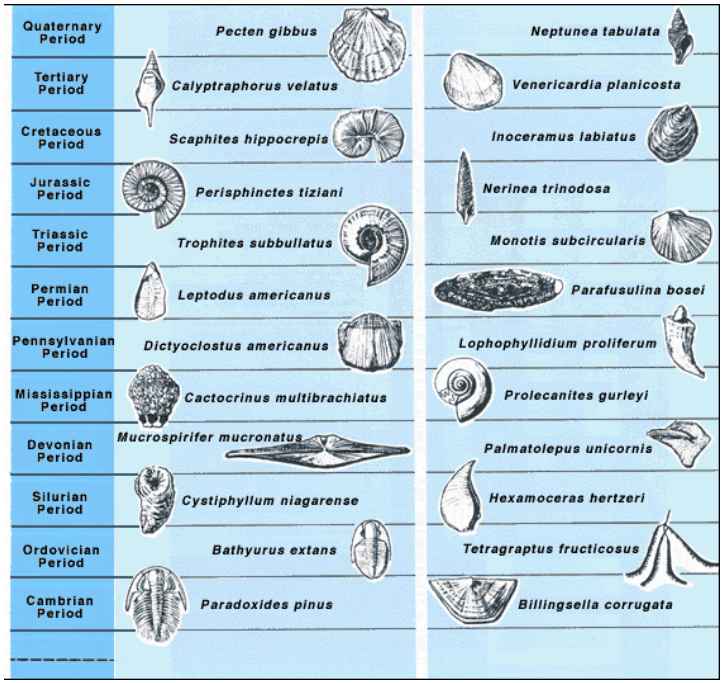


Fossils:

- Study of preserved remnants or imprints of organisms

* These are abiotic, do not show cellular or molecular data

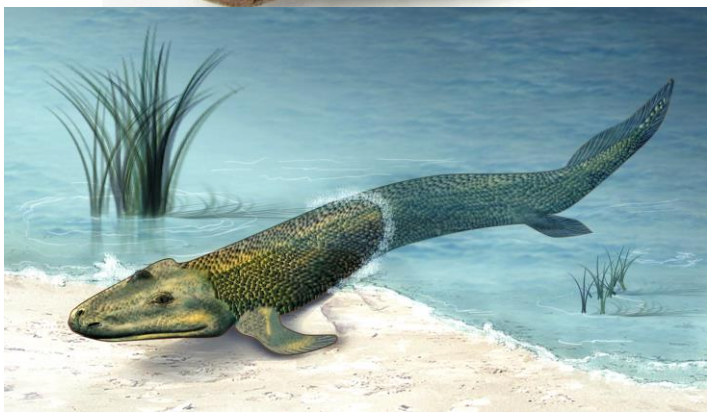




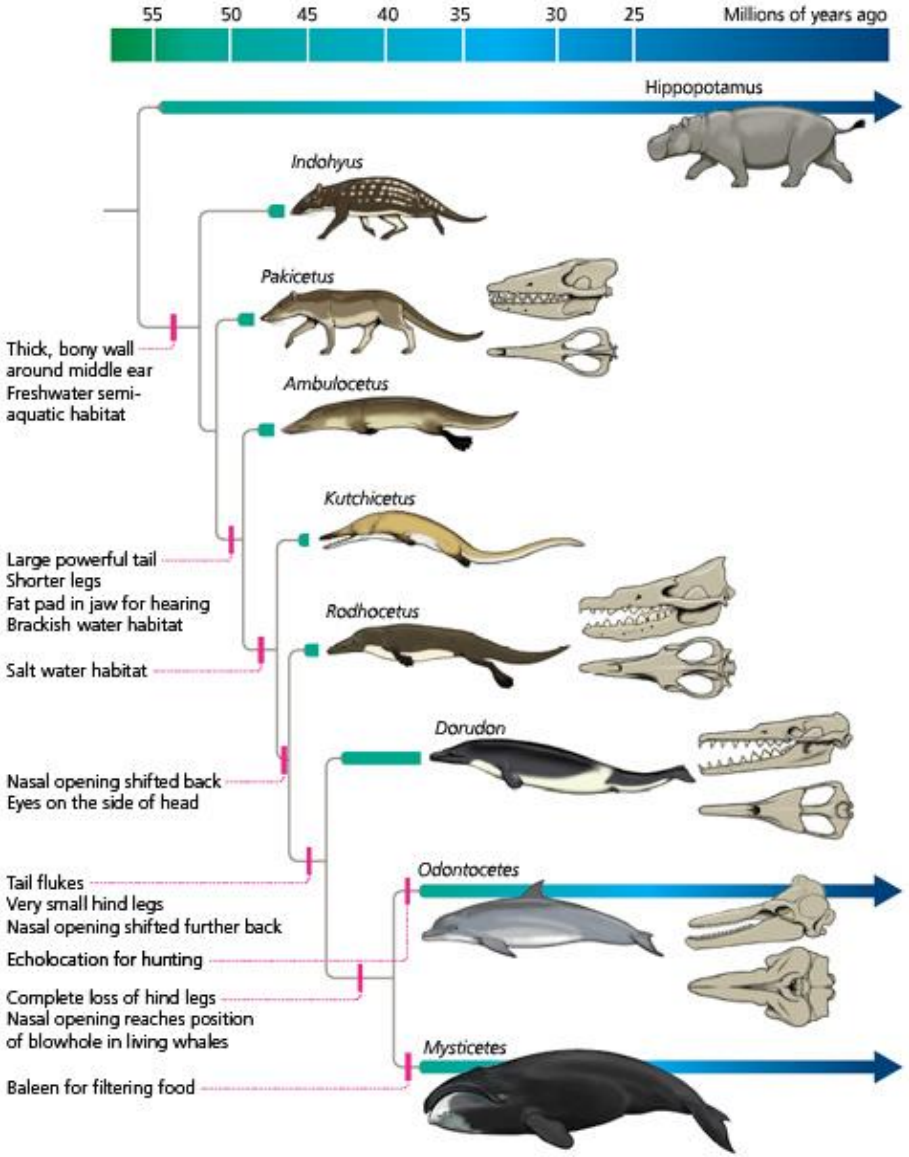
Transitional Fossils - Transitional fossils explain “links” between different groups

Tiktaalik

Archeopteryx



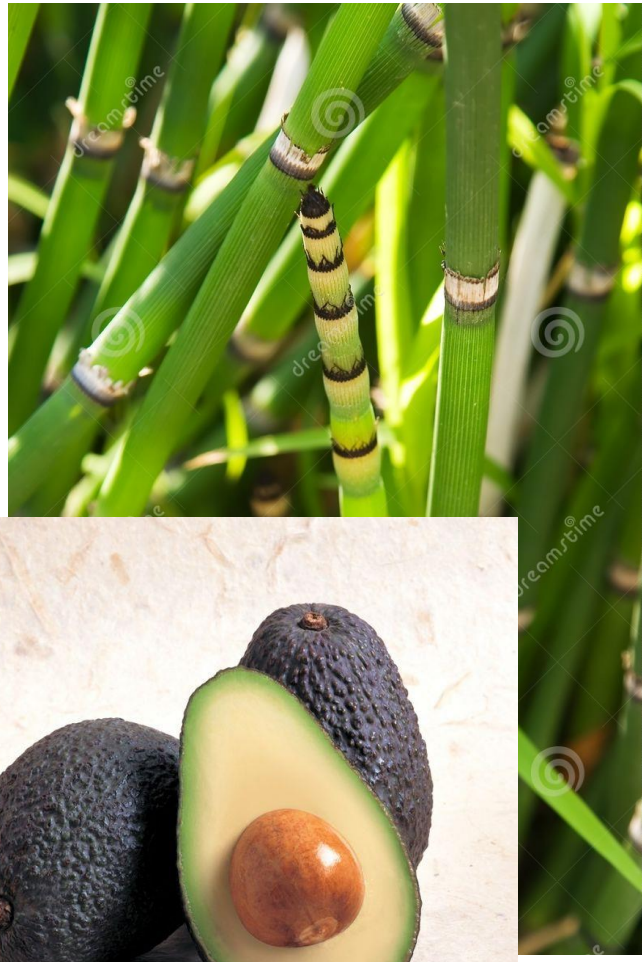
Sequential Transitional Fossils



Living Fossils

(ghosts of evolution, **anachronisms**)

Last of their lineage or “holdover” from earlier time.

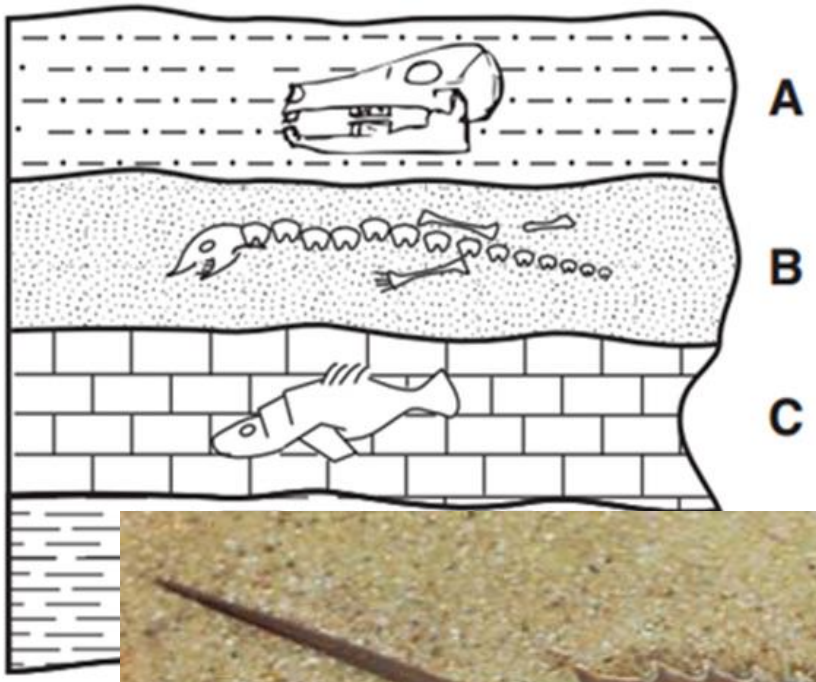


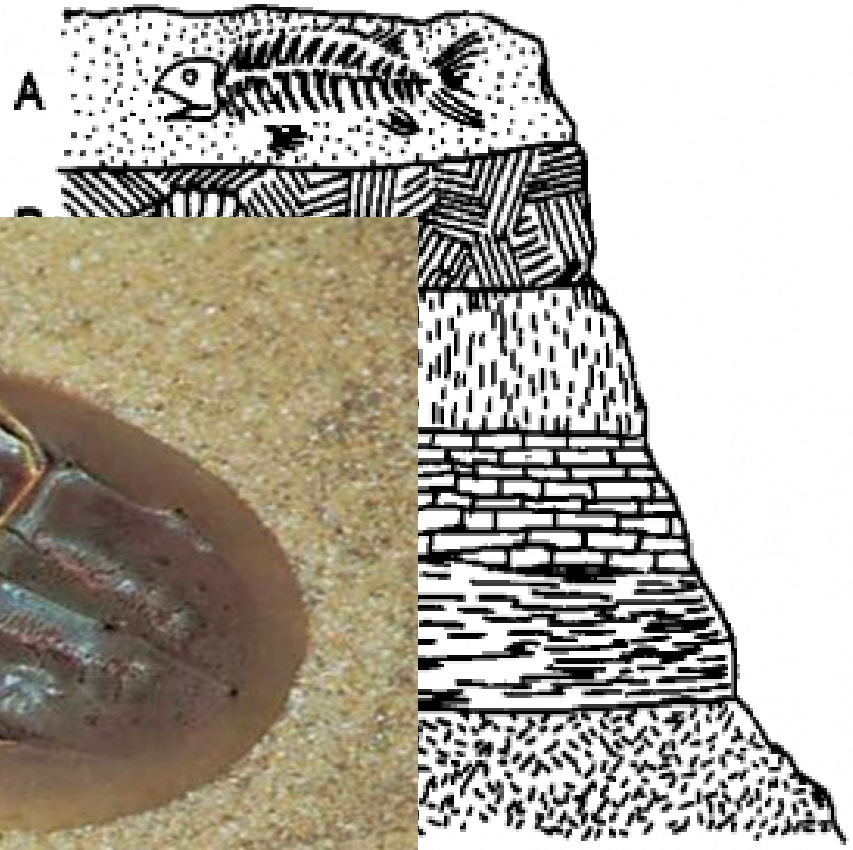
The Giant Sloth

The Giant Sloth ate horse apples from the bois d'arc (bow-dark) – now a living fossil

Fossil Evidence

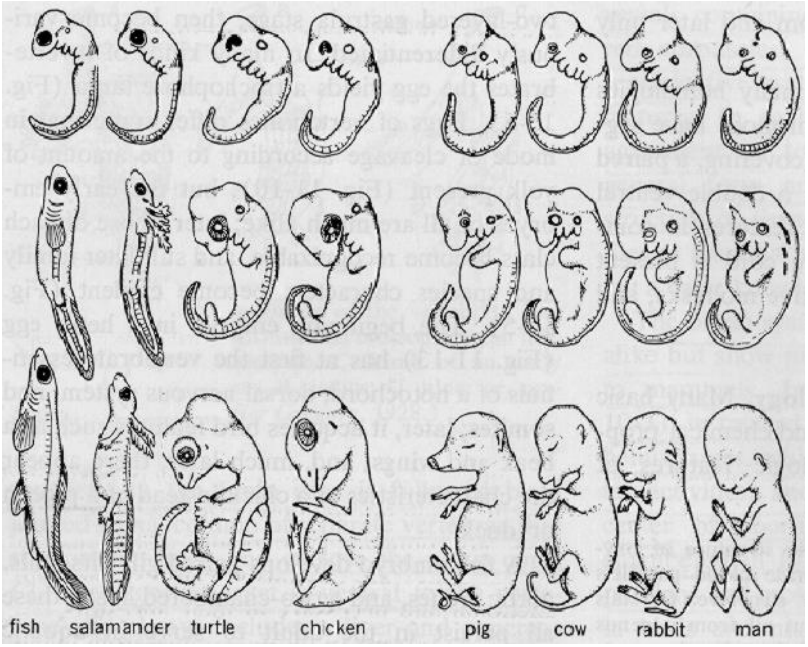
Law of Superposition





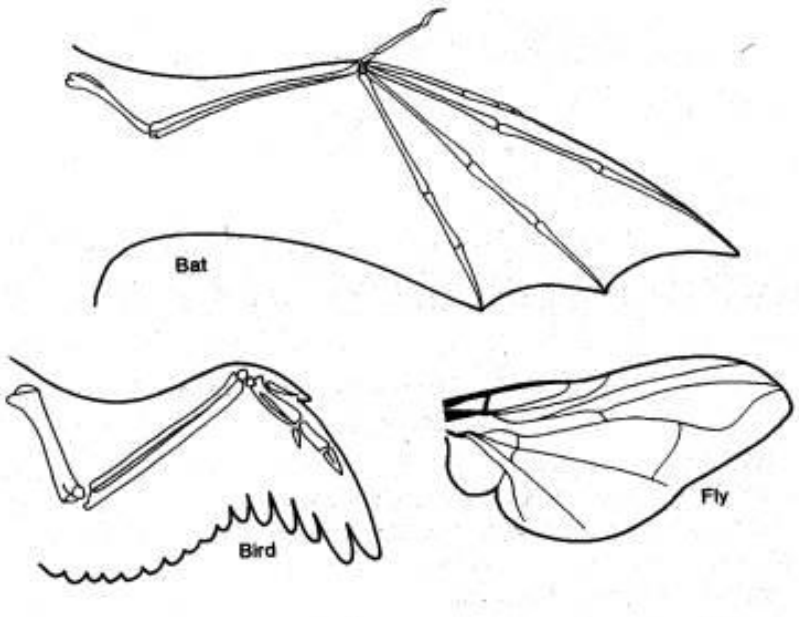
Embryology

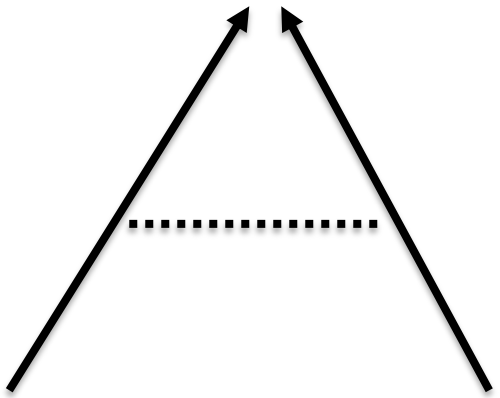
- Comparing embryos of different organisms for similarities showing the developmental process is the same in different species.
- Example:
  - All vertebrates have gill slits and a tail bone in the embryonic stage. In some animals these turn into actual gills in others they turn into ear bones.



Analogous Structures

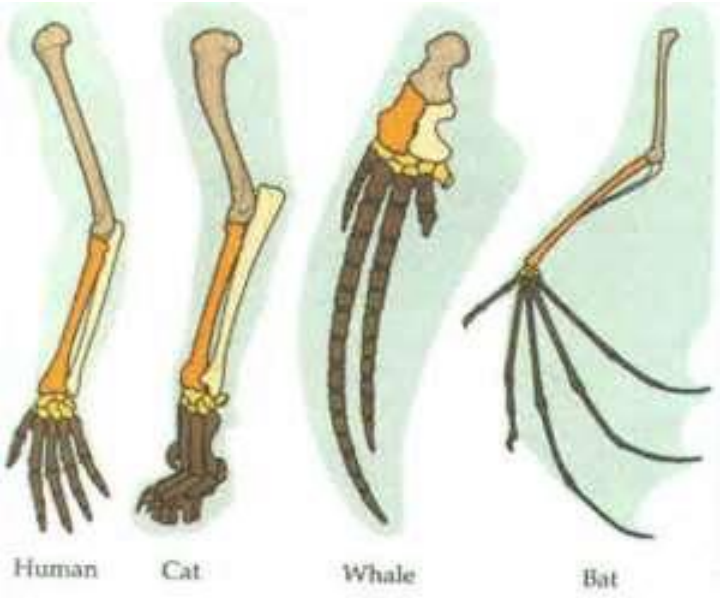
- Same function, derived from different structures
- Example:
  - Due to convergent evolution, different organisms need to function the same

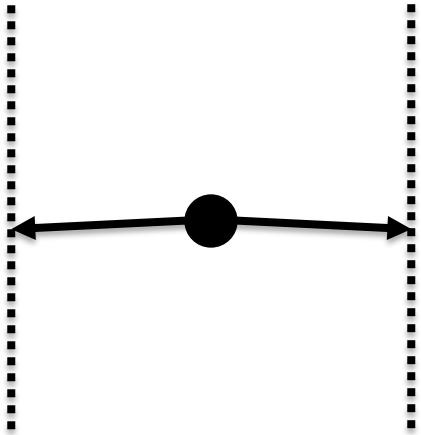




Homologous Structures

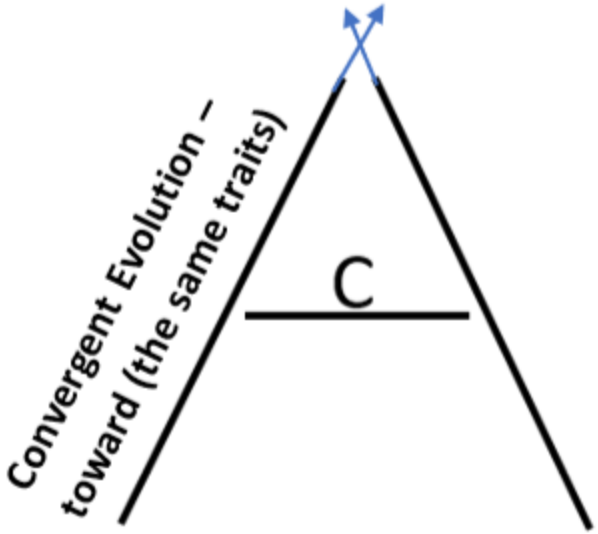
- **Structure and placement are the same. Function is different.**
  - Why? Due to a common ancestor
- Example:
  - Due to divergent evolution, like organisms develop different structures for different functions





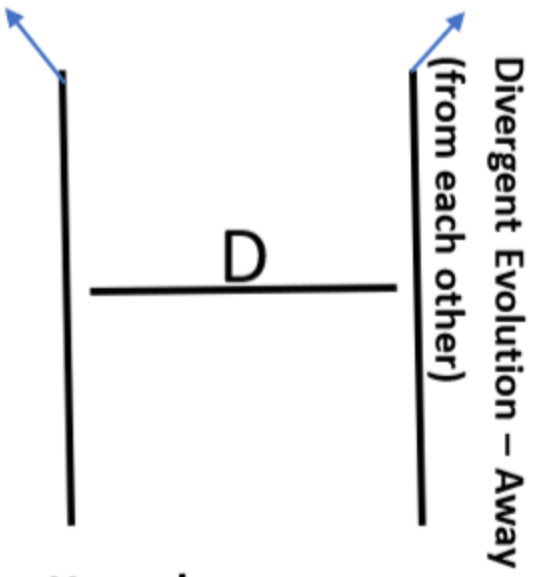
Anatomical Structures/ Patterns of Evolution

Anatomical Structures/ Patterns of Evolution



Analogous –

Different Structure, Same Function

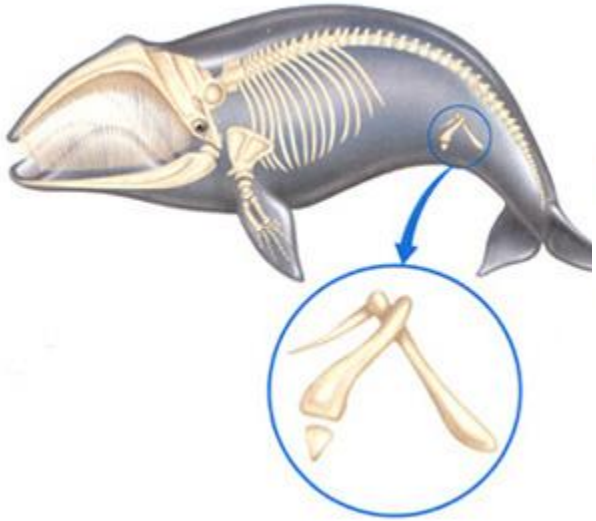


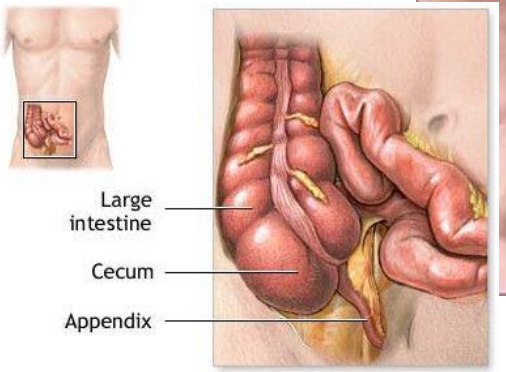
Homologous –

Same Structure, Different Function

Vestigial Structures

Structures present in modern organisms that no longer function, but functioned in ancestral organisms





YOU HAD A TAIL!

Human Origins

- https://www.youtube.com/watch?v=B9ih_NtCsRw (3:23)

The Science of Skin Color

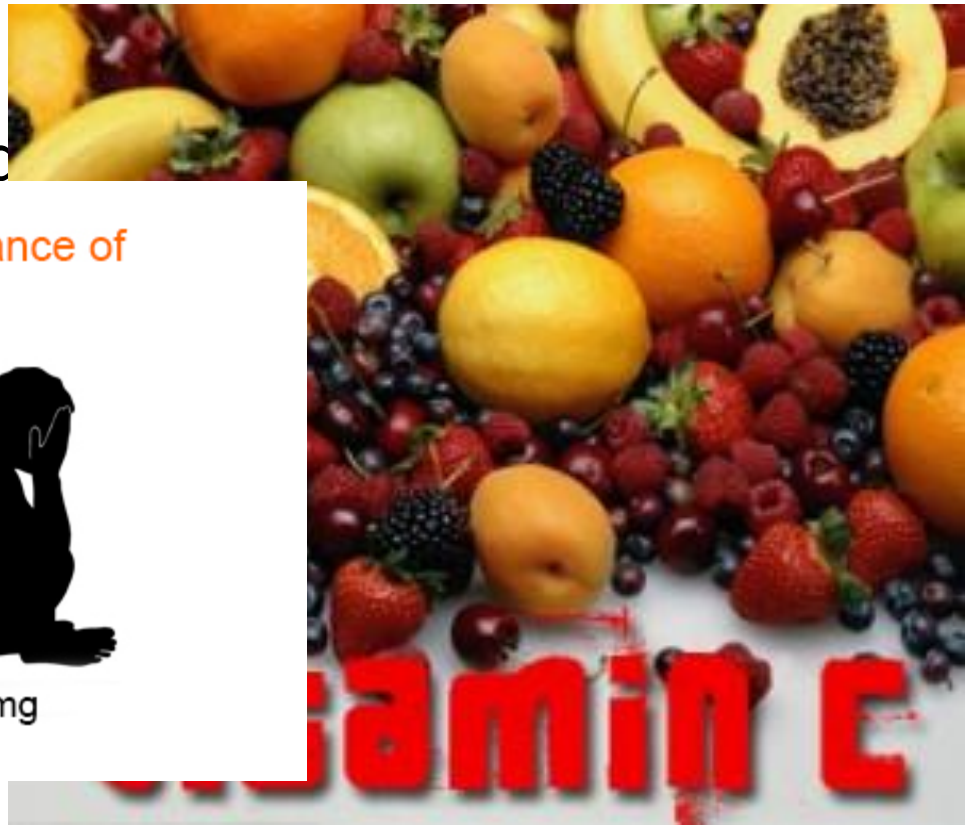
- https://www.youtube.com/watch?v=_r4c2NT4naQ (4:53)

Other Types of Evidence

- Domesticated Animals/Cultivated Plants
- Geographic Distribution/Biogeography
- Darwin didn’t know about:
  - Bacterial Resistance
  - Molecular Data
  - Endosymbiosis

Molecular Data

- Finding the relationships in the amino acids and DNA of different species to see how similar or different they are from each other.
- Example:
  - In the hemoglobin and

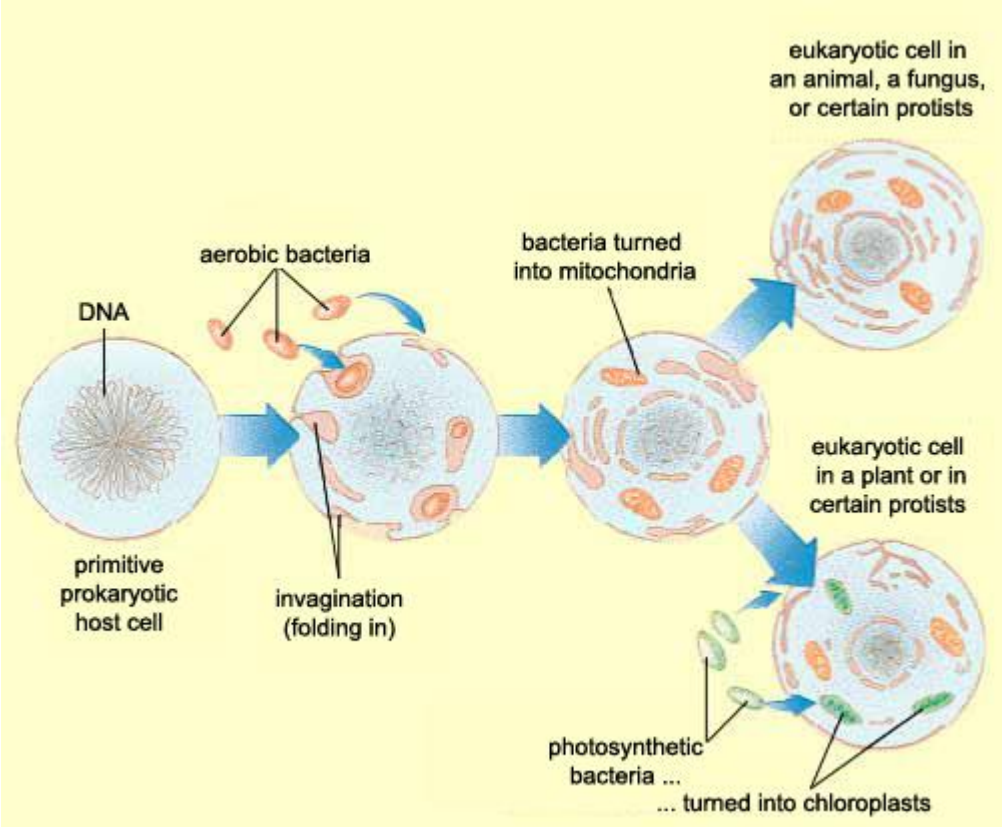


Let's practice! Which primate is the most closely related to the Chimp?

Amino Acid Sequences in Primates				
Baboon	Chimp	Lemur	Gorilla	Human
ASN	SER	ALA	SER	SER
THR	THR	THR	THR	THR
THR	ALA	SER	ALA	ALA
GLY	GLY	GLY	GLY	GLY
ASP	ASP	GLU	ASP	ASP
GLU	GLU	LYS	GLU	GLU
VAL	VAL	VAL	VAL	VAL
ASP	GLU	GLU	GLU	GLU
ASP	ASP	ASP	ASP	ASP
SER	THR	SER	THR	THR
PRO	PRO	PRO	PRO	PRO
GLY	GLY	GLY	GLY	GLY
GLY	GLY	SER	GLY	GLY
ASN	ALA	HIS	ALA	ALA
ASN	ASN	ASN	ASN	ASN

Endosymbiosis

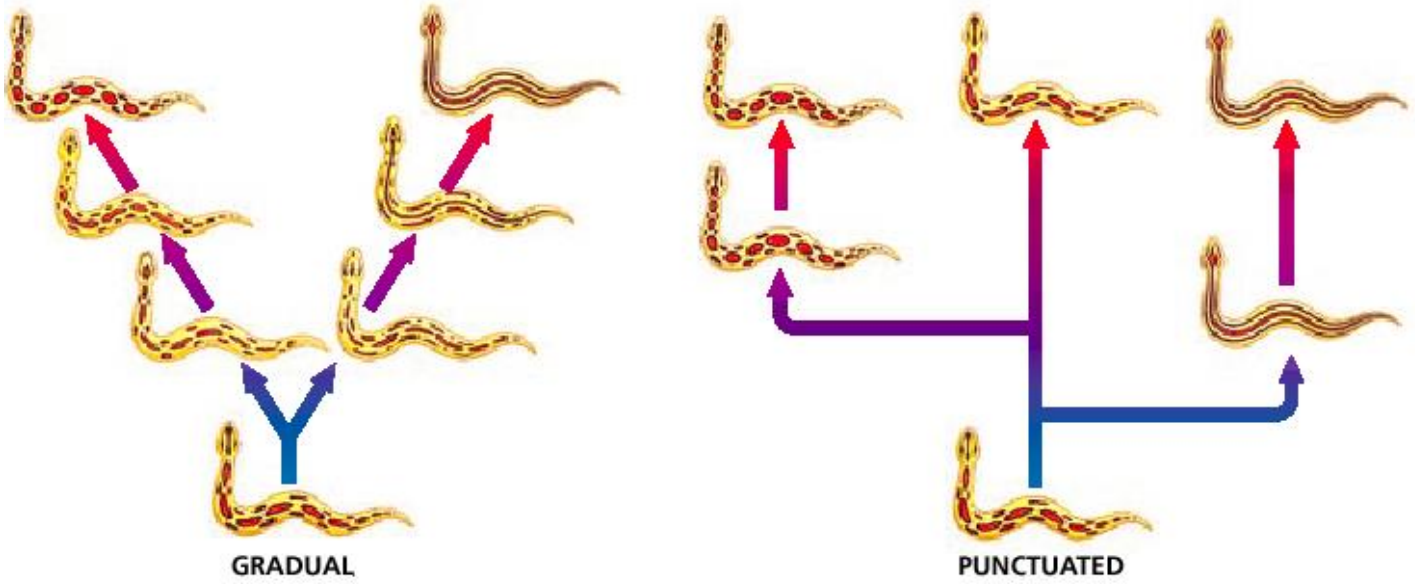
- Small bacteria cells entered larger bacterial cells. These smaller cells began to live inside and benefit their host cell, eventually becoming cellular organelles like mitochondria, and chloroplast.
- Example



Ancestral animal cell (mitochondria only)

Ancestral plant cell (mitochondria and chloroplasts)

Types of Evolution

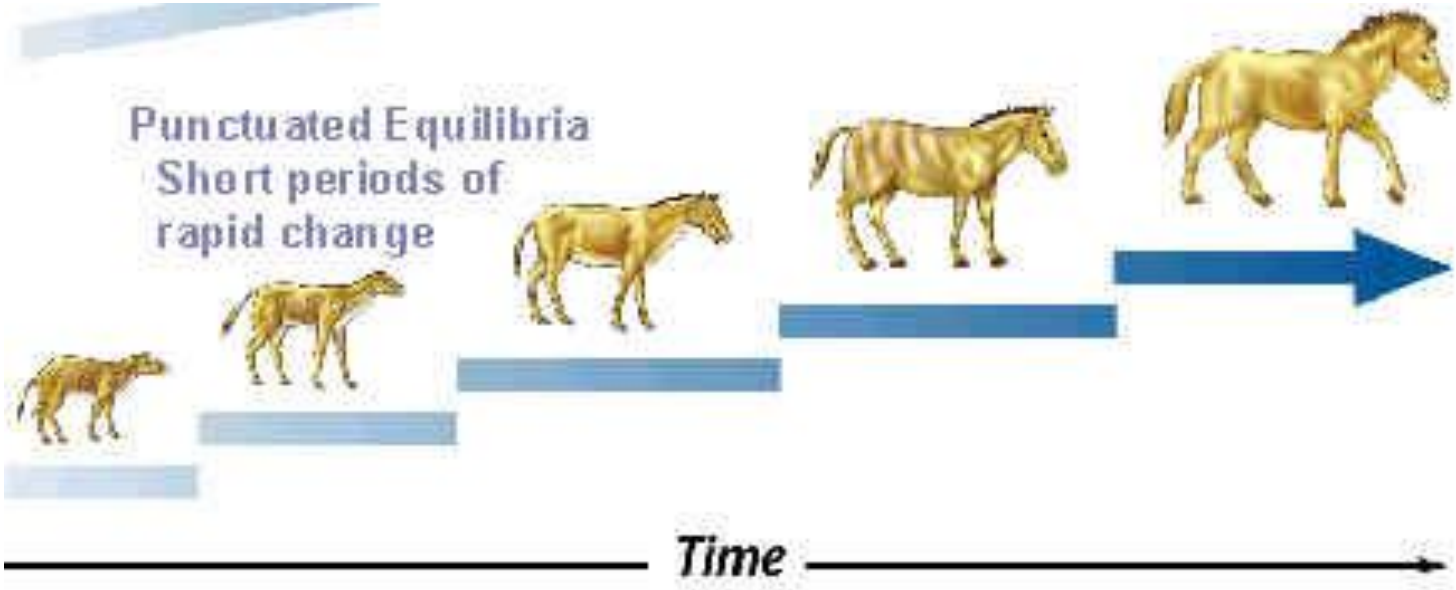


Gradualism:

- A process of evolution in which speciation occurs gradually over a long period of time.

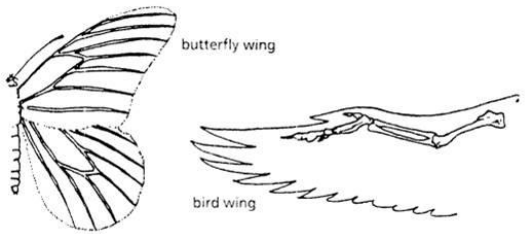
Punctuated Equilibrium:

- A process of evolution in which speciation occurs rapidly between periods of little or no change.



TYPES OF EVOLUTION

- **CONVERGENT EVOLUTION** -species that were once very different evolve similar traits (analogous structures)



Falcon

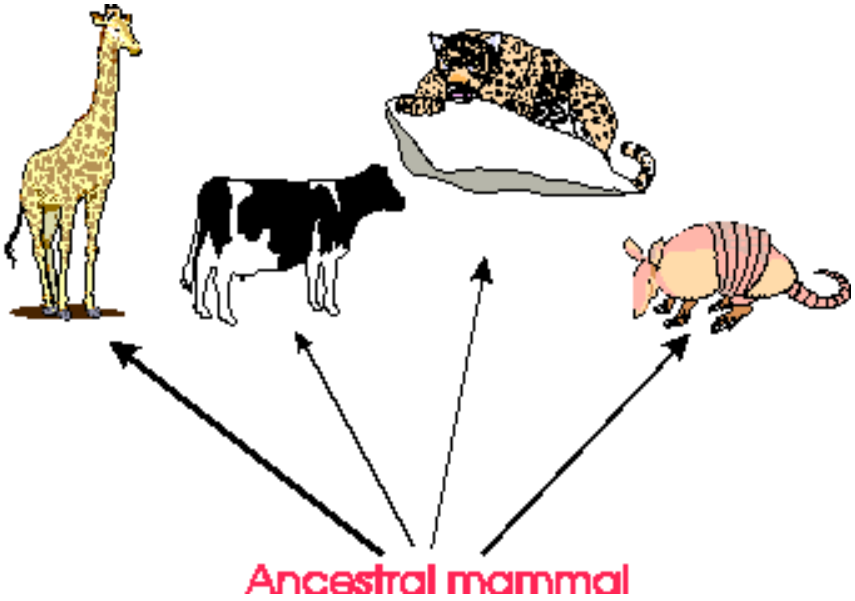
Ancestral bird

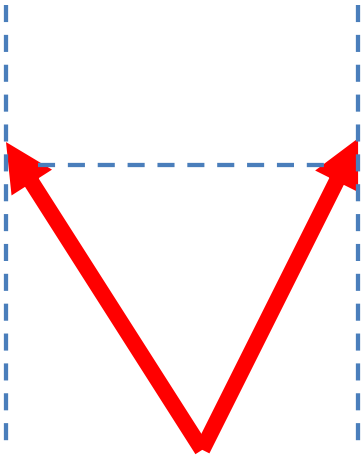
Bat

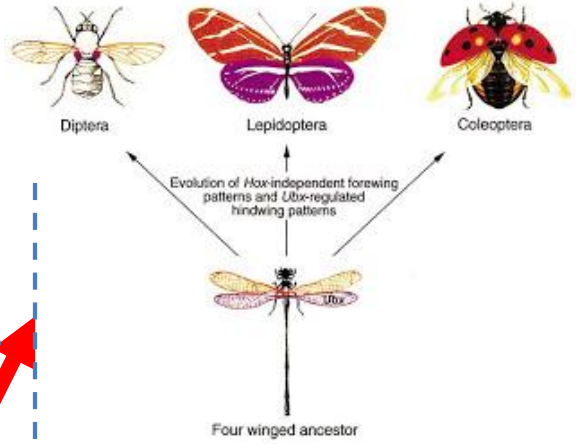
Ancestral mammal

- DIVERGENT EVOLUTION –

  species that were once similar evolve differently due to environment (homologous structures)

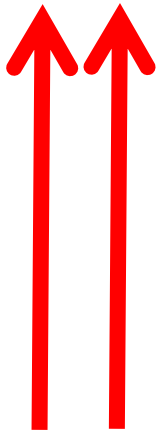






- CO-EVOLUTION – species evolve together

  (ex. predator/prey relationships, flower shape & bird beak formation)



Human Influenced Evolution