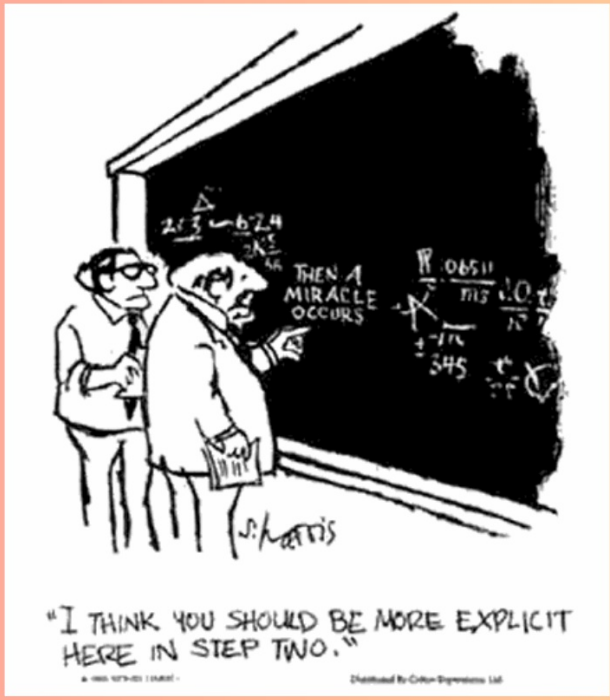
These three cats share 95.7% of the same DNA, making them Felidae.

No one disputes the fact that these animals are related.

Humans and Chimps share 98.5% of the same DNA, but this is one of the most heavily disputed pieces of science.

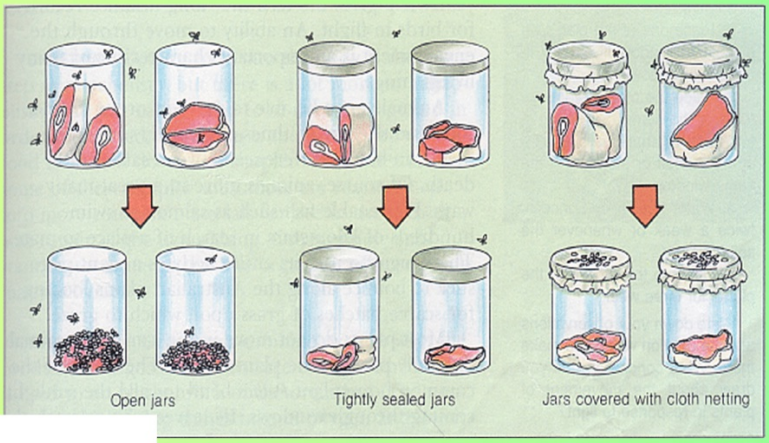
Early Earth and the Origins of Life

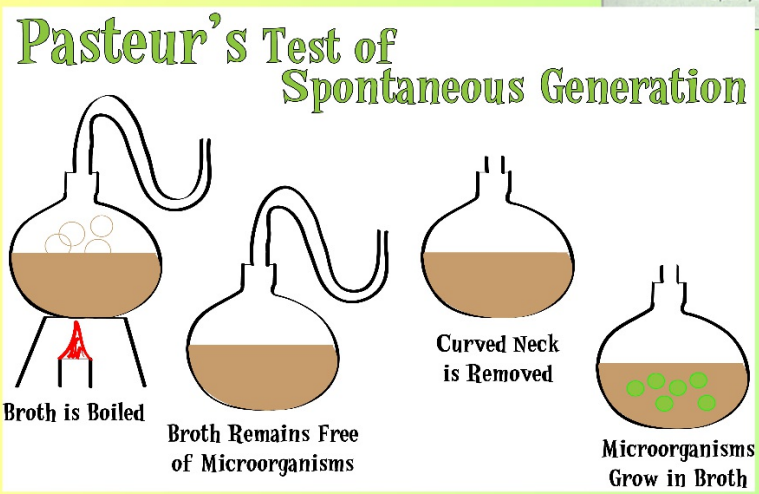
- Once thought life came from **spontaneous generation**, meaning that life comes from **nonliving** matter.
- This is the theory of **abiogenesis** (abio=**not living**)



This was disproved by:

1. Redi- experiment to test whether maggots (living) spontaneously generated from meat (dead)





2. Pasteur- used broth to prove that microorganisms cannot arise spontaneously

Redi and Pasteur's experiments proved **Biogenesis**: that life only comes from living things

So... if life has to come from living things, how did life first start??

Atmosphere of early Earth contained gases:

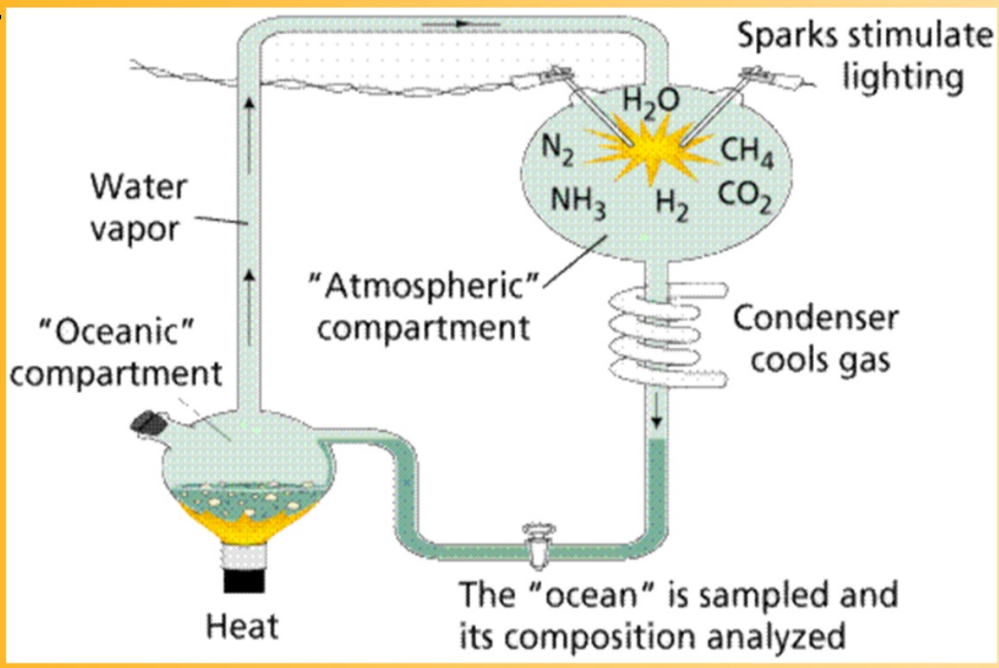
- hydrogen cyanide
- carbon dioxide
- carbon monoxide
- hydrogen sulfide
- nitrogen
- hydrogen
- water

**No free oxygen!

Gases reacted with **energy** from lightening to produce small organic molecules concentrated in primitive oceans.

This is known as the **primordial soup theory.**

In the 1950's Miller and Urey filled a flask with hydrogen, methane, ammonia, and water to represent the early Earth and they used electric lightening to stimulate the mixture. In a few days, organic compounds had formed! This suggested that life can be made from **simple compounds** on the **primitive earth**.

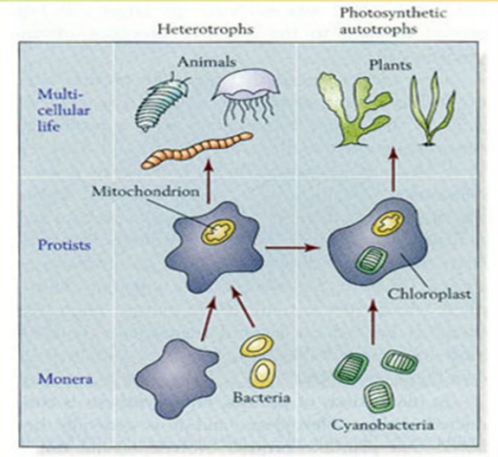


Origins of Cells

- The first true cells were **heterotrophic prokaryotes**
- They evolved the ability to do **photosynthesis** to make their own food
- Photosynthetic prokaryotes were responsible for the realease of **oxygen** into the atmosphere.

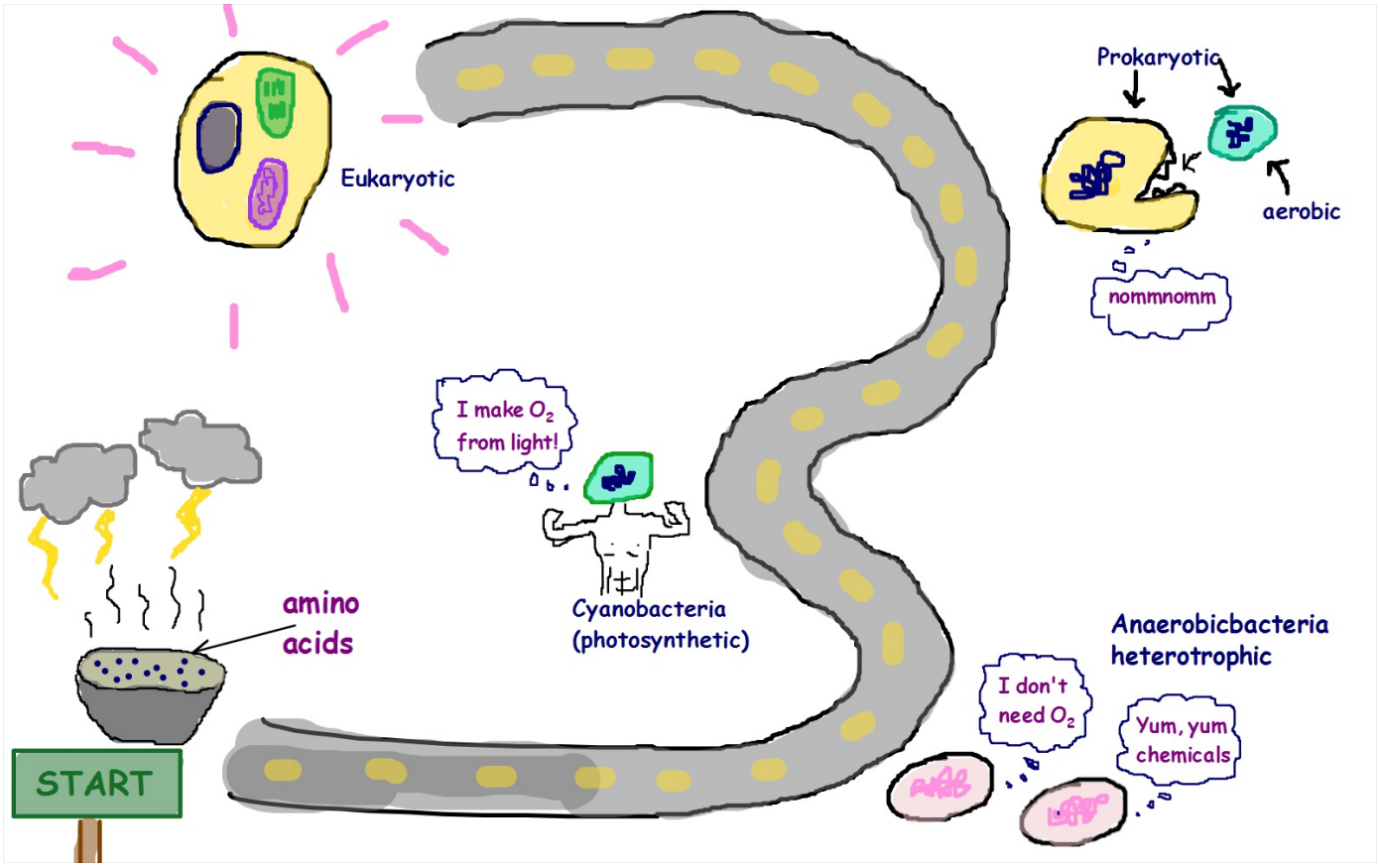
Endosymbiotic Theory

- Eukaryotic cells probably arose through a symbiotic relationship between two kinds of prokaryotic cells: We believe that mitochondrias and chloroplasts used to be prokaryotes (They have their own DNA)
- A photosynthetic bacteria (future chloroplast) and an aerobic heterotroph (future mitochondria)were consumed and incorporated into a cell.

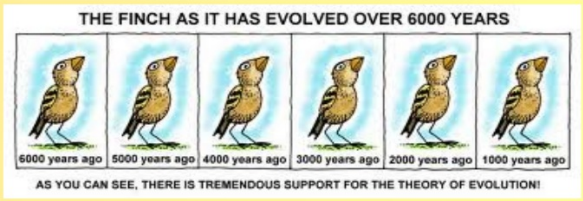


Heterotroph Hypothesis:
(The order cells were created)

1) Unicellular, Prokaryotic, Heterotrophic, Anaerobic
2) Unicellular, Prokaryotic, Autotrophic, Anaerobic
3) Unicellular, Prokaryotic, Auto/Hetero, Aerobic
4) Eukaryotic

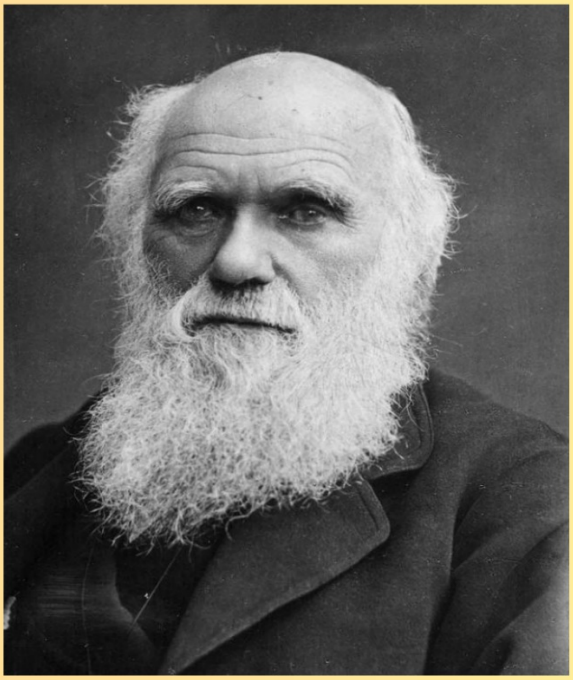

Eukaryotic
Prokaryotic
aerobic
nommnomm
I make O_2 from light!
Cyanobacteria (photosynthetic)
amino acids
START
Anaerobicbacteria heterotrophic
I don't need O_2
Yum, yum chemicals

Charles Darwin



- Sailed on the **HMS Beagle**
- Made very important collections in the **Galapagos Islands**
- Wrote the ***Origin of Species*** *in 1859*

Galapagos Islands



evolutionary arms race

Charles Darwin: Theory of **Natural Selection**

There are 4 major requirements for evolution: **OCVS**

1. Organisms produce **more** offspring than can survive. **OVERPRODUCTION**

2. These offspring **compete** for resources (food, shelter, mates) and not all can **survive**. **COMPETITION**

3. Organisms show **variation** (due to mutations and genetic recombination) and some of it is **heritable** (passed from parents to offspring) **VARIATION**

4. Those individuals that are most **suited** (have the best **traits** for their environment) survive, reprodoce, and pass **on their** adaptations to their offspring **SURVIVAL**

Five fingers of evolution

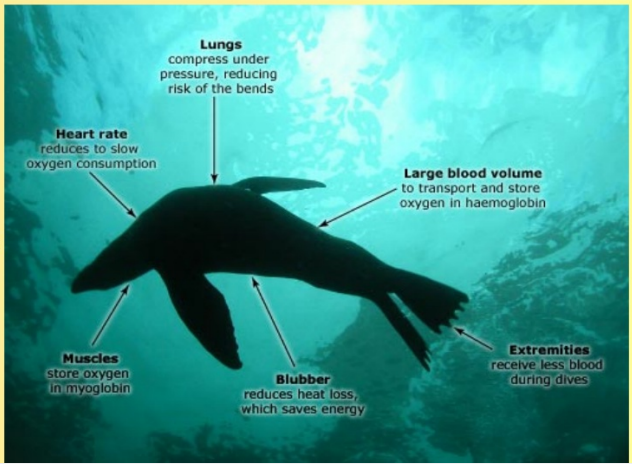
Survival of the fittest- survival of those best adapted individuals allows those best adapted traits to be passed on to offspring

Fitness- the ability of an organism to **survive** and **reproduce** in its environment

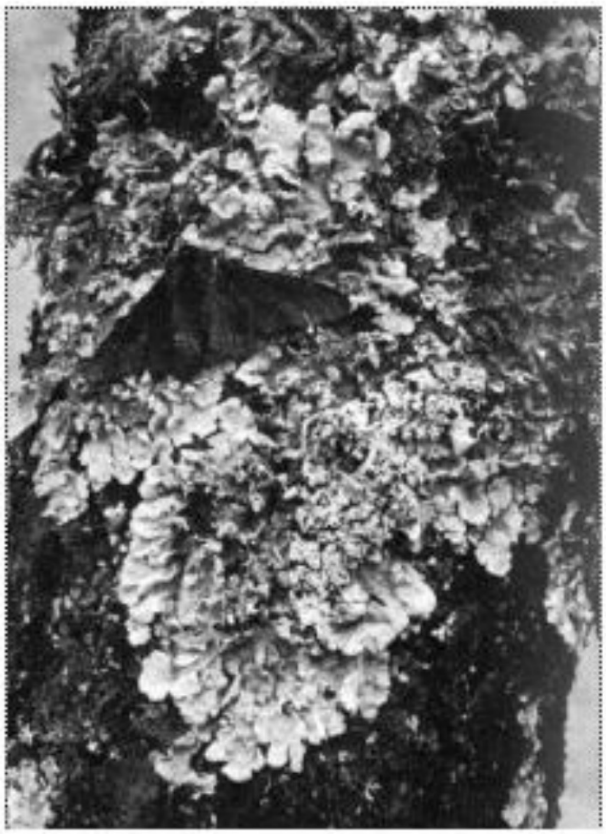
- over time that trait is seen more in the offspring because it has been passed on by those individuals that are best adapted to survive.

- **Evolution**: the theory that species change over time
- **Species**: a group of organisms that can interbreed and produce fertile offspring
- **Variation**: a difference exhibited by a member of a species
  Ex: Color, Speed, Food gathering, mating
- **Natural selection**: the theory that organisms with favorable traits are more likely to survive, reproduce, and pass on their adaptations to their offspring
- **Adaptation:** a beneficial trait that enables an organism to survive and reproduce

adaptations for diving



Peppered Moths



Types of Natural Selection

Stabilizing Selection- The extremes are selected

Ex: Birth weight in humans. Low weight die and high weight have problems fitting through the birth canal.

Directional Selection- One extreme value is selected for.

Ex: Peppered moths. Light ones and grey ones are seen and eaten. Dark ones blend in and survive.

Disruptive Selection- The extremes are both selected for.

Ex: Small individuals are capable of hiding from predators, while large individuals cannot fit in the available hiding places but can try to fight with predators. Medium-sized individuals are at a disadvantage – they cannot fit in hiding places and they are not strong enough to fight predators.

Evidences for Evolution

1. Fossil evidence
2. Comparative anatomy
3. Comparative biochemistry
4. Comparative embryology

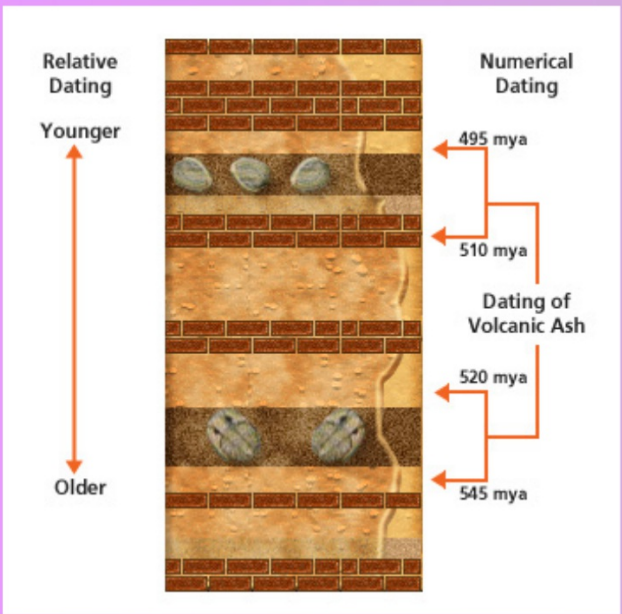
Fossil Evidence

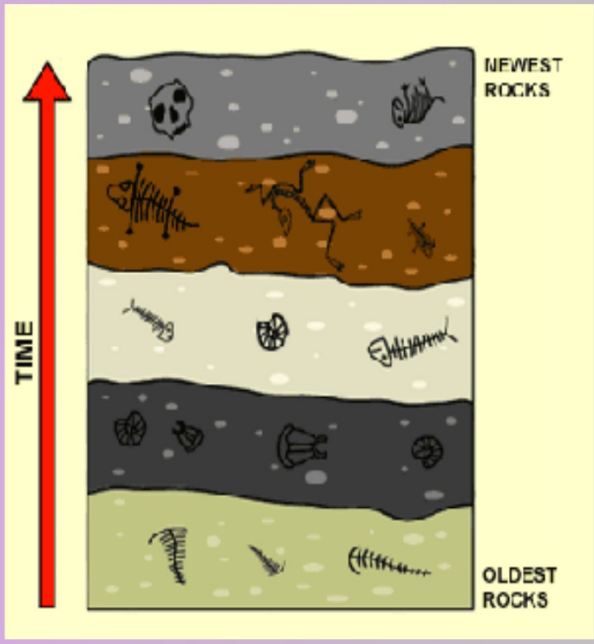
Fossils are the remains or traces of organisms that once lived.

Fossils show us that life went from simple to **complex**, moved from **water** to land, and existed over 3 billion years ago

- many found in **sedimentary rock**, which is formed from layers of slowly deposited sediments.

- **Relative dating:** dating based on the observation that fossils in teh bottom=**oldest**; top=**youngest**





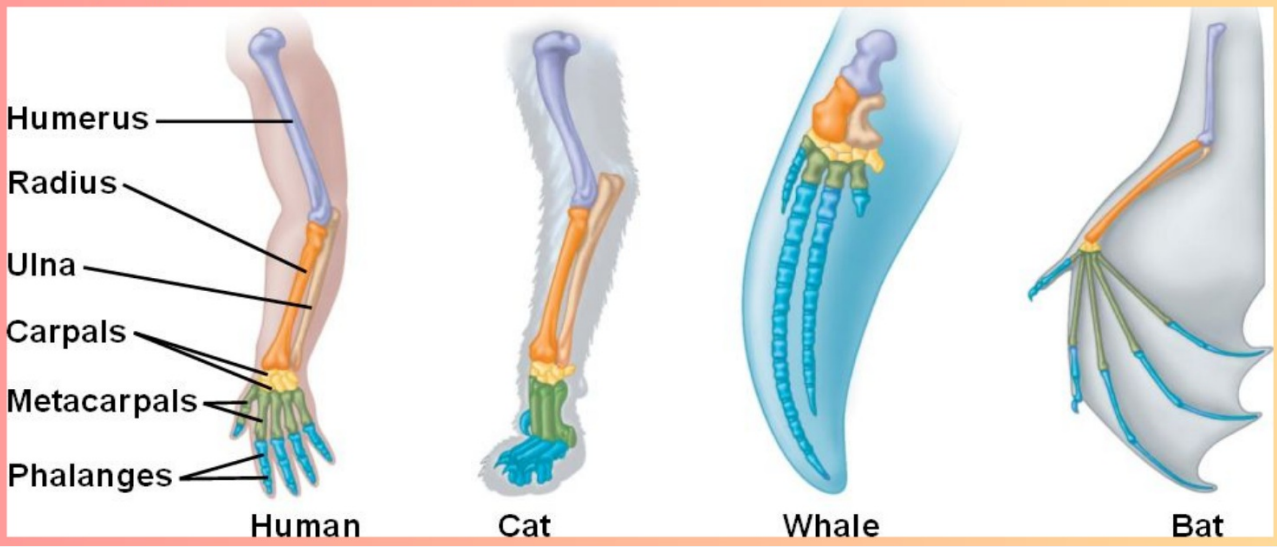
A B C D E F G

Where would these logos go?

Comparative anatomy-comparing anatomical (body) features between organisms, looking for evolutionary **similarities**

Homologous structures- have similar **structures** but different functions. Homo=Same

- organisms with similar bone structures may have evolved from a **common** ancestor
- ex: the **wings** of a bat, the **fin** of a whale, and a human **arm** are homologous structures because they have a very similar structure but perform different **functions**

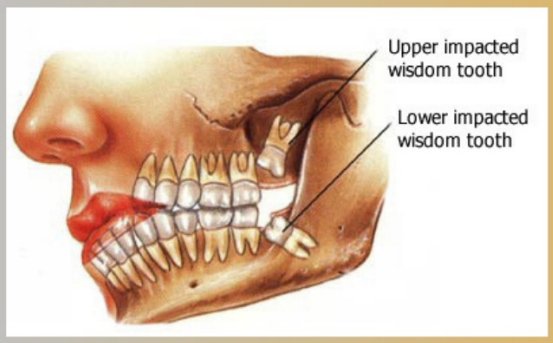


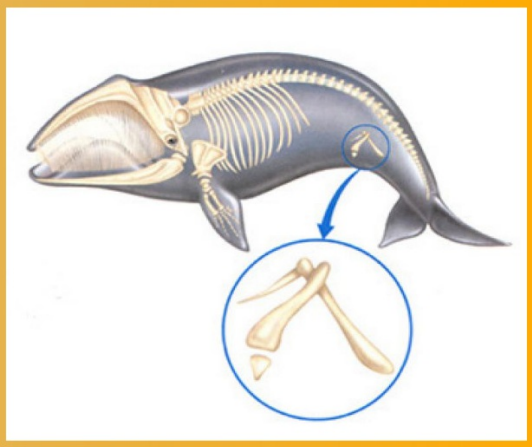
Vestigial Structures- have no function in present day organism, but was probably useful in its ancestors

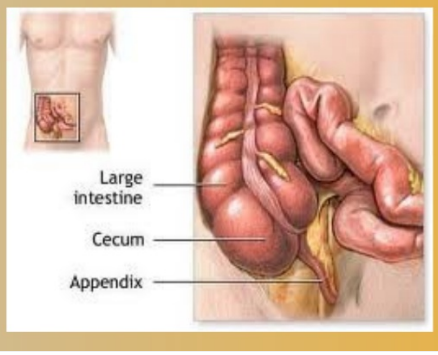
EX:

- human appendix
- leg bones of a whale

provide further evidence of homologous structure and function



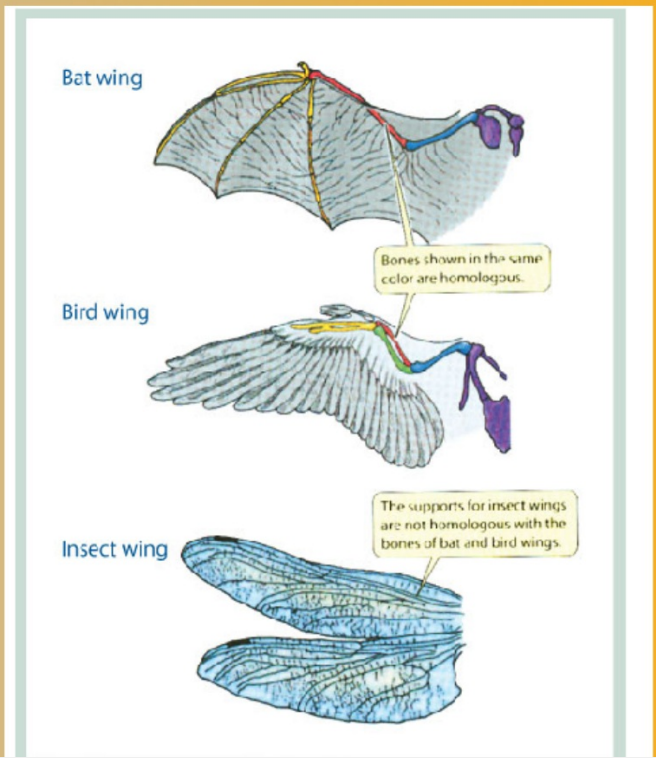




Analogous Structures

-Similar function in a variety of different organisms, but have different structures.

-Show that organisms have not evolved from a common ancestor.



Comparative biochemistry

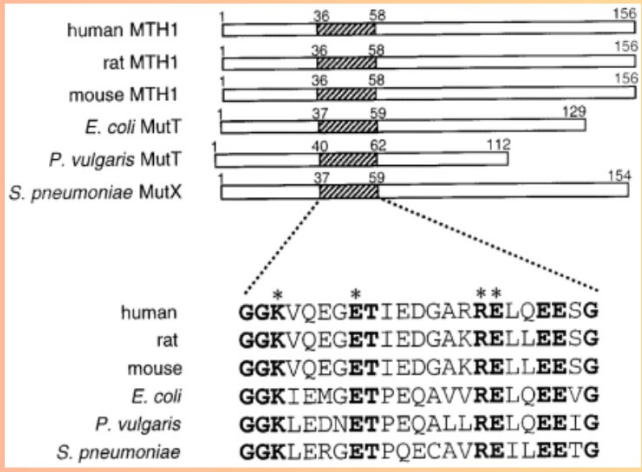
Comparing amino acid & DNA sequences between 2 different organisms

fewer differences ⟷ many differences

closely related ⟷ distantly related

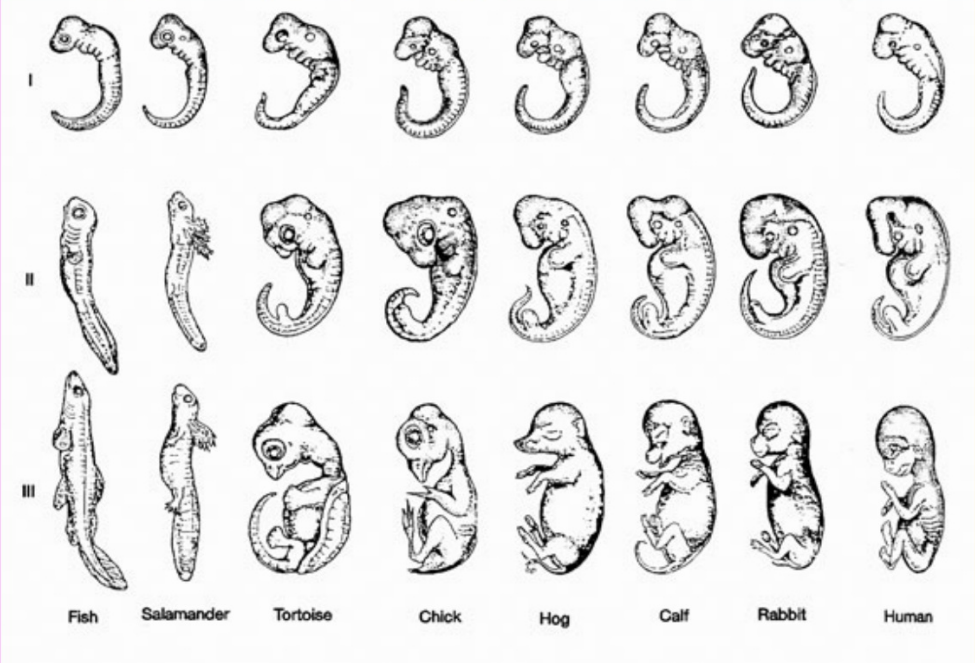
AA #	Horse	Chicken	Tuna	Frog	Human	Shark	Turtle	Monkey	Rabbit
42	Q	Q	Q	Q	Q	Q	Q	Q	Q
43	A	A	A	A	A	A	A	A	A
44	P	E	E	A	P	Q	E	P	V
46	F	F	Y	F	Y	F	F	Y	F

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



Compartive embryology- looking for similarities during the early stages of fetal development

- Embryo- early stage of development of an organism (before they are born)
- The more similar the embryos are throughout development, the closer related the are organisms are



Mechanisms Of Evolution

Speciation: is the evolutionary process by which new biological species arise.

Speciation is caused by:

Geographic Isolation: population is divided into two or more smaller populations. This can occur when rivers change course, mountains rise, continents drift, or organisms migrate.

Reproductive Isolation: A large population that is split into 2 parts may result in a new species if there is no gene flow between the new populations. Mutations accumulate in both populations and, along with recombination and different selective pressures, the genetics of each changes until they are no longer able to interbreed.

Abert Squirrel

Kaibab Squirrel