

#Evolution



Great moments in evolution

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



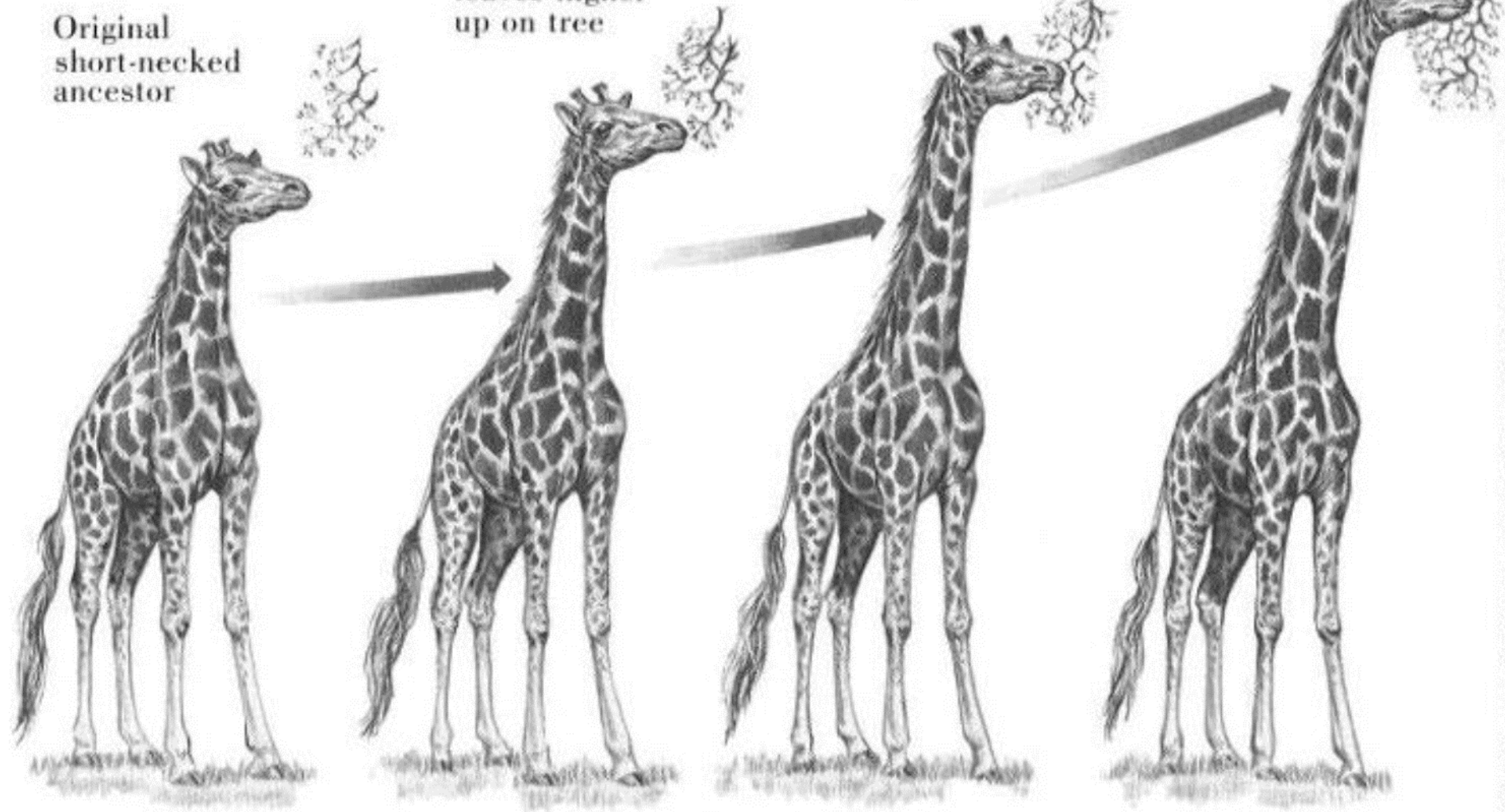
LAMARCK'S GIRAFFE

Original
short-necked
ancestor

Keeps stretching
neck to reach
leaves higher
up on tree

and
stretching

and stretching
until neck
becomes
progressively
longer



Driven by inner "need"



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

W. H. B. LONDON

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



Conclusion 1: **Struggle for Existence**

- Not all acorns or rabbits produced will survive!
- What does the fox say?



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 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**

Who is more "FIT"?



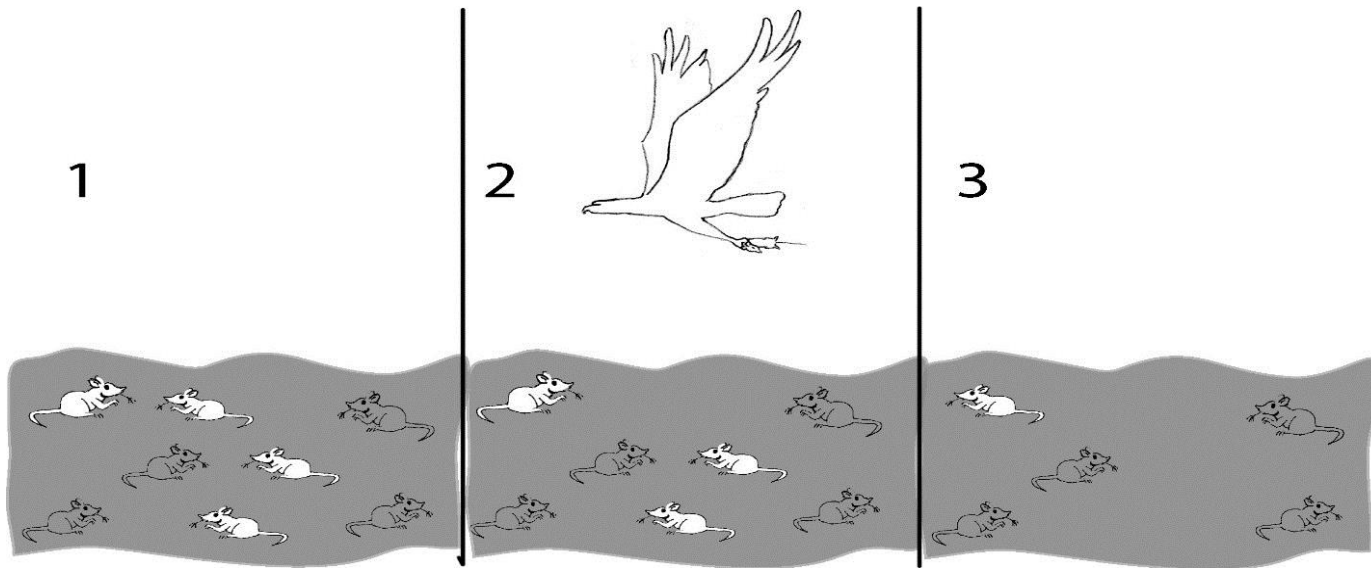
Mechanisms of Evolution

The HOW

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

Natural Selection -

- The organisms that are the most fit for the environment will survive and reproduce.
- Acts on **phenotypes**
- Requires **variation**



Note on Natural Selection

- Natural selection acts on the phenotypes of individuals which survive and reproduce
- The genes get passed on BUT it's the PHENOTYPES that are “selected” to survive!
- So, evolution acts directly on the population as a whole. Evolution does not occur in individuals.
- Variation (the differences in one species) is the Raw material for evolution

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



Viceroy Butterfly

Monarch Butterfly

Differential Reproductive Success

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



Camouflage!

Can you see me?



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)



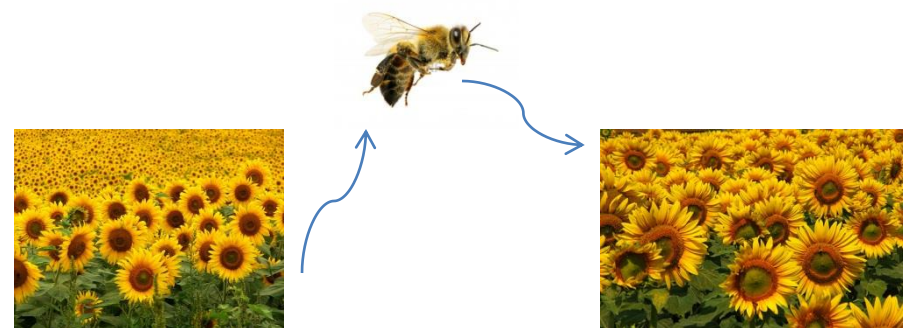
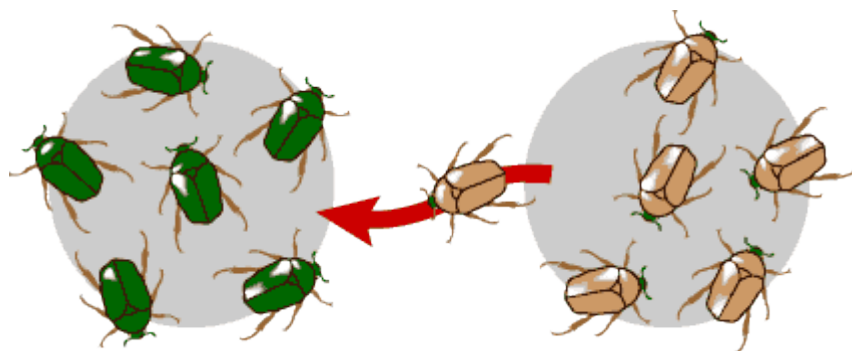
Mutations

- 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 (type of genes) only increase if the mutation is beneficial.
- **VERY RARE**



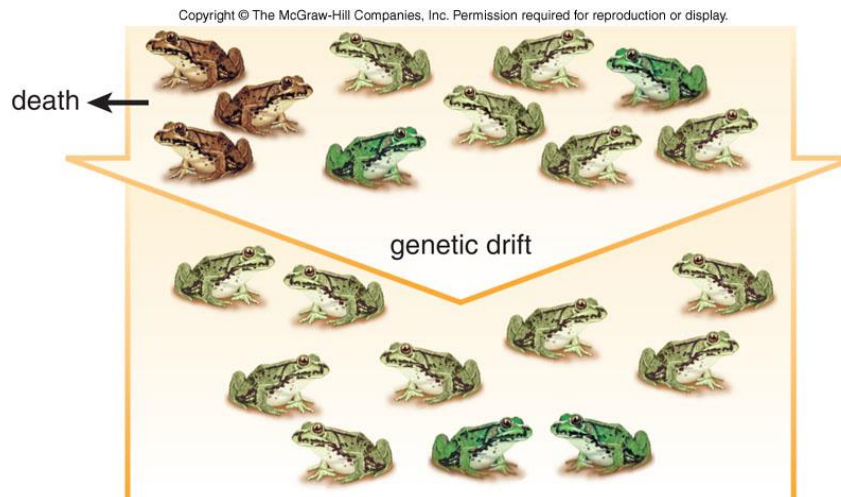
Gene Flow

- The transfer of alleles from one population to another.
- Think “river”. One flows down 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



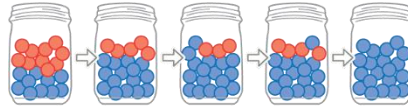
Genetic Drift

- The **RANDOM** change of frequency of alleles in one shrinking population in a certain area.
- Think “pond”. Many drifting to one side to make more. . .
- 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.

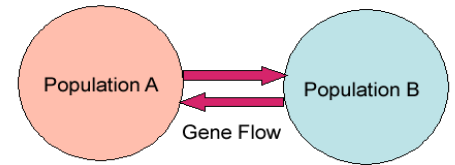


Genetic Drift vs Gene Flow

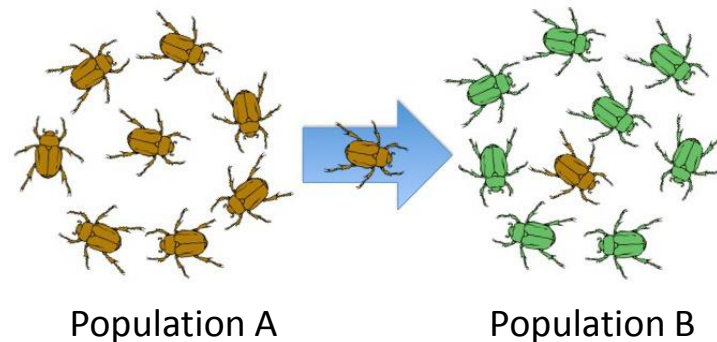
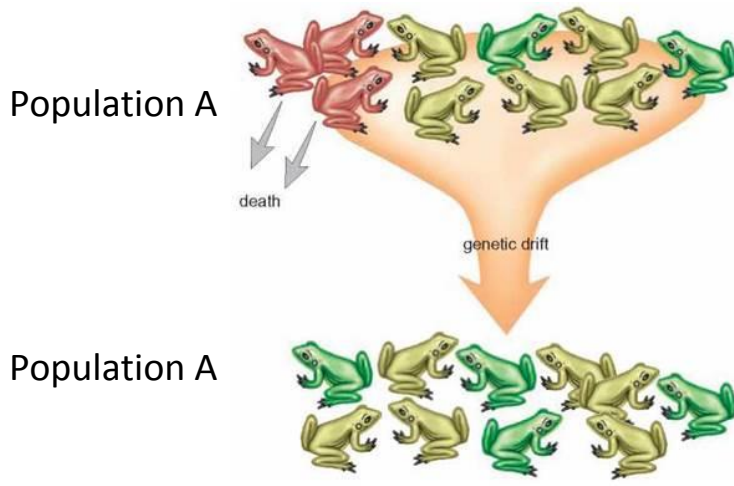
- **Genetic drift** – random change in allele frequency of a population. Purely by chance – not fitness!



- **Gene flow** – (gene migration) new genes/alleles move into a population increasing genetic variation.



- **THINK:** **Drift** (drifting to one side in a lake or pool)
Flow (flowing from one group upstream to another group downstream)



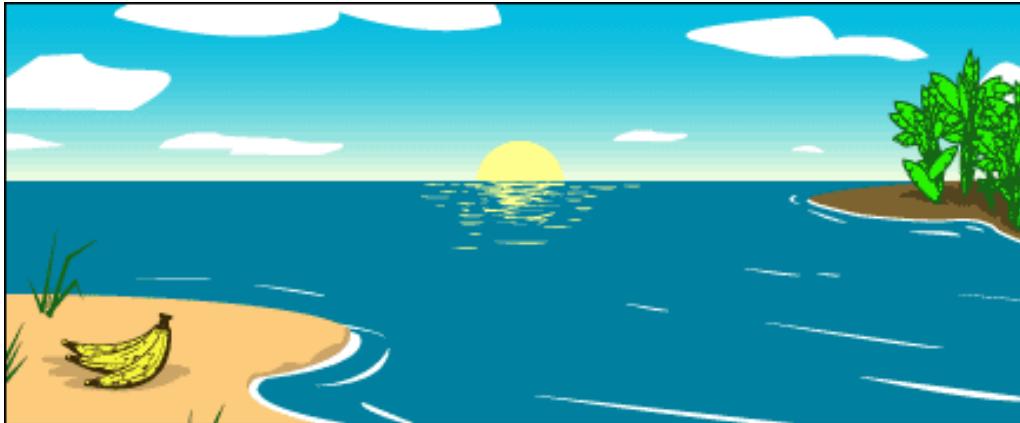
Behavioral Isolation

- Reproduction does not occur due to some type of behavior (mating dance not recognized)
- 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.



Geographic Isolation

- Populations are separated by water or land and evolve differently increasing biodiversity, leads to speciation.
- 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.



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*)

RECAP



Populations
are variable

Natural Selection

Some individuals
survive better &
reproduce more
than others

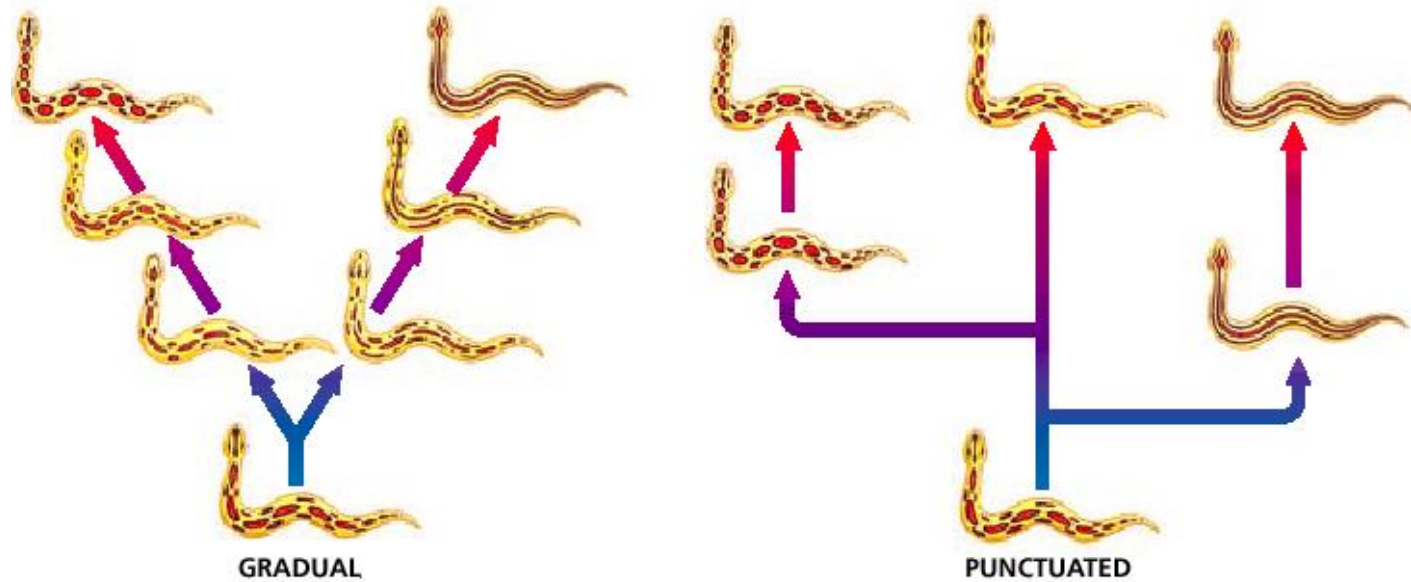


The next
generation is
more like the
survivors



Result: the population
changes = **evolution**

Types of Evolution



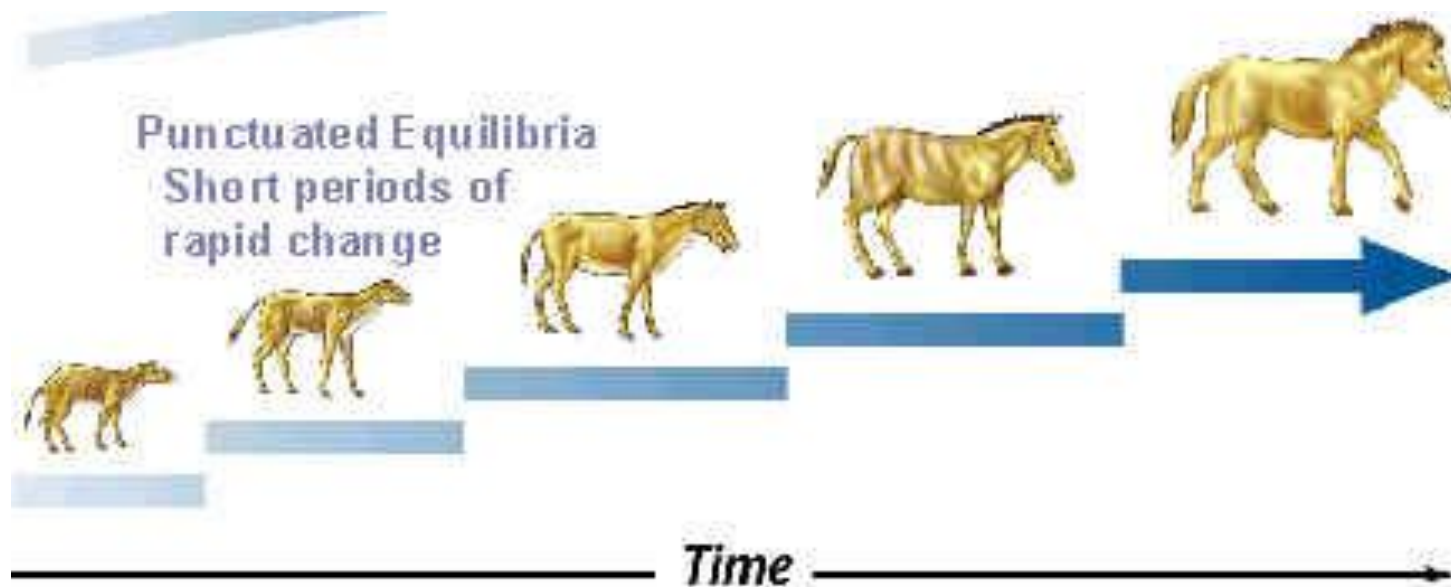
Gradualism:

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



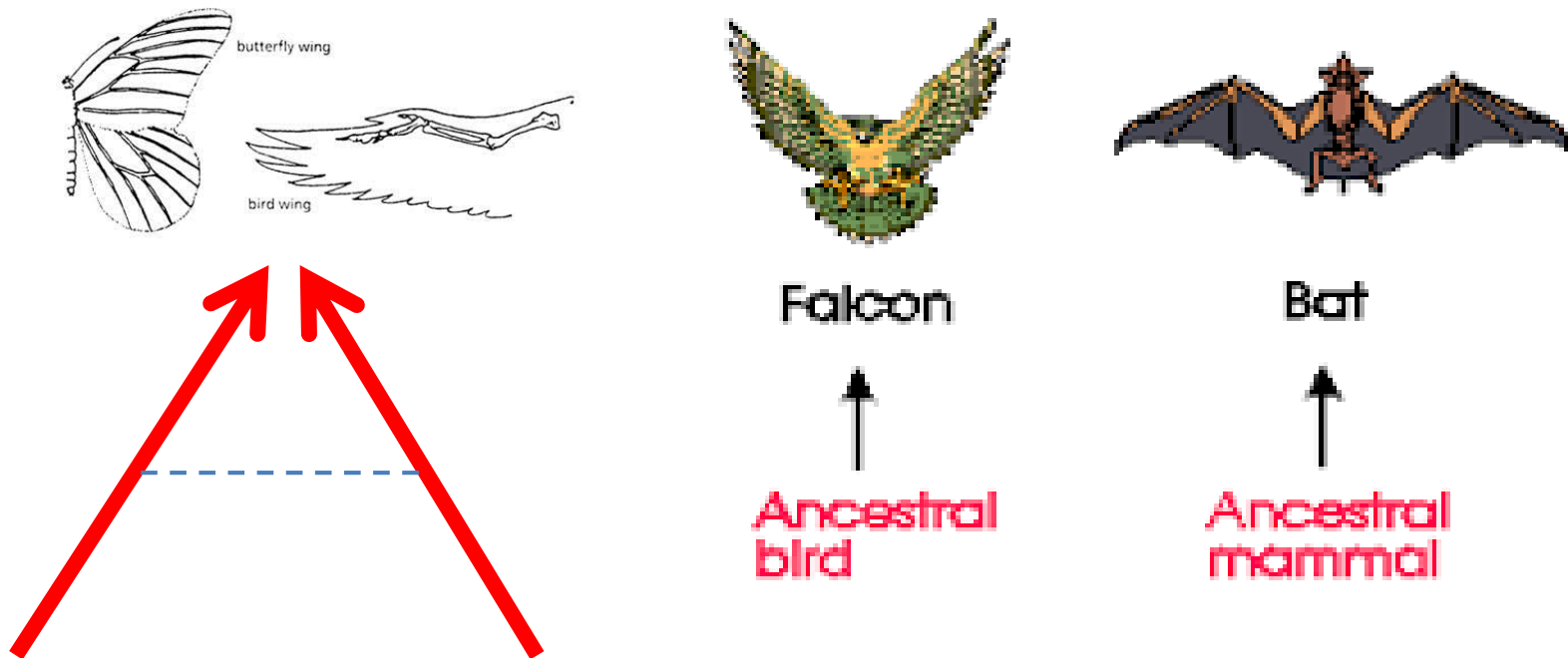
Punctuated Equilibrium:

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

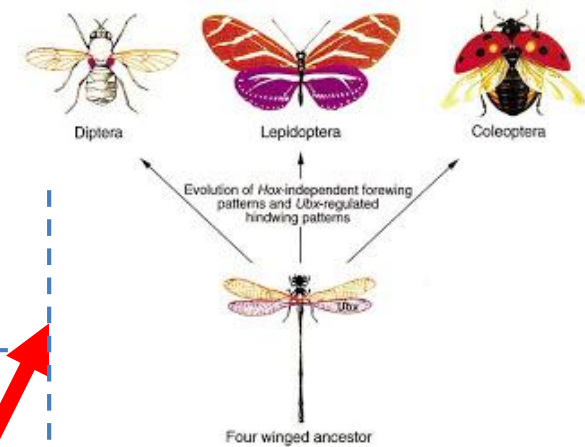
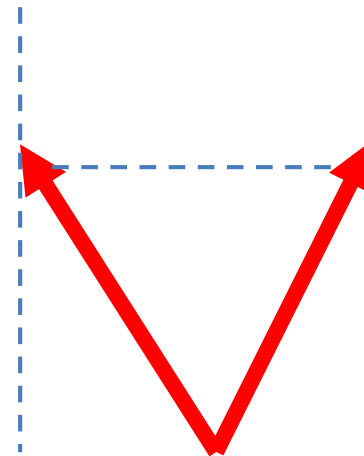
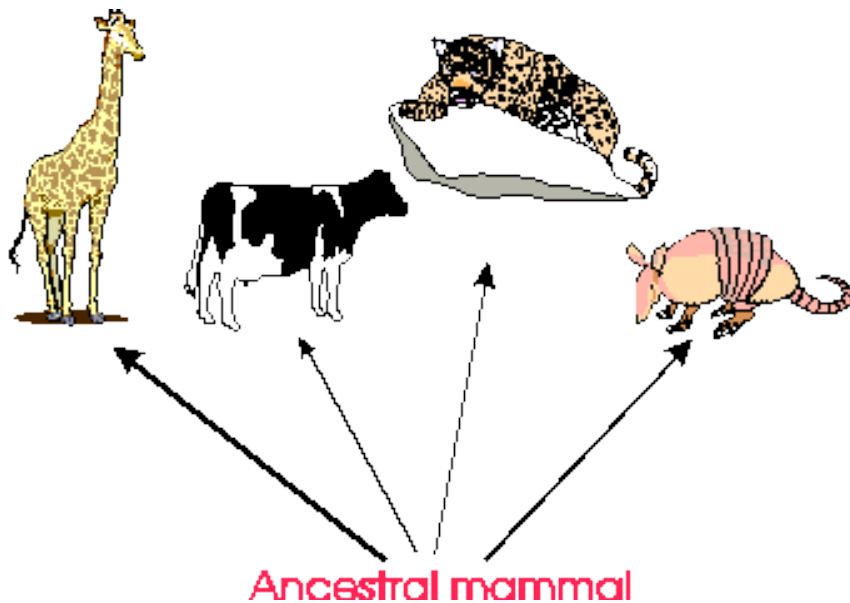


TYPES OF EVOLUTION

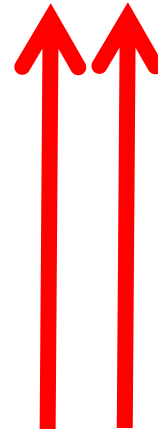
- **CONVERGENT EVOLUTION** -species that were once very different evolve similar traits (analogous structures)



- **DIVERGENT EVOLUTION –**
species that were once similar evolve differently due to environment (homologous structures)



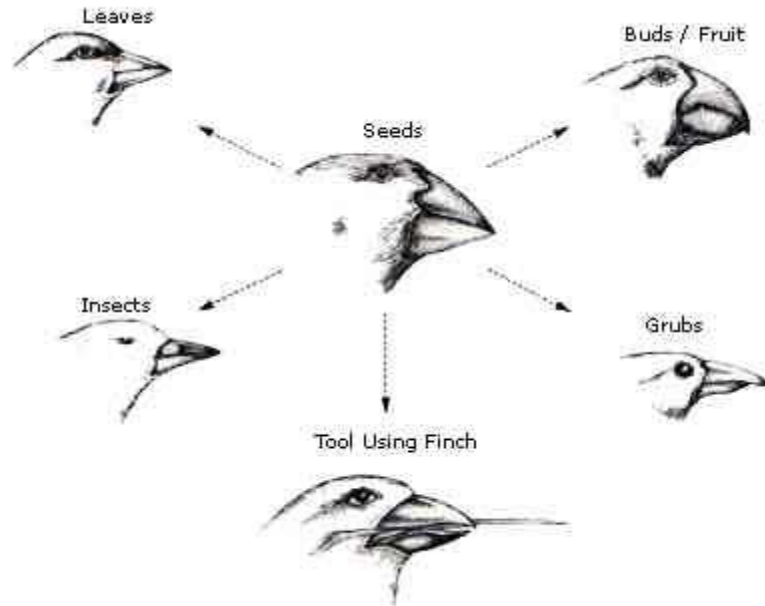
- **CO-EVOLUTION** – species evolve together
(ex. **predator/prey** relationships, flower shape & bird beak formation)



Evidence of Evolution

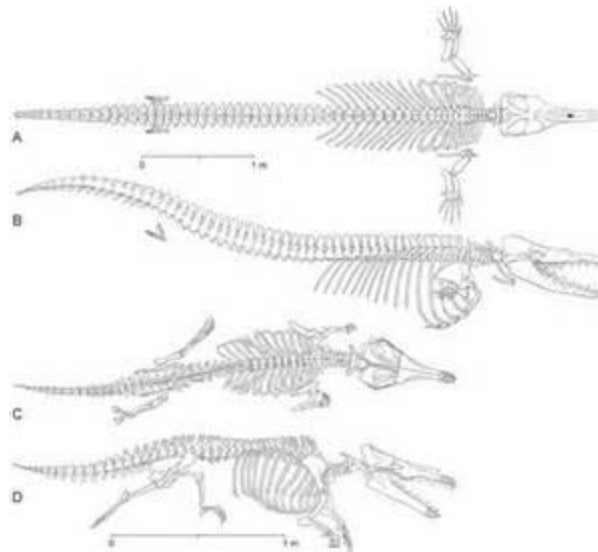
Morphologies


- 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



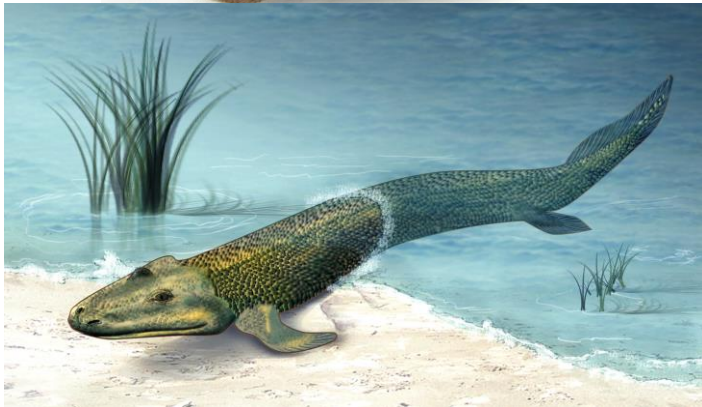
Quaternary Period	<i>Pecten gibbus</i>		<i>Neptunea tabulata</i>	
Tertiary Period	<i>Calyptrophorus velatus</i>		<i>Venericardia planicosta</i>	
Cretaceous Period	<i>Scaphites hippocrepis</i>		<i>Inoceramus labiatus</i>	
Jurassic Period	<i>Perisphinctes tiziani</i>		<i>Nerinea trinodosa</i>	
Triassic Period	<i>Trophites subbullatus</i>		<i>Monotis subcircularis</i>	
Permian Period	<i>Leptodus americanus</i>		<i>Parafusulina bosei</i>	
Pennsylvanian Period	<i>Dictyoclostus americanus</i>		<i>Lophophyllidium proliferum</i>	
Mississippian Period	<i>Cactocrinus multibrachiatus</i>		<i>Prolecanites gurleyi</i>	
Devonian Period	<i>Mucrospirifer mucronatus</i>		<i>Palmatolepus unicornis</i>	
Silurian Period	<i>Cystiphyllum niagarensis</i>		<i>Hexamoceras hertzeri</i>	
Ordovician Period	<i>Bathyurus extans</i>		<i>Tetragnostus fructicosus</i>	
Cambrian Period	<i>Paradoxides pinus</i>		<i>Billingsella corrugata</i>	

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

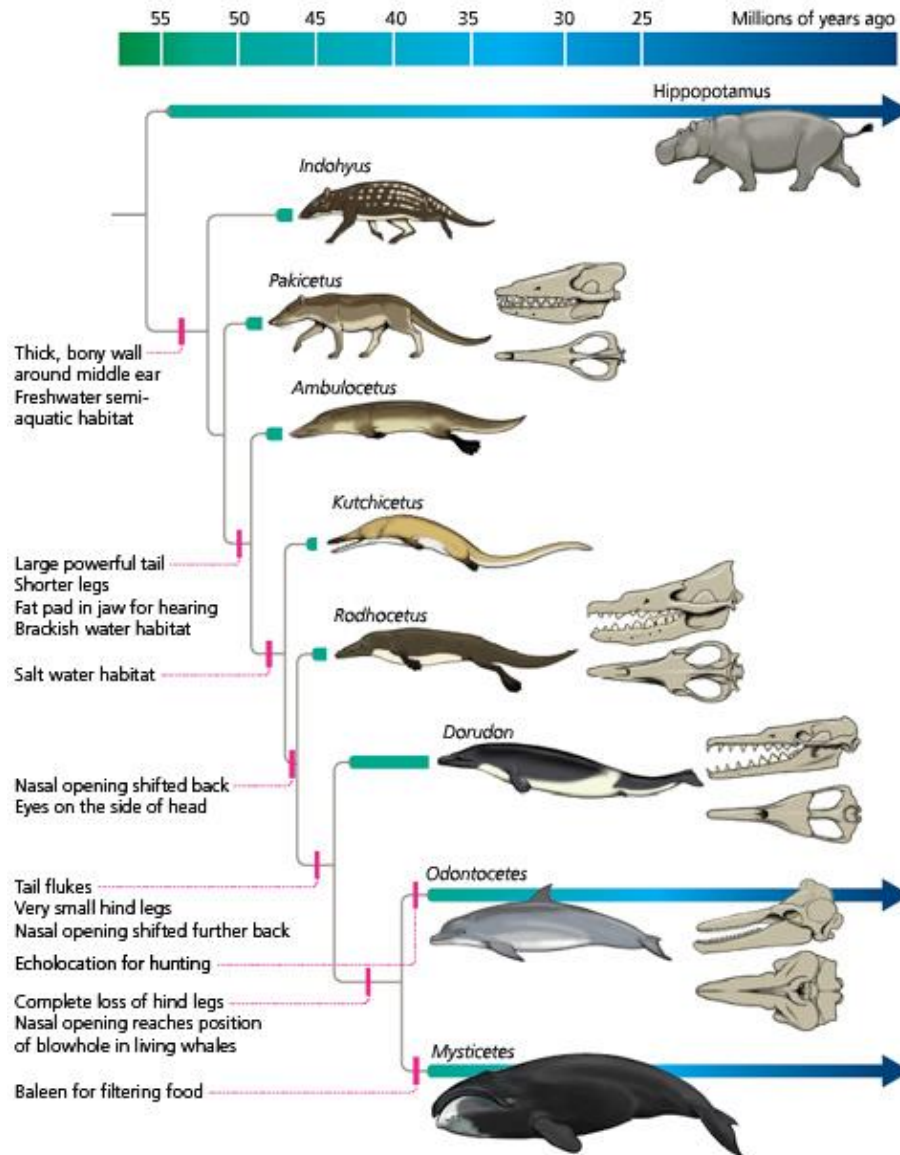
Tiktaalik



Archeopteryx



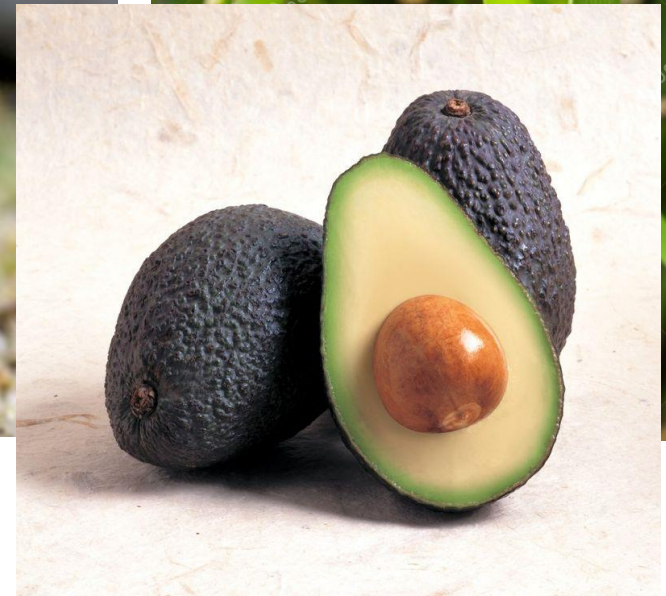
Sequential Transitional Fossils



Living Fossils

(ghosts of evolution, **anachronisms**)

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



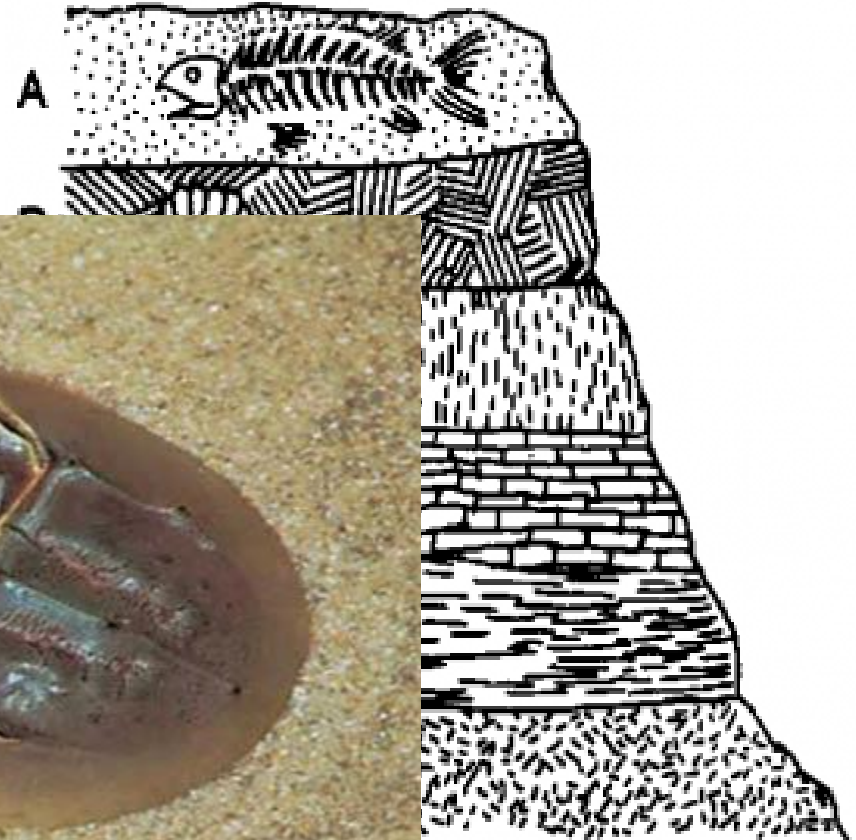
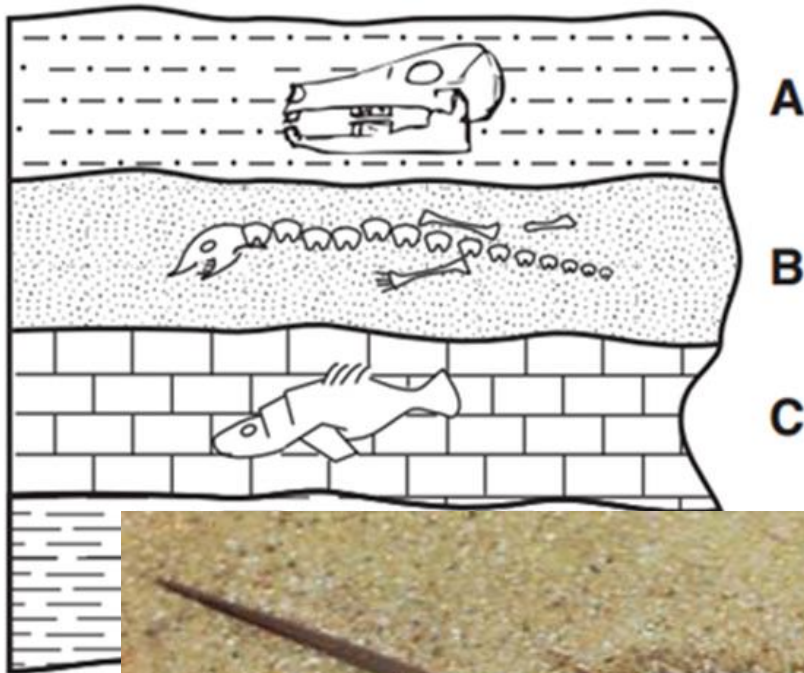
The Giant Sloth



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

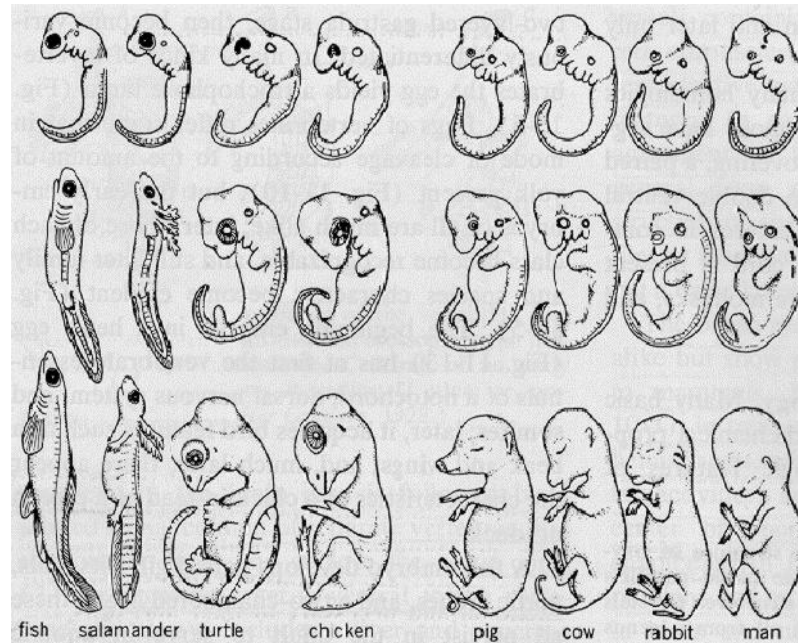
Fossil Evidence

Law of Superposition



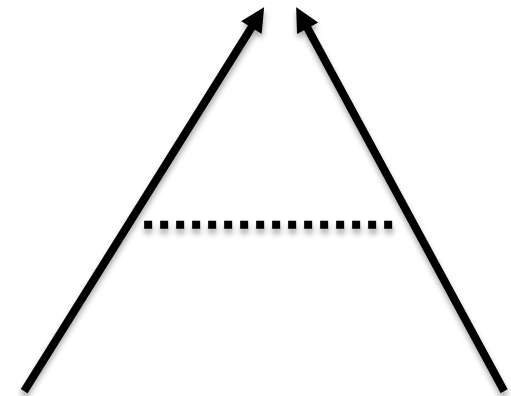
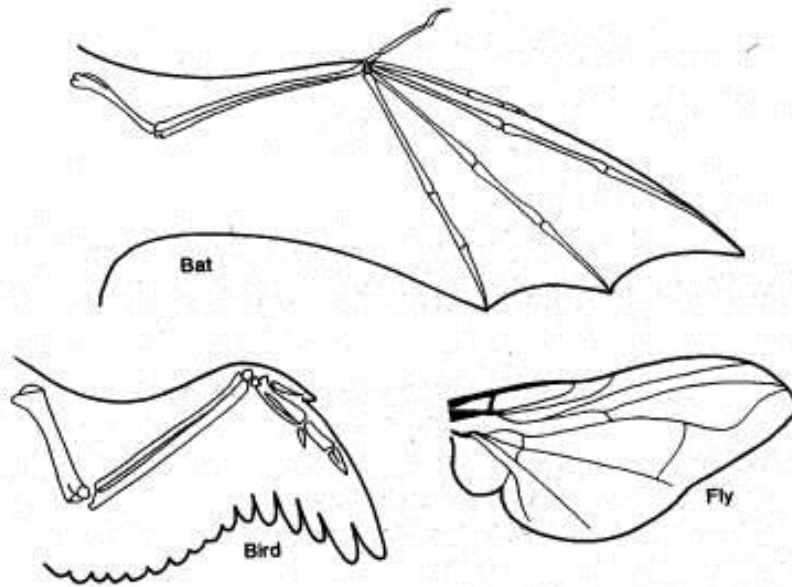
Embryology

- 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.



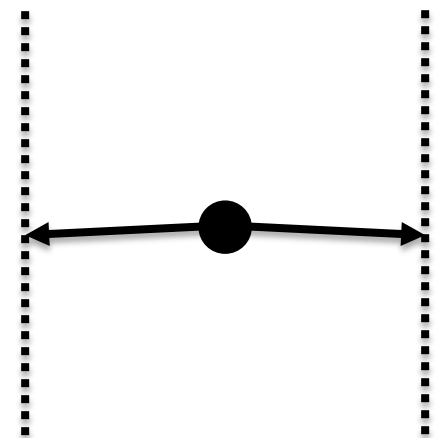
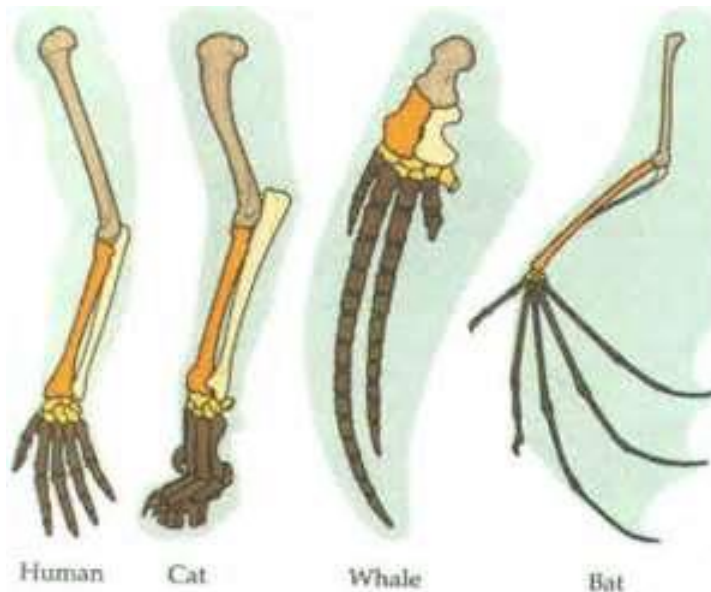
Analogous Structures

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



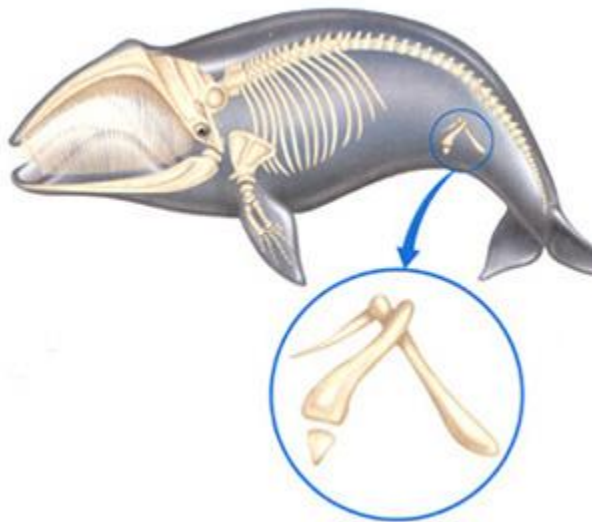
Homologous Structures

- **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

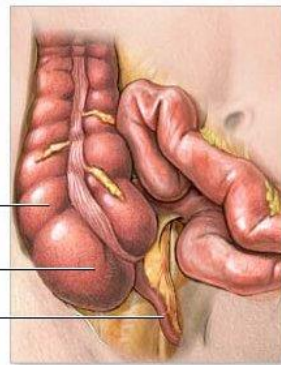


Vestigial Structures

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



Large intestine
Cecum
Appendix



YOU HAD A TAIL!

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

Average Recommended Daily Allowance of
vitamin C per pound per day



10 mg

Humans and Guinea
Pigs can't synthesize
Vitamin C, but still
have presence of gene



0.5 mg



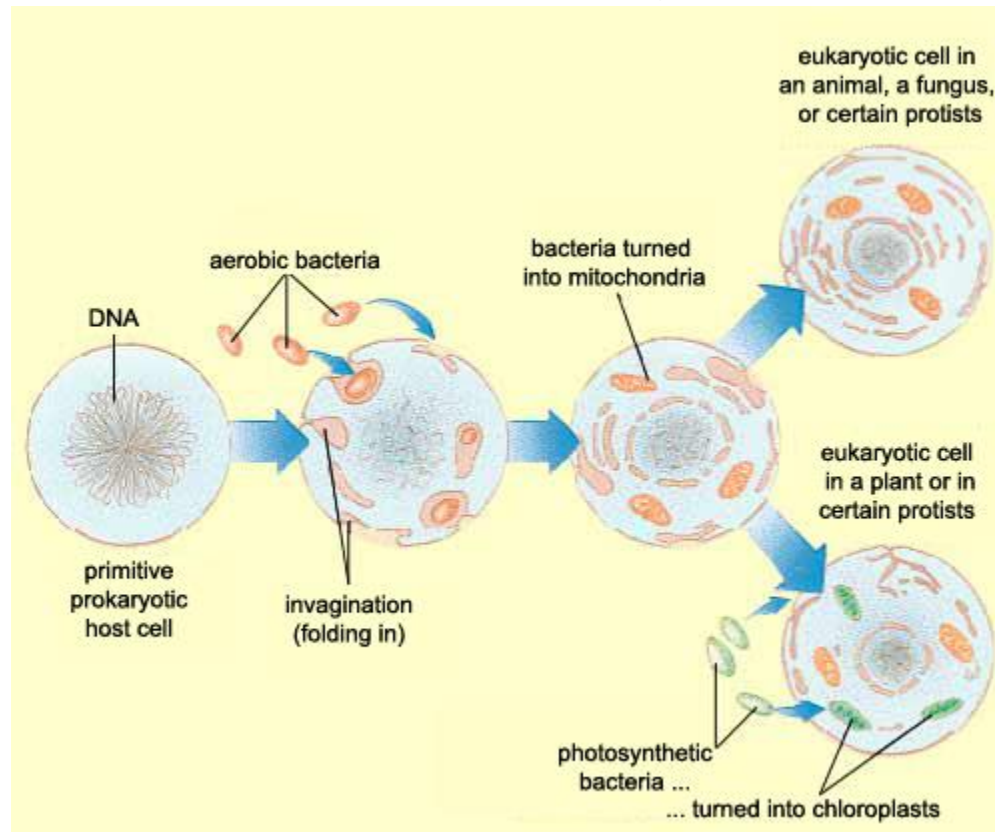
Let's practice! Which primate is the most closely related to the Chimp?

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)

Biogeography

- Leads to speciation (one species evolves into two different species)
- 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 American species
had separated no later than 14 mya

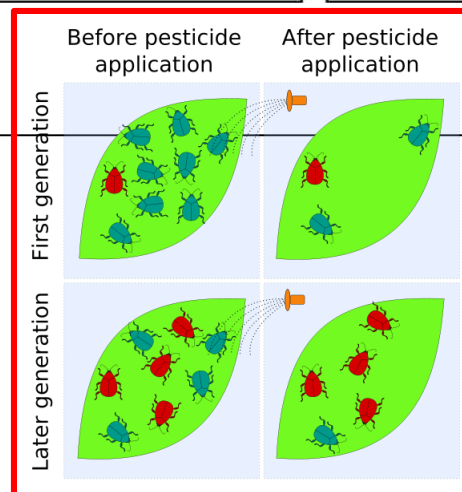
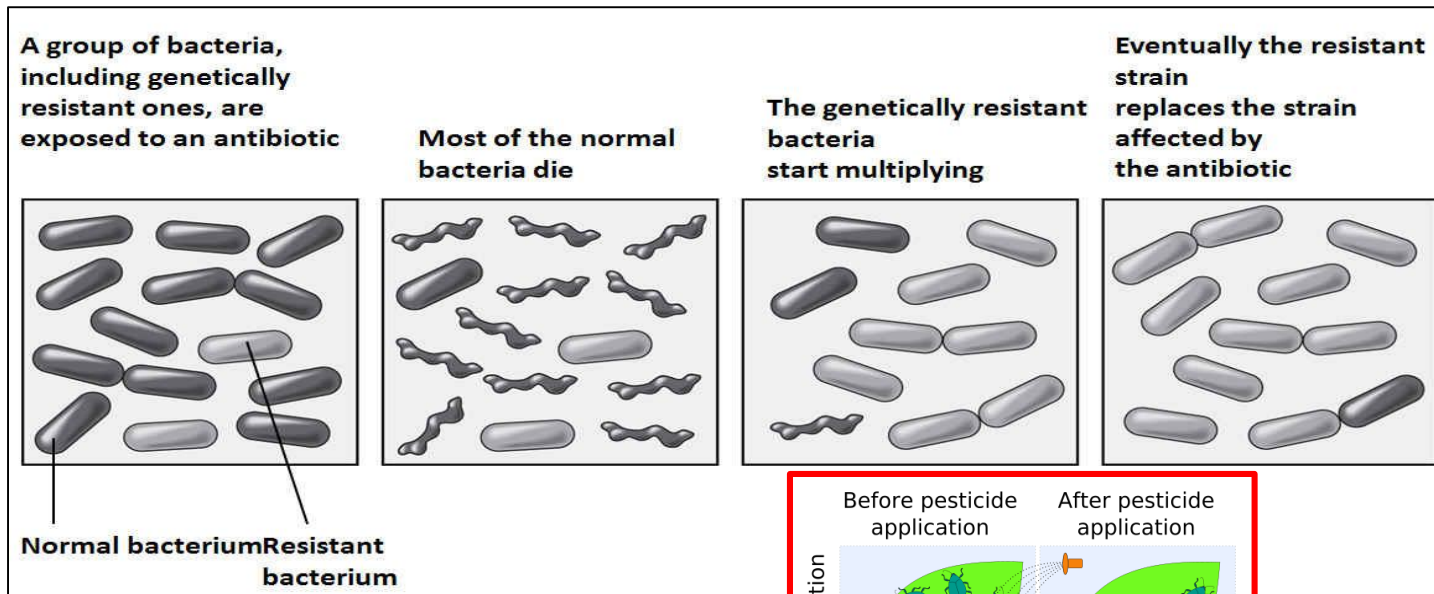


Other Types of Evidence

- **Human Influenced Evolution**

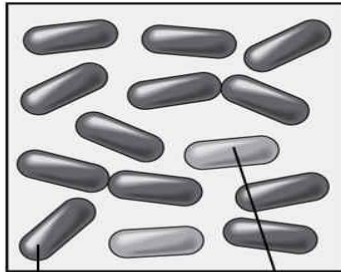
- Domesticated Animals/Cultivated Plants

- Bacterial & Pest Resistance



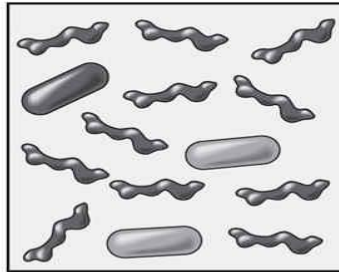
Human Influenced Evolution

A group of bacteria, including genetically resistant ones, are exposed to an antibiotic

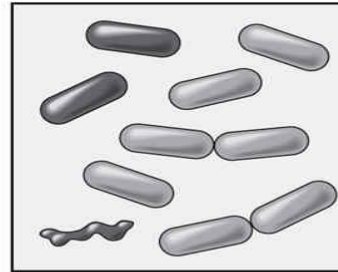


Normal bacterium
Resistant bacterium

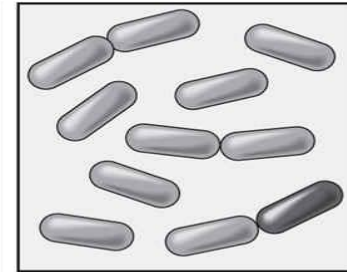
Most of the normal bacteria die



The genetically resistant bacteria start multiplying



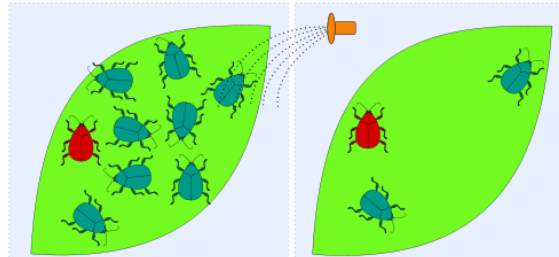
Eventually the resistant strain replaces the strain affected by the antibiotic



Before pesticide application

After pesticide application

First generation



Later generation

