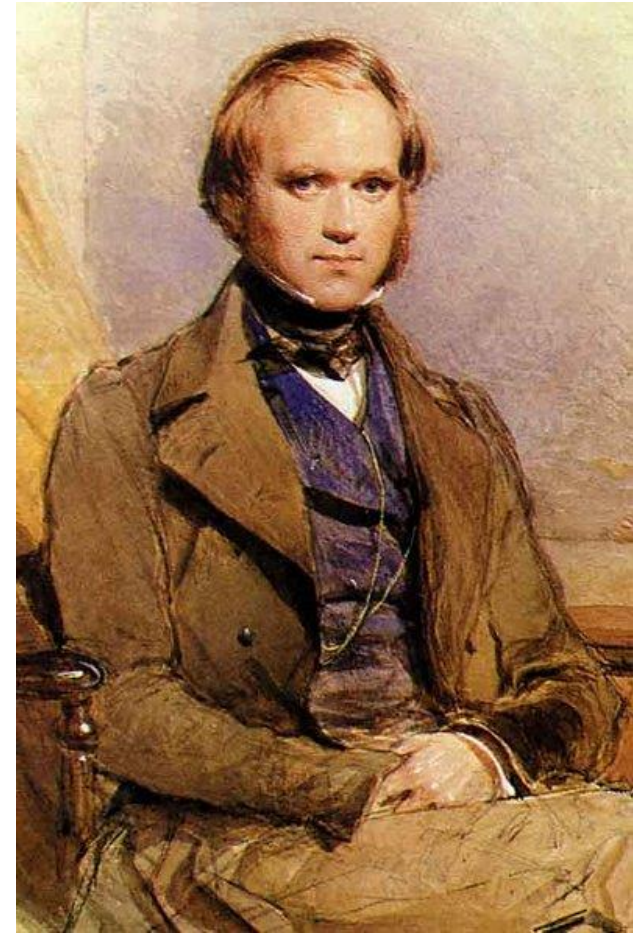


Evolution by Natural Selection

- **Evolution** is the change in inherited traits in a population/species from one generation to the next.
- **Natural selection** states that those individuals who are **better adapted** to their current environment will **survive better** and therefore **pass on these traits** to the next generation.
- Natural selection makes a population **better adapted** to the environment **over time** and makes **harmful traits** appear **less frequently**.



Evolution by Natural Selection

- Darwin's Theory was based on four observations he made and the three conclusions drawn on those observations
- 1) Natural populations have the potential to increase their numbers rapidly since they can produce more offspring than needed.
 - 2) The sizes of the population, however, stay relatively constant over time.

Conclusion: Therefore in each generation many organisms will die young, fail to reproduce or produce few/less fit offspring

Evolution by Natural Selection

3) Individuals of the same population/species differ from one another in their ability to obtain resources, find a mate, escape predators, withstand environmental changes, etc...

Conclusion: The organisms best adapted to the environment will survive the best, produce more offspring and have these traits passed down to the next generation (**NATURAL SELECTION**).

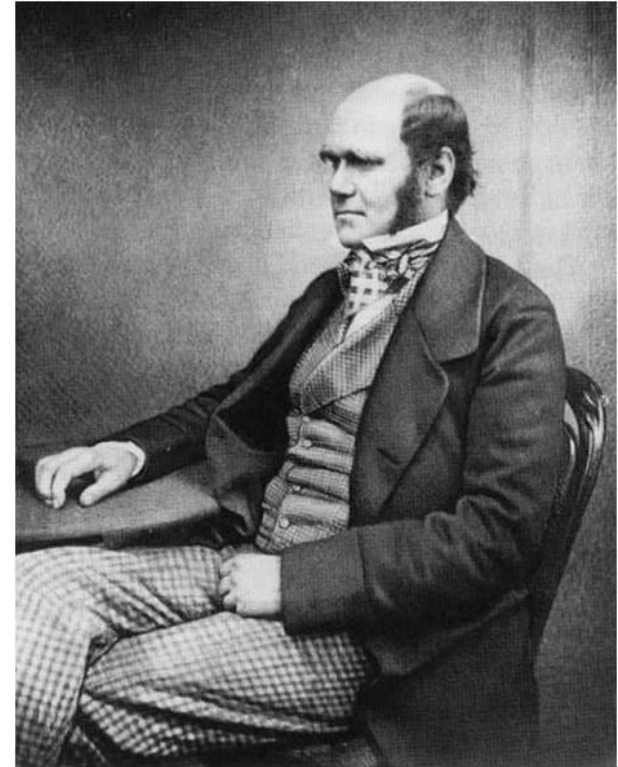
Evolution by Natural Selection

- 4) Some of the variation between individuals is inherited.

Conclusion: Over long periods of time, differential reproduction (in English: the fitter individuals reproduce more than the less fit) will change the overall genetic composition of the population to better suit the changing environment **(EVOLUTION)**.

Proof of Evolution by Natural Selection

- There are four main pieces of evidence to support Darwin's Theory of Evolution by Natural Selection:
 - 1) The Fossil Record/Extinctions
 - 2) Biogeography
 - 3) Anatomy
 - 4) Embryonic Development
 - 5) Biochemical/DNA analysis



1) The Fossil Record/Extinctions

- **Originally** fossils were seen as proof of the **catastrophism** (biblical flood, etc...).
- As fossils became **more and more common** finds in an ever modernizing world, they helped support **Darwin's theory**.



1) The Fossil Record/Extinction

- **Extinctions help** by showing that creatures **appear and disappear** on the Earth at different times.
- Darwin used fossils of extinct animals to support his theory by saying that those creatures who are **not best adapted** to their environment will **die off**.

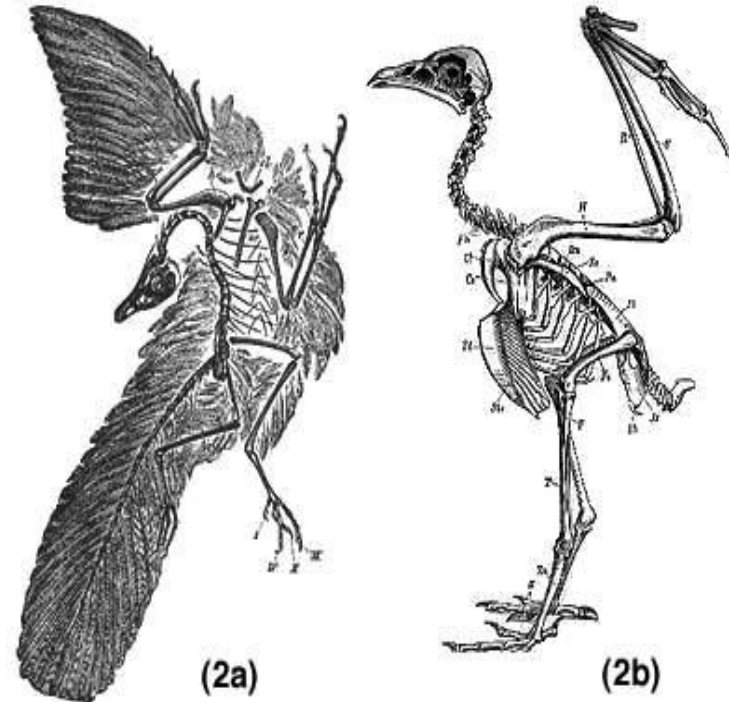


1) The Fossil Record/Extinctions

- The fossil record supports evolution in many ways.
- Firstly, **it pushes back the age of the Earth.**
- This allows for a longer period of time for organisms to change and also discredits the age of the Earth brought about by Ussher.

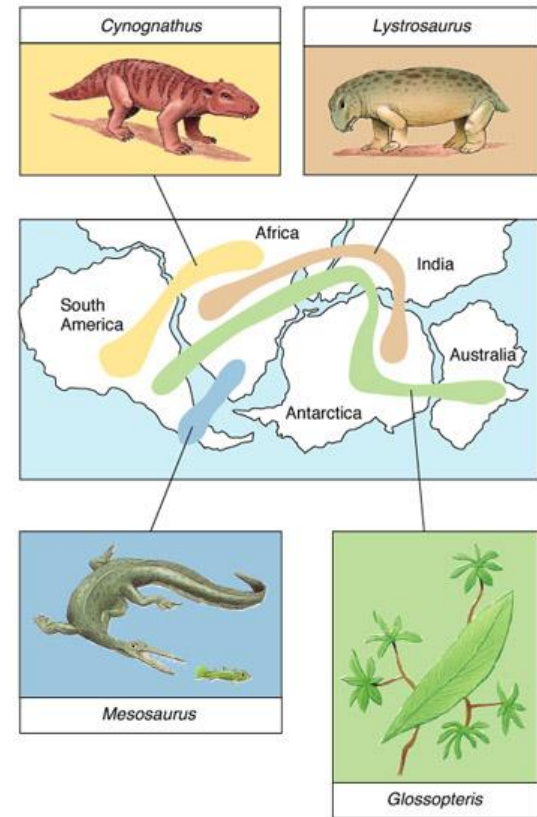
1) The Fossil Record/Extinctions

- The main issue against the fossil record is that it **does not show the change between one general type of organism and the organisms that evolved from it.** (i.e. between reptiles and mammals)
- These organisms are called '**missing links**' .
- However more and more of these organisms are being found (i.e. **Archaeopteryx**).



2) Biogeography

- The study of the past and present geographical distribution of species or populations
- Wallace “father of biogeography”



2) Biogeography

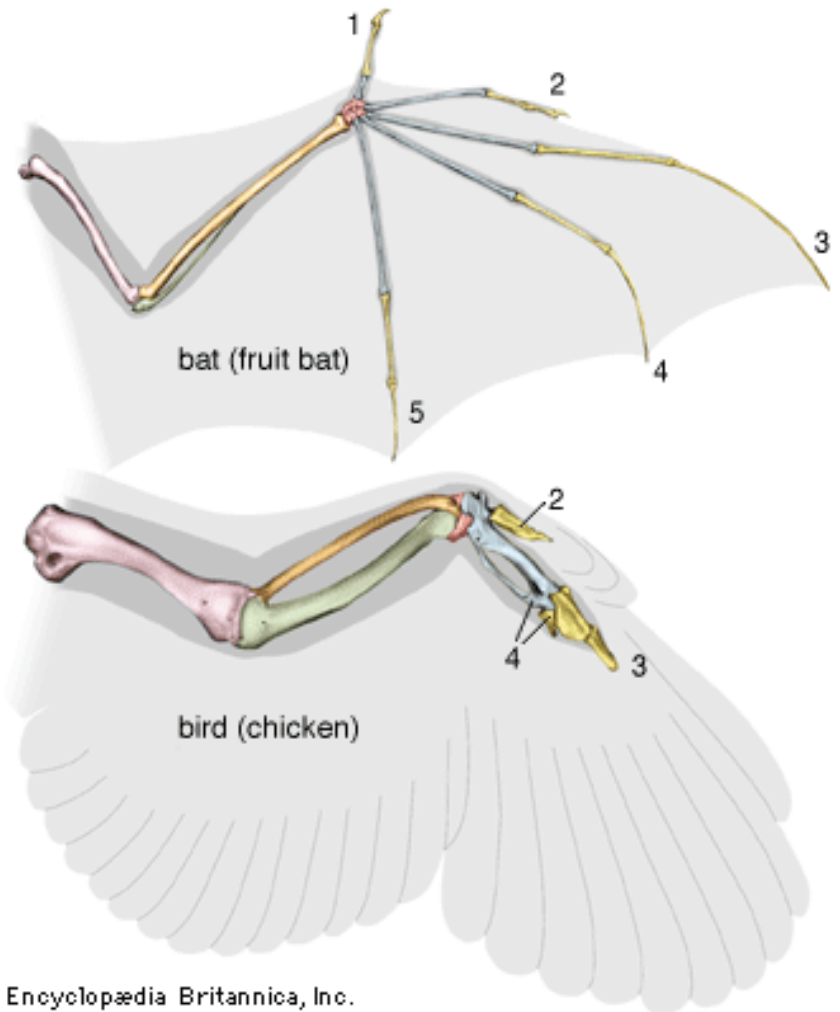
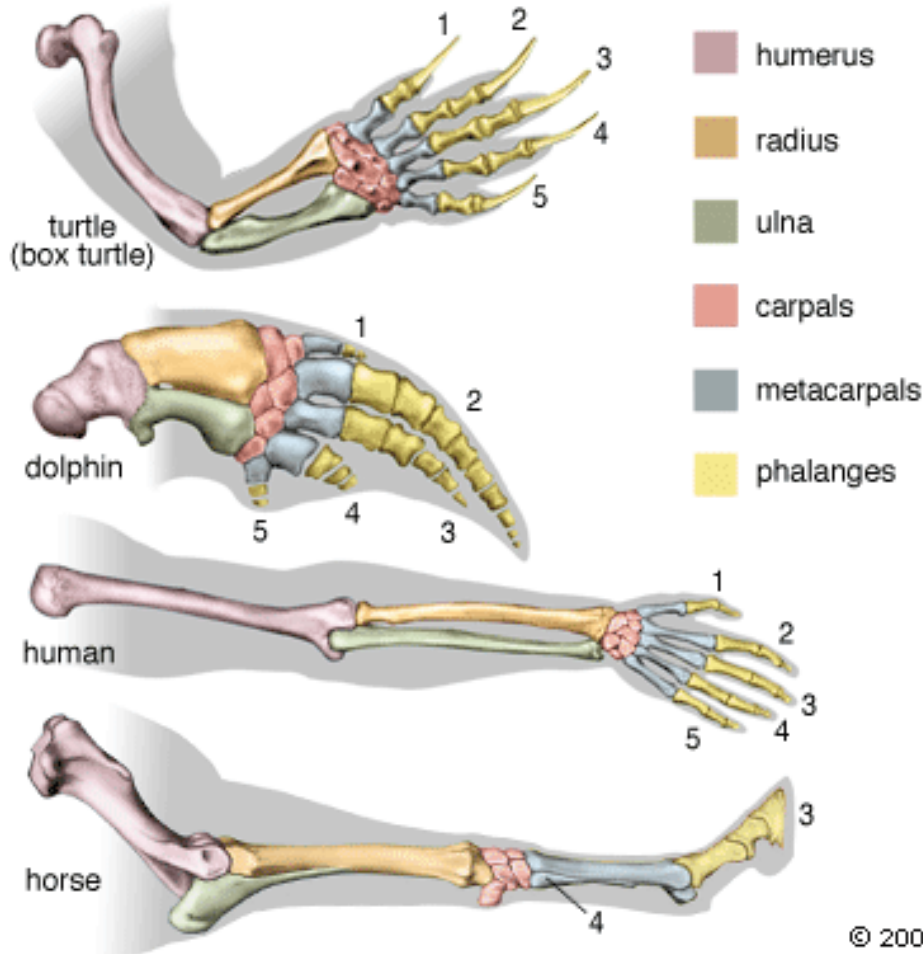
- **Darwin's Finches:** An ancestral finch population got blown off the mainland of South America onto the Galapagos Islands. Over time that finch species **evolved to fulfill all the niches on the islands** and thereby give rise to the variety of finches seen on the islands.
- **Mammals after the extinction of the Dinosaurs:** With Dinosaurs out of the way, mammals were able to grow bigger and **fill all the niches vacated by the larger reptiles**, which explains the wide diversity of forms we see in mammals today.

3) Anatomy

- It supports evolution by showing that groups of organisms (i.e. mammals) are all **related** to each other and came from a **common ancestor** that inhabited new environments and **evolved to adapt** to these environments.
- All **mammalian forelimbs** contain the **same bones** which shows that they all evolved from a **common ancestor**. This is called a **homologous structure**.

3) Anatomy

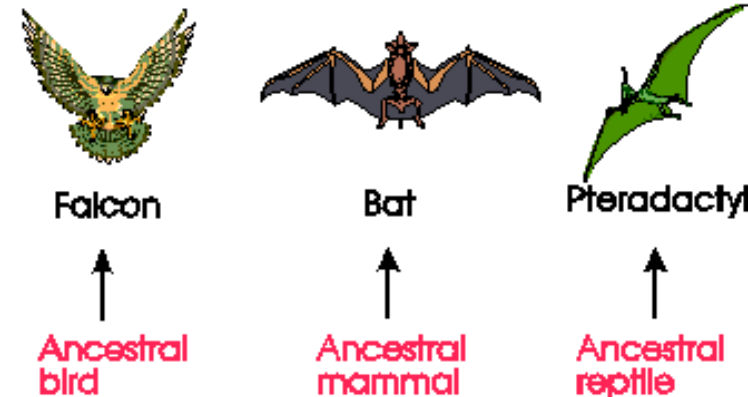
Homologies of the forelimb in six vertebrates



3) Anatomy

- The opposite of homologous structures are **analogous structures**.

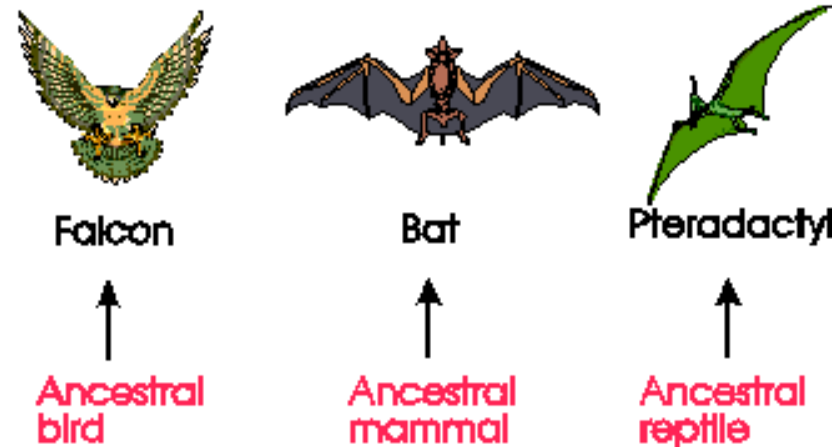
These are **similar structures**, performing **similar functions**, that have appeared **in very different organisms** and are **not the result of evolution from a common ancestor**.



3) Anatomy

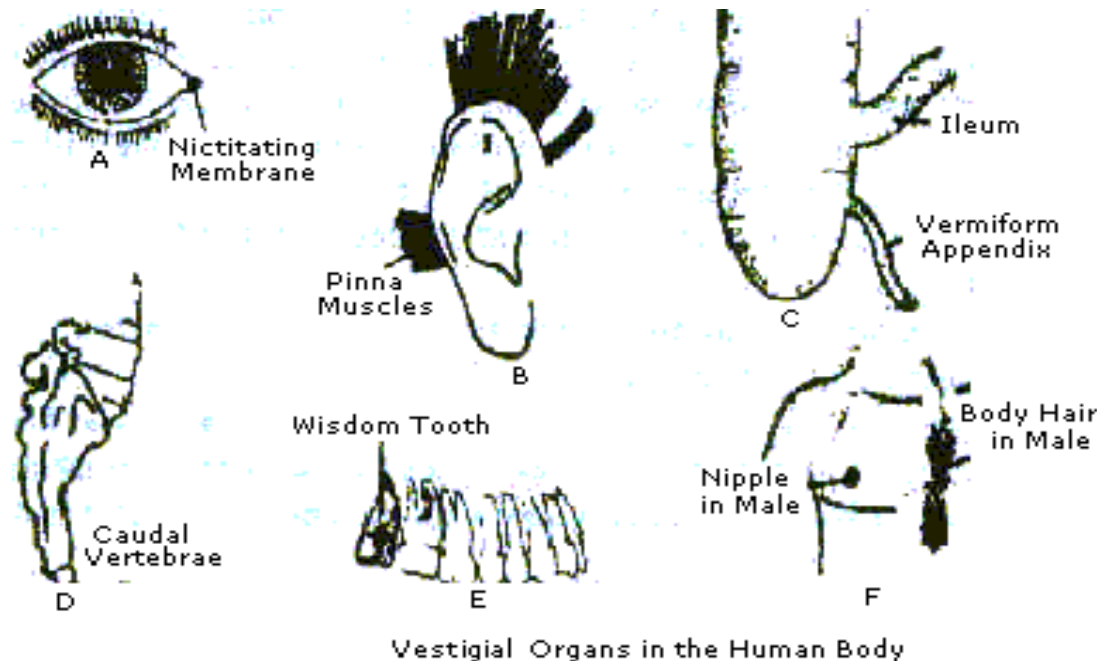
- Examples of analogous structures:
 - 1) Wings in birds, bats and **insects**
 - 2) Jointed legs of insects and **vertebrates**
 - 3) Tail fin of whales, fish and **lobsters**

This shows **convergent evolution**, many species showing the evolution of a **similar trait**, but they are **not closely related**.



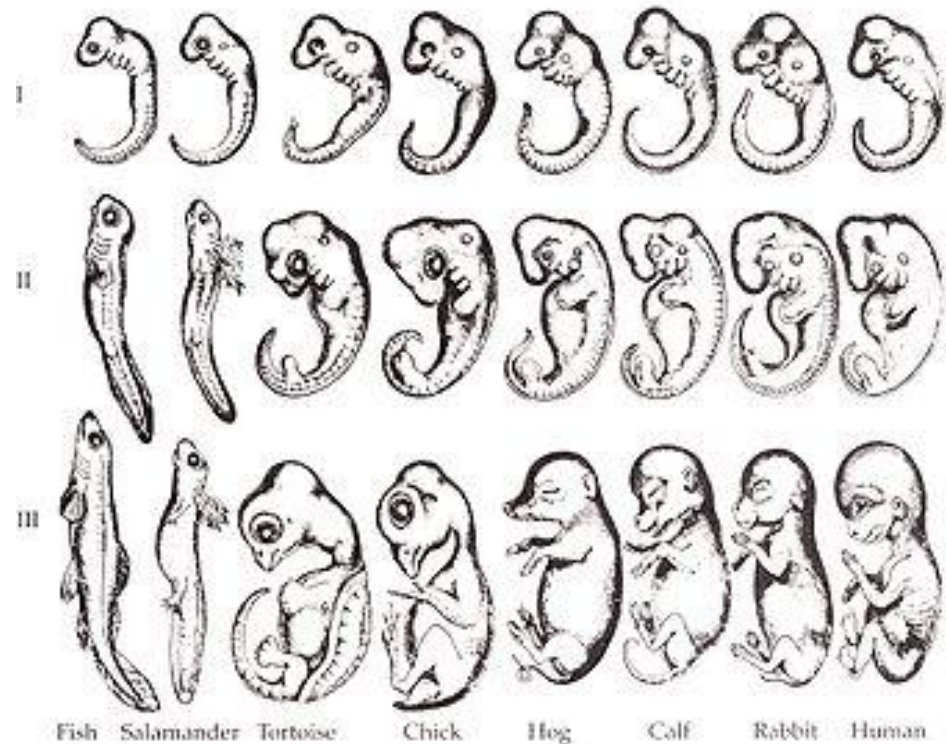
3) Anatomy

- Vestigial Structures are **those structures still present in an organism, but serve no current purpose.**
- They were **once useful in an ancestral organism** from which the current organism evolved, thus they are proof of evolution.



4) Embryonic Development

- Biogenetic Law (Theory of Recapitulation) by Ernst Haeckel in 1866 stated that “ontogeny recapitulates phylogeny”.
- In English this means that the growth of an organism throughout its embryo stage follows its evolutionary history.



4) Embryonic Development

- We know this is untrue from embryonic studies that have shown that development is **non-linear** (i.e. different parts of the same organ develop at different rates and at different times).



4) Embryonic Development

- This still supports Evolution because there are still **commonalities in development** between similar groups of organisms. Examples:

1) The **backbone** is one of the earliest structures to appear in **all vertebrates**.

2) **Tails** in humans and **legs/hair** in whales appear and then **disappear** later in development.












4) Biochemical/DNA evidence

- With the improvement of molecular technology, more and more evidence mounts to support evolution.
- DNA analysis and protein analysis have both shown that those species that are **supposed to have evolved from each other sooner back in time**, do indeed **share the majority of their DNA/Amino acid sequence.**

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Amino acids reveal evolution

Cytochrome <i>c</i> Evolution	
Organism	Number of amino acid differences from humans
 Chimpanzee	0
 Rhesus monkey	1
 Rabbit	9
 Cow	10
 Pigeon	12
 Bullfrog	20
 Fruit fly	24
 Wheat germ	37
 Yeast	42

A

4) Biochemical/DNA evidence

- Carl Woese used DNA and amino acid differences to **prove the existence** of a second type of prokaryotic organism, the **archaea**, in 1977.
- The majority of studies have been done to show support for **human ancestry**.

Other evidence

- There are so many more pieces of evidence to help support evolution. Examples:
 - 1) **Antibiotic and Pesticide resistance**
 - 2) Artificial Selection