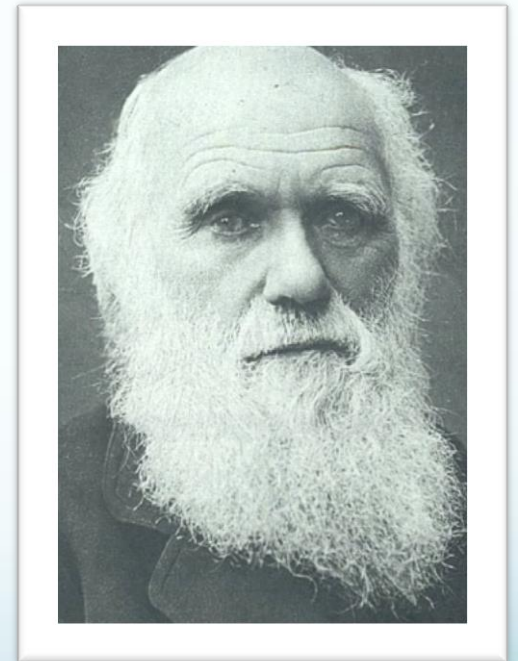


# Evolution

## Diversity of Life

**“Nothing in biology  
makes sense EXCEPT  
in the light of  
evolution.”**

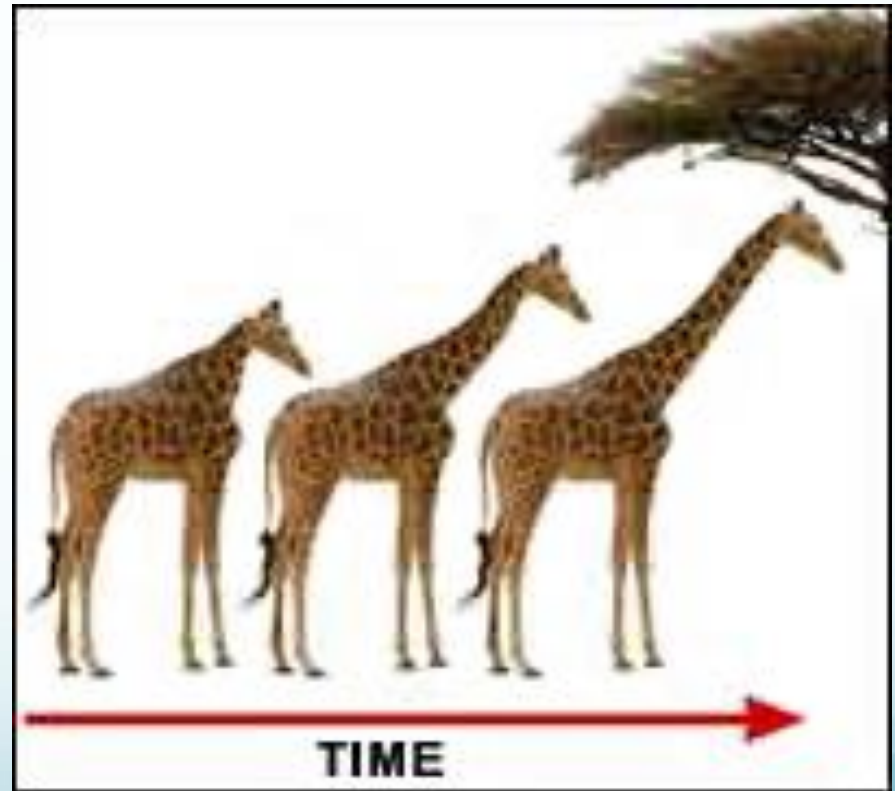
***Theodosius Dobzhansky***



Charles Darwin at 72 years  
old in 1881

# Lamarck's Theory of Evolution

- Idea called **Law of Use and Disuse**
- If a body part were used, it got stronger
- If body part NOT used, it deteriorated



# Lamarck's Contributions

Lamarck is credited with helping put evolution on the map and with acknowledging that the **environment plays a role** in shaping the species that live in it.

Lamarck held that evolution was a **constant process** of striving toward greater complexity and perfection.

- Even though this belief eventually gave way to Darwin's theory of natural selection, Darwin **disagreed that evolution strived for perfection.**
- **Darwin** concluded evolution was based on **random variation**, rather than striving towards a goal (perfection).

# Population Growth

- **Thomas Malthus**, 1798
- Economist
- Observed **babies being born faster than people were dying.**
- **Population size is limited by resources** such as the food supply.



# Population Growth

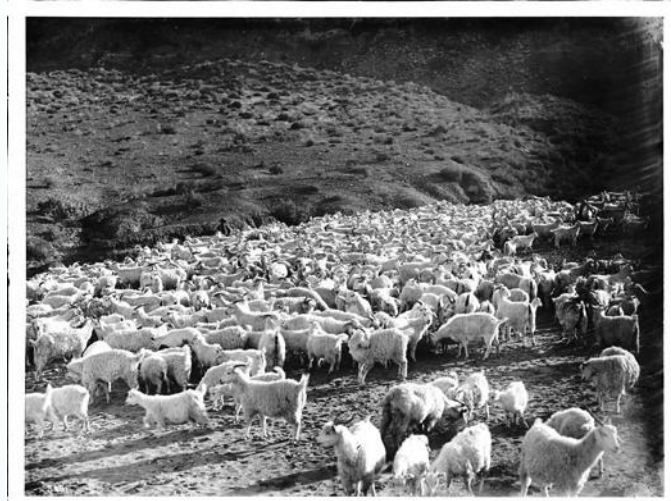
- **Malthus** reasoned that if the human population **continued to grow unchecked**, sooner or later there would be **insufficient living space & food for everyone**
- **Death rate** will increase to **balance population size & food supply**





# Population Growth

- Darwin realized Malthus's principles were visible in nature.
- Plants & animals produce far **more offspring than can be supported.**
  - Most offspring die; otherwise the Earth would be **overpopulated.**



# Charles Darwin the Naturalist



# The Galapagos Islands

- **Group of 16 Islands 1000 km West of South America, part of Ecuador.**

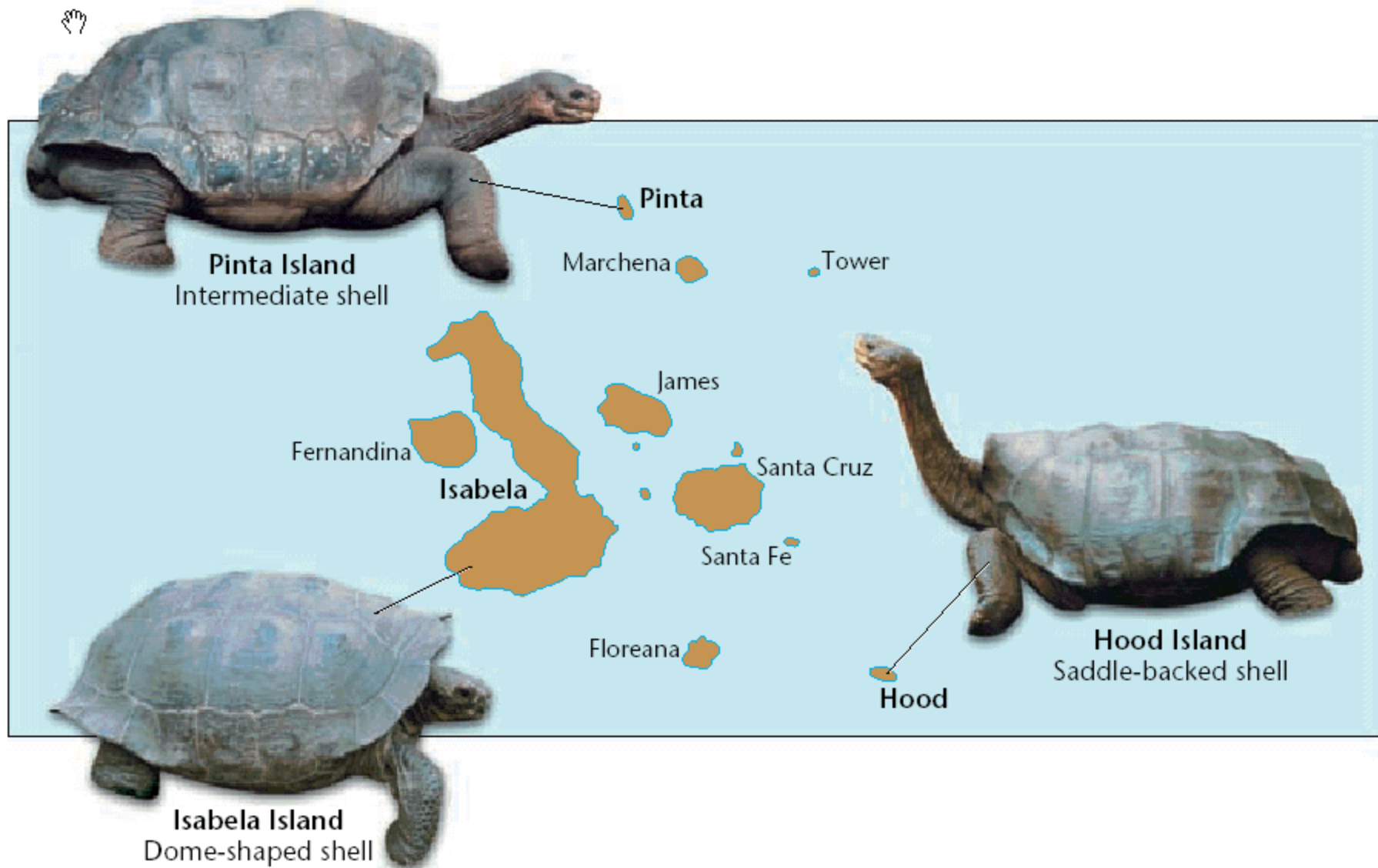




The Galapagos islands are named after the unique giant tortoises that live there.



In Spanish, “galápagos” means tortoise.

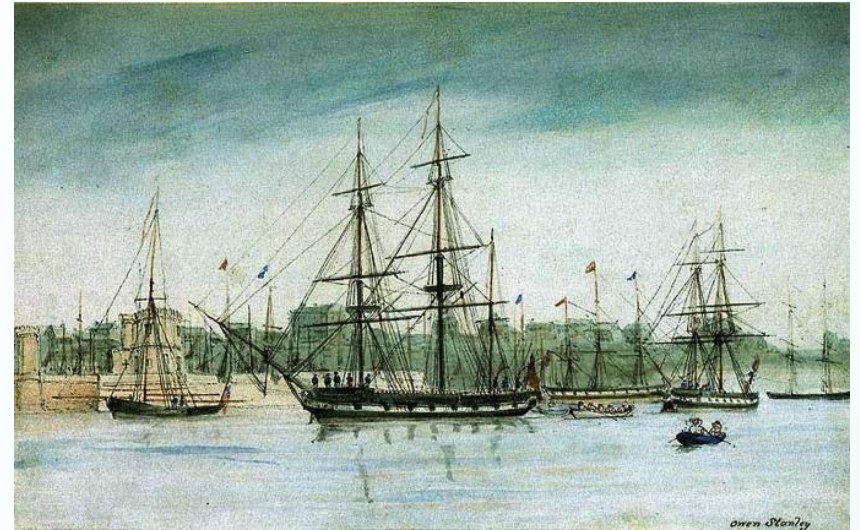


# The Voyage of the Beagle

The *HMS Beagle* sailed from England on December 27<sup>th</sup>, 1831 and returned on October 2<sup>nd</sup>, 1836.

The Beagle sailed across the Atlantic Ocean to do detailed hydrographic surveys around the southern coasts of **South America**.

The Captain, Robert **FitzRoy**, invited Charles Darwin because he wanted a naturalist to accompany him.



The Beagle arrived at the Galapagos islands on September 15<sup>th</sup>, 1835.



# The Galapagos Islands & Darwin

“It is like witnessing the appearance of new beings on earth” –Charles Darwin in regards to his trip to the Galapagos islands.

**Darwin enjoyed observing the giant tortoises; it was pointed out to him that you could tell which tortoise came from which island simply by observing its shell.**



**However, it was the FINCHES of the Galapagos that gave Darwin his “aha” moment!**







# The Galapagos Islands

- Finches on the islands resembled a **mainland finch**.
- **More** types of finches appeared on the islands where the **available food was different** (seeds, nuts, berries, insects...)
- Finches had **different types of beaks adapted** to their **type of food gathering**





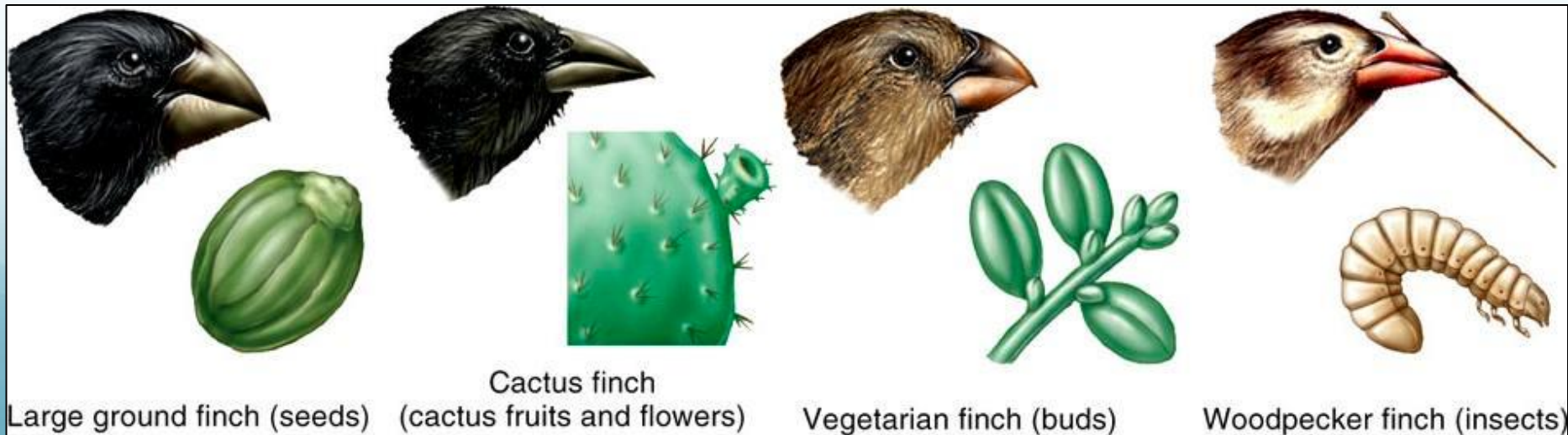
## Galápagos Islands Finches

<b>Shape of Head and Beak</b>						
<b>Name</b>	Vegetarian tree finch	Large insectivorous tree finch	Woodpecker finch	Cactus ground finch	Sharp-beaked ground finch	Large ground finch
<b>Main Food</b>	Fruit	Insects	Insects	Cactus	Seeds	Seeds
<b>Feeding Adaptation</b>	Parrotlike beak	Grasping beak	Uses cactus spines	Large crushing beak	Pointed crushing beak	Large crushing beak
<b>Habitat</b>	Trees	Trees	Trees	Ground	Ground	Ground

# The Galapagos Islands & Darwin

Darwin concluded that one type of finch from South America had arrived on the recently-risen islands and, like the tortoises, had adapted to the different opportunities found on each island.

Later, On the Origin of Species, Darwin drew heavily on the animals he saw in the Galapagos, to advance his radical notion that their creation was not a single event, but a process of change, from one form, into many different ones.

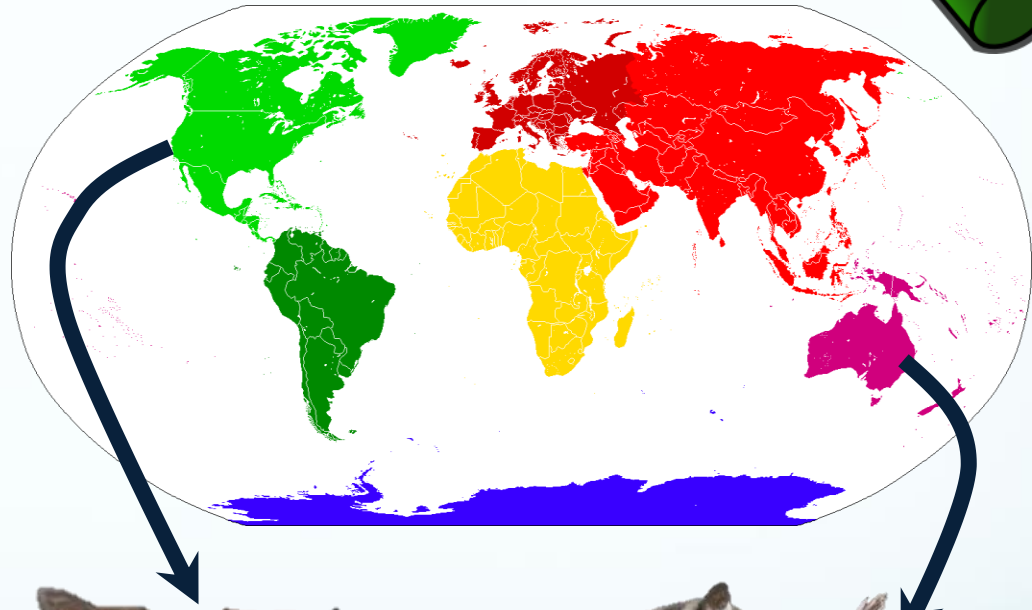




# Darwin's Observations



- **Patterns of diversity** were seen
- **Unique** adaptations in organisms
- Species **were not evenly distributed**
  - **Australia= Kangaroos, but no rabbits**
  - **S. America= llamas**



Flying squirrel-  
North America

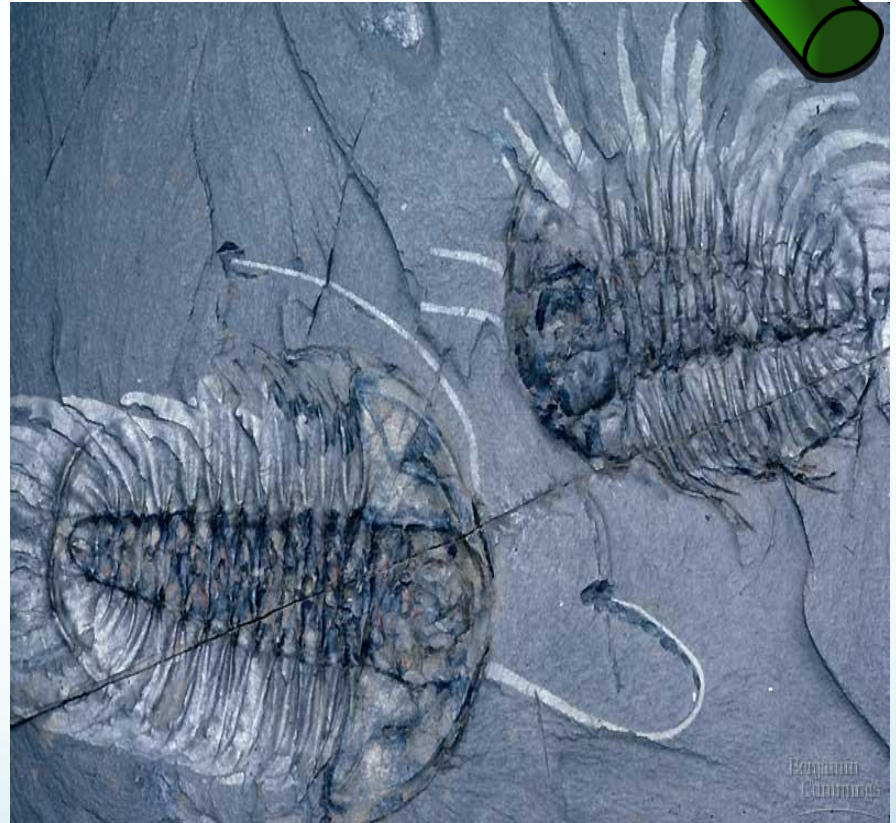


Sugar glider- Australia

# Darwin's Observations



- Darwin collected fossils of both extant (still living) and **extinct** organisms.
- Fossils included:
  - ✓ **Trilobites**
  - ✓ Giant ground sloth of South America

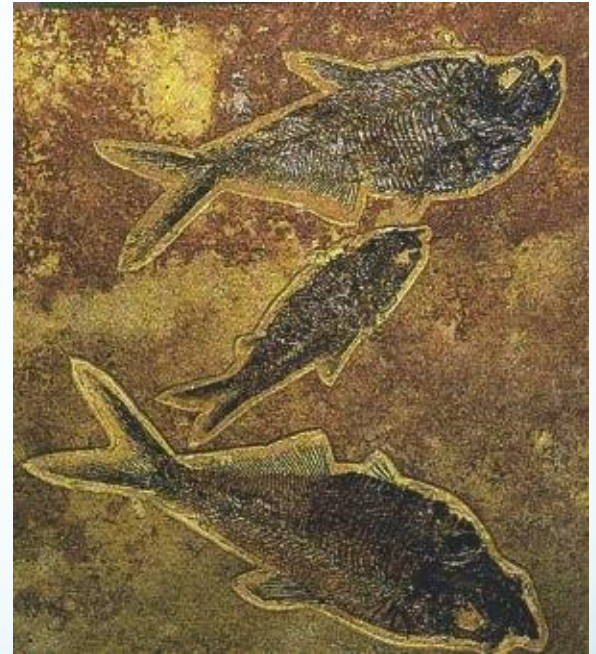


**This species NO longer existed.**  
**What had happened to them?**

# Darwin's Observations



- Left unchecked, the number of organisms of each species will **increase exponentially**, generation to generation
- In nature, populations tend to **remain stable** in size
- Environmental **resources are limited.**





# Darwin's Observations



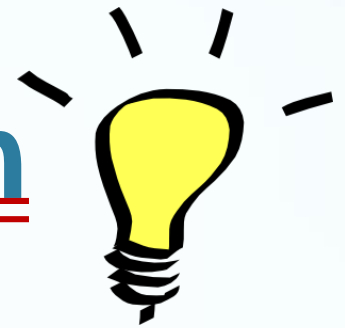
Individuals of a population vary extensively in their characteristics with **no two individuals being exactly alike.**



- Much of this variation between individuals is **inheritable.**



# Darwin's Conclusion



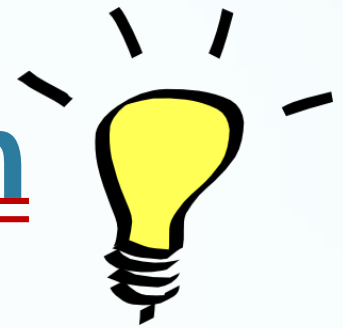
- Production of more individuals than can be supported by the environment leads to a **struggle for existence among individuals.**

- Only a fraction of offspring survive each generation

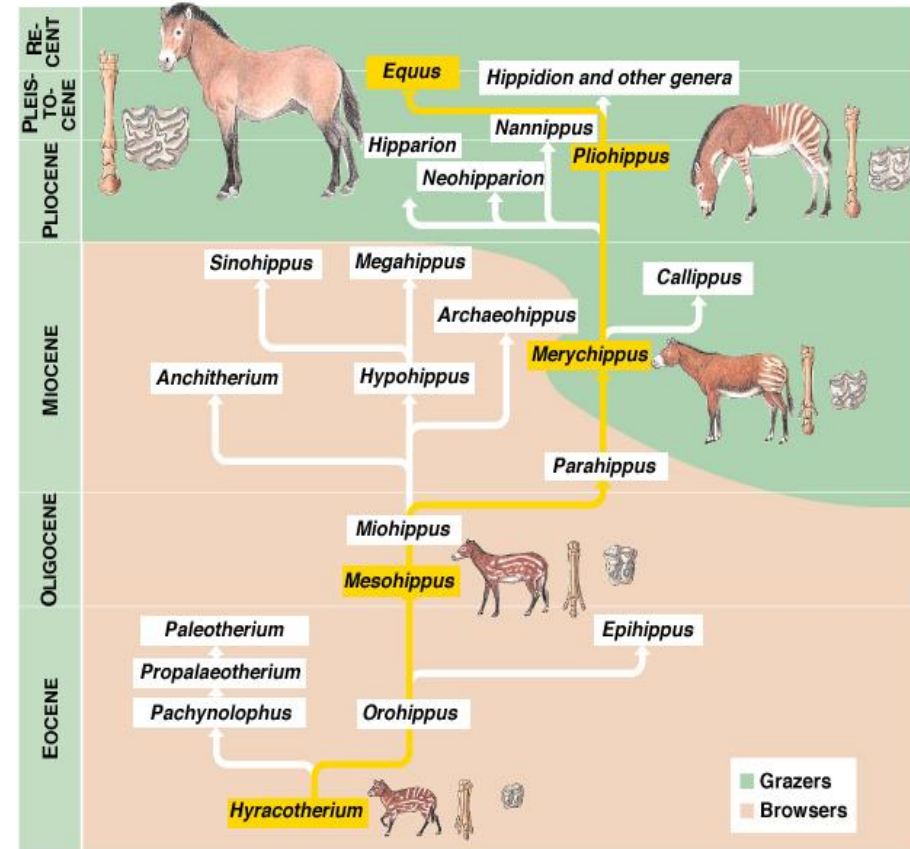
- **Survival of the Fittest**



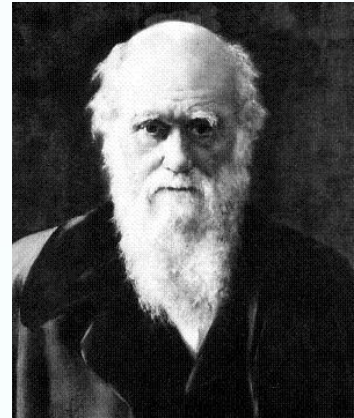
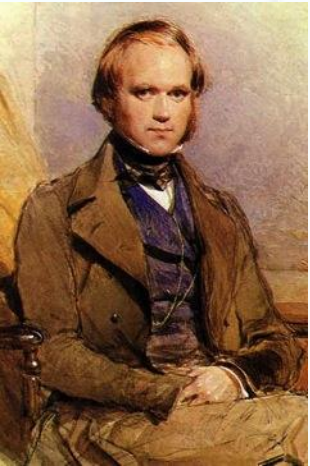
# Darwin's Conclusion



Individuals who **inherit characteristics most fit for their environment** are likely to leave **more offspring** than less fit individuals.



# Darwin's Evolutional Theory of Natural Selection





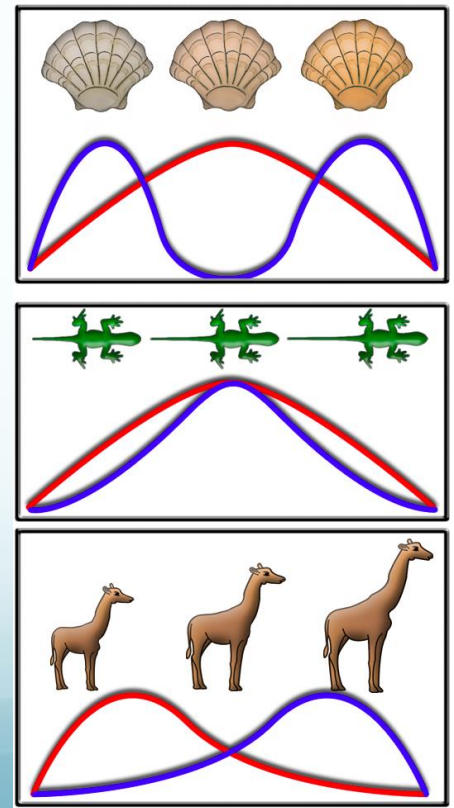
# What is natural selection?

- Individuals that have physical or behavioral traits that better suit their environment are more likely to survive and will reproduce more successfully than those that do not have such traits.

Survival of the fittest!!!!

- Acts on a range of **phenotypes** in a **population**.
  - NOT Individuals!!!!!!!!!!

Population- all members of a species that live in an area.



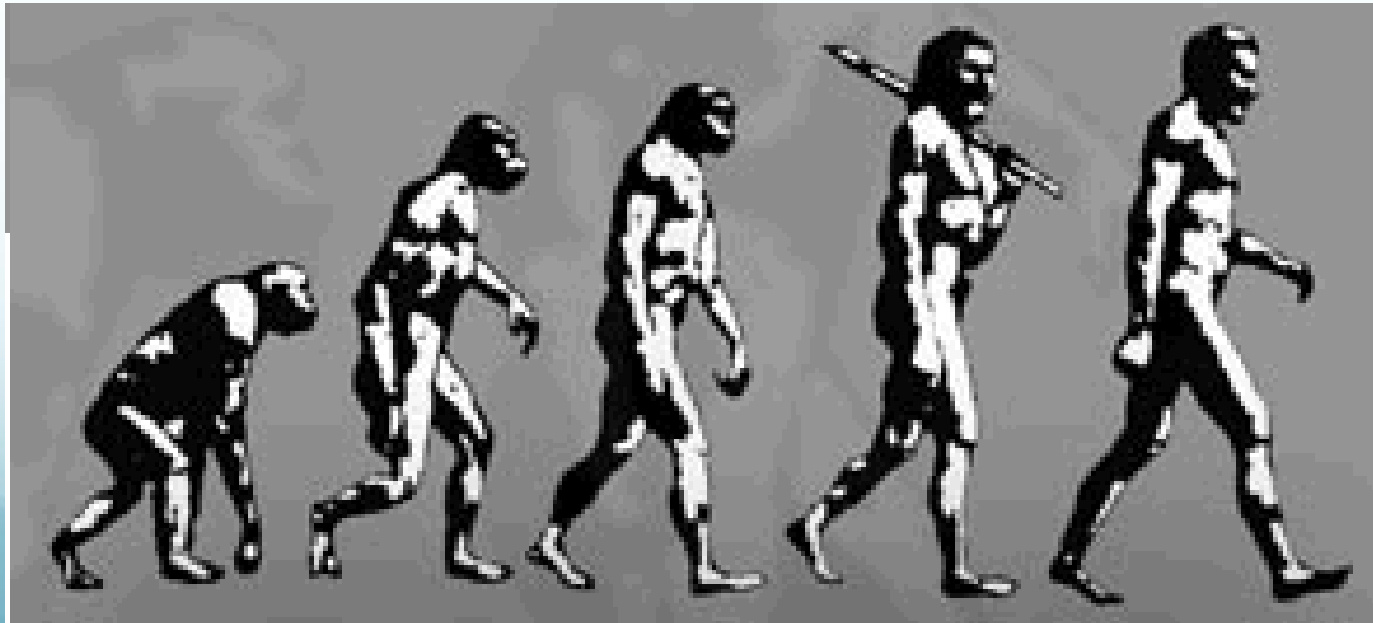


# So what is Evolution?

**Evolution** occurs as a population's genes and frequencies change over time!

- Creating new phenotypes

**But how can things change??????**



# What can cause genetic changes?

\*Mutations      \*Environmental changes

\*Radiation      \*Chemicals

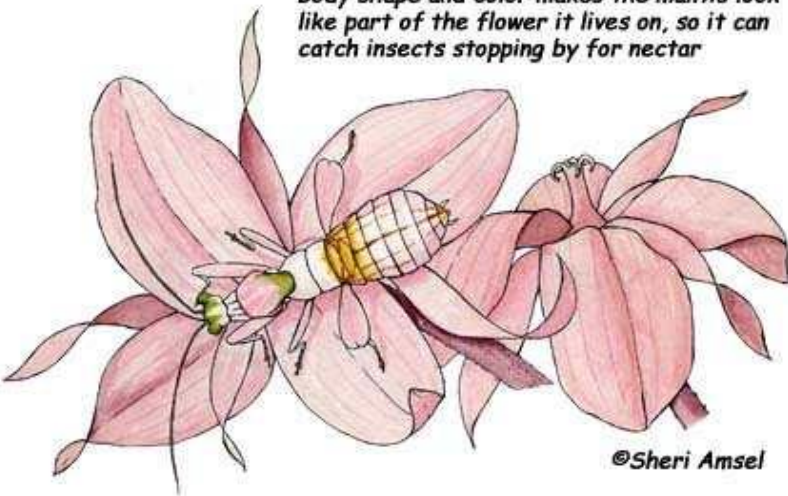
Some examples are:

Reproductive isolation-when populations can't breed due to geographic separation

Gradualism-gradual change over a long period of time leading to new species

### Orchid Mantis

body shape and color makes the mantis look like part of the flower it lives on, so it can catch insects stopping by for nectar



# Adaptation

An adaptation is **an inherited characteristic that increases an organism's chance for survival.**

**Could be a behavior, sound, appearance, etc.**

**Adaptations become common in a species. The more common it is, the more adapted the species is.**



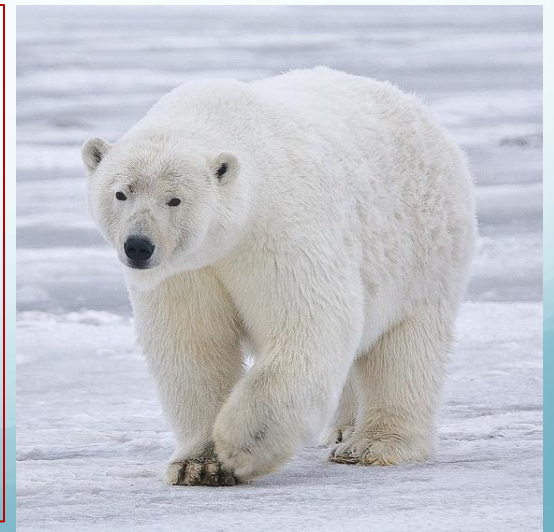
# Adaptation

- Adaptations can be:
  - **Physical**
  - Speed, camouflage, **claws**, quills, etc.
  - **Behavioral**
    - Solitary, **herds**, packs, activity, etc.



Individuals do not get to pick and choose their adaptations.

Adaptations are qualities already present among some individuals in a population (luck of the draw). As the adaptations become more common, the species adapts.



# Mimicry

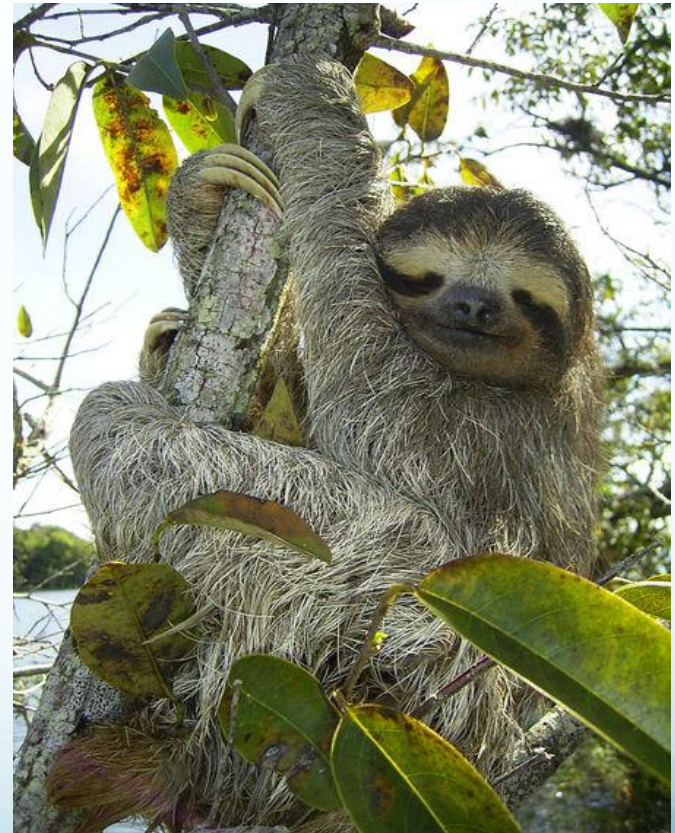
- When one species is able to resemble another
  - Species is harmless resembling something harmful





# Camouflage

- To resemble its surroundings
  - A defense mechanism used by many animals!
    - Fish
    - Crabs
    - Bugs
    - Snakes
    - Frogs
    - Can you think of any others?





**Can you find  
the animals in  
these 2  
pictures?**







# In other words.....

- Natural Selection is:
  - When certain variations survive, reproduce and pass their **variations** to the next **generation**.
  - Take many generations to develop

Examples?

Examples?

Examples?



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

Examples?

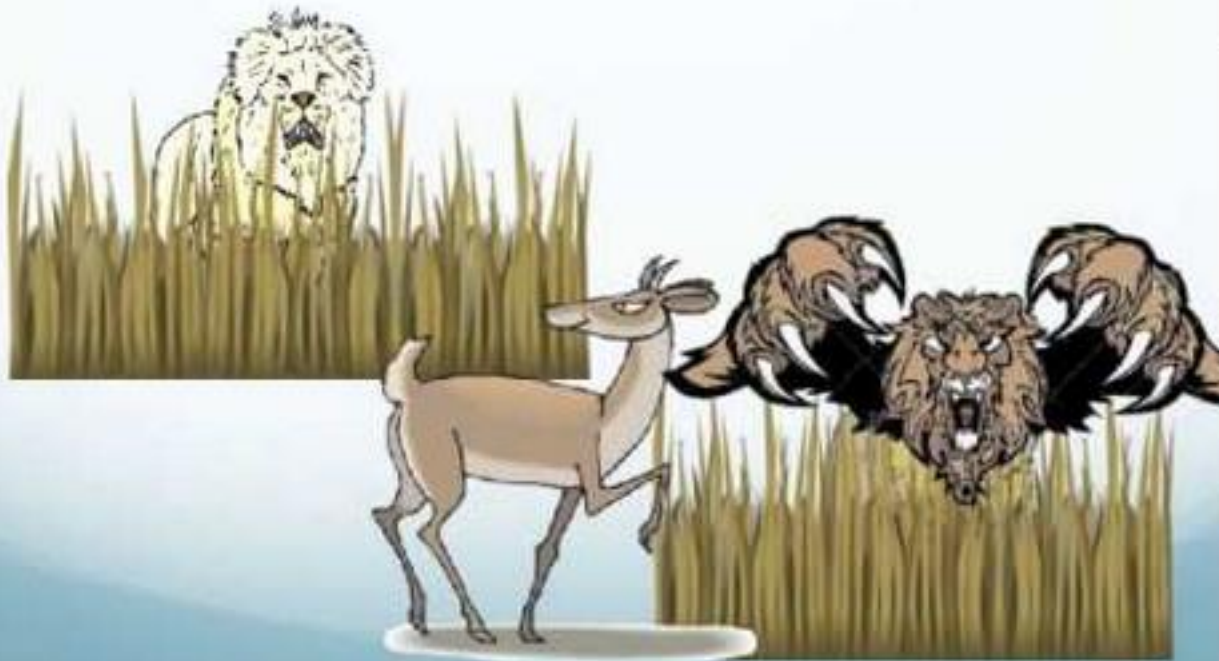
Examples?

Examples?





# Natural Selection





0:45 / 4:24



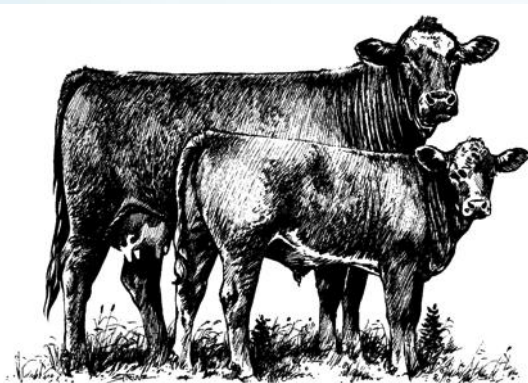
# Natural Selection

## IMPORTANT NOTES

- Adaptations are a “luck of the draw”- **if a species does not adapt, it does not survive**. Chances are slim.
- Any individual CANNOT **change during its lifetime**; it can however pass changes (**mutations within sex cells**) onto its offspring.
- Natural selection does not “give” organisms what they need; it is a **long process** that **favors certain variations**.
- The driving mechanism behind the process of natural selection is **genetic variation**.
  - Natural selection **favors/acts upon PHENOTYPES** (the physical quality of an organism)- which as a result causes a change in the **gene pool** – genes determine the phenotypes.

# Natural Variation and Artificial Selection

- **Natural Variation**
  - Differences among individuals of a species
- **Artificial Selection**
  - Selective breeding to **enhance desired traits among stock or crops**





# Examples of Selective Breeding



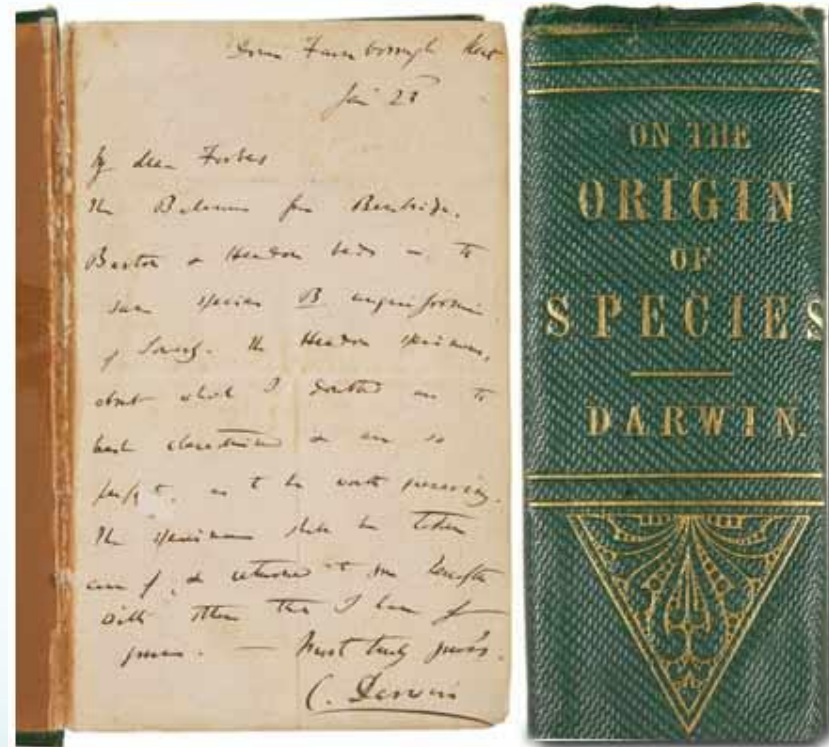
# *The Origin of Species*

Darwin's *The Origin of Species* was published on November 24<sup>th</sup>, 1859.

(Full title: *On the Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life.*)

Darwin initially only shared his research with a select few.

Darwin published because Charles Lyell urged him to after Alfred Russel Wallace published an article with ideas similar to Darwin's.



# Mendel's Studies are the Missing Link

- In Darwin's time, there was no mechanism to explain natural selection.

How could **favorable variations** be transmitted to later generations?

With the rediscovery of **Mendel's work** in the first half of the 20th century, the missing link in evolutionary theory was found.

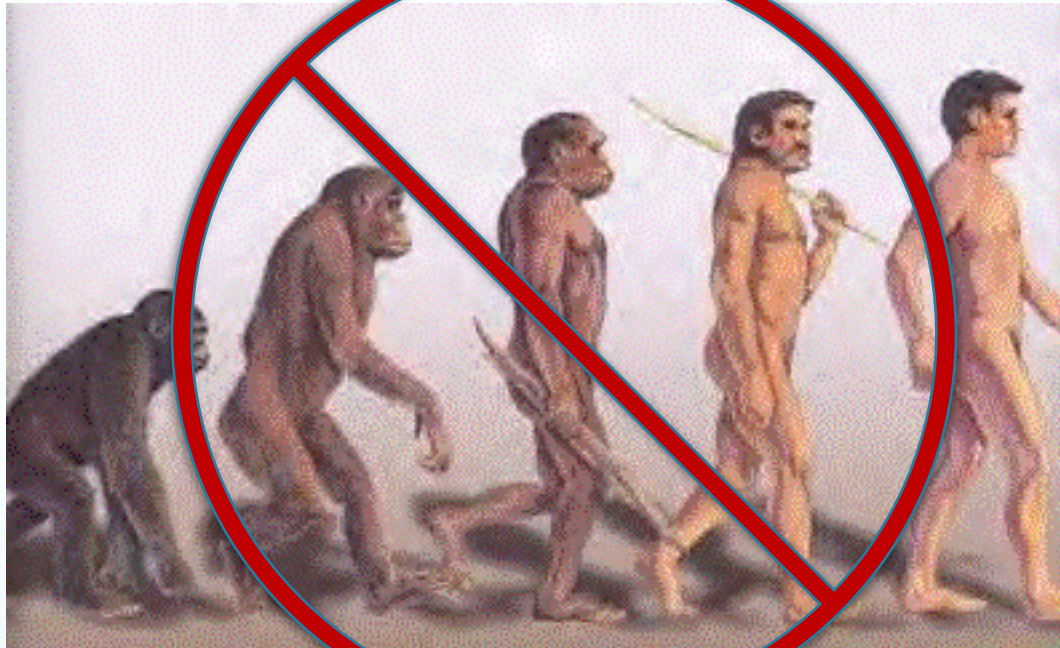






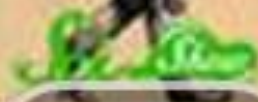


# This is NOT Evolution



Darwin and others were not suggesting that man evolved from apes. They were suggesting that apes and humans share a common ancestor.

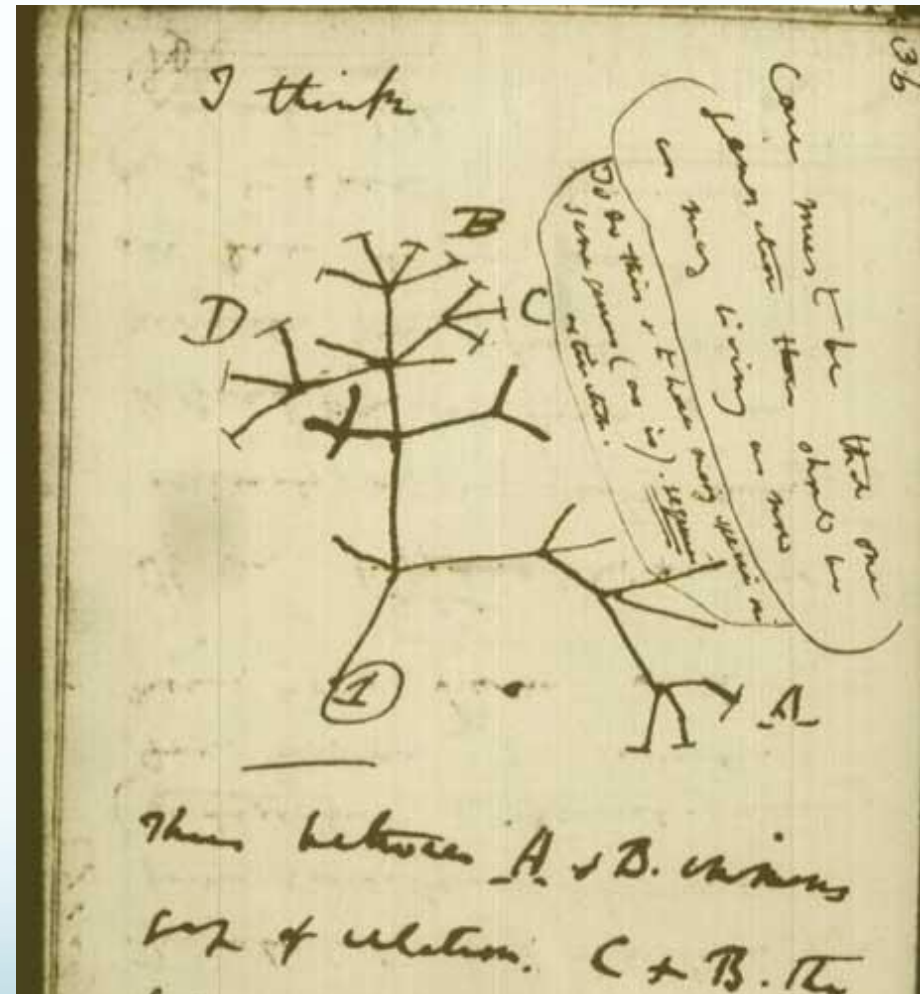
THIS IS **NOT**  
WHAT **EVOLUTION**  
**LOOKS** LIKE



▶ **PLAY**

- Evolution is more like a branch, or a tree, rather than a lineage.

"I think case must be that one generation should have as many living as now. To do this and to have as many species in same genus (as is) requires extinction. Thus between A + B the immense gap of relation. C + B the finest gradation. B + D rather greater distinction. Thus genera would be formed. Bearing relation" (next page begins) "to ancient types with several extinct forms"- **Darwin as written in his journal from the Voyage of the Beagle**



# Evidence for Evolution



**Embryonic  
Development**

**Microevolution**

**Body Structures**

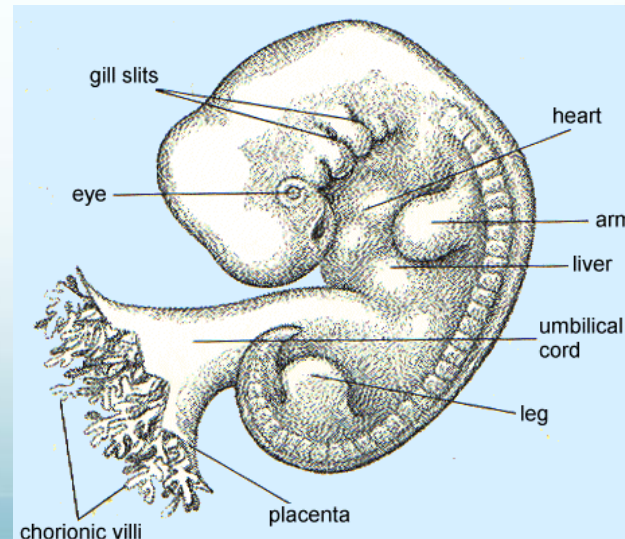
**Biological  
Molecules**

**The Fossil Record**

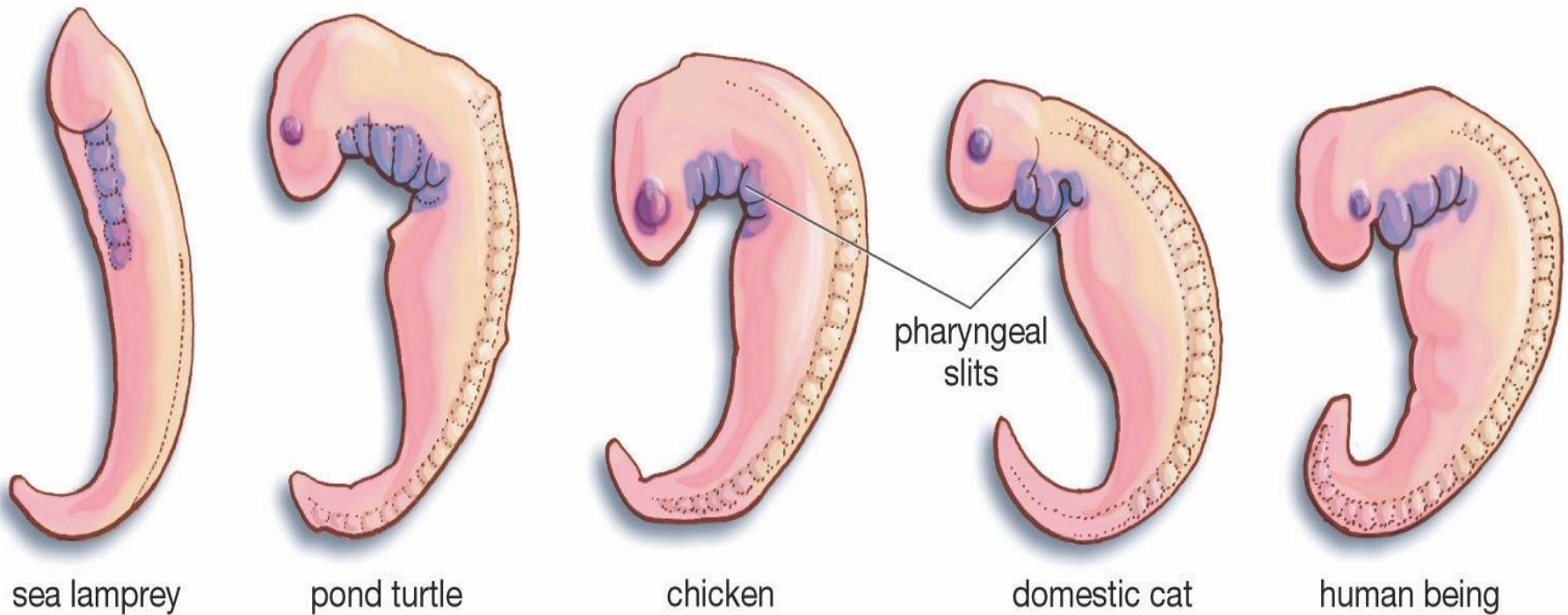


# Similarities In Early Development

- Embryonic Structures Of Different Species Show Significant Similarities
- **Embryo** – early stages of vertebrate development



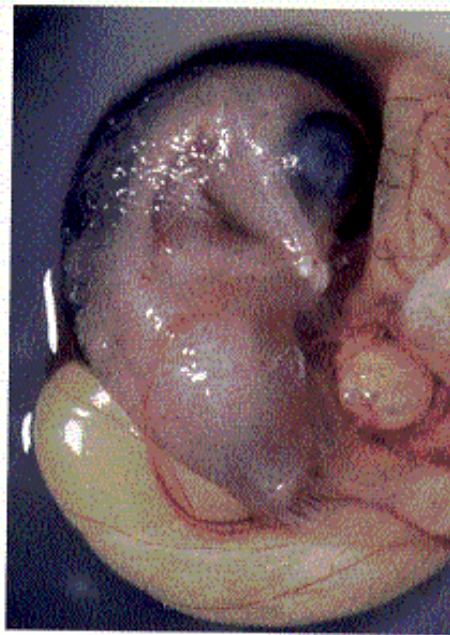
Pharyngeal slits exist in these five vertebrate animals ...



... evidence that all five evolved from a common ancestor.

# Similarities In Embryonic Development

# Chicken



# Turtle



Pharyngeal pouches are present during embryonic development.

# Human





# Microevolution

- Evolution that we can see in action during a small amount of time (remember evolution is change {in genes} over time).
- Examples include Peppered moths, antibiotic resistance, pesticide resistance in insects.

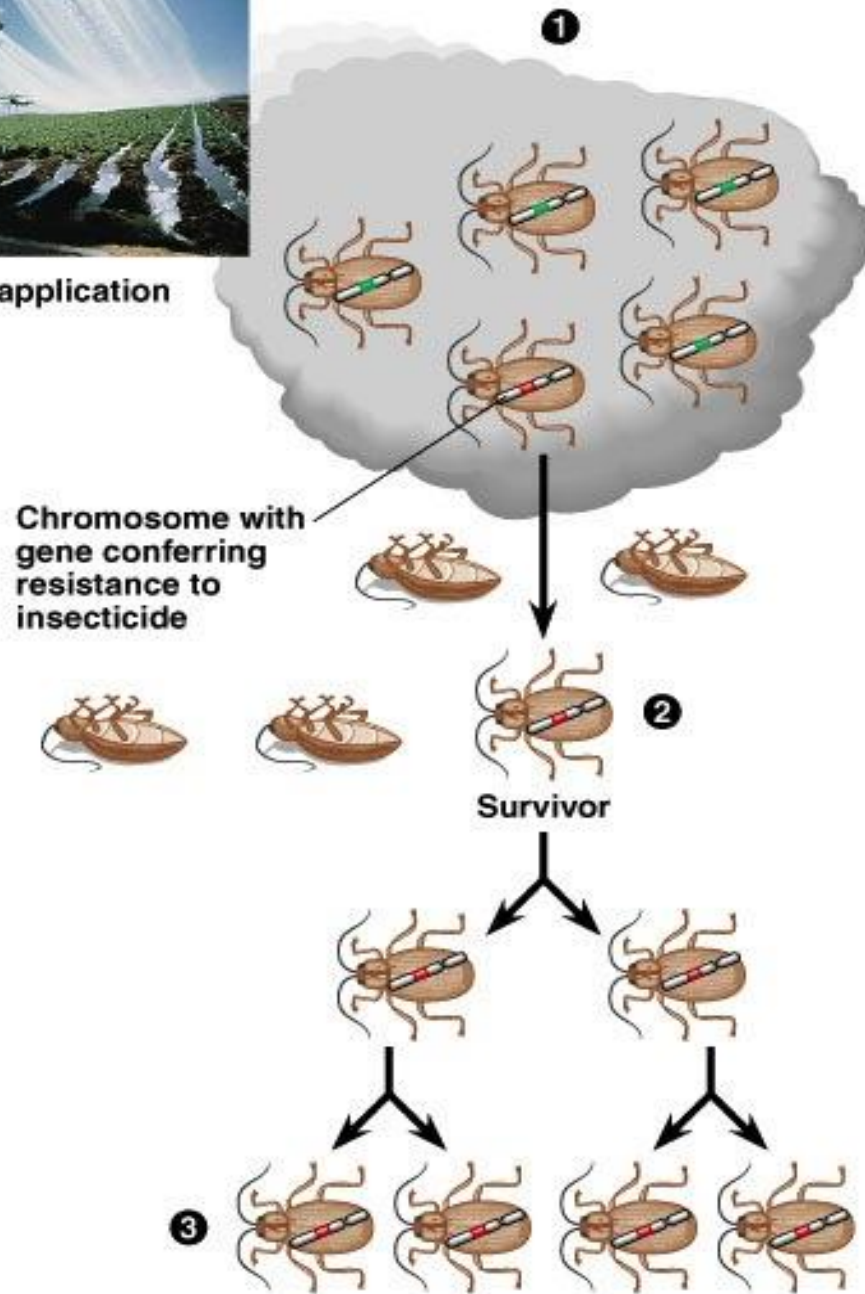


The Peppered Moth

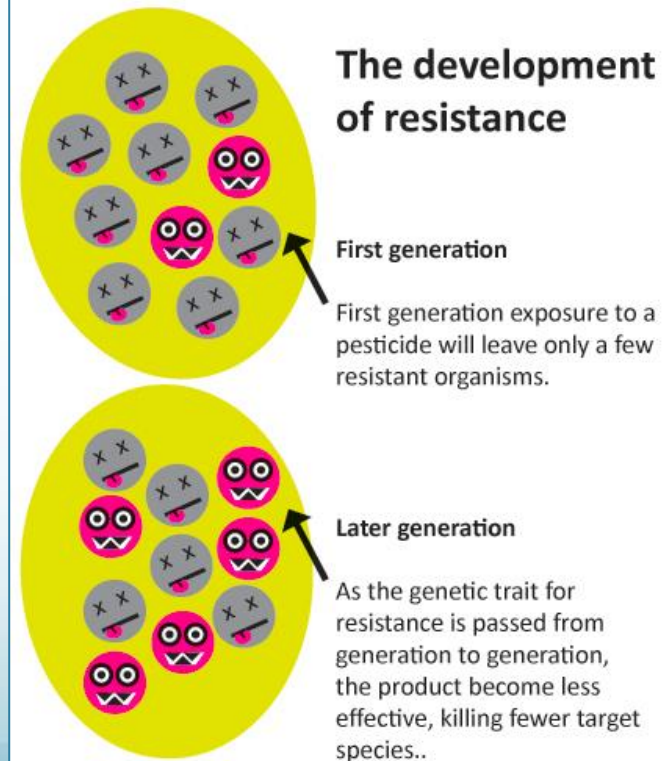


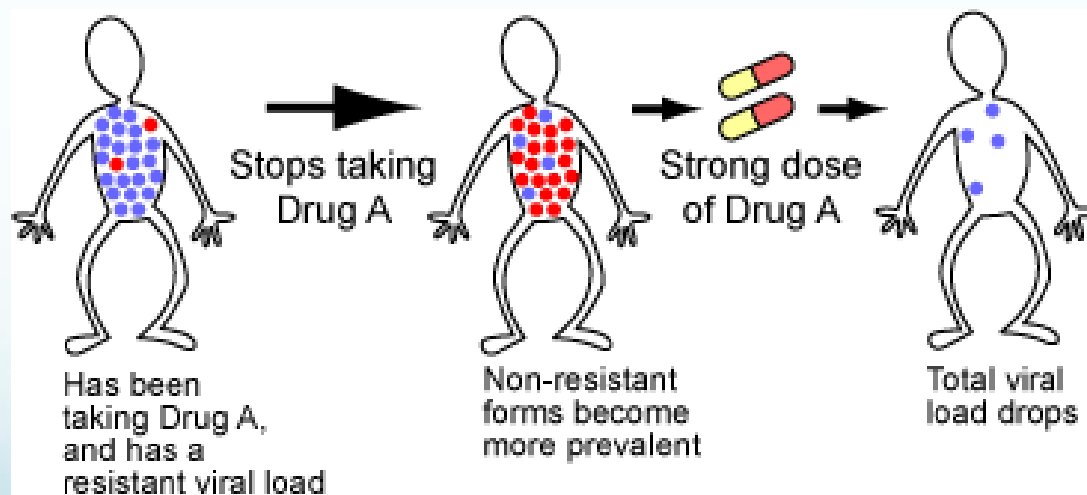
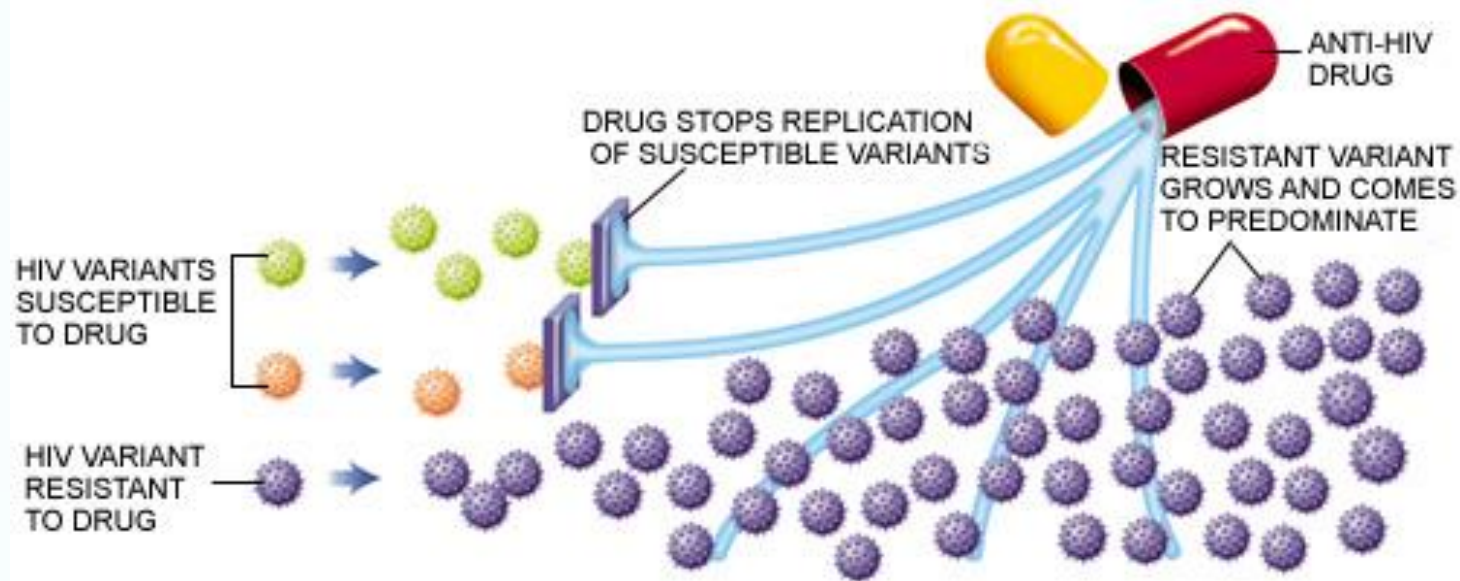


**Insecticide application**



# Evolution of pesticide resistance in response to selection

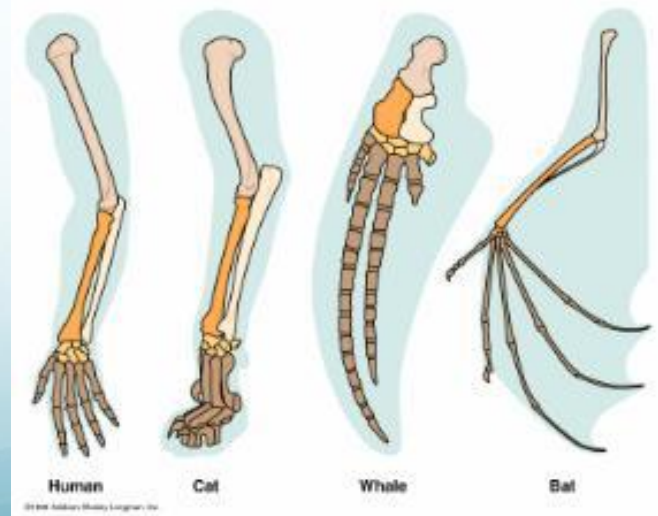




## Evolution of drug-resistance in HIV

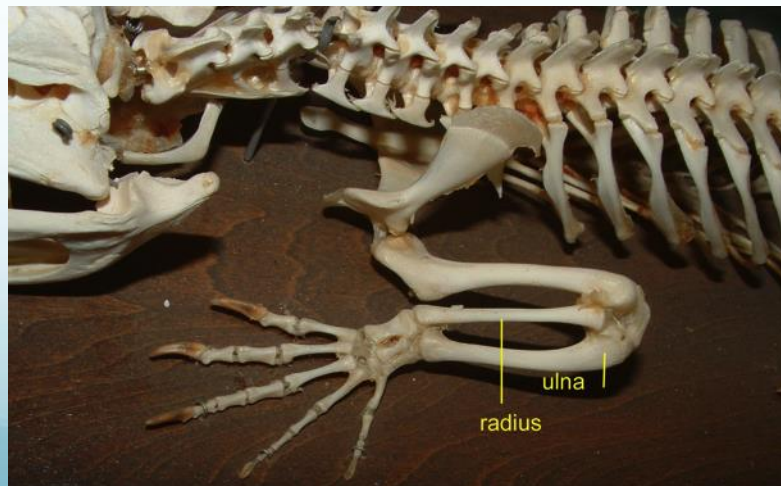
# Homologous Body Structures

- **Related** structures that are inherited from a **common ancestor**.
  - Structures have **different mature forms** but develop from the **same embryonic tissues**
- Provide strong evidence that all four-limbed animals with backbones descended, with modification, from a common ancestor.

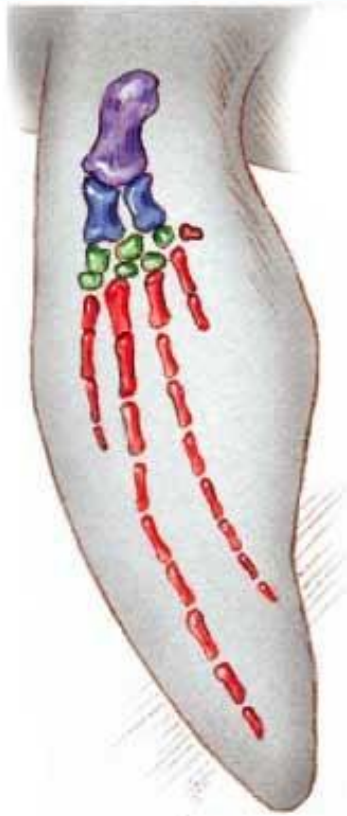


# Homologous Body Structures

- Scientists noticed animals with backbones (vertebrates) had similar **bone structure**
- May differ in form or function
- **Limb bones develop in similar patterns**
  - Arms, wings, legs, flippers



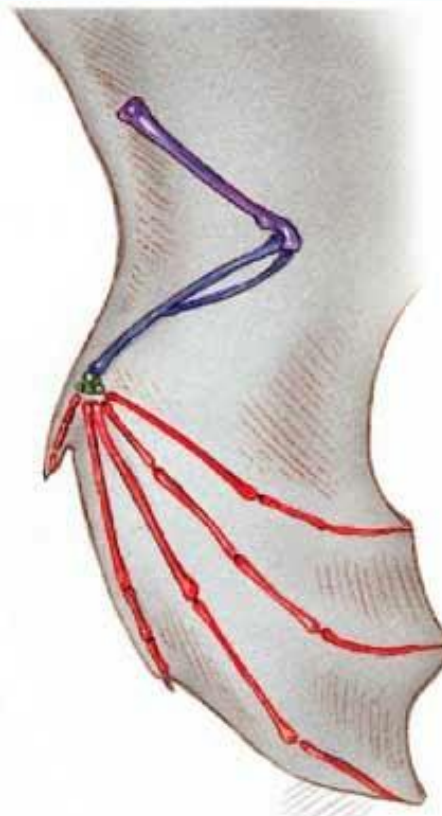




**Whale**



**Cat**



**Bat**

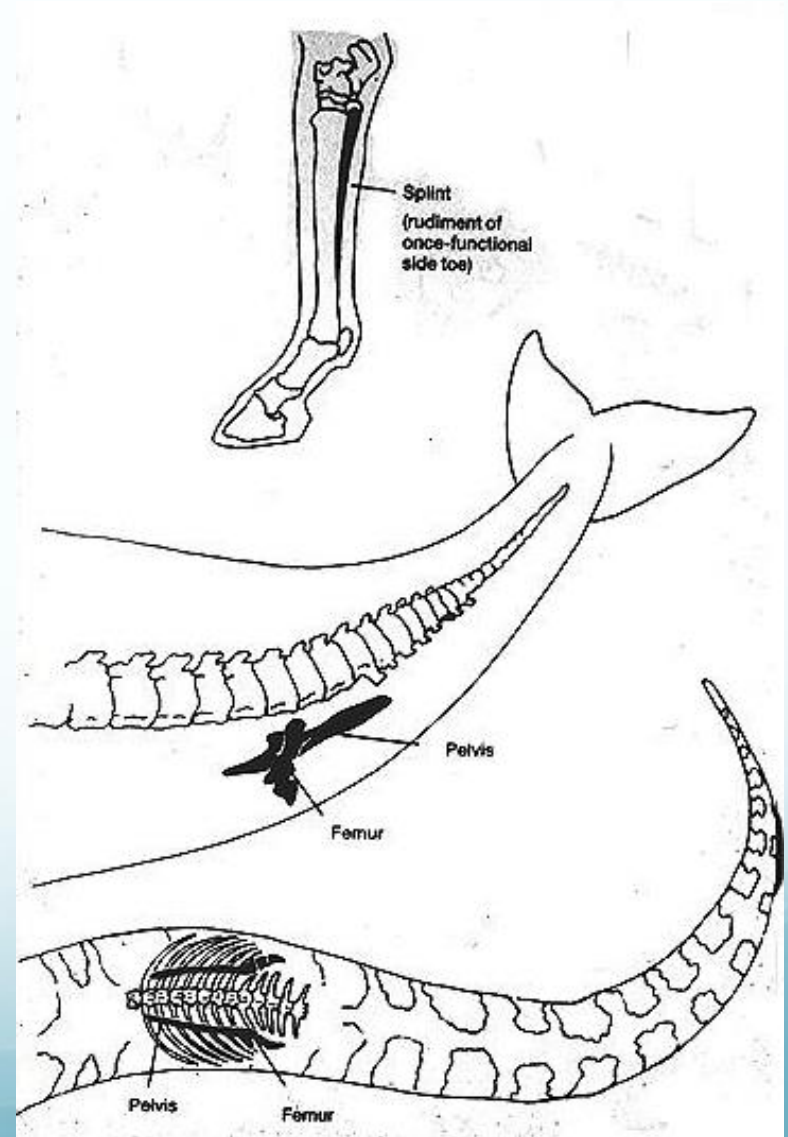


**Gorilla**

# Homologous Structures

# Vestigial Structures

- Structures that are **present in an organism, but serve no apparent purpose.**
  - Examples: appendix in man, legs on skinks, pelvic bone of whales

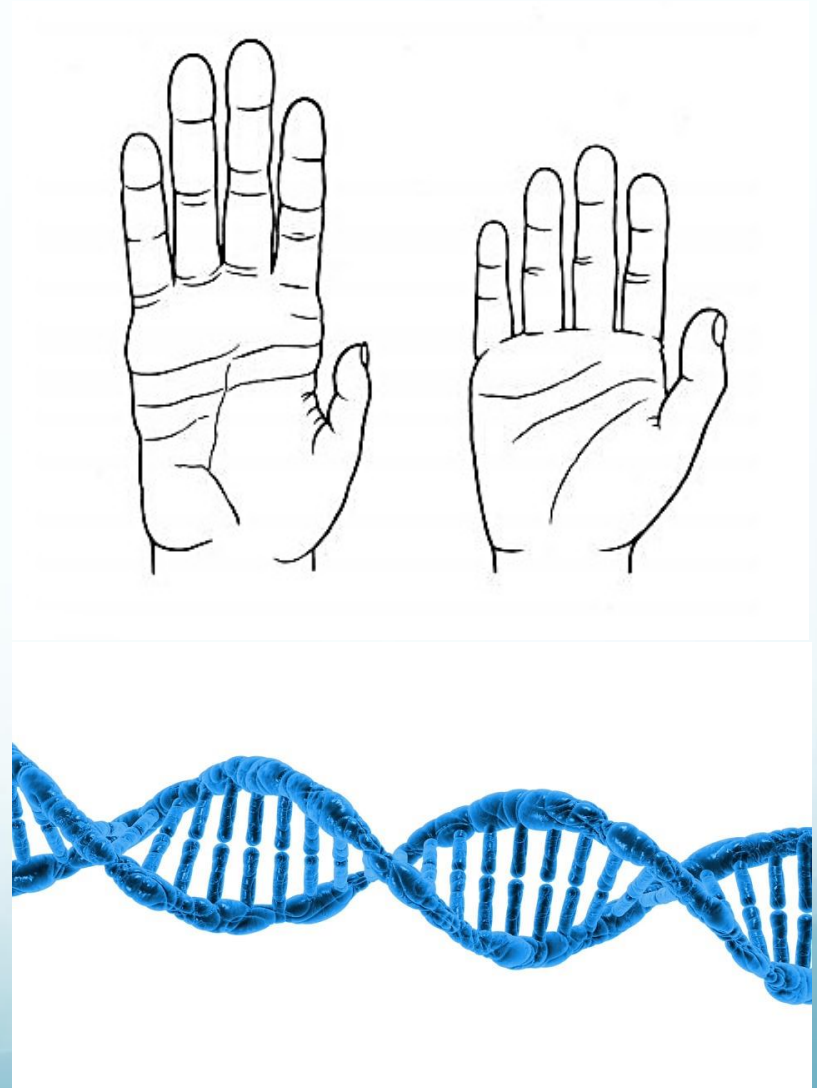


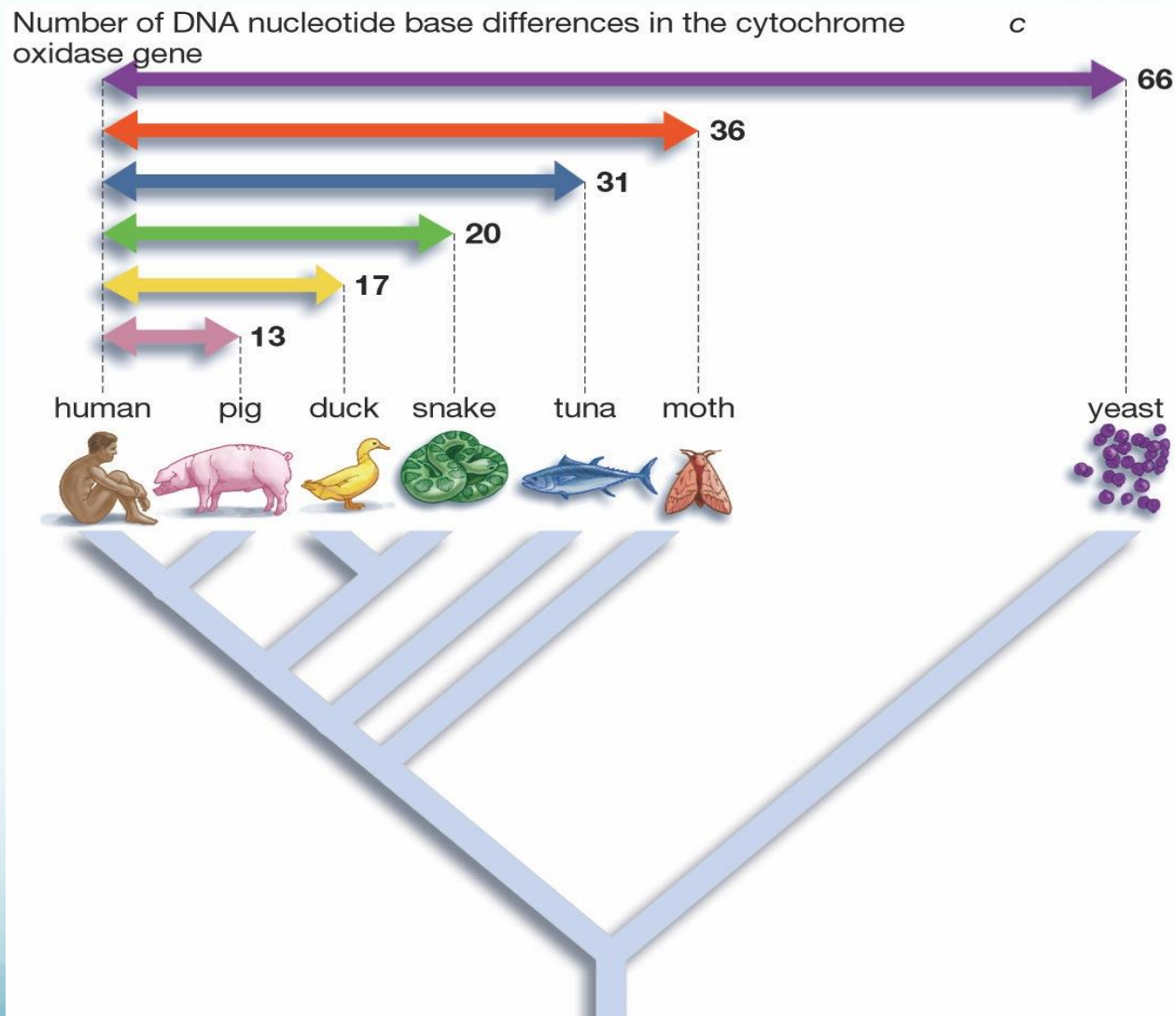
# Biological Molecules

## Similarities in **DNA sequences-**

The more alike two organisms are, the more **amino acids** they have in common (genetic sequence).

Example- Chimpanzees and humans share a nearly identical amino acid sequence.





**The idea is simple:**  
the more alike two organisms are, the more alike their DNA is (and vice versa).

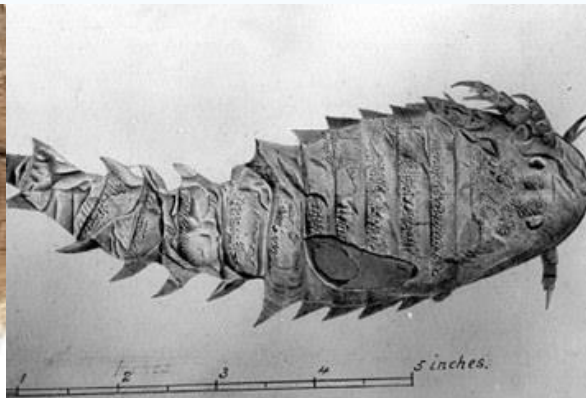
What does this diagram tell us?

**Similarities in DNA Sequence**



# The Fossil Record

- **FOSSIL RECORD:** all information about past life that can provide evidence about the **history of life** on Earth.
  - The fossil record is **incomplete**, because not all organisms become fossilized after death.
  - Over **99%** of all species that have ever lived on Earth have become **extinct**.



# Evidence for Evolution – The Fossil Record

(a) Strata of sedimentary rock with fossils embedded



(b) Fossilized sea urchin, at least 65 million years old





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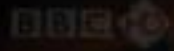


# EVOLUTION



0:35 / 9:18





JAMES MAY'S

THINGS  
YOU NEED TO  
KNOW



0:35 / 28:58

CC

Settings icons: play, volume, closed captions, settings, full screen