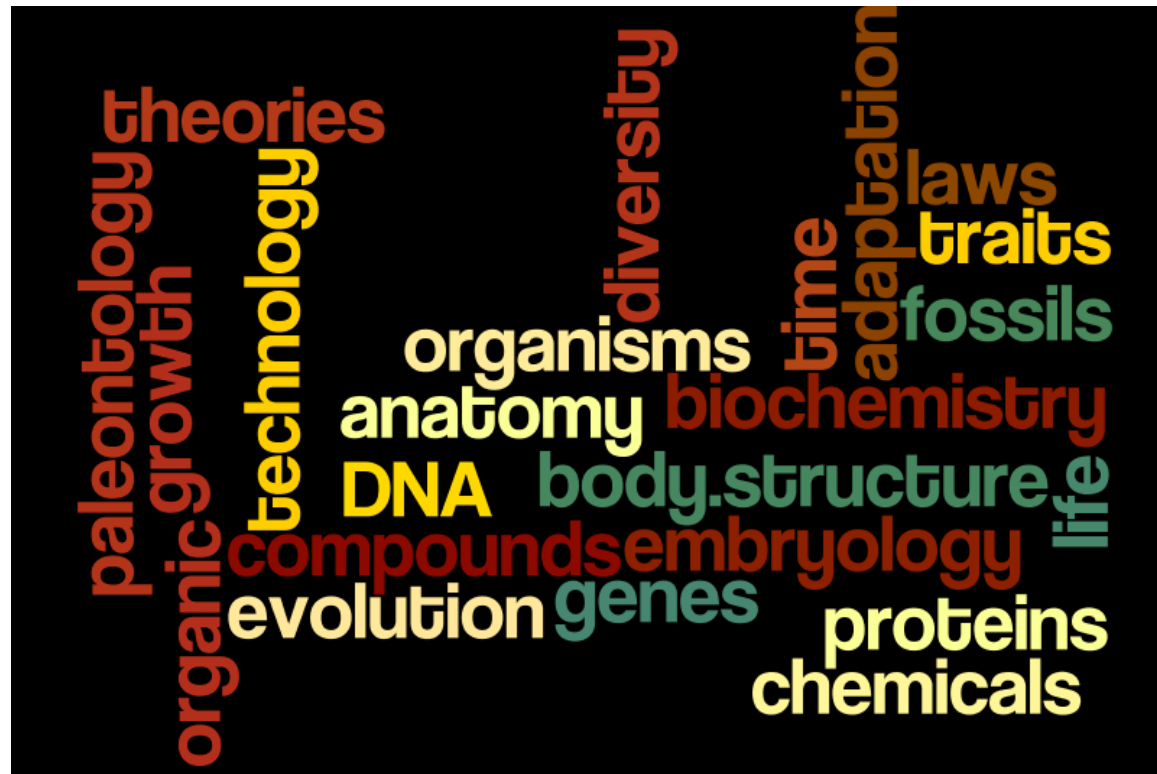


# SCIENTIFIC EVIDENCE TO SUPPORT THE THEORY OF EVOLUTION

Using Anatomy, Embryology, Biochemistry, and  
Paleontology

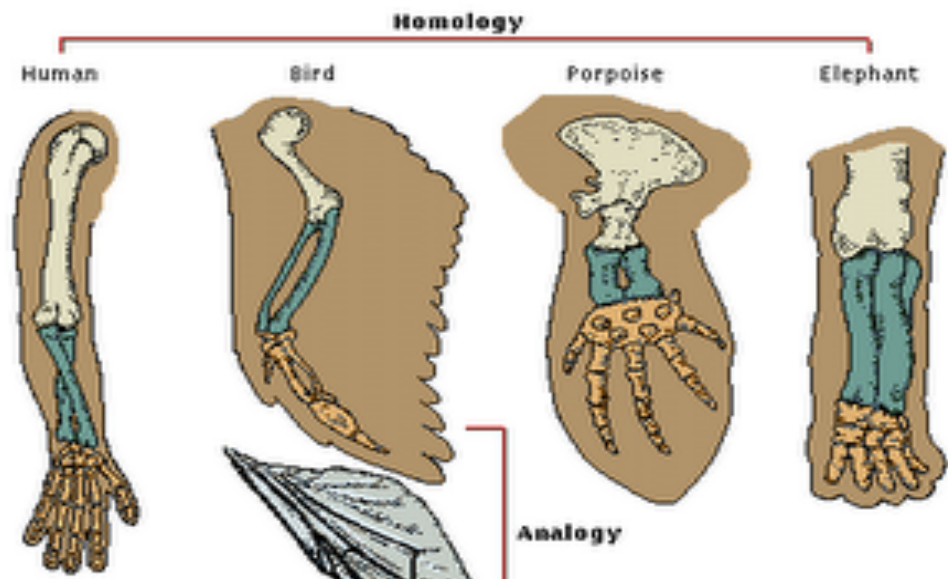
# Scientific Fields

- Different fields of science have contributed evidence for the theory of evolution
  - ▣ Anatomy
  - ▣ Embryology
  - ▣ Biochemistry
  - ▣ Paleontology



# Anatomy

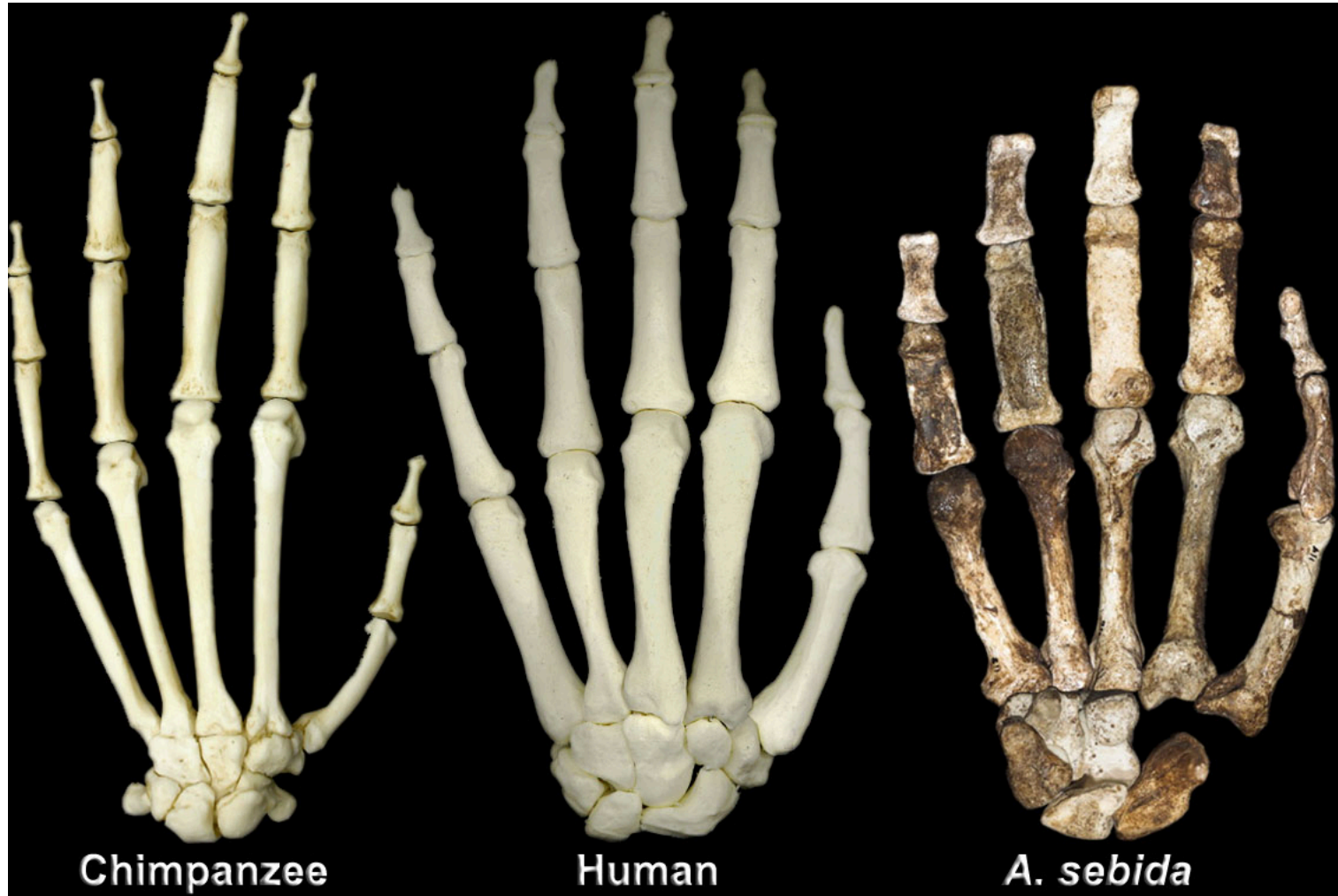
- Anatomy:
  - ▣ The study of **structures of organisms**
  
- Provides support for evolution through “**homologous structures**”



# Anatomy: Homologous Structures

- **Similar characteristics** resulting from common ancestry
- Can be used to **determine the relationships between evolutionary paths** of two species
- The **greater the number of shared structures** between two species, the **more closely the species are related**

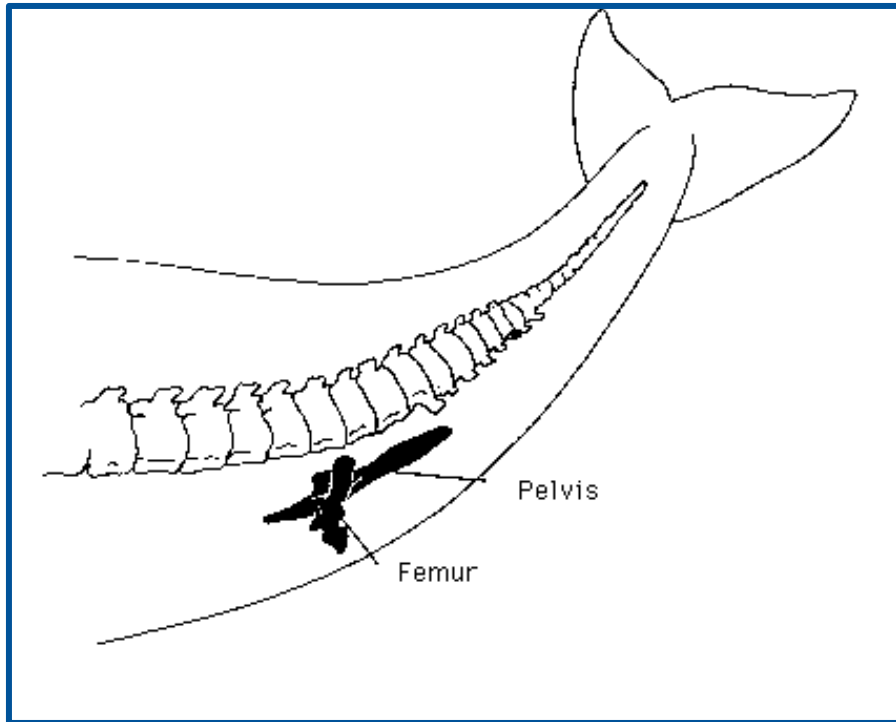
# Anatomy: Homologous Structures



# Anatomy: Vestigial Organs

- A structure with **little or no function to the organism**
- Many species have these structures left over as they served important functions in an ancestor of the species.
- The **vestigial organ** of one species are **often homologous with structures in related species** where the structure has remained functional.

# Anatomy: Vestigial Organs



# Anatomy: Evolution

- Studies show that species living in different locations under similar ecological conditions have **developed similar structures and behaviors.**
- If a species encountered a different ecosystem due to a change in geographical location, **favorable anatomical traits may become established.**

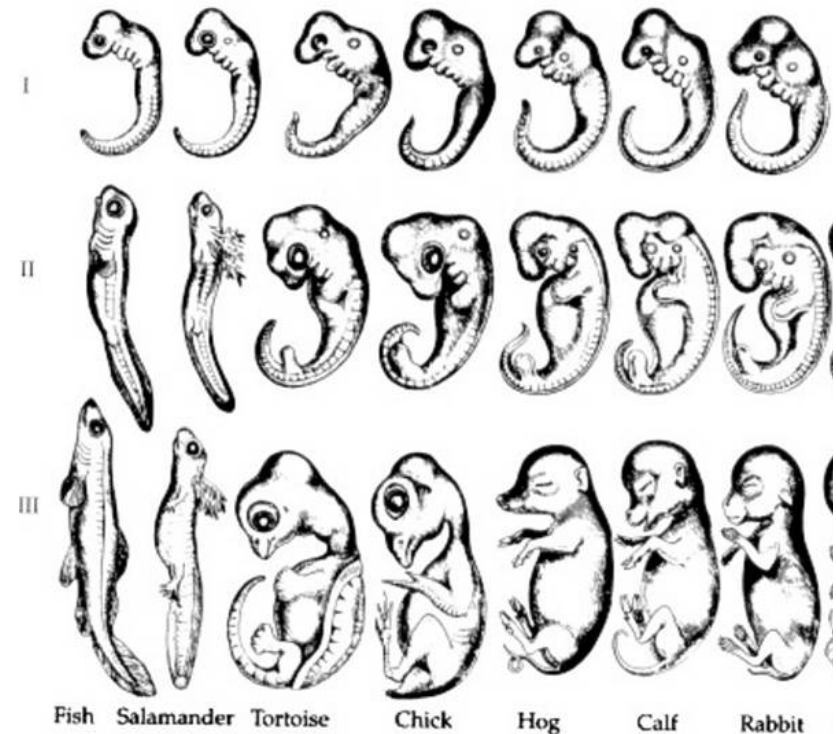


# Embryology

- The study of **embryonic development of organisms.**
  - ▣ Embryo: the early stage of an organisms development.
- Supports evolution by **comparing the anatomies of embryos.**
- In adults, the patterns of development or structures may not be so obvious.
  - ▣ However, they can be observed in embryos.

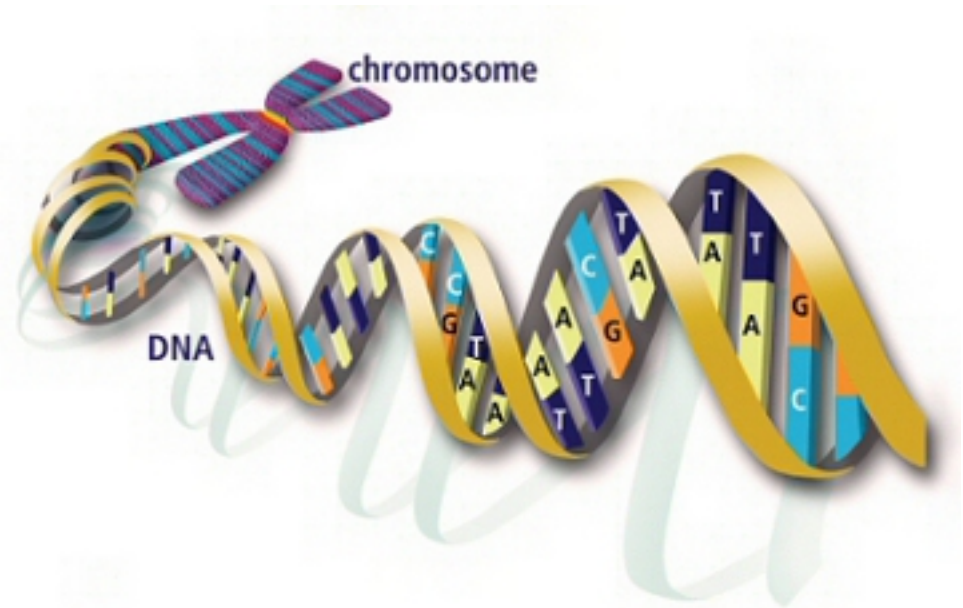
# Embryology: Evolution

- Embryos of vertebrates are **similar in appearance** but may grow into different structures in the adult form.
- The **similar structures** of these embryos **may suggest that these species evolved from common ancestors.**



# Biochemistry

- The study of the **chemical processes in organisms**.
- **Studies genes and proteins** to provide support for biological evolution.



# Biochemistry: Evolution

- The more **similar the DNA and amino acid sequences** are of two species, the more likely they are to have diverged from a common ancestor.
- Biochemistry can be used to support evolution when the anatomical structures are difficult to see.
  - Examples:
    - If two species are so closely related that they do not appear to be different
    - If two species are so diverse that they share few similar structures.

# Paleontology

- The study of **prehistoric life**.
- **Fossil record** provides good evidence for life forms along a timeline.



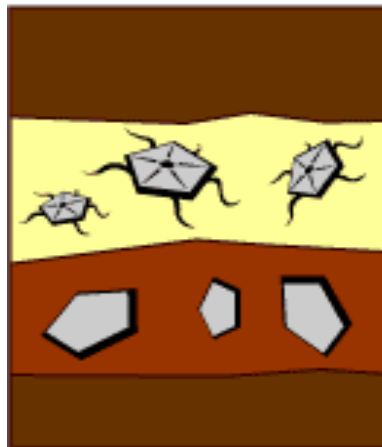
# Paleontology: Evolution

- Supports evolutionary relationships by **showing the similarities between current and ancient species.**
  - ▣ Shows a patterns of gradual change between current and ancient species.
- Current fossil records displays how different types of organisms lived on earth and the relative ages of those fossils.

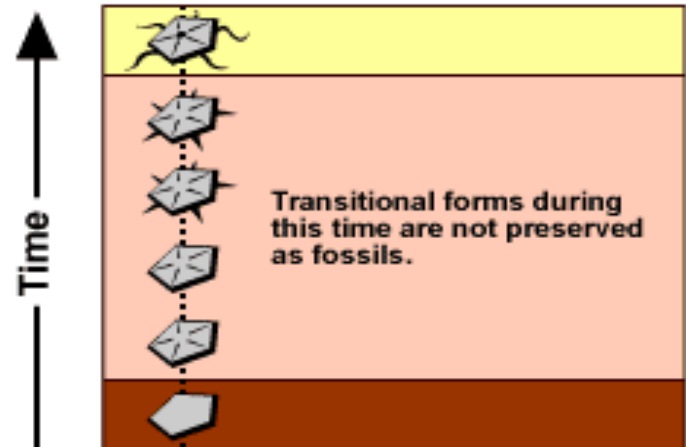
# Paleontology: Evolution

- **Fossil record is not complete** because most organisms do not form fossils.
  - ▣ As more fossils are discovered, gaps can be filled in.
- The older the fossil, the less they resemble their modern species.

The observed fossil record seems to show rapid evolution...



...but this pattern can also be explained by irregular preservation of transitional forms.

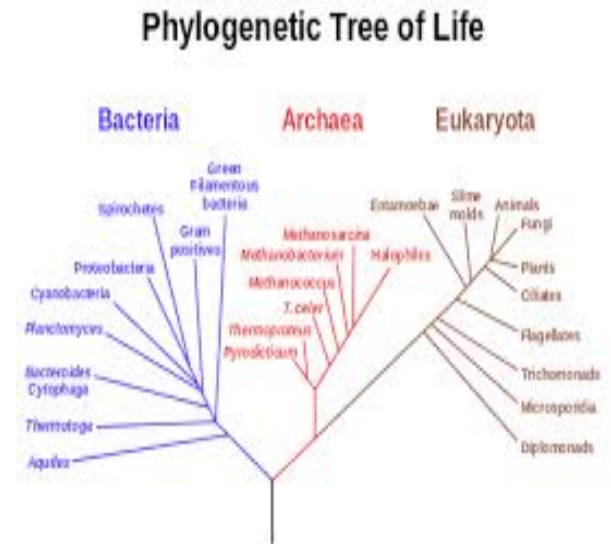


# Phylogeny

- Phylogeny: **evolutionary history**
- An evolutionary theory has been developed that states **all forms of life on earth are related** because the **ancestry of organisms can be traced back to a common origin.**

- Evidence:

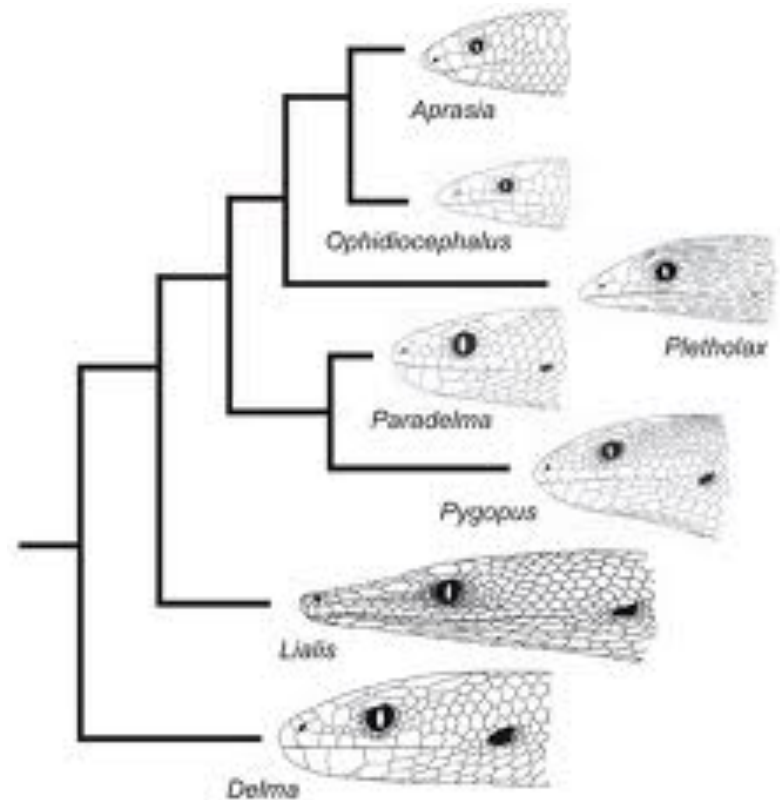
- **Physical features**
- Structures of **proteins**
- Sequences found in **RNA and DNA**





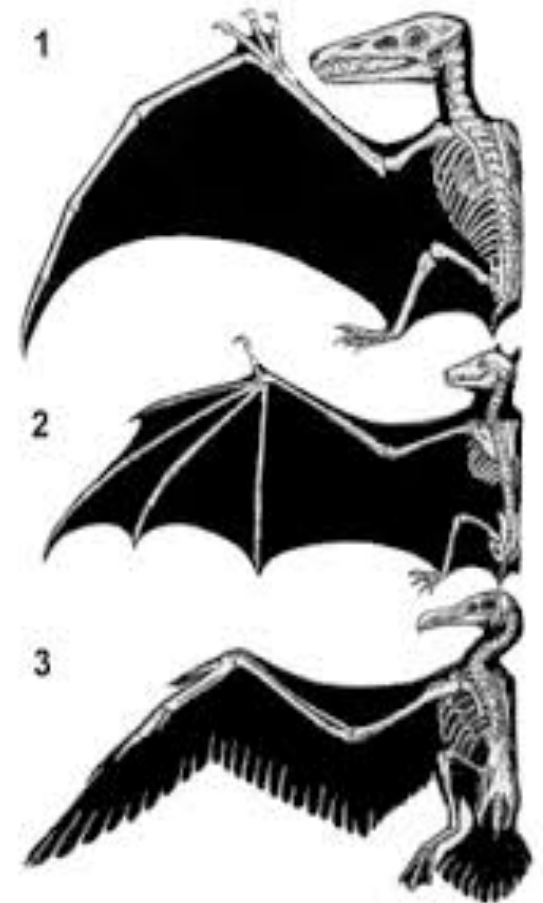
# Phylogeny: Anatomy

- Phylogenies are **constructed assuming anatomical differences increase with time.**
- The greater the similarity, the more recently a pair of species share a common ancestor.
- Evolutionary difference = **divergence**



# Phylogeny: Anatomy

- Many anatomical structures are used to construct phylogenies.
- Sometimes individual structures suggest relationships that differ from the bulk of the evidence.
  - May result from **convergence**:
    - Structures of two species becoming more similar with time when the species have different evolutionary histories.



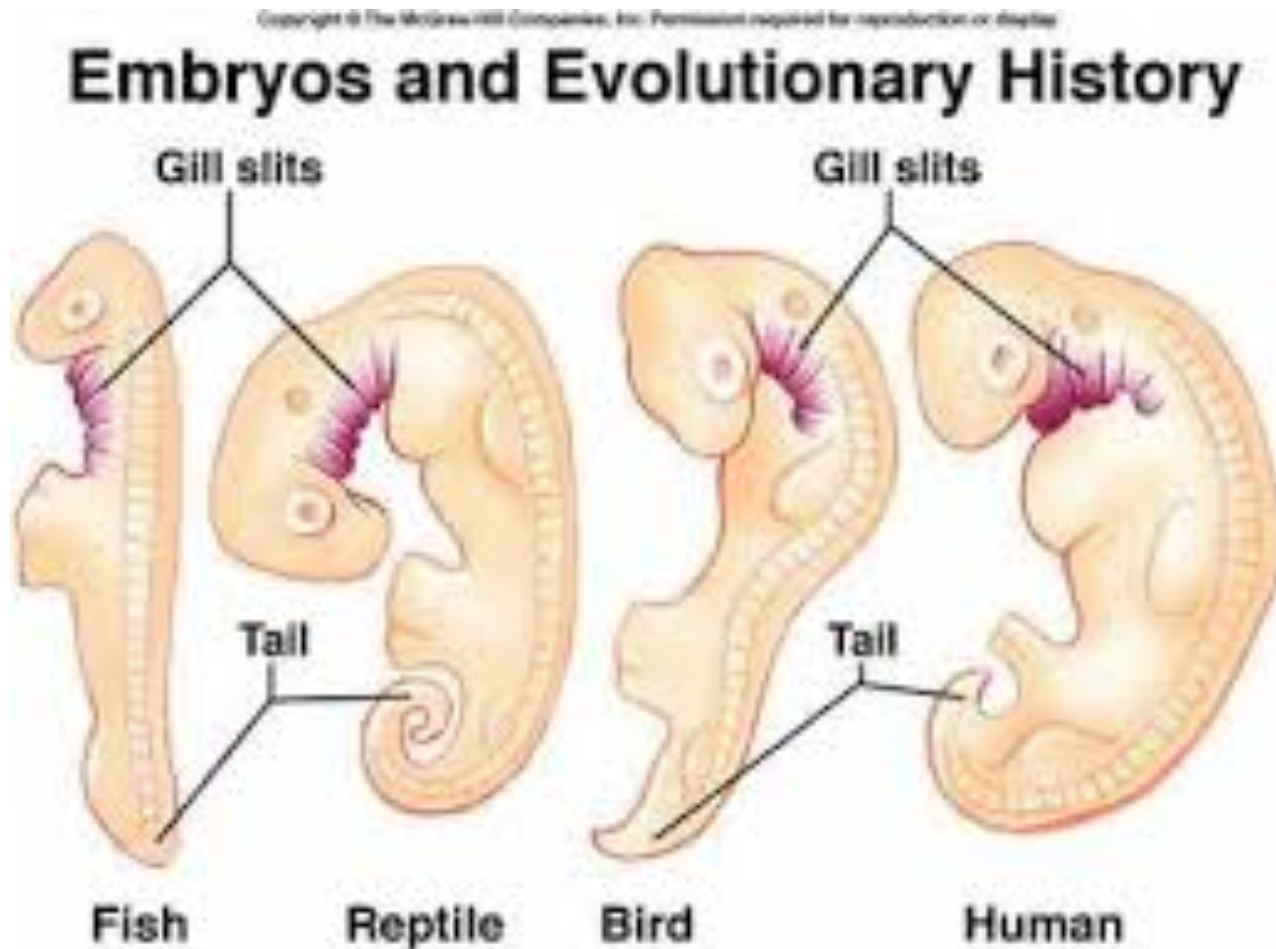
# Phylogeny: Embryology

- Scientists are able to reconstruct the phylogenies of highly divergent taxa (groups) that may have evolved so many anatomical differences that they are difficult to compare.
- Selection for successive new stages at the end of embryonic development = a mechanism for evolution.

# Phylogeny: Embryology

- “Ontogeny recapitulates phylogeny”
- Ontogeny:
  - ▣ Growth and development of an individual organism
- Recapitulate means to summarize.
- As we go through development, from embryo to adult, animals go through stages representing stages in the evolution of their remote ancestors.

# Phylogeny: Embryology



# Phylogeny: Paleontology

- The fossil record provides information regarding the **dates and order of divergence** for phylogenies.
- Fossils that show **links in traits** are termed **“transitional fossils”**
  - ▣ They document intermediate stages in the evolution of a species.

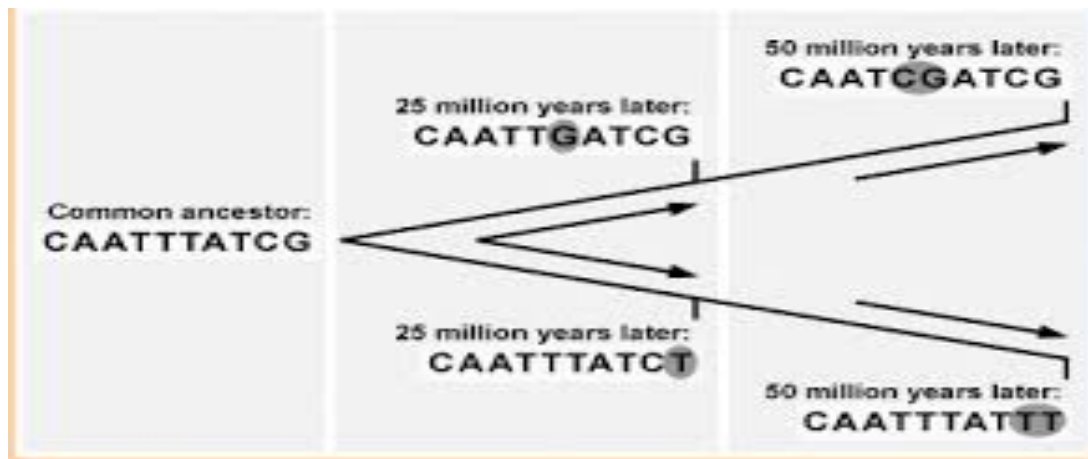


# Phylogeny: Paleontology

- One of the biggest challenges of using the fossil record to map evolutionary history is that **it is incomplete**.
- Millions of fossils have been discovered, but large gaps still exist.
  - Lots of **environmental conditions must be met** to create a fossil.
  - Fossil records favor organisms that were long lasting, abundant, and had hard shells/exoskeletons
  - **Gaps DO NOT indicate weakness** in the theory of evolution.

# Phylogeny: Biochemistry

- Histories can be constructed **assuming that differences in DNA, proteins, and other molecules increase over time.**
- The greater the genetic similarity, the more recently a pair of species shared a common ancestor.
- “Molecular Clock” – time since a pair of species diverged.





# Phylogeny: Biochemistry

- Challenges to comparing DNA sequences:
  - ▣ **Genes evolve at different rates** making it difficult to gather information about groups of organisms
  - ▣ Different assumptions = **different phylogenetic trees.**
  - ▣ Natural selection can cause **convergence in molecules.**

# Theory of Evolution

- One piece of evidence does not mean an accurate picture of the history of evolution.
- The **more pieces of evidence collected** from all of the different fields, **the more reliable the hypothesis** becomes.
- Theory of evolution:
  - ▣ A **well-tested explanation that accounts for a wide range of observations.**
- No scientist suggests all parts of the theory are understood and many questions still remain.