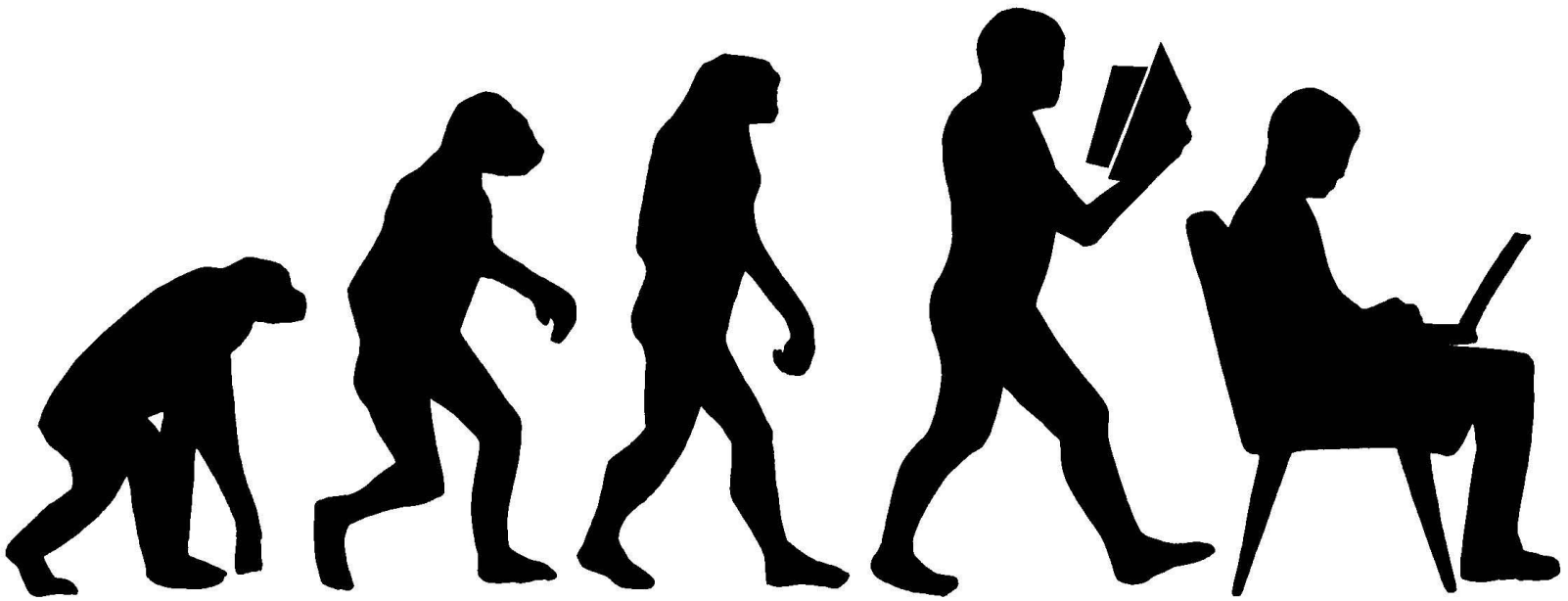
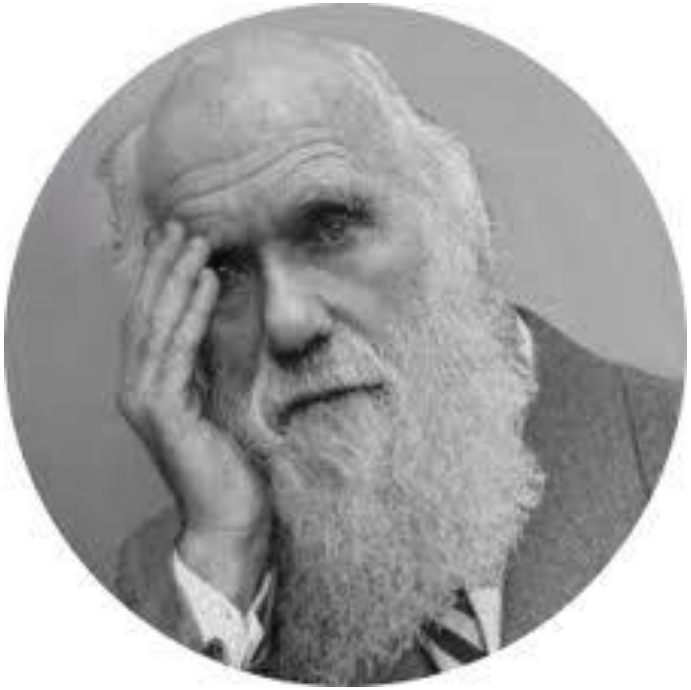
EVOLUTION



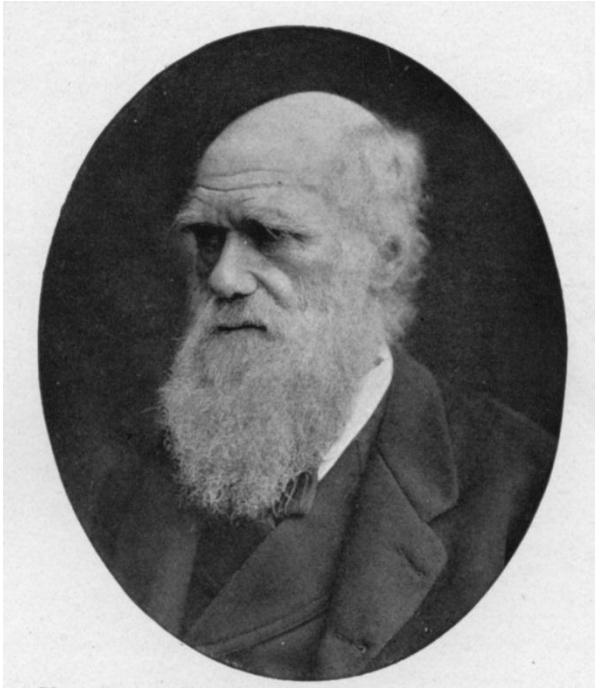
Charles Darwin

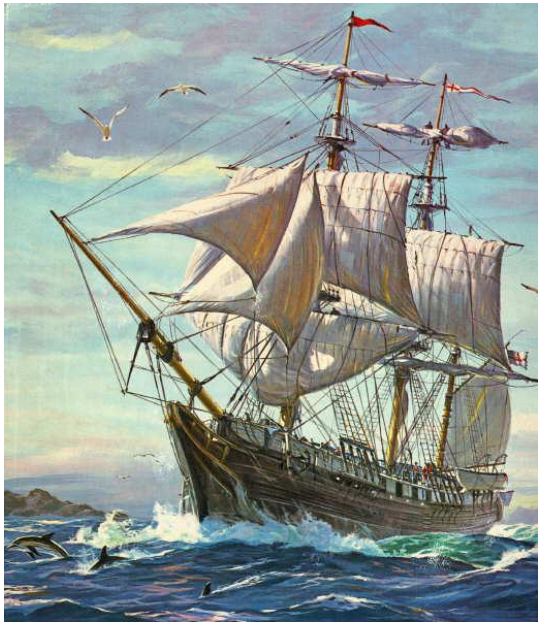


- Born February 12, 1809
- Country from= England
- Developed a scientific **theory** of biological evolution that explains how **modern** organisms evolved over time

Charles Darwin

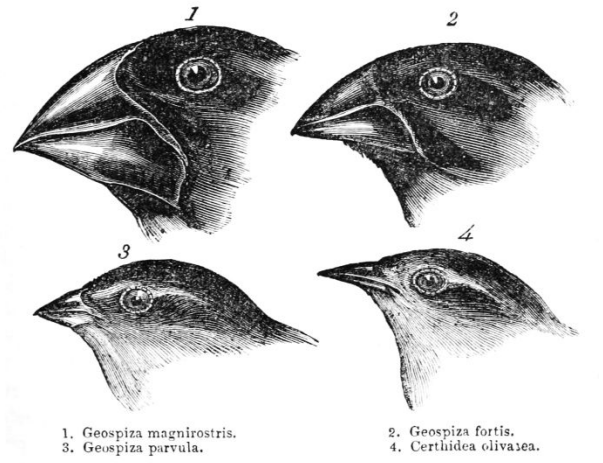
- People believed plants and animals were **unchanging** and the Earth was **6000** years old
  - Darwin was scary…
- In 1831 left England for coast of **South America**
- Sailed on the ***HMS Beagle***
- He was a naturalist, job was to collect **specimens** during the trip
- Sailed around South America and around the **Galapagos Islands**





Charles Darwin

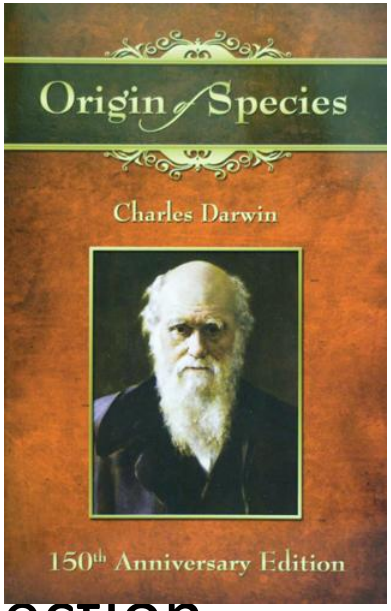
- Galapagos Islands
- Noticed that each island **differed** from organisms on the other islands
- Plants and animals resembled the species in South America



Charles Darwin

- Noticed that **finches** were different on each island
- Finches also different along the coast of **South America**
- Thought that they must have **changed** once they reached the islands
- Hypothesized that a **new species** could change gradually over **time**

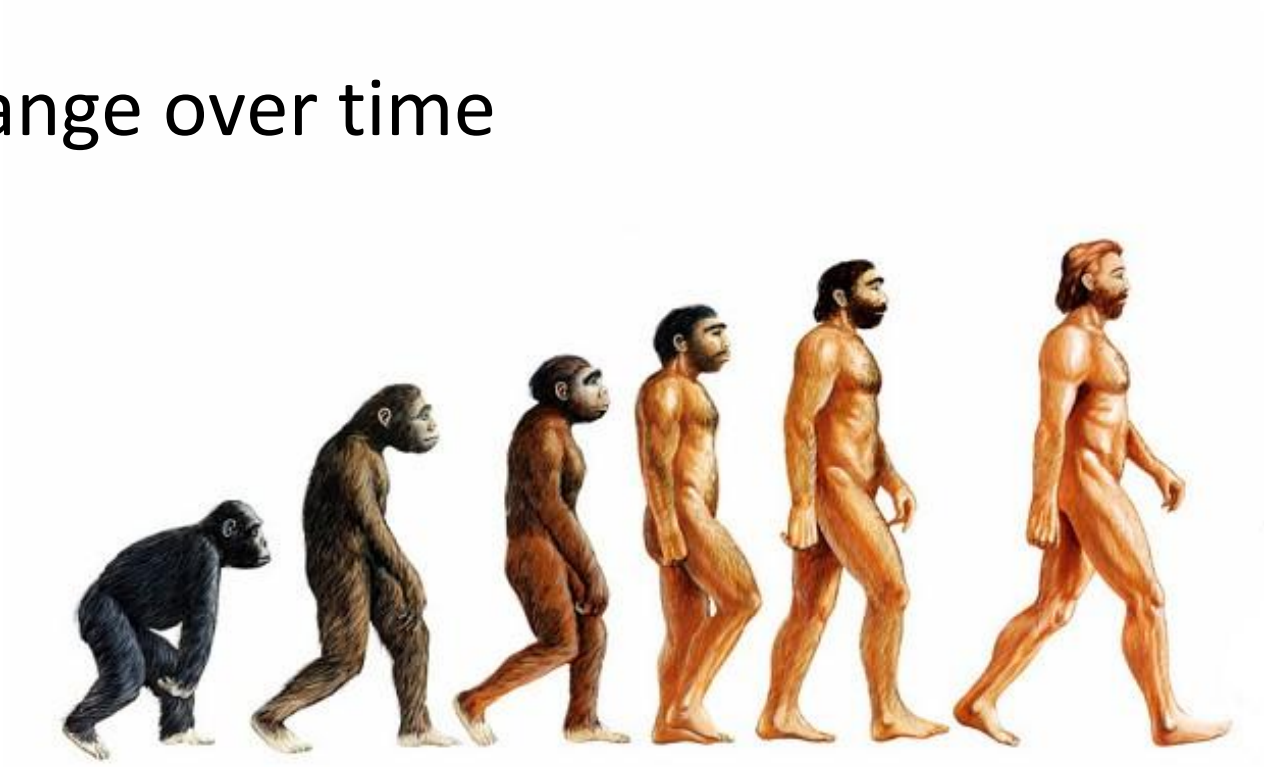
Charles Darwin



- Published in 1859
- Wrote a book
  - ***On the Origin of Species***
- 4 main principles of Natural Selection
- Belief was that with enough time, **Natural selection** could modify a population into a new **species**
- **Evolution** takes place because of natural selection
- Natural selection is mechanism for evolution

Evolution

- Change over time



Proof of evolution that you can find on your body

- Check this out

Artificial Selection

- Process of breeding (by humans) to produce offspring with desired traits
- *Dog breeding*
- *Race-horse breeding*
- *Cattle*
- *Pigeon*

Question pondered

- If humans could select the traits they preferred in animals…. Then why couldn't nature do the same to create a new species?

https://youtu.be/xOl0tHVV6Ck
Video about Darwin

http://www.evolution-of-life.com/en/observe/video/fiche/darwin-on-the-evolution-trail.html

Natural Selection

Natural selection does not grant organisms what they "need".

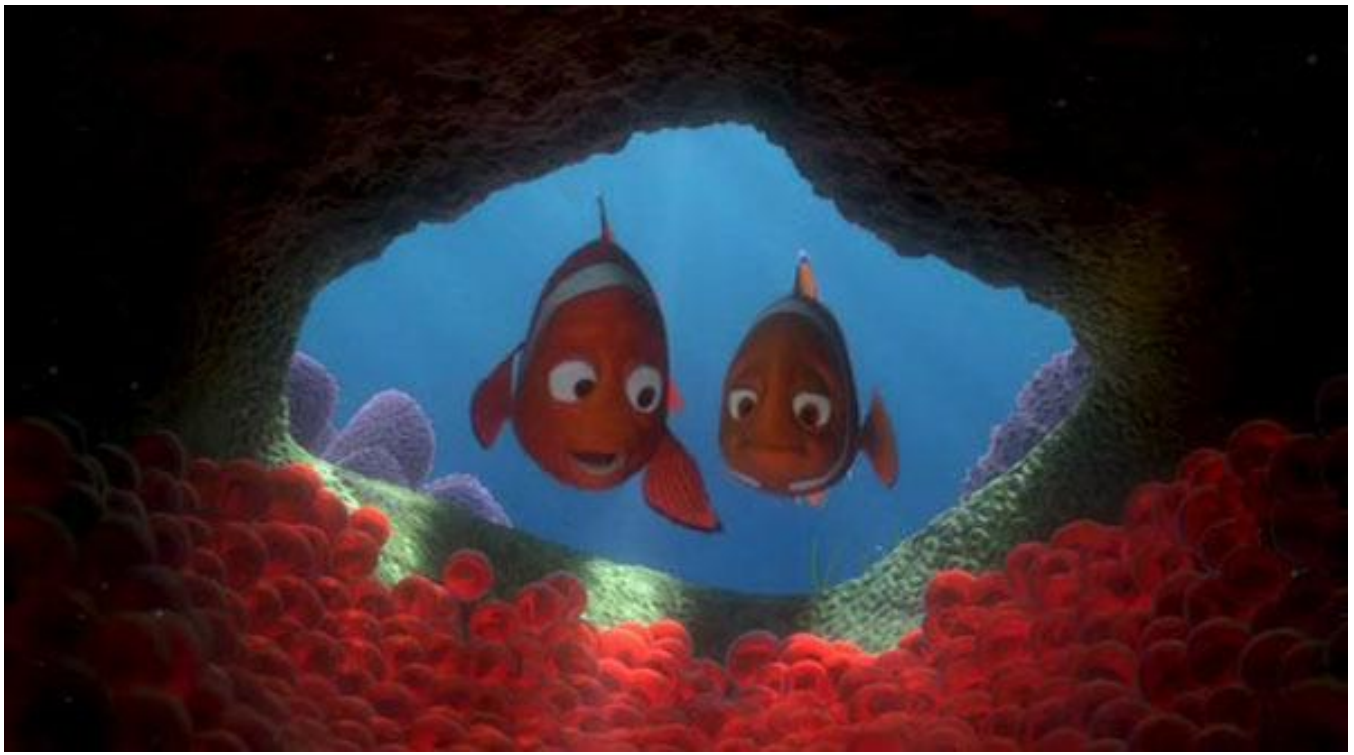
- Survival of the fittest
- The environment “picks” what will survive

Darwin's 4 Principles of Natural Selection

- 1) Struggle for existence
- 2) Populations have Variation and animals Adapt
- 3) Survival of the Fittest
- 4) Natural Selection

Darwin's Ideas: *1) Struggle for existence*

- Organisms will produce more offspring than can survive
  - Must compete for living space, food, water, etc.



Darwin's Ideas: *2) Variation and Adaptation*

- Organisms have natural variations among themselves
- These make them better suited for life in that environment
- These variations are called **ADAPTATIONS**
  - This is a trait that increases an organism's ability to survive
  - Example: mimicry, camo, behavior

Animal Adaptations

https://youtu.be/wNqiclBUxdY

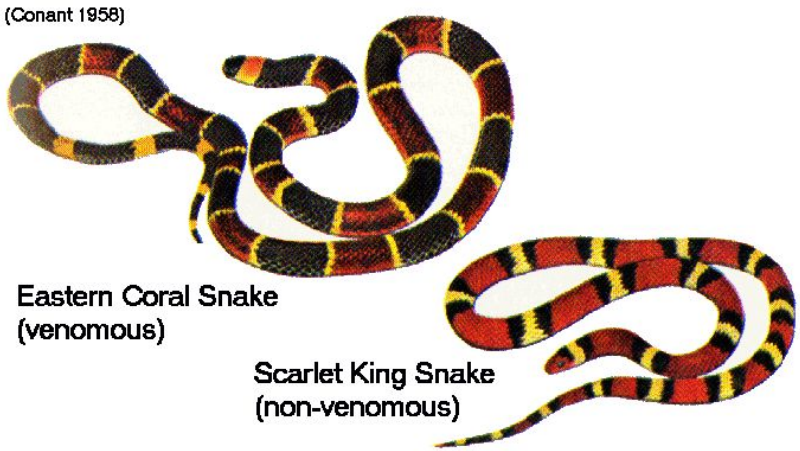
Camouflage

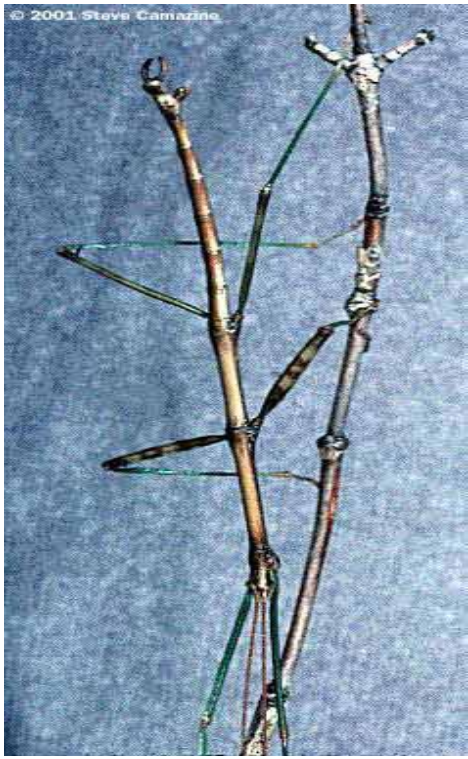
- adaptations that allow organisms to blend into their surroundings

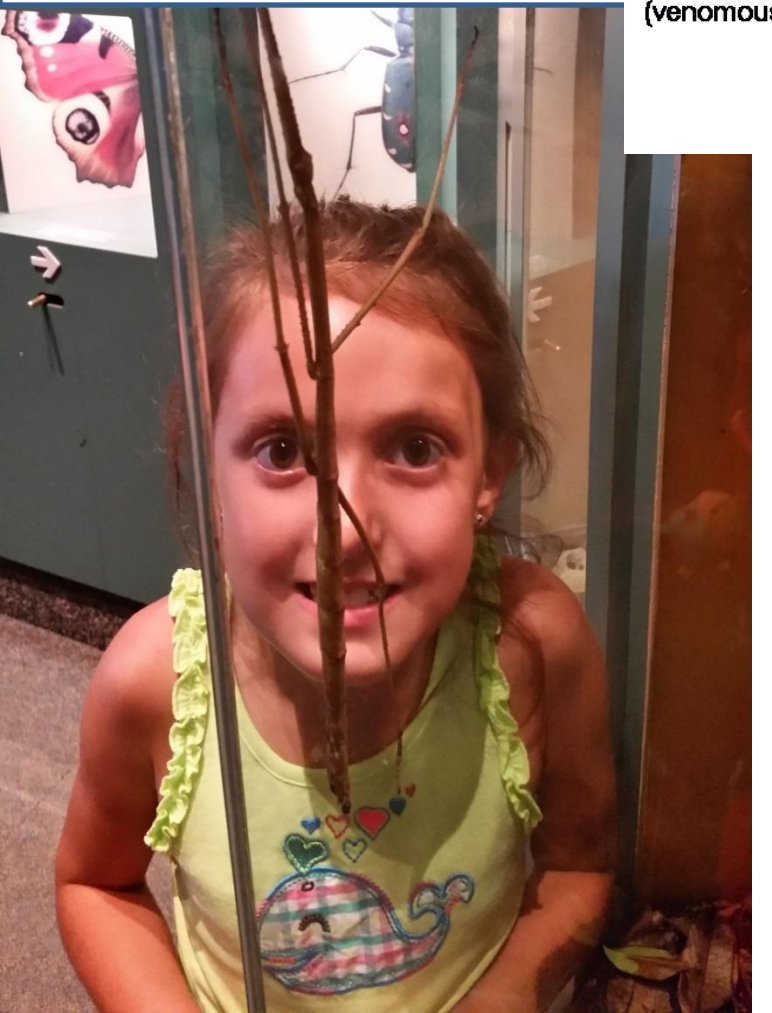
Top Camouflaged Animals

https://youtu.be/XpdoDBYuHIA

Mimicry





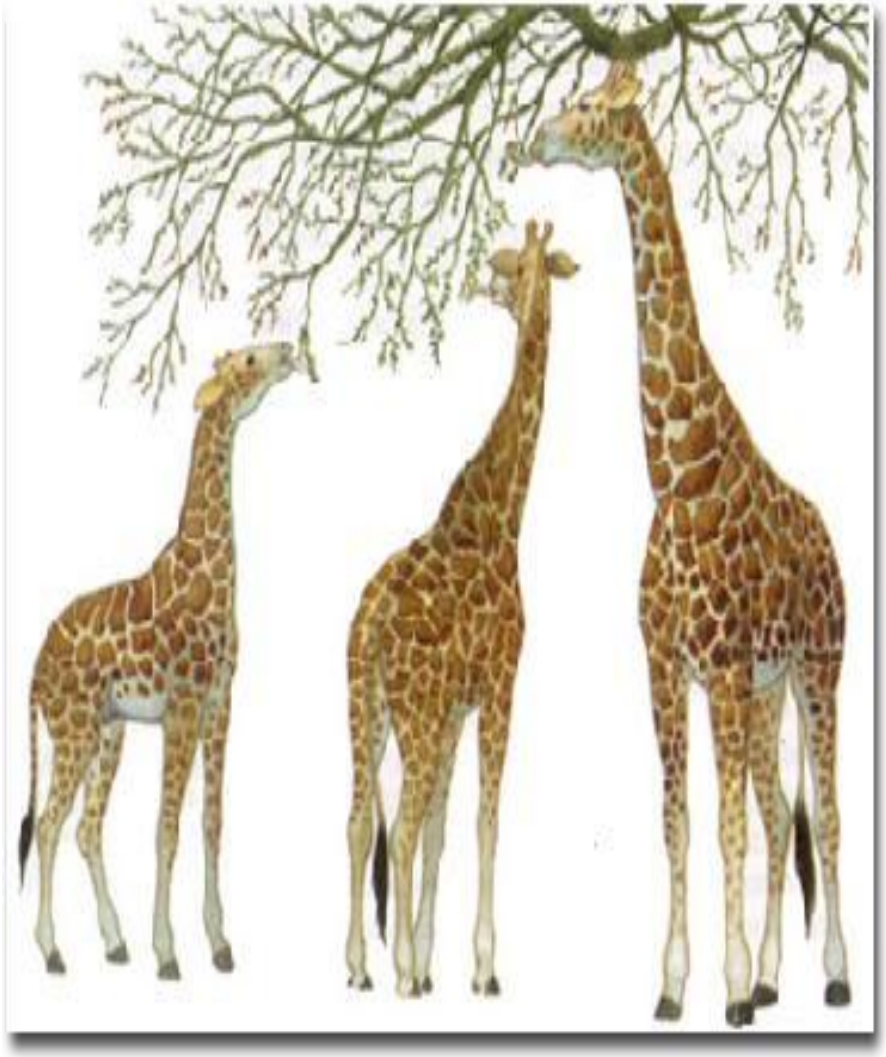


- adaptation when one species beginning to look like another for protection or other advantages

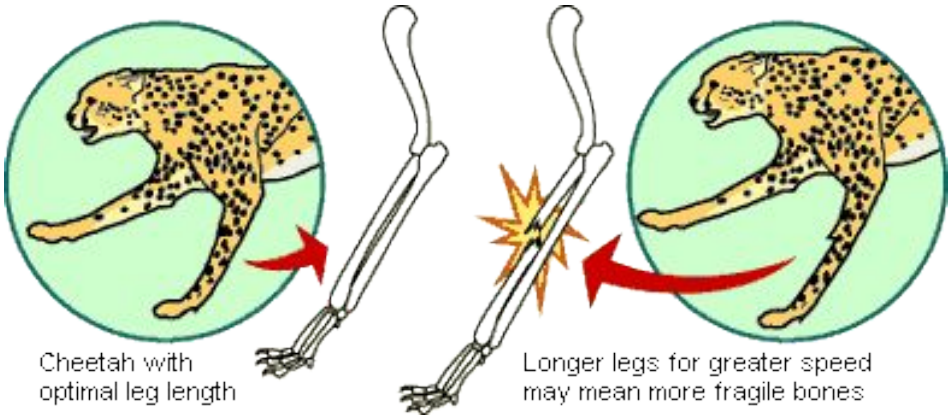
Darwin's Ideas: 3) Survival of the fittest

- The more "suited" the more it will survive and pass on those traits
- This is called **FITNESS**
  - How well an organism can survive in that environment
  - If the environment changes then they organism is not suited anymore

Fitness

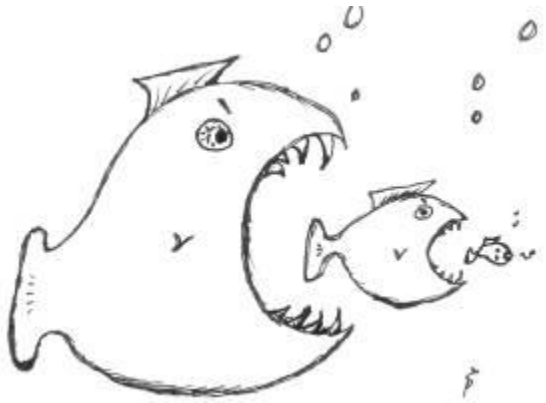


- Measure of traits relative contribution to the following generation



Darwin's Idea: **4) Natural Selection**

- Organisms with variations most suited to their local environment survive and leave more offspring
  - If environment changes so does that varied trait



Darwin Worksheet

Read each situation and identify the 4 points of Darwin's Natural Selection

Influences to Darwin

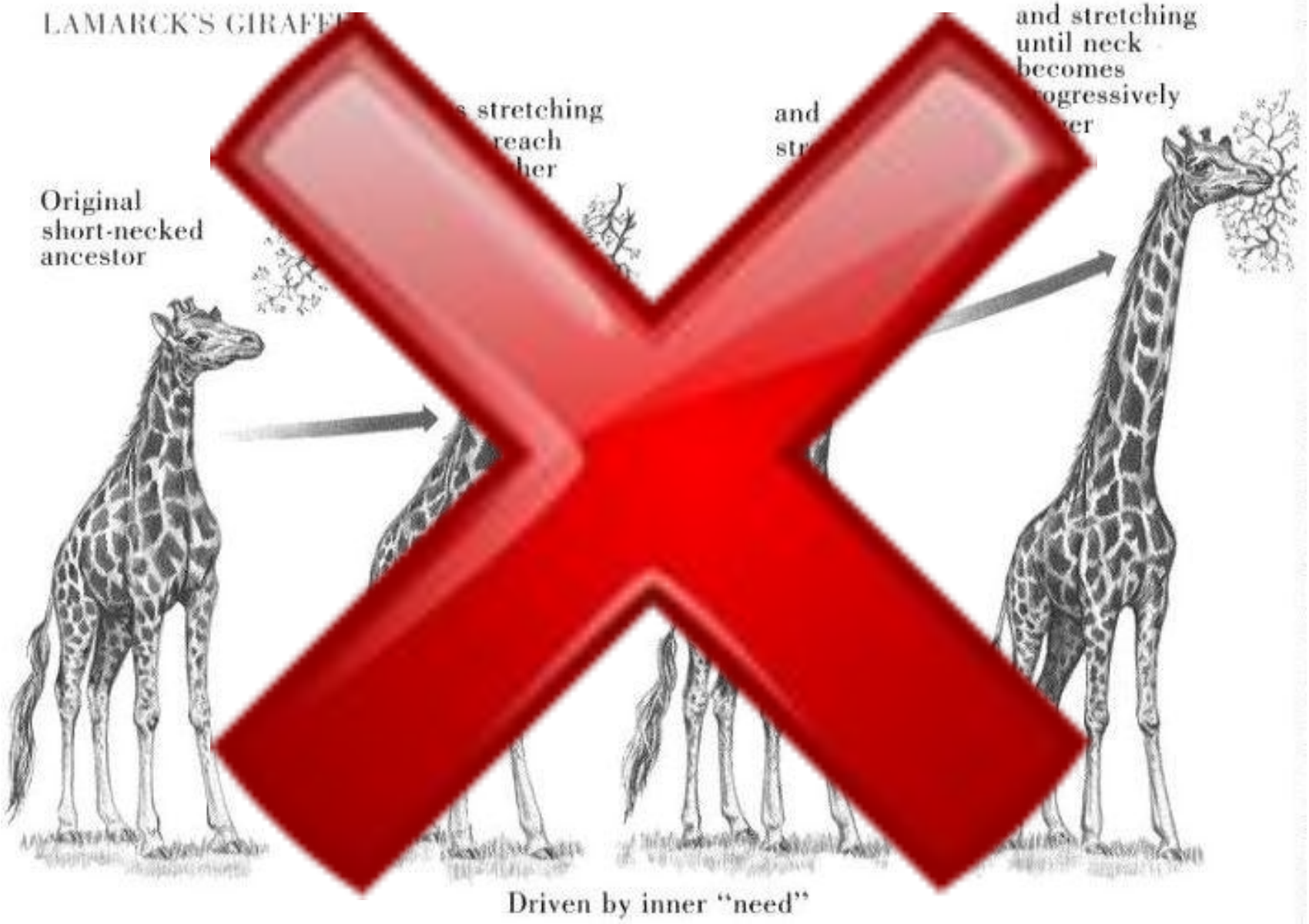
- **James Hutton and Charles Lyell**
  - Believed the Earth to be extremely old
  - Processes that changed Earth in the <u>past</u> are the same that are changing <u>present</u> Earth
    - Examples:
      - Mountain building
      - Volcano
      - Earthquakes

Influences to Darwin

Jean Baptiste Lamarck

- Believed that organisms could change during their lifetime by selectively using or not using various body parts
- Organisms could just change the shape or size of their body parts
- These "new" acquired traits cold be passed on to offspring

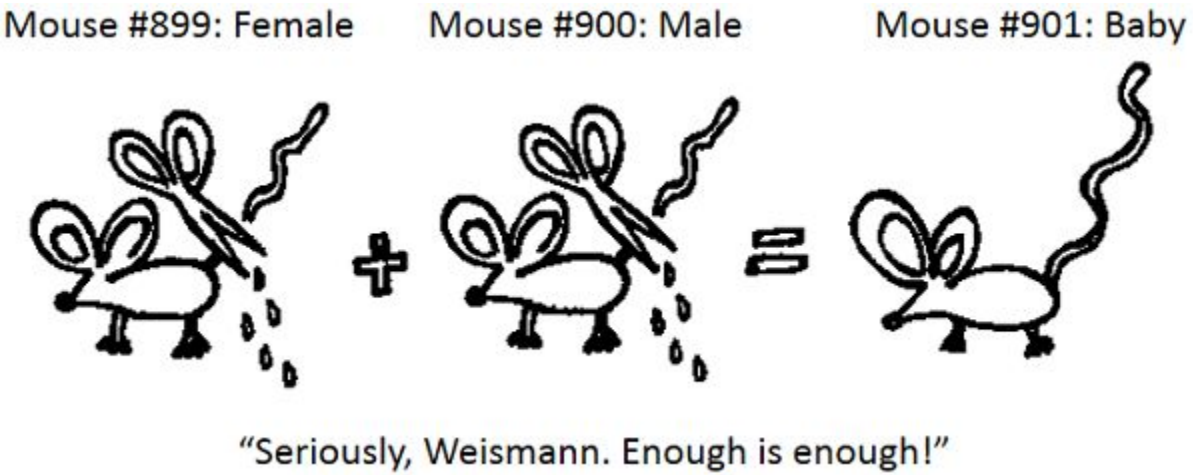
- Giraffes just "stretch" their necks to get them long
- tattoo


LAMARCK'S GIRAFFE
Original short-necked ancestor
and stretching until neck becomes progressively
Driven by inner "need"

Influences to Darwin

Weismann

- Proved Lamarck incorrect
- Took mice and cut off their tails
- The offspring shouldn't have any tails if Lamarck was correct
- Tattoo



Influences to Darwin

- **Thomas Malthus**
  - Worried about human population growing unchecked
  - Believed that their would not be enough living space or food for everyone
  - This led to artificial selection

Evidence of Evolution

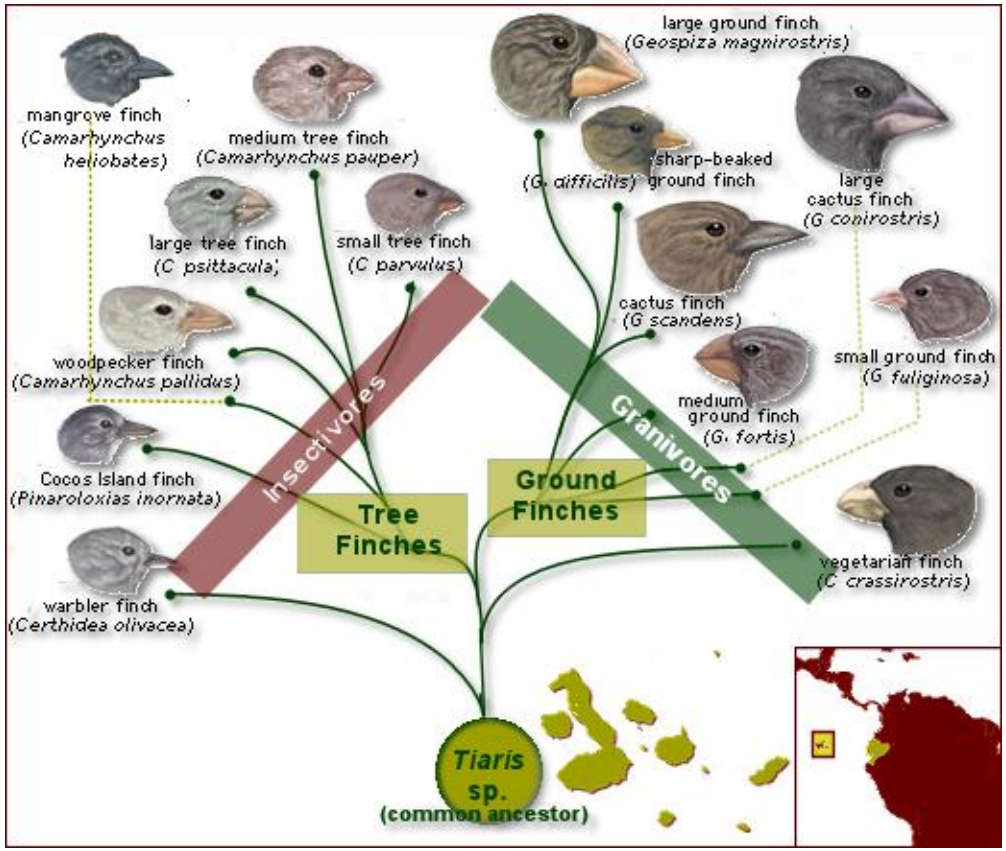
- The following:
  - Derived traits
  - Ancestral traits
  - Transitional fossils
  - Comparative anatomy
  - Homologous structures
  - Analogous structures
  - Vestigial structures
  - Embryology
  - Biogeography
- Helped Darwin to shape his theory of Evolution of natural selection

Evidence of Evolution

- Check out this video

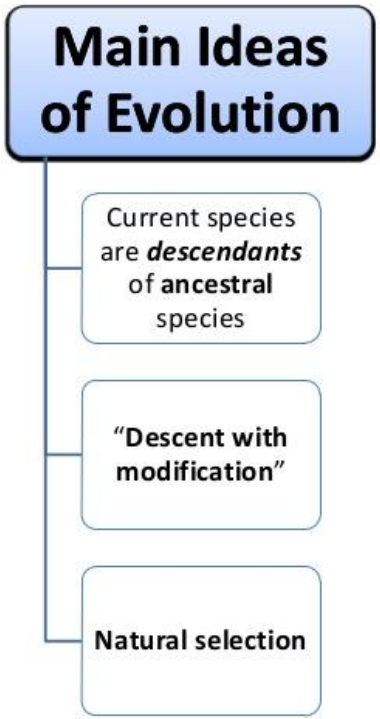
Charles Darwin

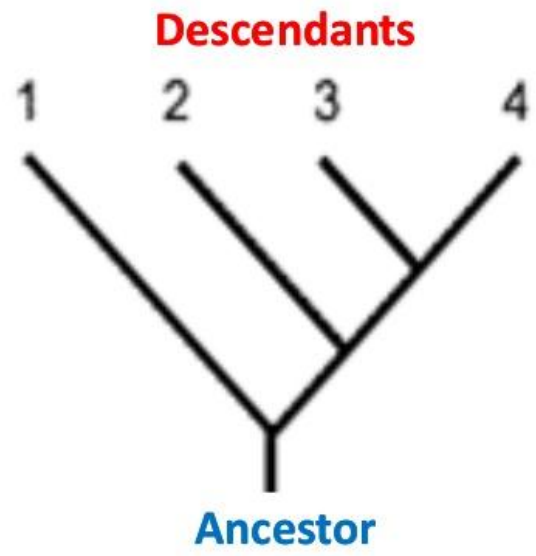
- Led to his conclusion of "**descent with modification**" (these organisms changed gradually over time).
    - EVOLUTION!



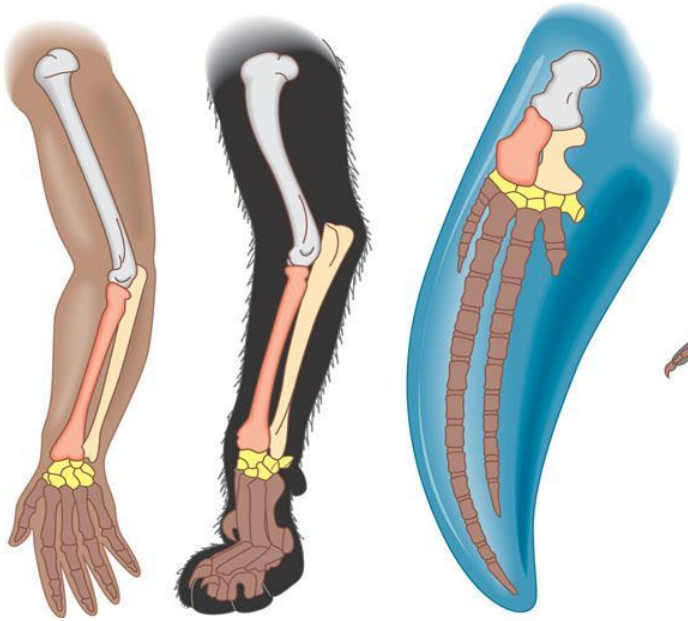
Common Descent

- All species (living and extinct) are descended from a common ancestor



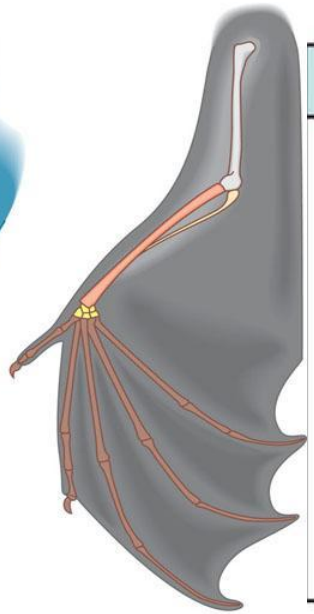


Homologous Structures

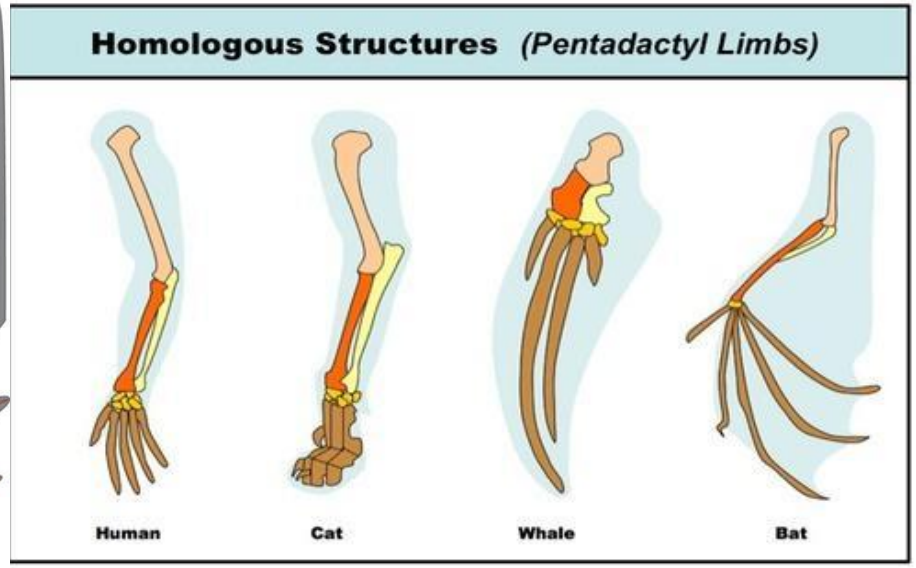


Human Dog

Whale



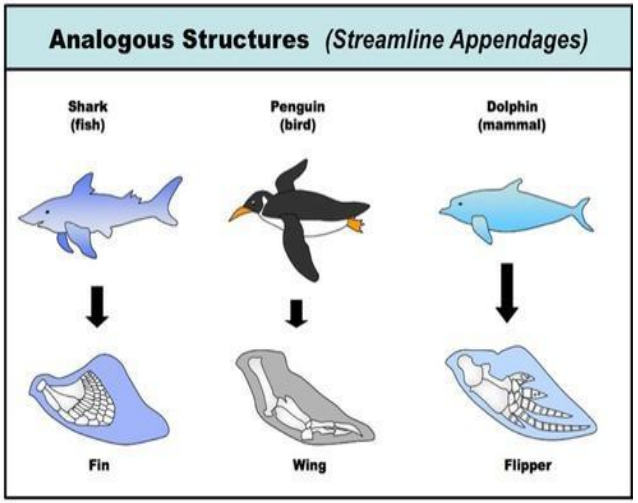
Bat

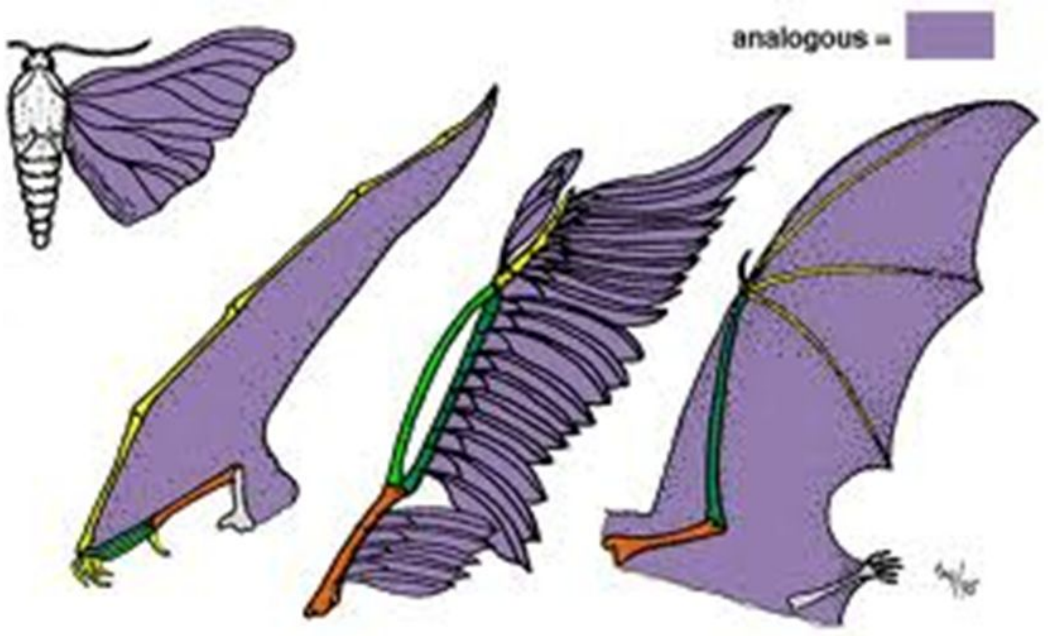


- structures that is similar in different species of common ancestry
- Example: front limb of reptile, bird, human, whale

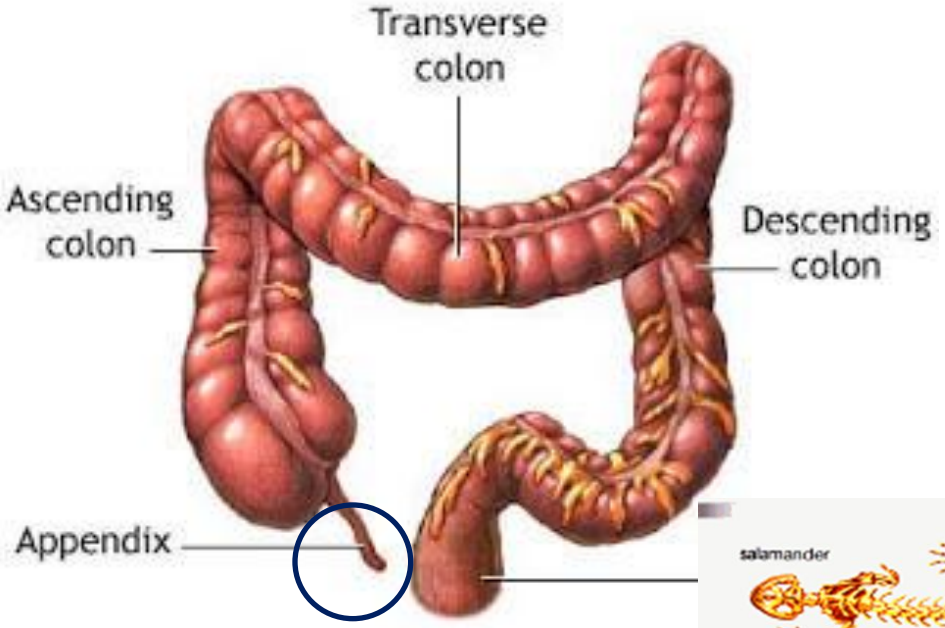
Analogous Structures

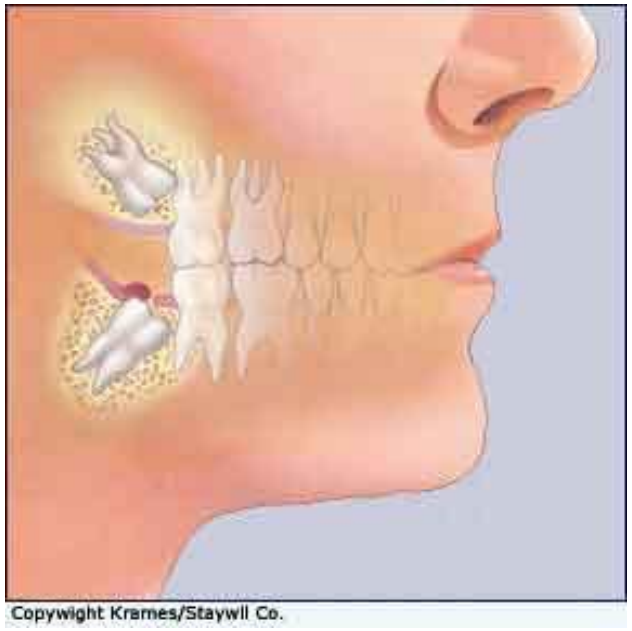
- Body parts that share a common function but NOT structure
  - Example: bird wing and bee wing

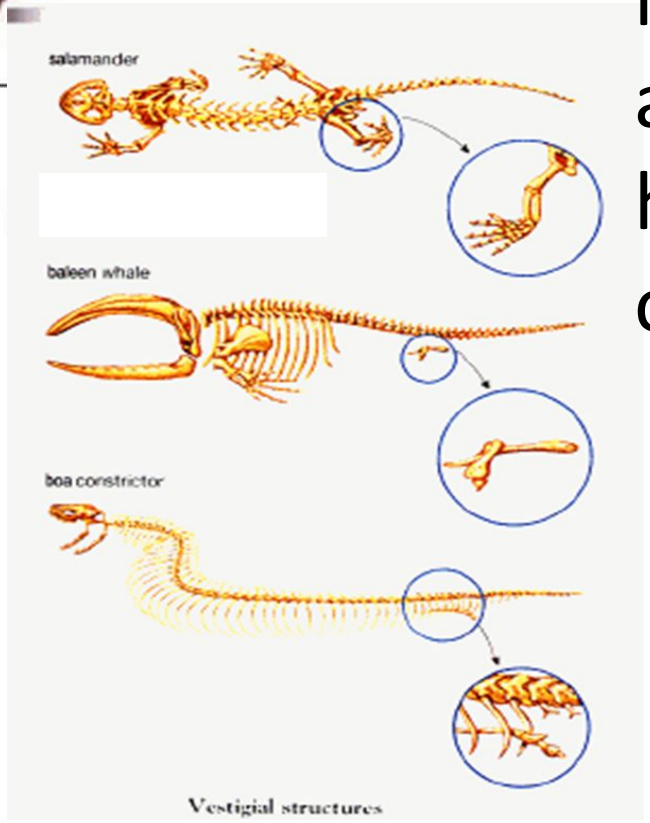




Vestigial Structures



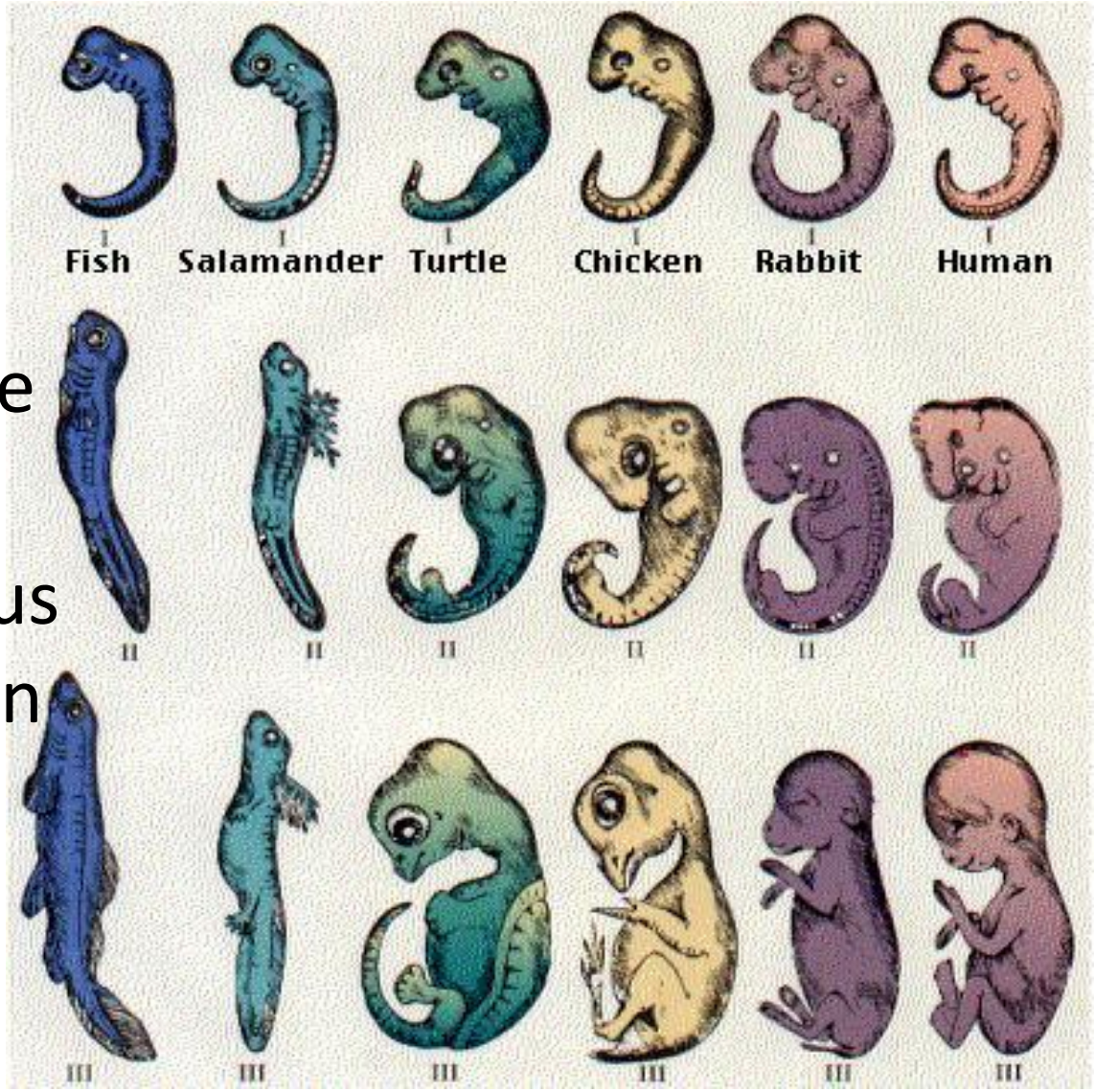




- Structure inherited from ancestors but has lost most of its function

Embryology

- evolutionary relationships between vertebrate embryos
- Can see homologous structures at certain phases in development



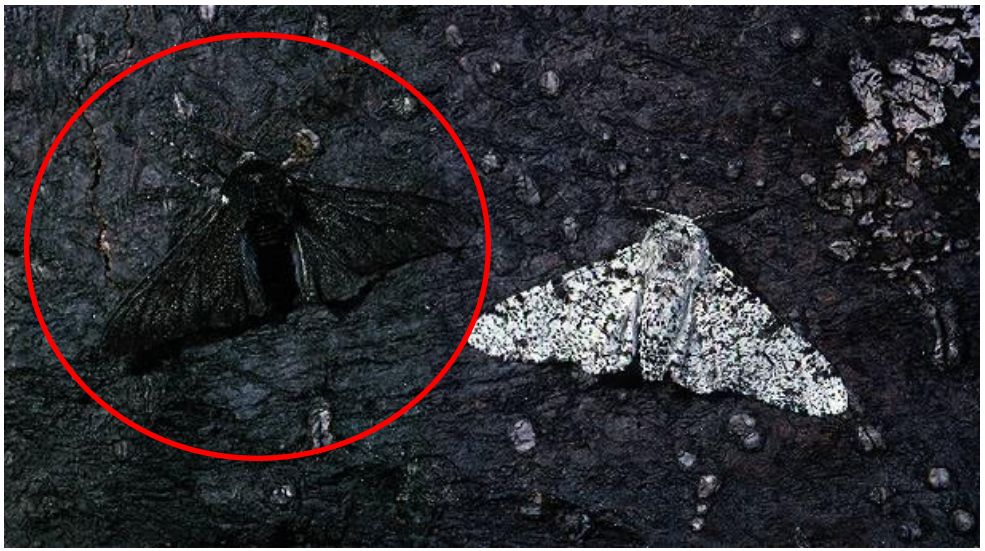
Biochemical (Genetic) Evidence

- Comparison of DNA, RNA and protein Synthesis is very similar among many different species
- Genetic code is almost universal
- Example: RNA, DNA sequences, protein sequences

Species	Sequence of Amino Acids in the Same Part of the Hemoglobin Molecules
Human	Lys–Glu–His–Iso
Horse	Arg–Lys–His–Lys
Gorilla	Lys–Glu–His–Lys
Chimpanzee	Lys–Glu–His–Iso
Zebra	Arg–Lys–His–Arg

Add to notes

Industrial Melanism



The darkening of populations over time in response to industrial pollution.

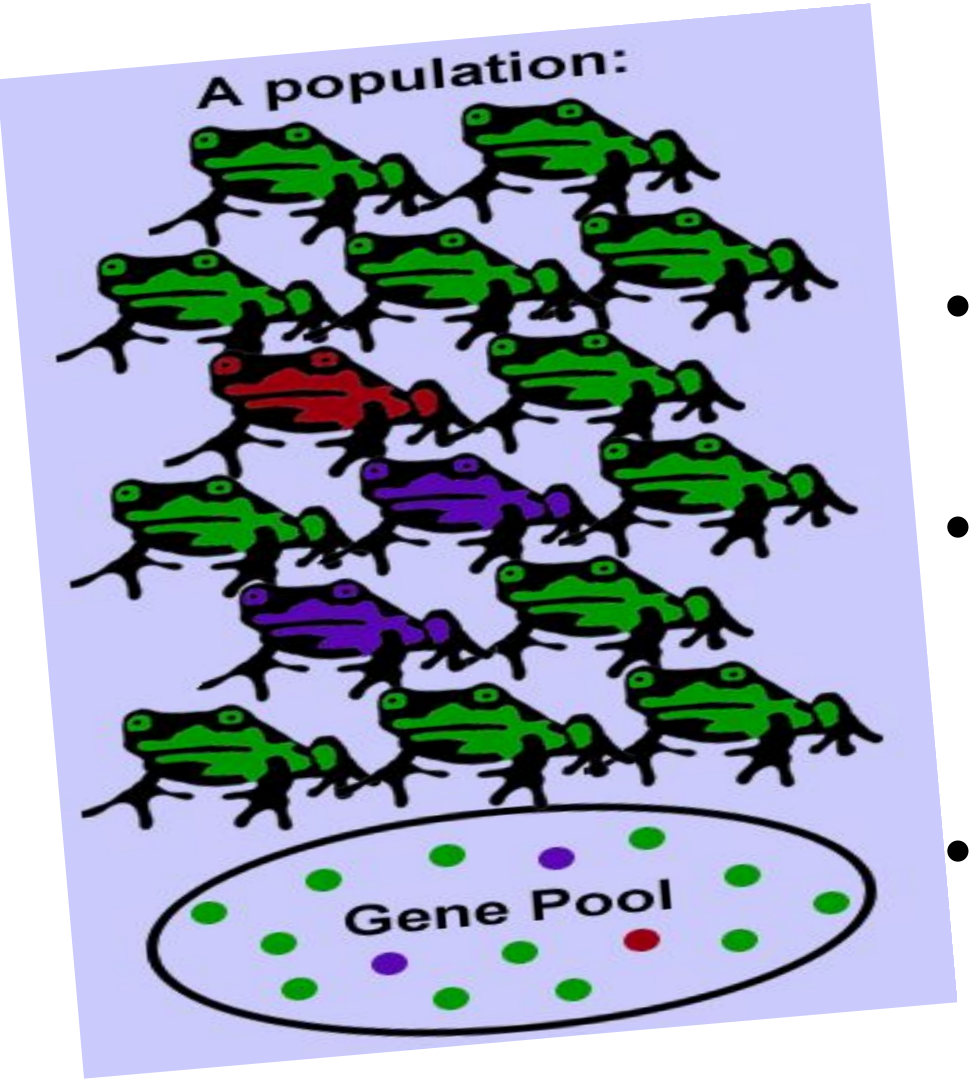
http://www.techapps.net/interactives/peppermoths.htm

Industrial Melanism

The darkening of populations of organisms over time in response to industrial pollution

Genes and Variation

- The more favorable a **phenotype** the better suited for the environment an organism is and will produce more **offspring**
- Natural selection does **NOT** act on **genes** but on an entire **organism**
  - Those favorable will **survive and reproduce**
  - Those unfavorable will **die without reproducing**



Gene Pool

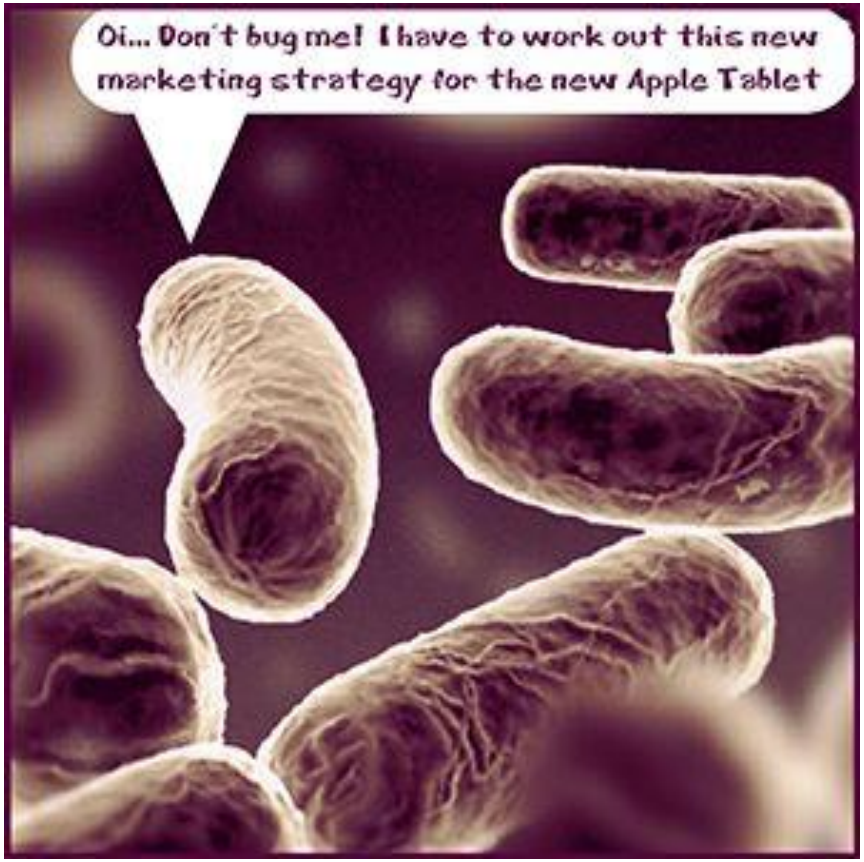
- All of the gene's in a population
- Evolution involves changes in frequency of **alleles** in a population
- Increases genetic variation

Genetic Variation

- 3 types
  - 1) Mutations
  - 2) Meiosis (crossing over)
  - 3) Latent gene transfer

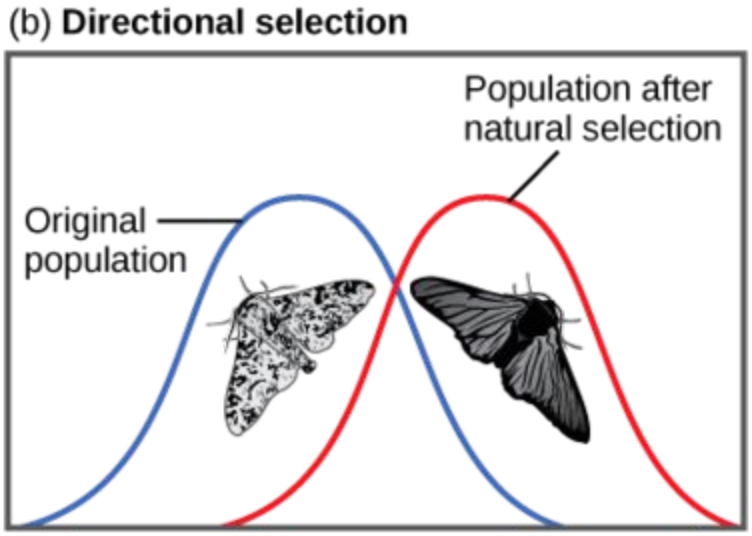
Becoming resistant

- Farmers that spray pesticides on insects
- Some die but others not affected
- Flu vaccine every year- why?



Directional Selection

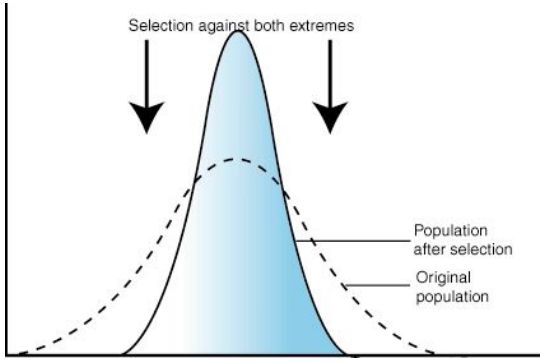
- Moves to extremes

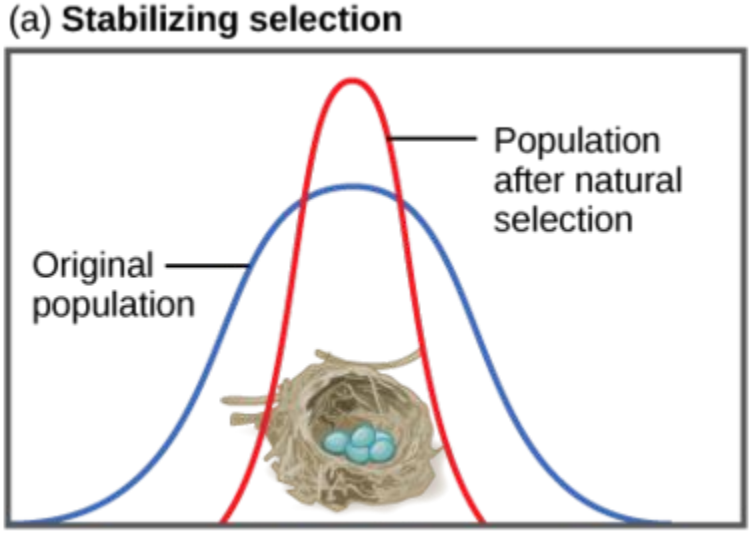


Light-colored peppered moths are better camouflaged against a pristine environment; likewise, dark-colored peppered moths are better camouflaged against a sooty environment. Thus, as the Industrial Revolution progressed in nineteenth-century England, the color of the moth population shifted from light to dark, an example of directional selection.

Stabilizing selection

- Elimination of the extremes

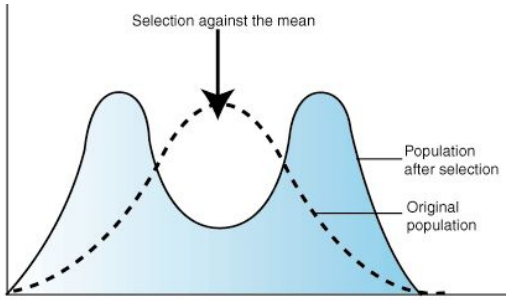


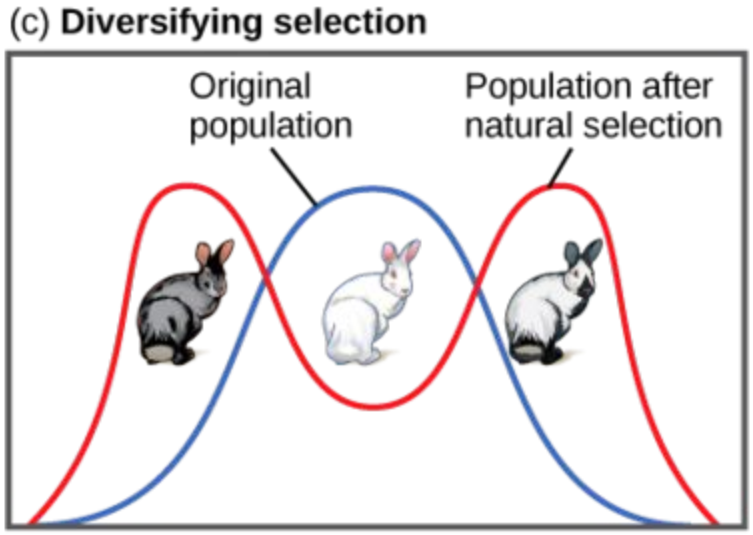


Robins typically lay four eggs, an example of stabilizing selection. Larger clutches may result in malnourished chicks, while smaller clutches may result in no viable offspring.

Disruptive selection

- Acts against the intermediate

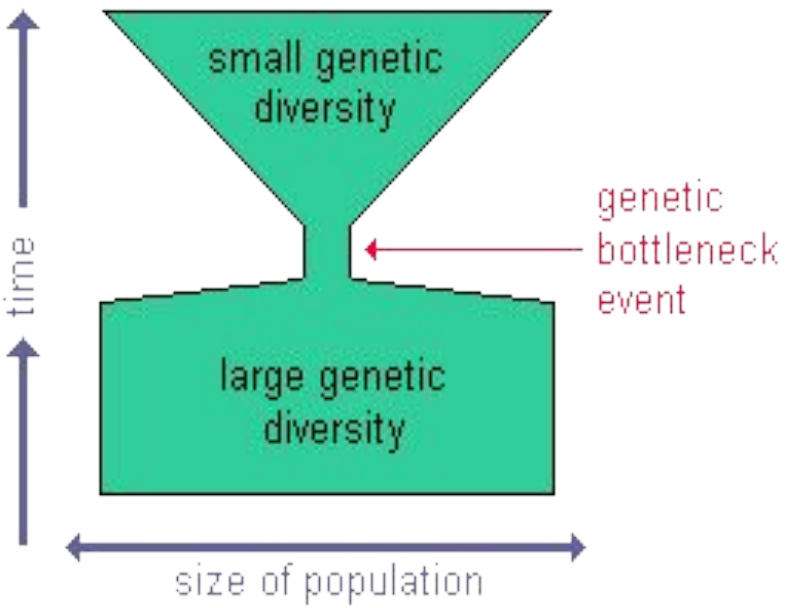




In a hyphothetical population, gray and Himalayan (gray and white) rabbits are better able to blend with a rocky environment than white rabbits, resulting in diversifying selection.

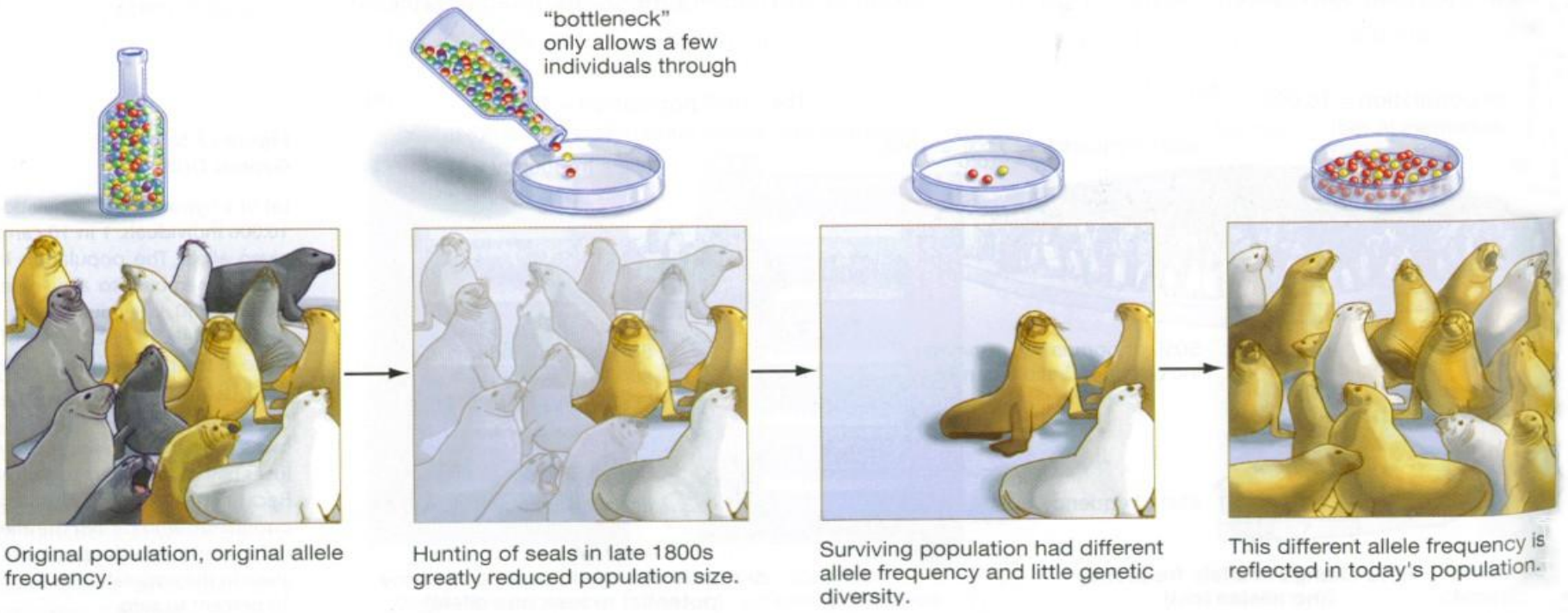
Genetic Drift

- Random change in allelic frequencies in a population



Bottleneck

Change in allele frequency due to a dramatic decrease in population

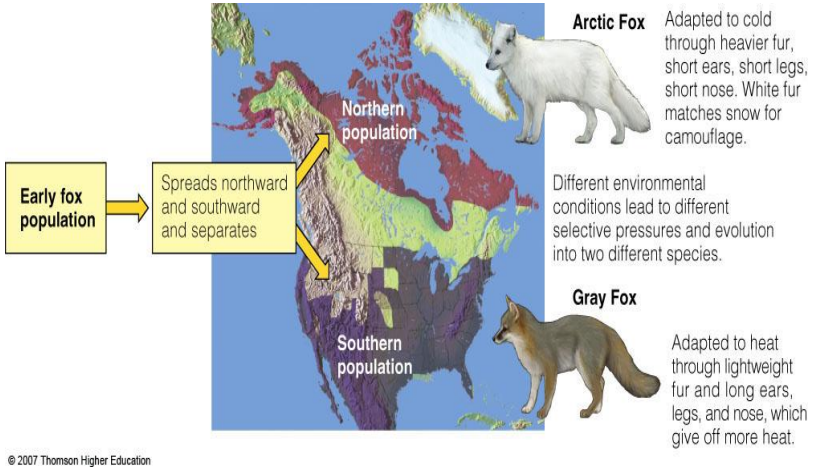


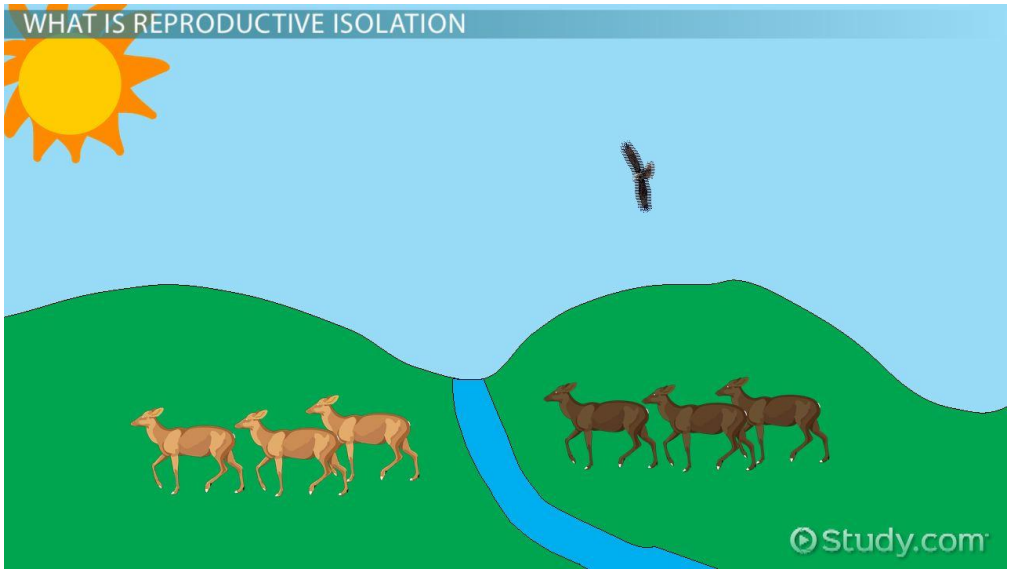
Hardy-Weinberg Principle

- In the absence of allele forces, a population will remain the same
- If a population does not change then it is at genetic equilibrium
- Principle states that allele frequencies remain constant
- $p^2 + 2pq + q^2 = 1$ (know this)

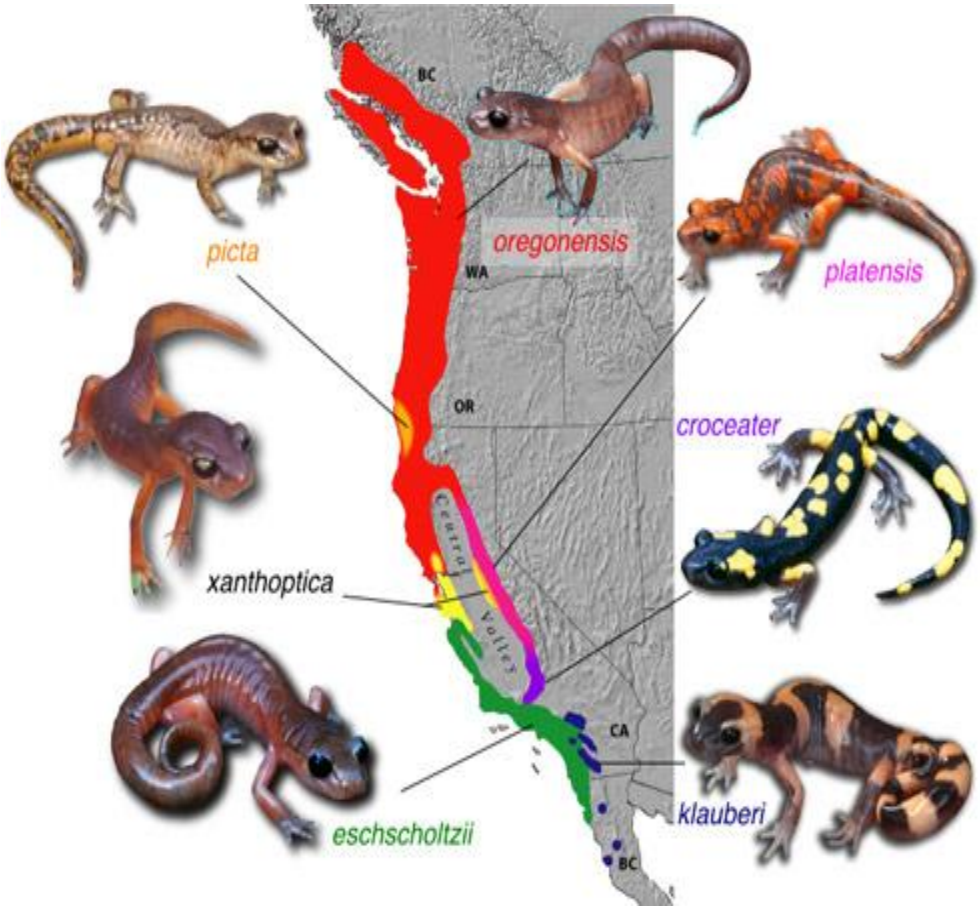
Isolation

- When a species has become separated into 2 groups
- These groups cannot reproduce and gene pool is changed
- Different types
  - **Reproductive** isolation
  - **Behavioral** isolation
  - **Geographic** isolation





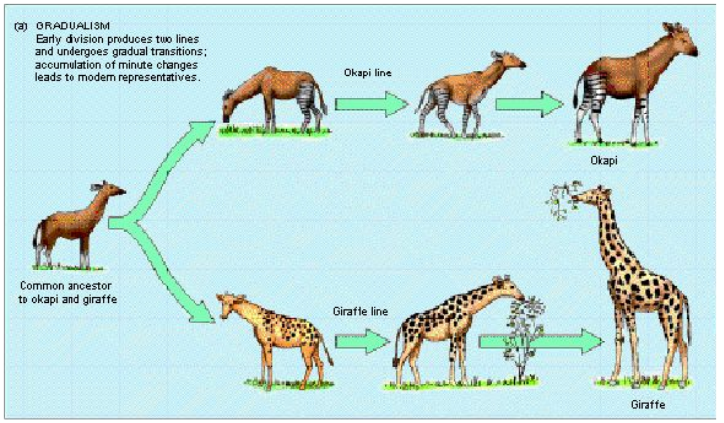
Isolation leads to species formation.

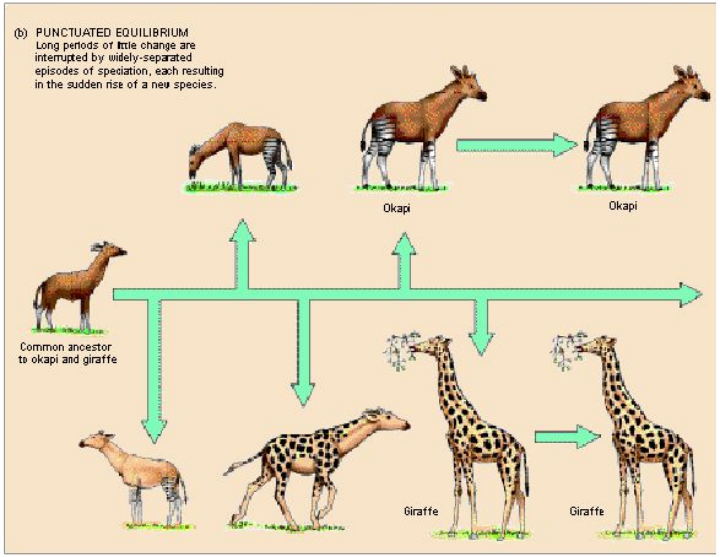


Pace of Evolution

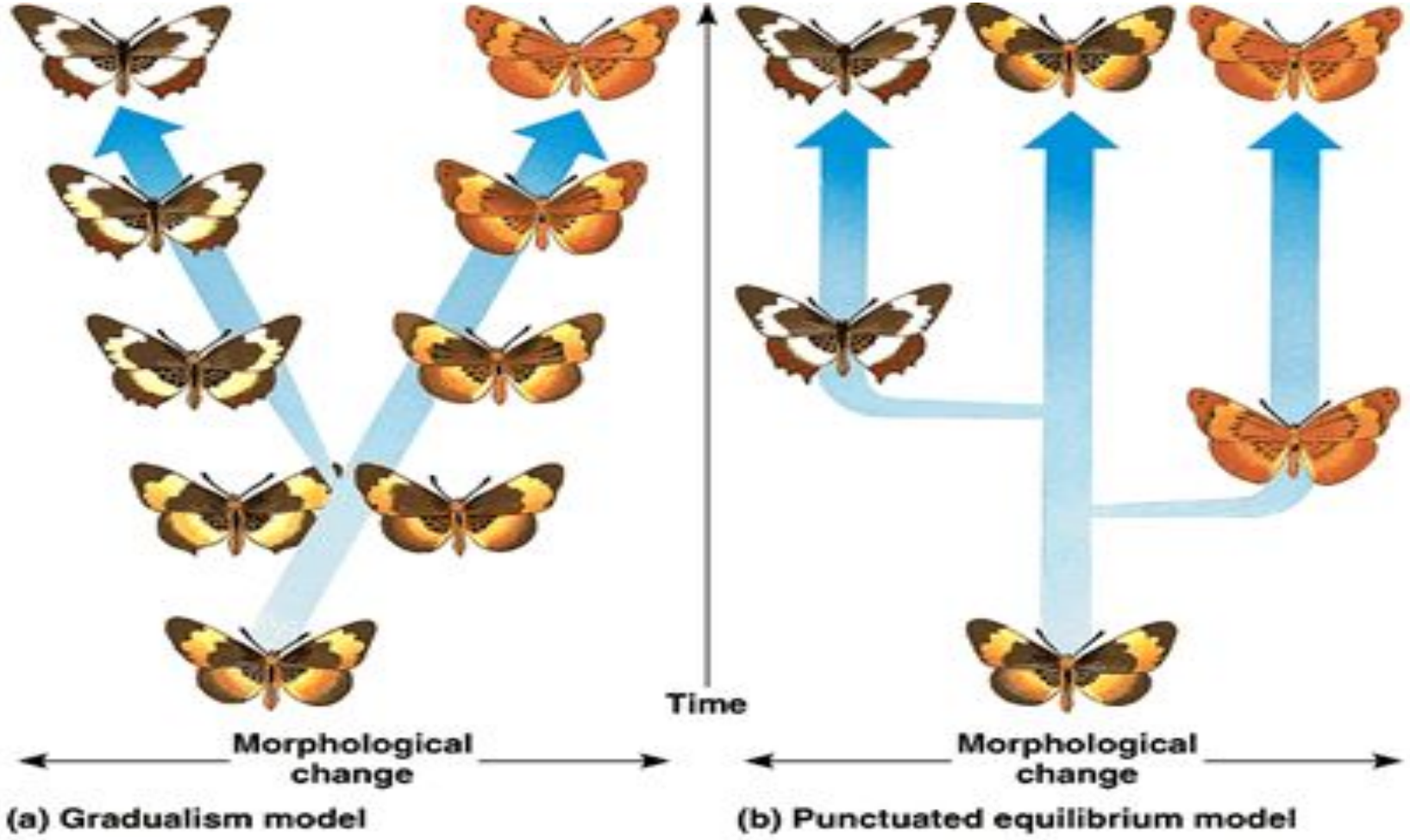
- **Gradualism: Slow**
  - Many generations
  - Evolution proceeds in a small <u>gradual</u> steps

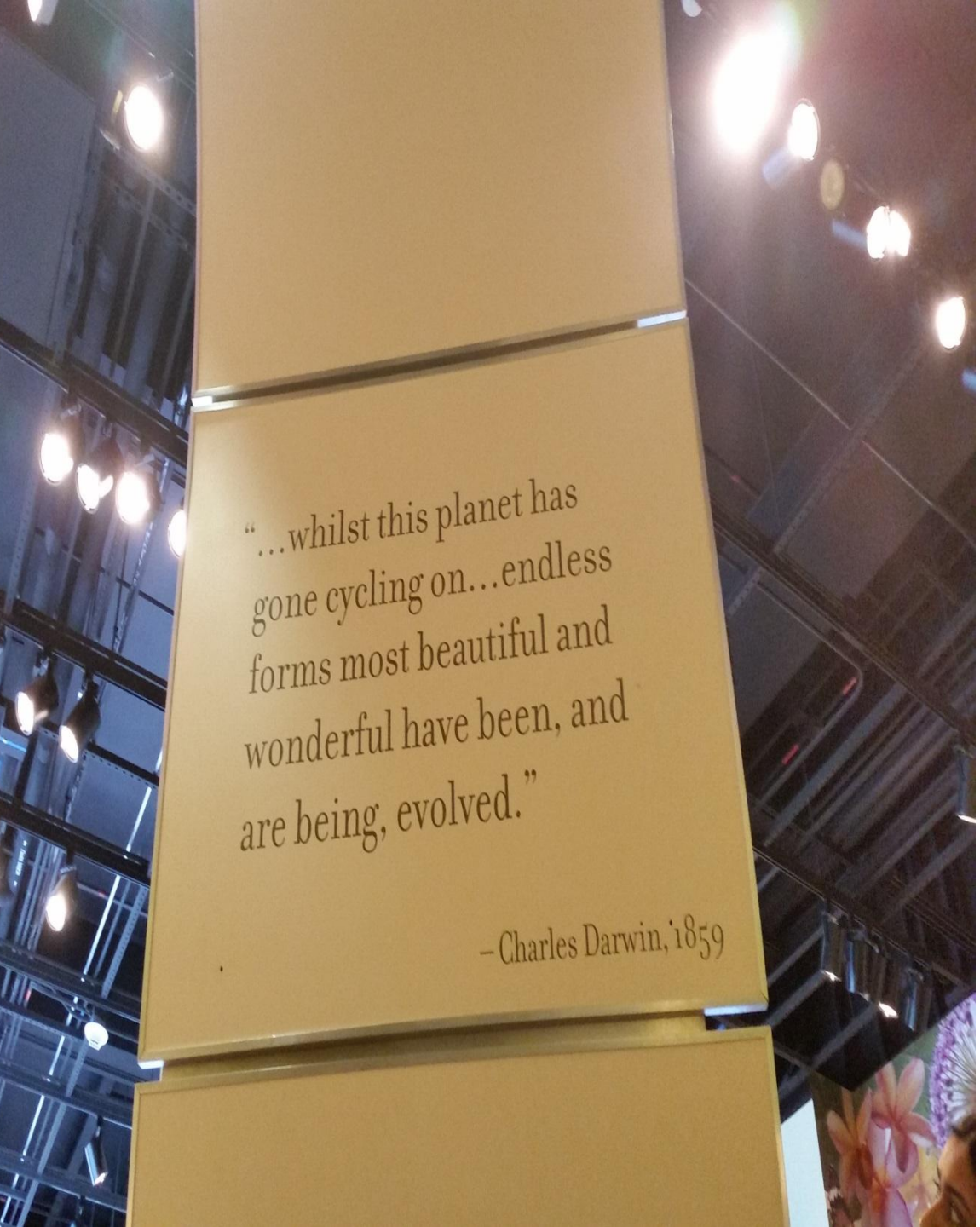
- **Punctuated Equilibrium: Random**
  - Equilibrium interrupted with <u>rapid</u> change





Gradualism –vs- Punctuated Equilibrium





Evolution

- Heredity changes in groups of living organisms over time

Bird Beak Lab Journal

Pg 143/44

- Learn how adaptation has been helpful to birds
- Complete Chart (next slide)
- Complete questions

Copy the following chart into journals

	LONG BEAKED BIRD	MEDIUM BEAKED BIRD	SHORT BEAKED BIRD
Time for BEANS			
Time for PEAS			
Time for NOODLE			
TIME for BEADS			
Average time			

Bird Lab Questions

Pg 143

1. Did the **short-beaked bird** have any problems grabbing the various objects? Why or why not?

2. Did the **Medium-beaked bird** have any problems grabbing the various objects? Why or why not?

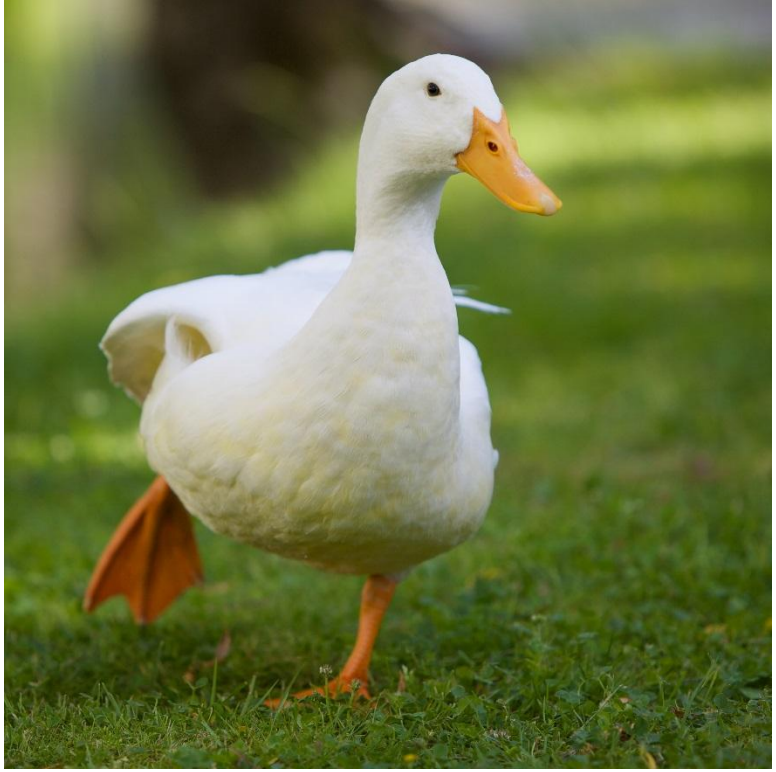
3. Did the **Long-beaked bird** have any problems grabbing the various objects? Why or why not?

4. Describe the habitat of each type of bird.

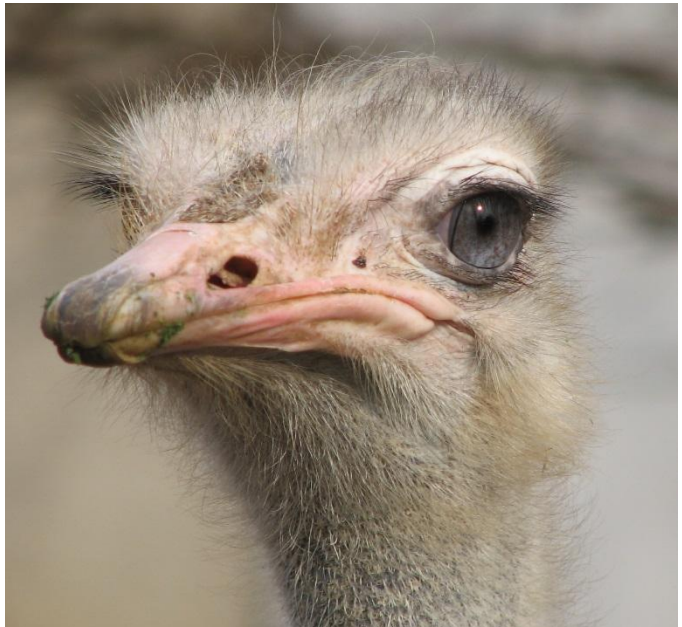
5. What type of food would be best for EACH type of bird?

6. Find 2 very specific examples of each type of bird.

Short-beak Birds

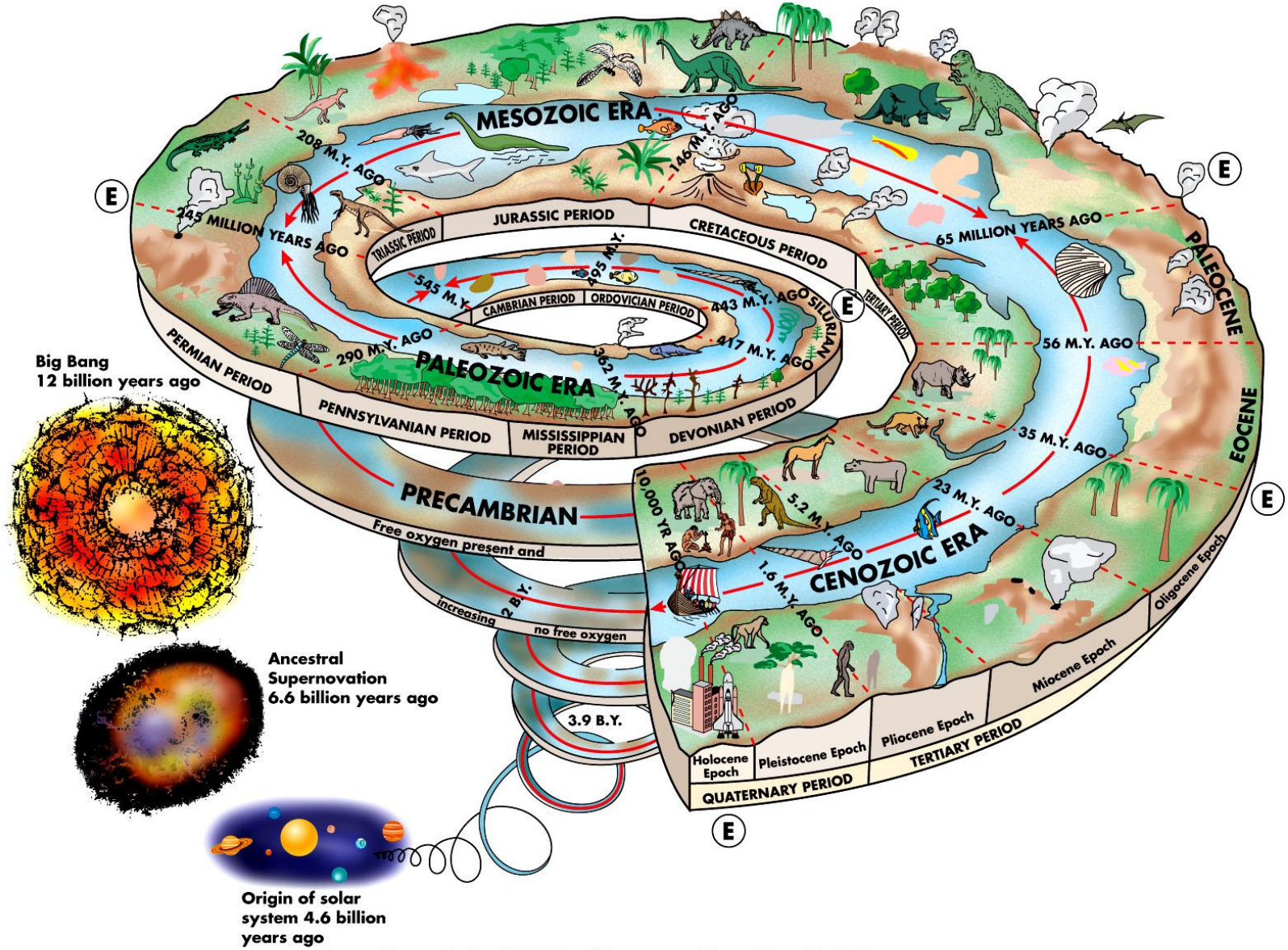


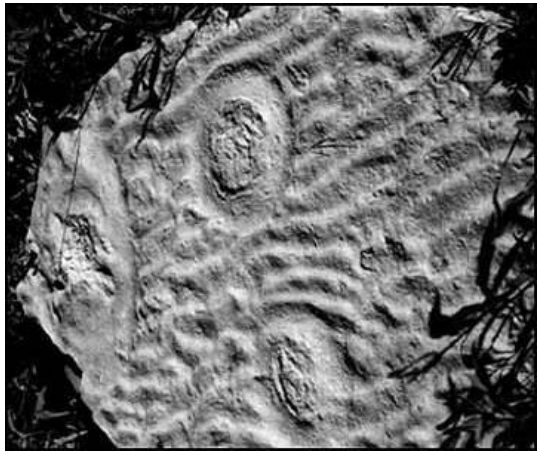
Medium Beaked Birds



Long Beaked Birds

History of Life Chap 19





Fossil

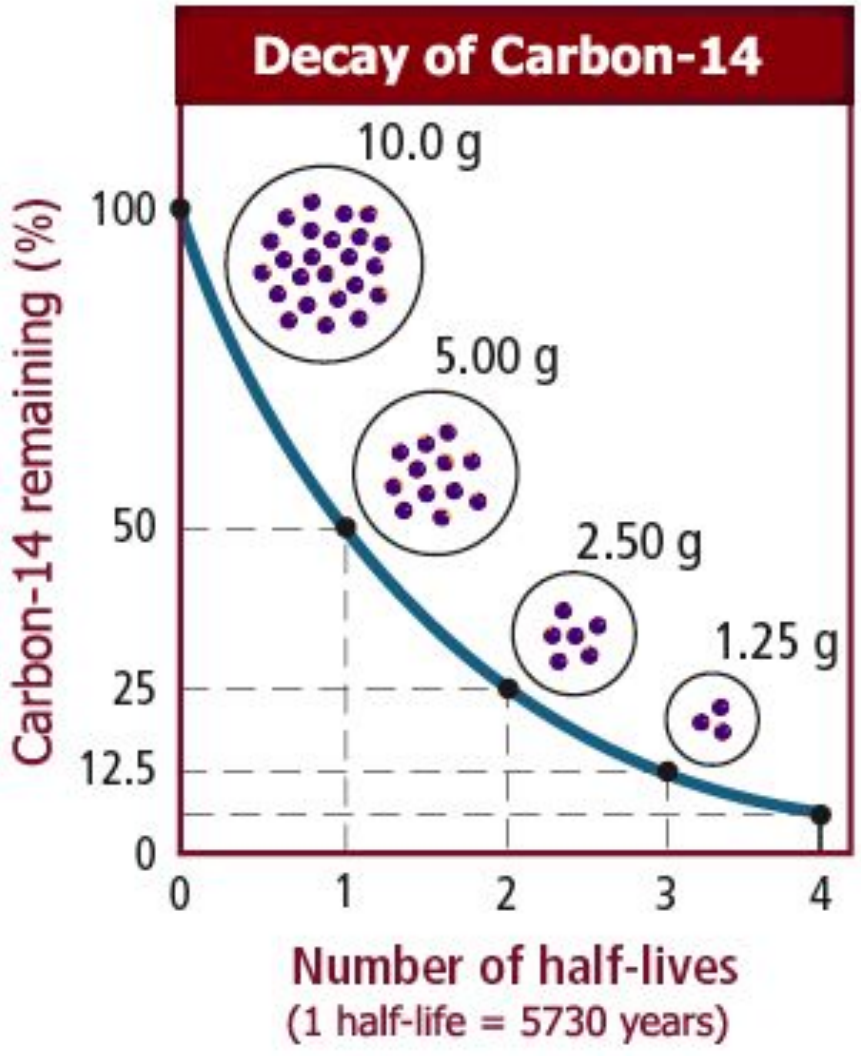
- Preserved remains from ancient organisms
- Best if found in <u>sedimentary</u> rocks that provides evidence of a past life
- The <u>hard</u> parts will remain like <u>bone, teeth, shells</u>

Fossils

- **Paleontologist**
  - The scientist who studies fossils
  - When studying fossils and living organisms, a single species can show that they have diversified over time

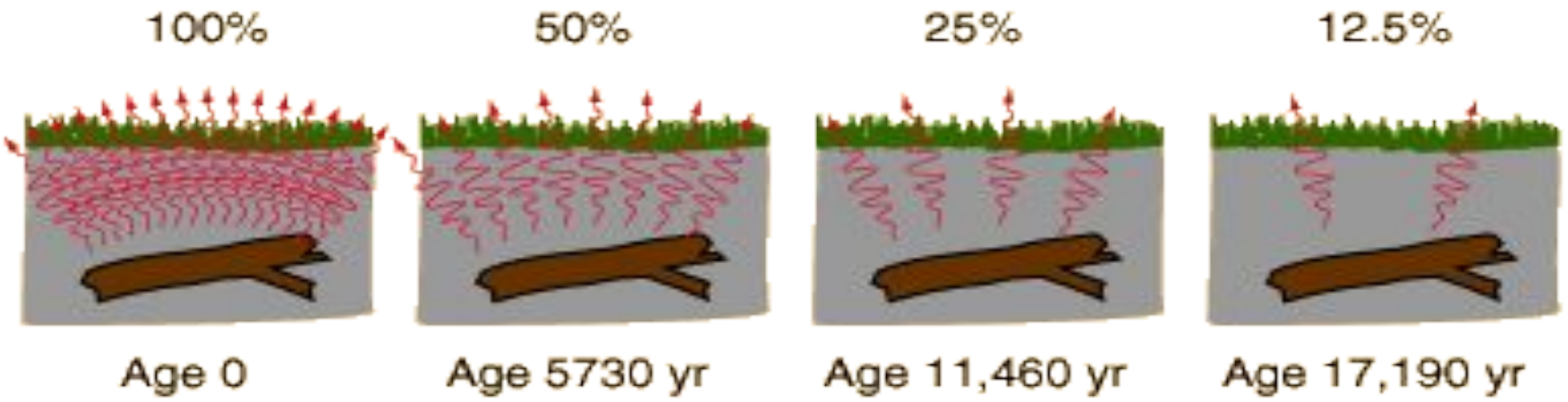
Radiometric Dating

- Method used to determine the age of rocks using the rate of decay of radioactive isotopes



Half-life

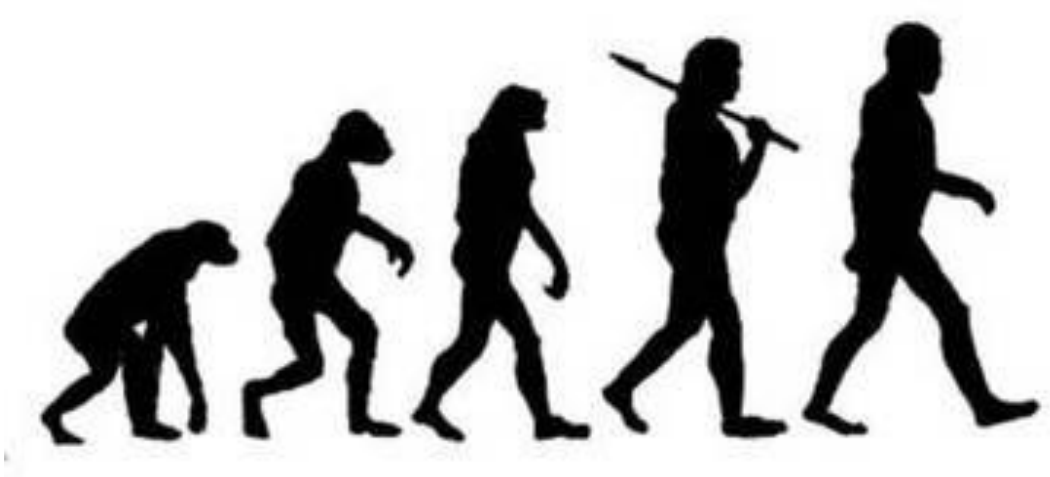
Measurement of the beta decay activity of a buried piece of wood provides a measurement of the time elapsed since it was living and in equilibrium with the atmosphere.



- Amount of time required for half of a radioactive isotope to decay
  - **Carbon-14** = 5,730 years
  - **Potassium-40**= 1.26 billions years
  - **Uranium-238** = 4.5 billion years

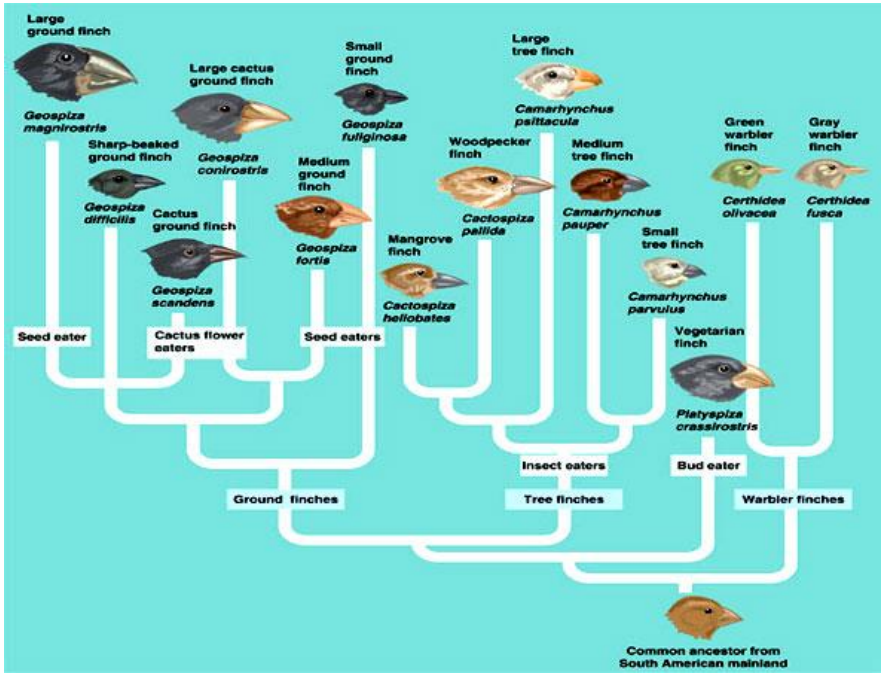
Studying fossils

- When studying fossils and living organisms, a single species can show that they have diversified over time



Adaptive Radiation

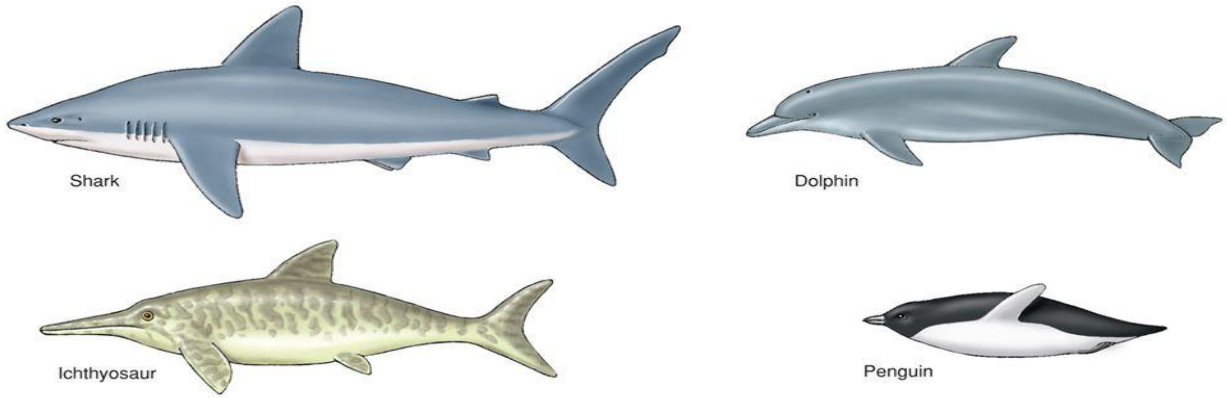
- When 1 species gives rise to many species due to a new habitat
- Ex: finches, cichlids



Convergent Evolution

- Process when unrelated organisms independently evolve similarities when adapting to similar environments
- Example:

Convergent Evolution: Streamlining



Convergent evolution is the process by which unrelated species evolve similar physical characteristics because they have similar lifestyles

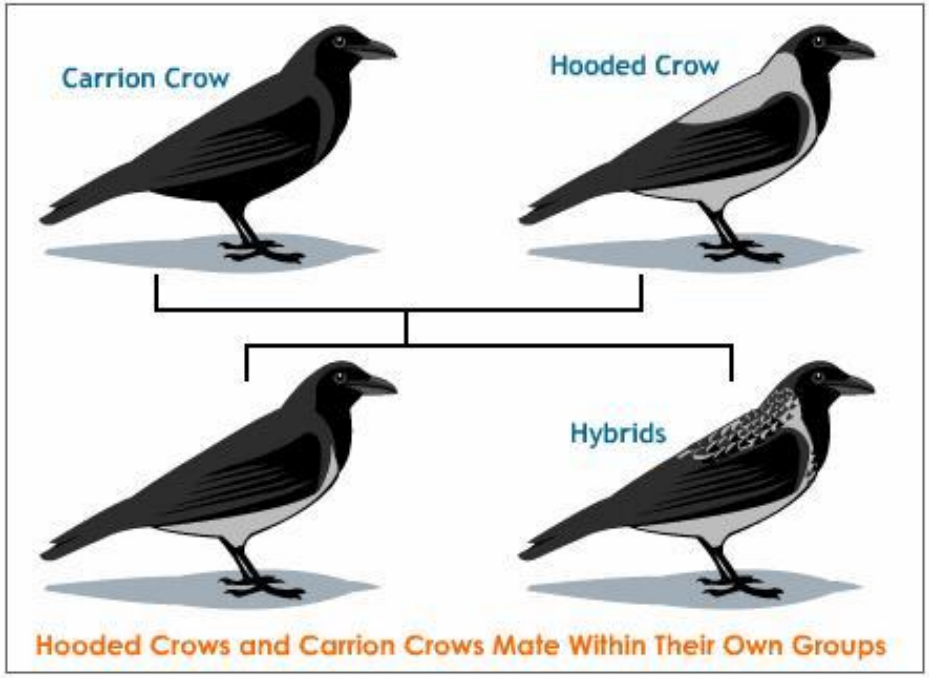
Co-evolution

- When species evolve in close relationships together
- Ex: Flower and bee

Add to notes

Speciation

- A population diverges and becomes reproductively isolated
- Thus a new species



Important changes in Earth's History

- Age of Earth= **4.6 billion** years old
  - at first it was a big ball of fiery molten rock
  - Then it began to cool (about 4.2 billion years ago)
  - This allowed the oceans to form

Earth's history

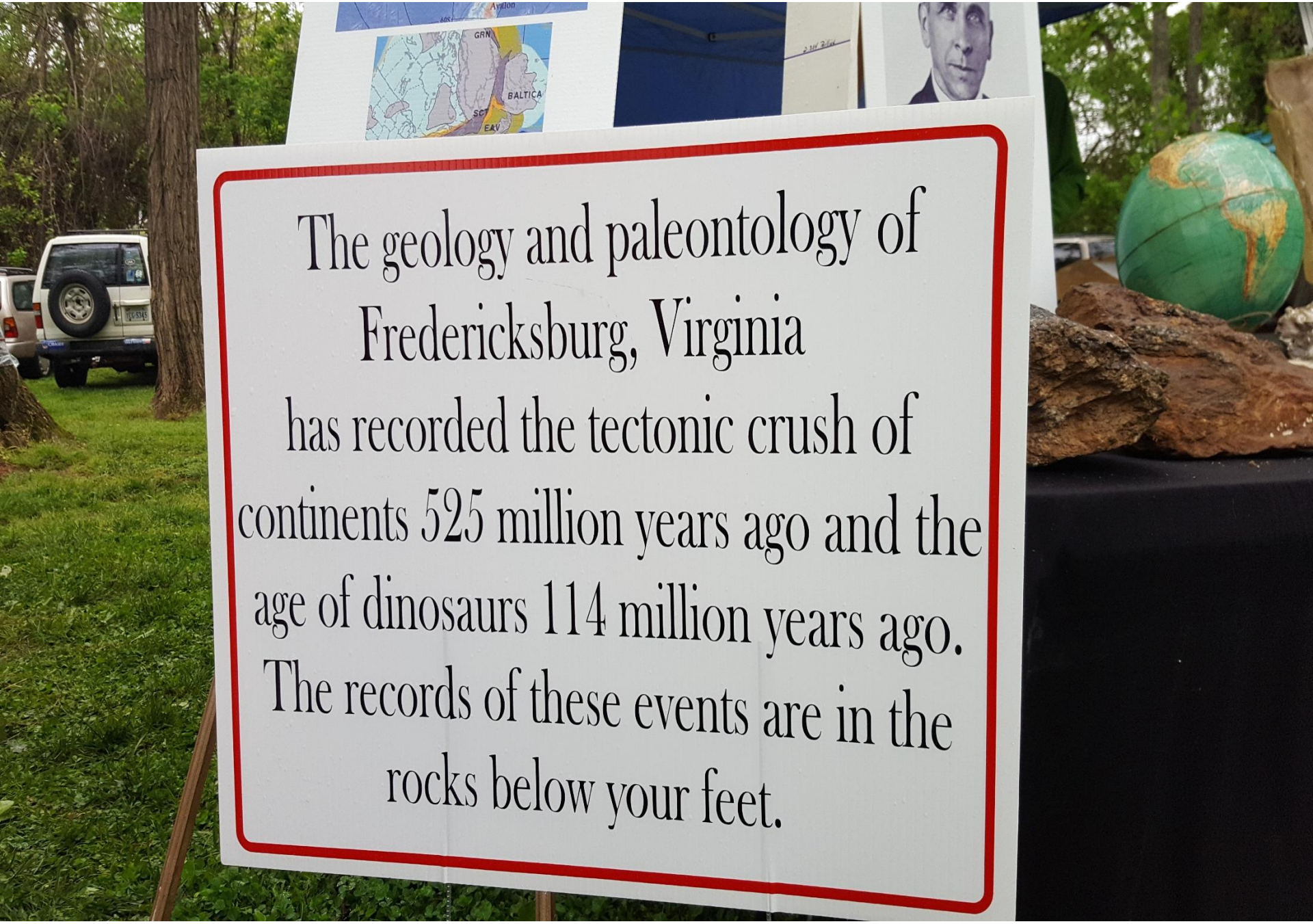
- The atmosphere contained NO oxygen
  - Thus no life yet
- Was composed of:
  - CO_2,
  - water vapor,
  - Nitrogen,
  - carbon monoxide,
  - hydrogen sulfide

Earth's history

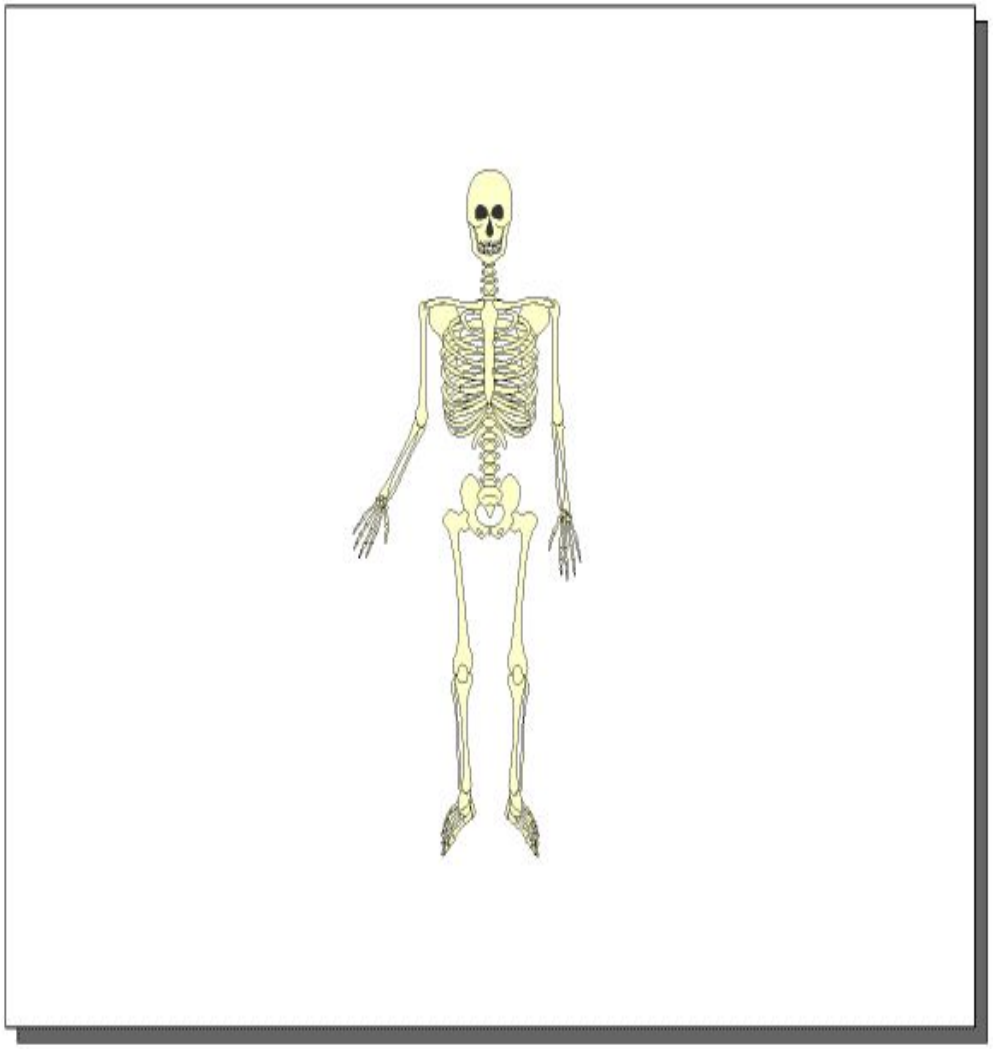
- Over time amino acids began to form
- **3.5 billion** years ago = first prokaryotes
- Then the ozone layer formed (protective shield)
- **1.5 billion** years ago = first Eukaryotes
- Live continued to evolve

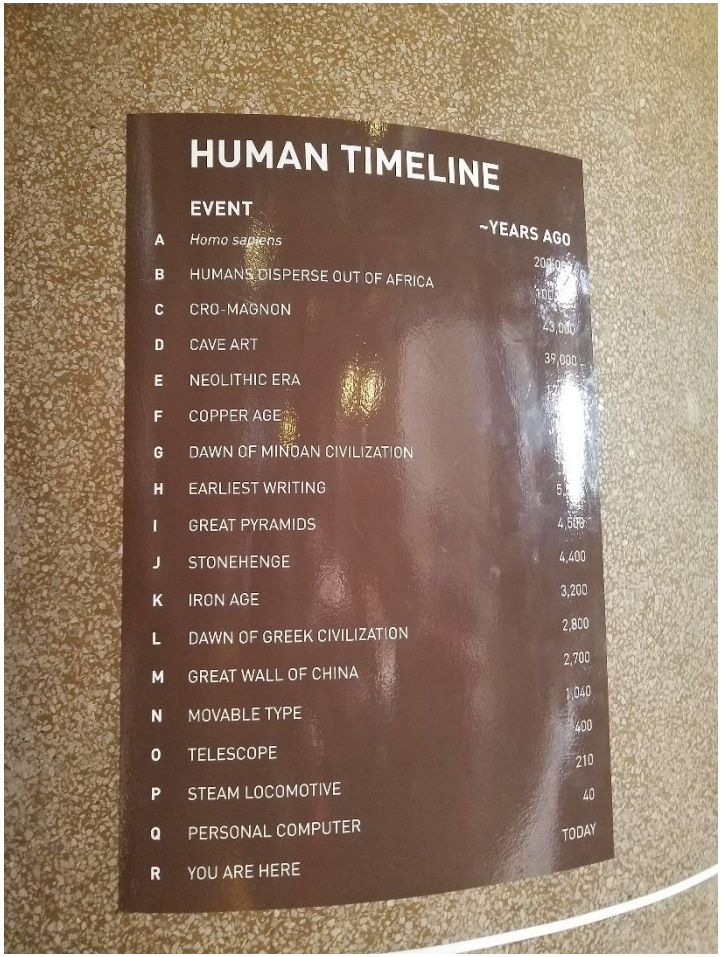
Earth's history

- **65** million years ago = dinosaurs extinct
- **60** million years ago = birds and mammals become dominant life on Earth
- **36** million years ago = animals become diurnal (more active during the day)


GRN
BALTICA
SCT
EAV
The geology and paleontology of
Fredericksburg, Virginia
has recorded the tectonic crush of
continents 525 million years ago and the
age of dinosaurs 114 million years ago.
The records of these events are in the
rocks below your feet.

Human Evolution



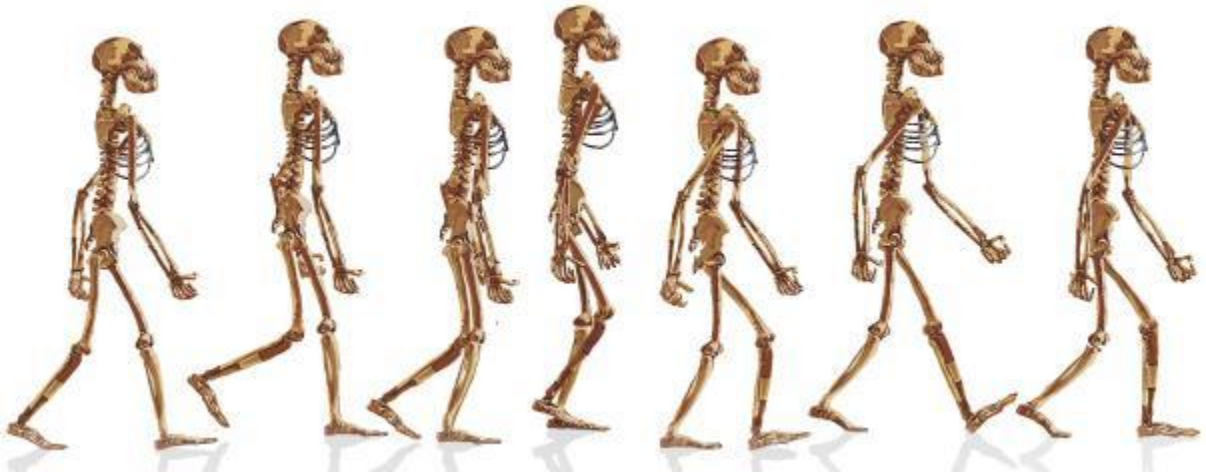


HUMAN TIMELINE

	EVENT	~YEARS AGO
A	*Homo sapiens*	200,000
B	HUMANS DISPERSE OUT OF AFRICA	100,000
C	CRO-MAGNON	43,000
D	CAVE ART	39,000
E	NEOLITHIC ERA	12,000
F	COPPER AGE	7,000
G	DAWN OF MINOAN CIVILIZATION	5,000
H	EARLIEST WRITING	5,000
I	GREAT PYRAMIDS	4,500
J	STONEHENGE	4,400
K	IRON AGE	3,200
L	DAWN OF GREEK CIVILIZATION	2,800
M	GREAT WALL OF CHINA	2,700
N	MOVABLE TYPE	1,040
O	TELESCOPE	400
P	STEAM LOCOMOTIVE	210
Q	PERSONAL COMPUTER	40
R	YOU ARE HERE	TODAY

Bipedal

- Ability to walk upright on 2 legs

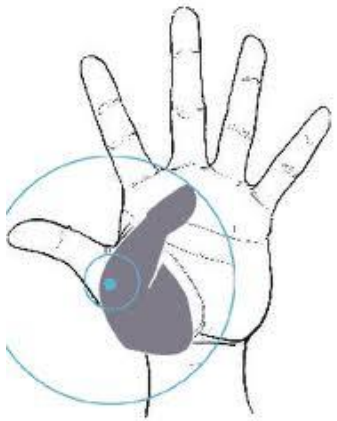


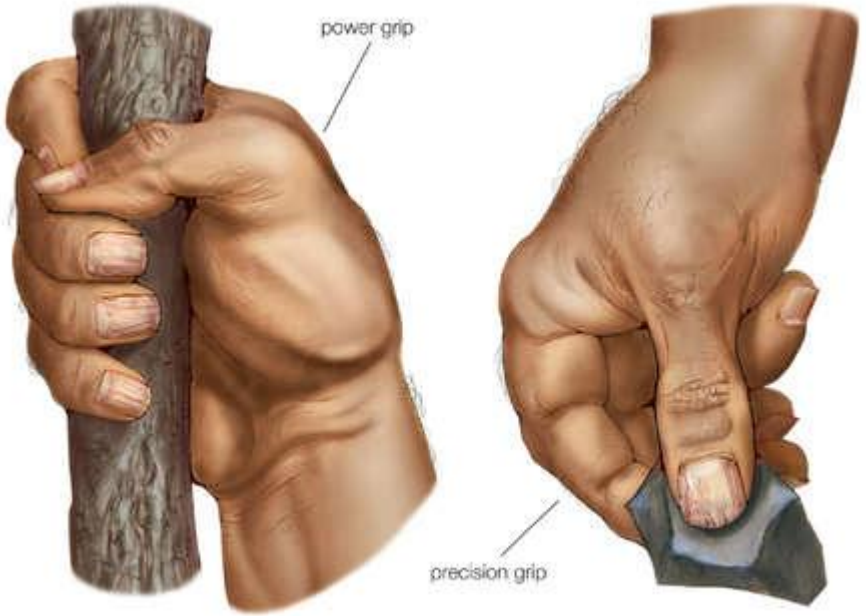
BIPEDALISM

Advantages	Disadvantages
Less energy using only 2 limbs instead of 4 to walk	Cannot run as fast
Higher up to see – food	Strain on hips/back since upright
Can spot predators	More energy used since defying gravity
Less sun exposure	

Opposable Thumb

- **Manual dexterity**
  - Flexible hands
  - 5 digits
  - Use tools
  - grasp





NO thumbs ☹

- How would handwriting look?
- How about a high 5?
- How about turning a door knob?
- How about eating?
- Can you think of others?

Shamus (my cat) has No thumbs ☹

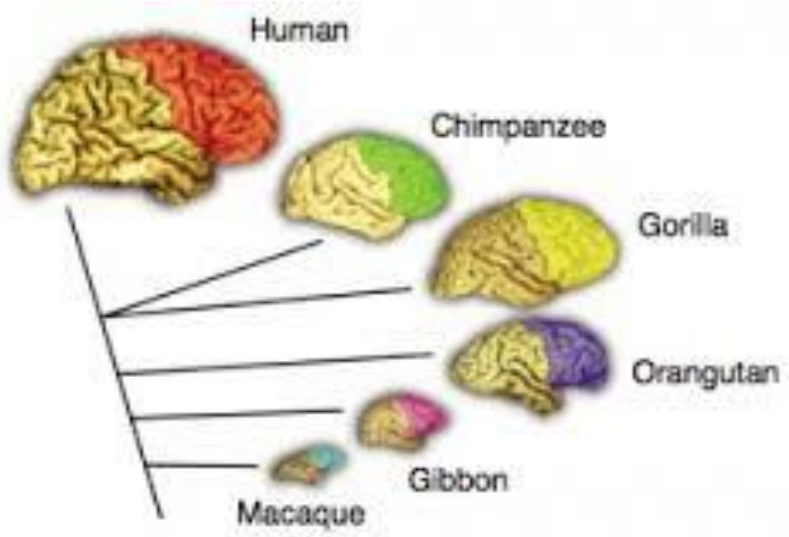
How can he grab things?

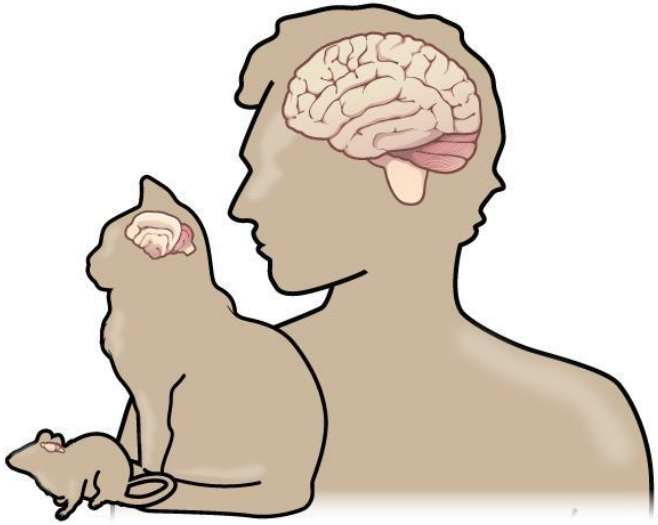
Diurnal

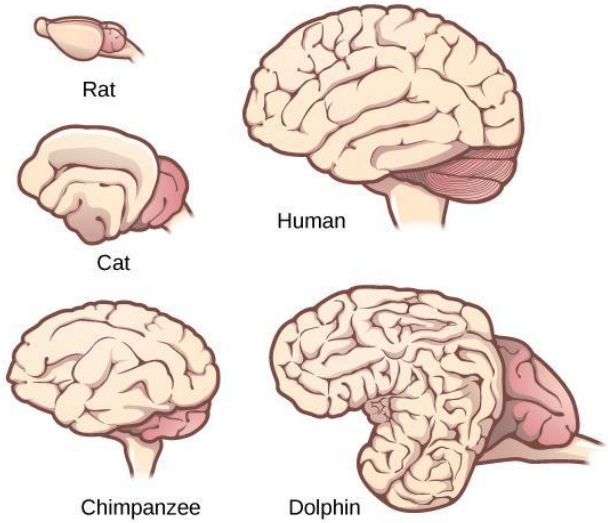
- Active during the day

Brain

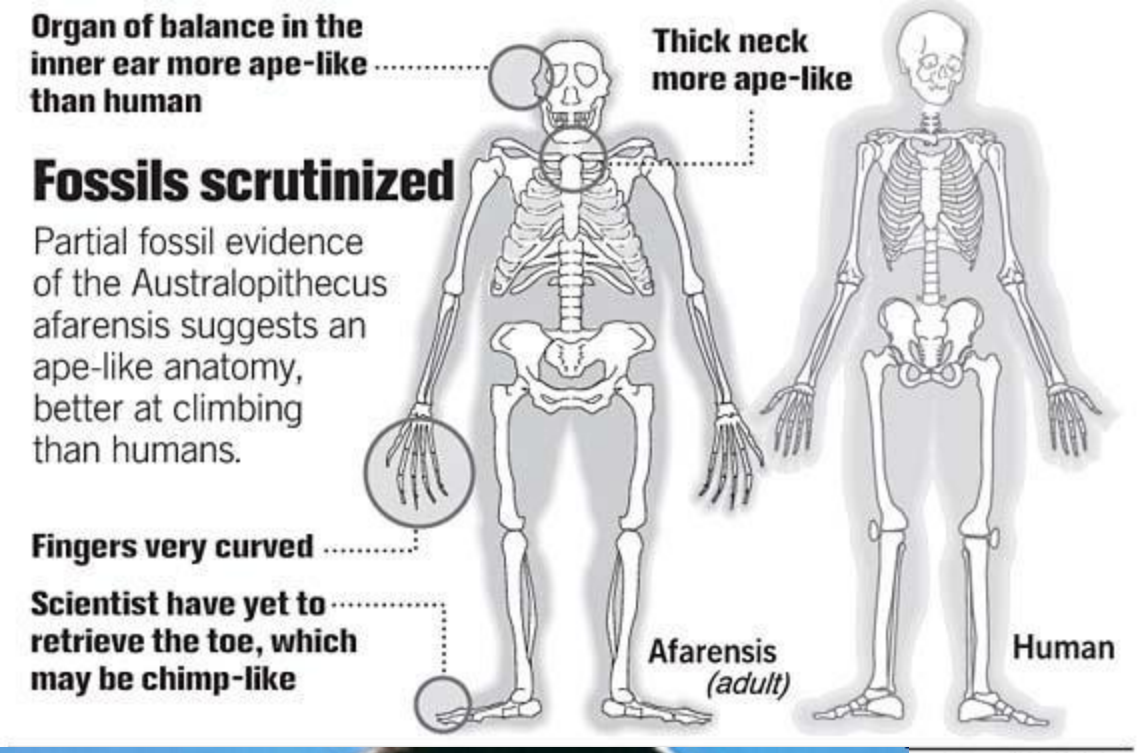
- Become larger and **<u>larger</u>**
- Ability to think in complex terms
- Formed language
- Formed culture

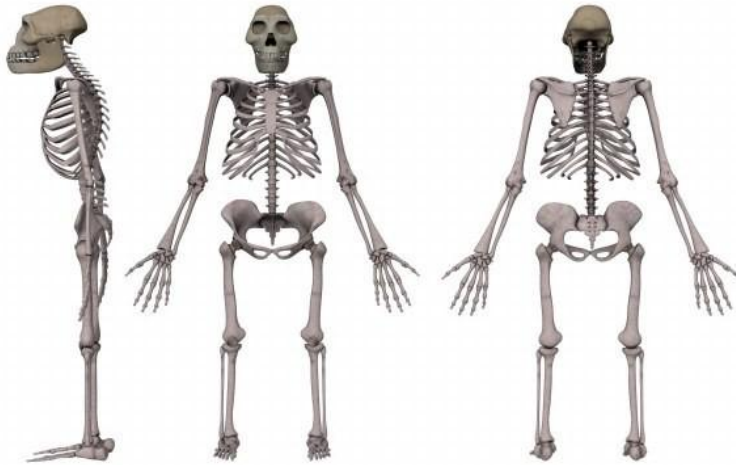




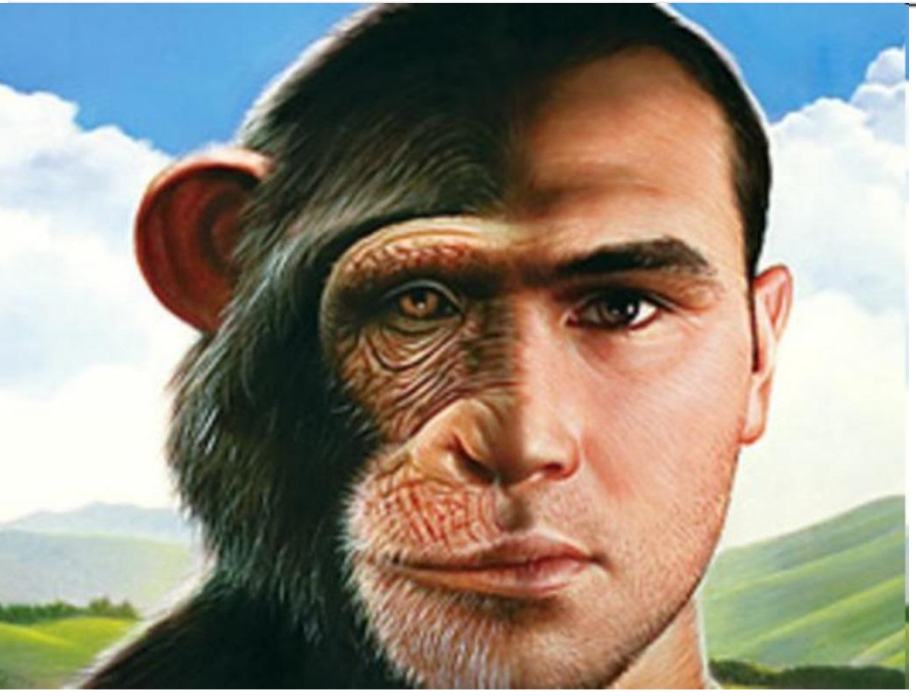


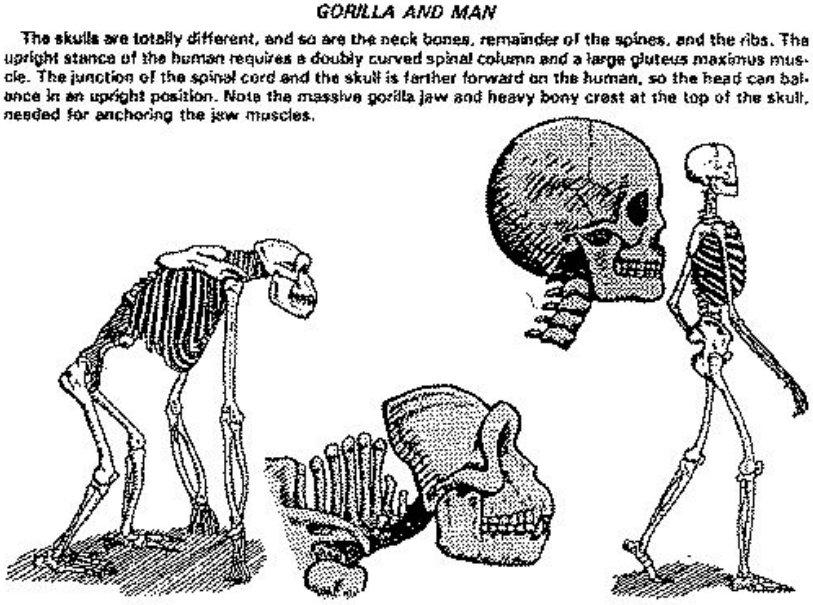
Quadrupeds vs Bipeds





Australopithecus afarensis





Gorilla	Hominin
Skull attached in the posterior (back)	Skull attached inferiorly (bottom)
Spine has a slight “C” curve	Spine has a “S” curve
Arms longer to help with walking	Legs longer and used most with walking
Long narrow pelvis	Bowl shaped pelvis
Femur angled outward	Femur angled inward

Homo habilis

- Nickname is "**handy man**"
- Lived 2.4 mya – 1.4 mya
- Height about 4 ft.
- Lived in Africa
- Brain size 650 cm^3
- Flat face
- Low forehead
- Long arms
- Human-like teeth
- Climb trees

Homo erectus

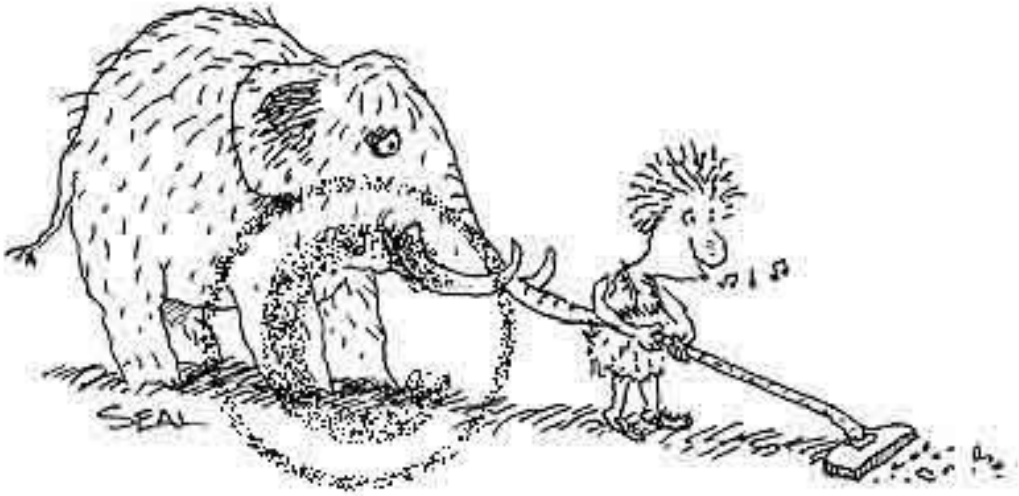
- Nickname is "**<u>Upright man</u>**"
  - Java man and Peking man (fossils found)
  - Lived 1.8 mya – 400,000 y/o
  - 1100 cm^3 brain size
  - Long skull
  - Low forehead
  - Used fire, tools and caves

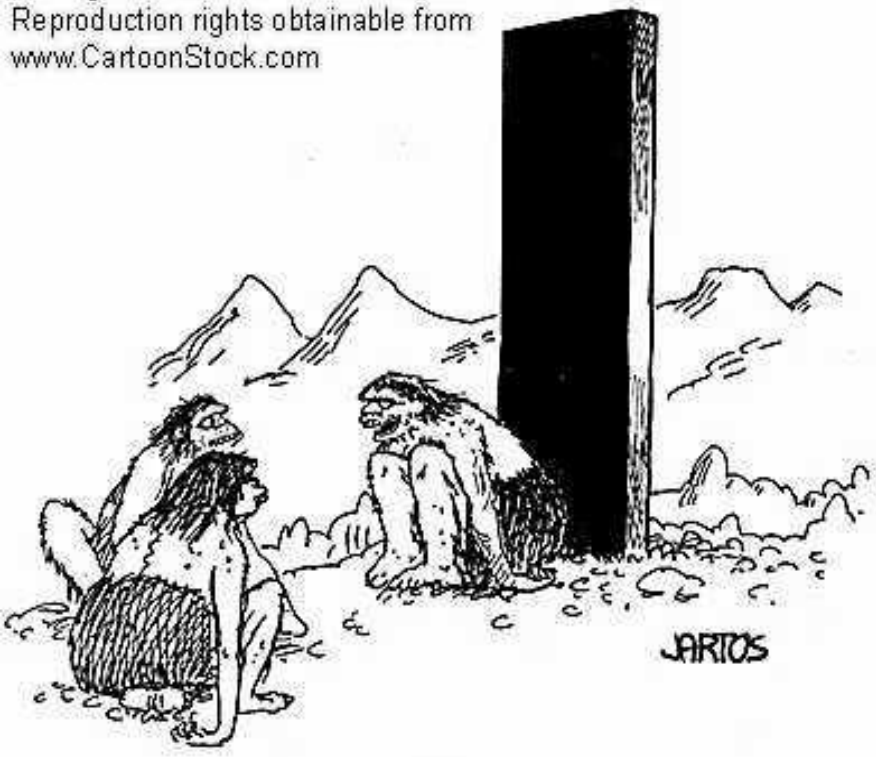
Homo neanderthalenis

- The Neanderthals
- Lived 300,000 – 200,000 y/o
- Short
- Very muscular
- Large brow ridge
- Believed in after-life
- Cared for sick

Homo sapien

- Nickname is "**Wise man"**
- Lived 195,000 – present
- 1350 cm3 brain size
- No brow ridge
- Small chin
- Developed a language
- culture





"I'm an idea man."

"HE JUST WALKS THAT WAY TO TAKE ADVANTAGE OF THE NEW TAX BREAKS FOR BIPEDALS."

Darwin Awards - 1990

The following mind-boggling attempt at a crime spree appeared to be the robber's first, due to his lack of a previous record of violence, and his terminally stupid choices:

- 1. His target was H&J Leather & Firearms. *A gun shop.*
- 2. The shop was full of customers - *firearms customers.*
- 3. To enter the shop, the robber had to step *around a marked police patrol car* parked at the front door.
- 4. A uniformed officer was standing at the counter, having coffee before work.
- Upon seeing the officer, the would-be robber announced a holdup, and fired a few wild shots. The officer and a clerk promptly returned fire, covered by several customers who also drew their guns, thereby removing the confused criminal from the gene pool.
- No one else was hurt.

Darwin Awards – 2008 Florida

- Wearing only swim trunks and sneakers, a 37-year-old man raced his motorcycle toward the Manasota Key drawbridge. As the bridge began to open, it was clear that he intended to "shoot the gap."
- Bridge designers had anticipated such lunacy and invented the crossing guard. The closing gates swept him off his Suzuki, over the side of the bridge, into the water, and out of the gene pool.
- By a twist of fate the motorcycle continued up the ramp and made it across to the other side.

Darwin Awards – 1998 Buenos Aires

- Did he win the argument?
- It happened in February 1998 in a working-class neighborhood. During a heated marital dispute, a 25-year-old man picked up his 20-year-old wife and threw her off their eighth-floor apartment balcony.
- To his dismay, she became tangled in the power lines below. He immediately leapt from the balcony and fell towards his wife. We can only speculate as to his reasons: Was he angrily trying to finish the job, or was he remorsefully hoping to rescue her? He did not accomplish either goal. He missed the power lines completely, and plunged to his death.
- The woman managed to swing over to a nearby balcony and was saved.

Darwin Awards – 2016 Wyoming

- Colin Mathaniel Scott, 23, was enjoying a graduation vacation at Yellowstone National Park
- The hot spring reminded him that he could use a good soak! But "hot-potting" is a forbidden delight, ruled off-limits for good reason: You will die.
- Still, this was a college graduation trip.
- Colin left the boardwalk and cruised up a hill in search of a private *hot* soaking spot. In this area of the park, thin mineral crusts that resemble solid ground conceal scalding water pools! But he avoided these unseen pitfalls and found a secluded spring.
- Recorded on unreleased video, Colin is seen reaching down to check the temperature, slipping, and falling into the boiling acidic water. That was the beginning of the end.