

PHYS 3800 Physical Geology

Interlude E

Memories of Past Life: Fossils and Evolution

The Discovery of Fossils

- What is a fossil? From the latin word *fossilis*, which means “dug up”.
- Fossils are remnants or traces of ancient living organisms, now preserved in rock, and that fossils formed when organisms were buried in sediment.



Paleontology

- Paleontology is the study of ancient life (i.e. fossils).



Paleontologists

- Herodotus-Fossils traces of ancient life first proposed by Herodotus
- Leonardo Da Vinci-Revived by Leonardo
- Nicholas Steno-1669 Steno argued that buried shells, teeth and bones could become part of the rock without losing their distinctive shape
- Robert Hooke-in the 1600s realized that most fossils represent extinct species
- William Smith-during the 1790s realized that different fossils occur in different layers of strata. Fossils occur in a predictable succession.



What kinds of rocks contain fossils?

- Sedimentary Rocks!!!!



How do fossils form?

HOW FOSSILIZATION OCCURS

The Textbook Story, with a Twist

In the classic picture of how an animal becomes fossilized, the skin, muscles, guts and tendons degrade, leaving bones. Cells, proteins and blood vessels in bone degrade as well, and minerals from the surrounding sediment seep into the spaces left behind. Ultimately, these create a solid composite with the minerals of the original bone. But cells, proteins and soft tissues found in various ancient bones show that fossilization does not always proceed in strictly this way. Scientists do not understand exactly what sometimes allows organic substances to persist for tens of millions of years, but they have identified factors (highlighted in red) that may aid the preservation and recovery of these materials.

Death

Animal dies in a setting where it somehow escapes scavengers.

Burial

Carcass is covered with sediment before scavengers or weathering obliterates it, such as may happen when a river with a heavy sediment load washes over a floodplain.

Sandstone sediments in particular seem to protect against complete loss of organic remains, possibly because the porous sands allow the corrosive fluids that form during decomposition to drain away.

Deeper Burial

Repeated deposition of sediments over millions of years buries the carcass far below the surface, where minerals from groundwater filter into the bones.

Especially deep burial may promote soft-tissue preservation because it protects against oxidation, changes in pH and temperature, and exposure to ultraviolet radiation that can occur at the surface. Eventually the animal comes into chemical equilibrium with the underground environment, which may be key to preservation.

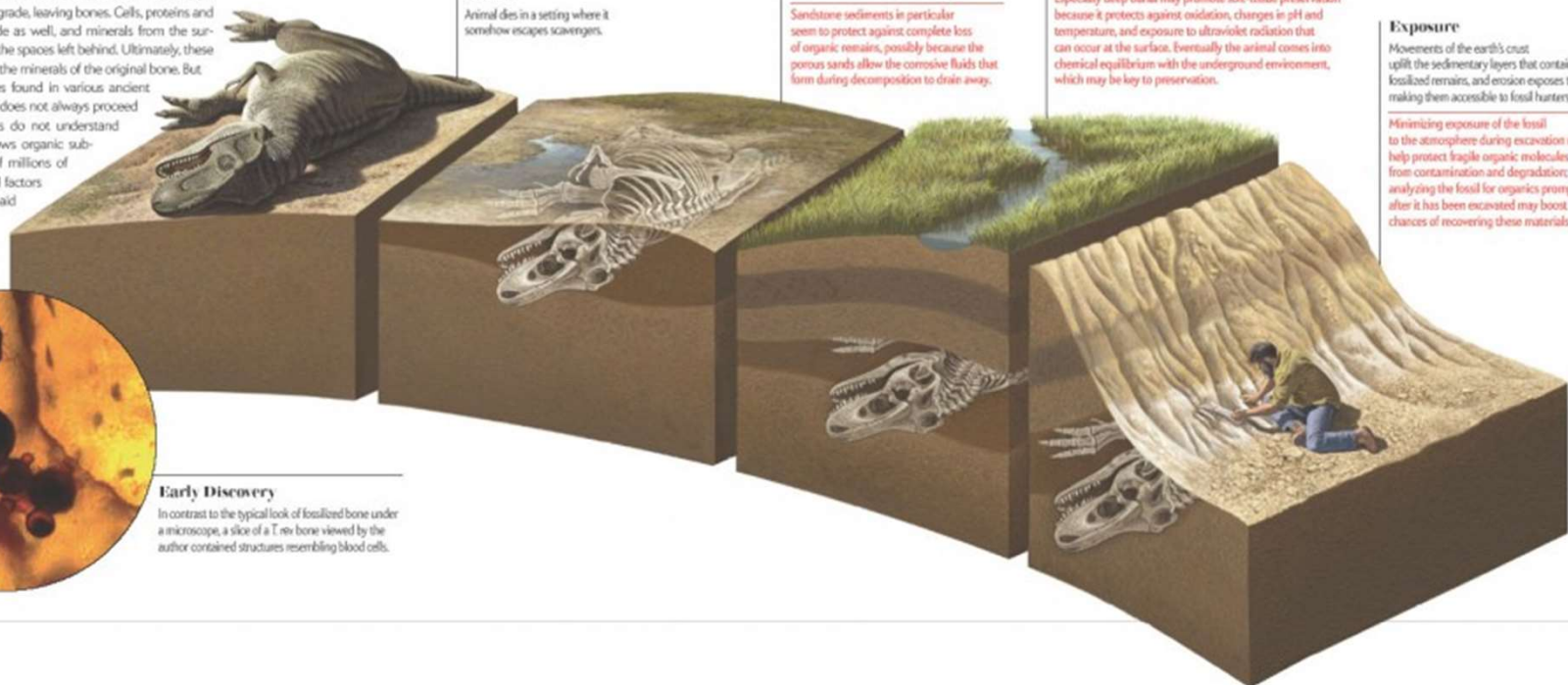
Exposure

Movements of the earth's crust uplift the sedimentary layers that contain the fossilized remains, and erosion exposes them, making them accessible to fossil hunters.

Minimizing exposure of the fossil to the atmosphere during excavation may help protect fragile organic molecules from contamination and degradation; analyzing the fossil for organics promptly after it has been excavated may boost chances of recovering these materials.

Early Discovery

In contrast to the typical look of fossilized bone under a microscope, a slice of a T. rex bone viewed by the author contained structures resembling blood cells.



The Many Different Types of Fossils

- Frozen or dried body fossils



The Many Different Types of Fossils

- Body fossils preserved in amber or tar



The Many Different Types of Fossils

- Preserved or replaced bones, teeth and shells



The Many Different Types of Fossils

- Molds and casts of bodies



The Many Different Types of Fossils

- Carbonized impressions of bodies



The Many Different Types of Fossils

- Permineralized organisms



Many Different Types of Fossils

- Trace Fossils



Many Different Types of Fossils

- Chemical Fossils (DNA)



Many Different Types of Fossils

- Fossilized tools (Cassetticus Tapus)



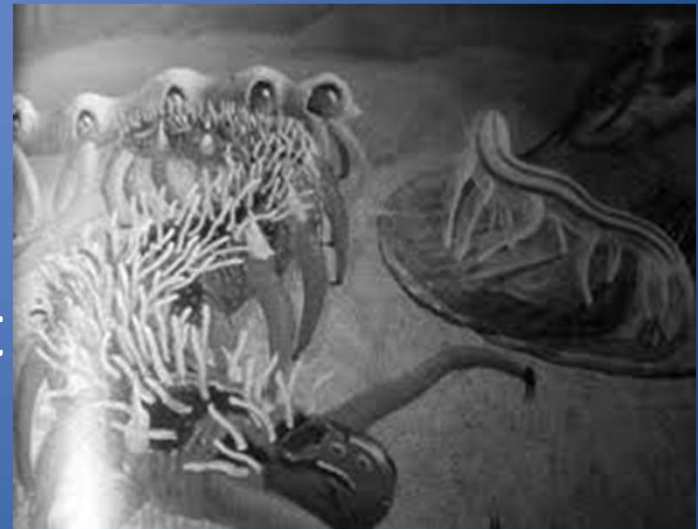
Fossil Preservation

- Death in an anoxic (oxygen poor) environment
- Rapid burial
- The presence of hard parts

Extraordinary Fossils:

A Special Window to the Past

- Soft part burial
- DNA



Typical Fossils

- Trilobites
- Gastropods
- Bivalves
- Brachiopods



Typical Fossils

- Bryozoans
- Crinoids
- Graptolites
- Cephalopods
- Corals



Common Types of Invertebrate Fossils

An artist's reconstruction of a Cambrian ecosystem. The painting is based on Burgess Shale fossils.



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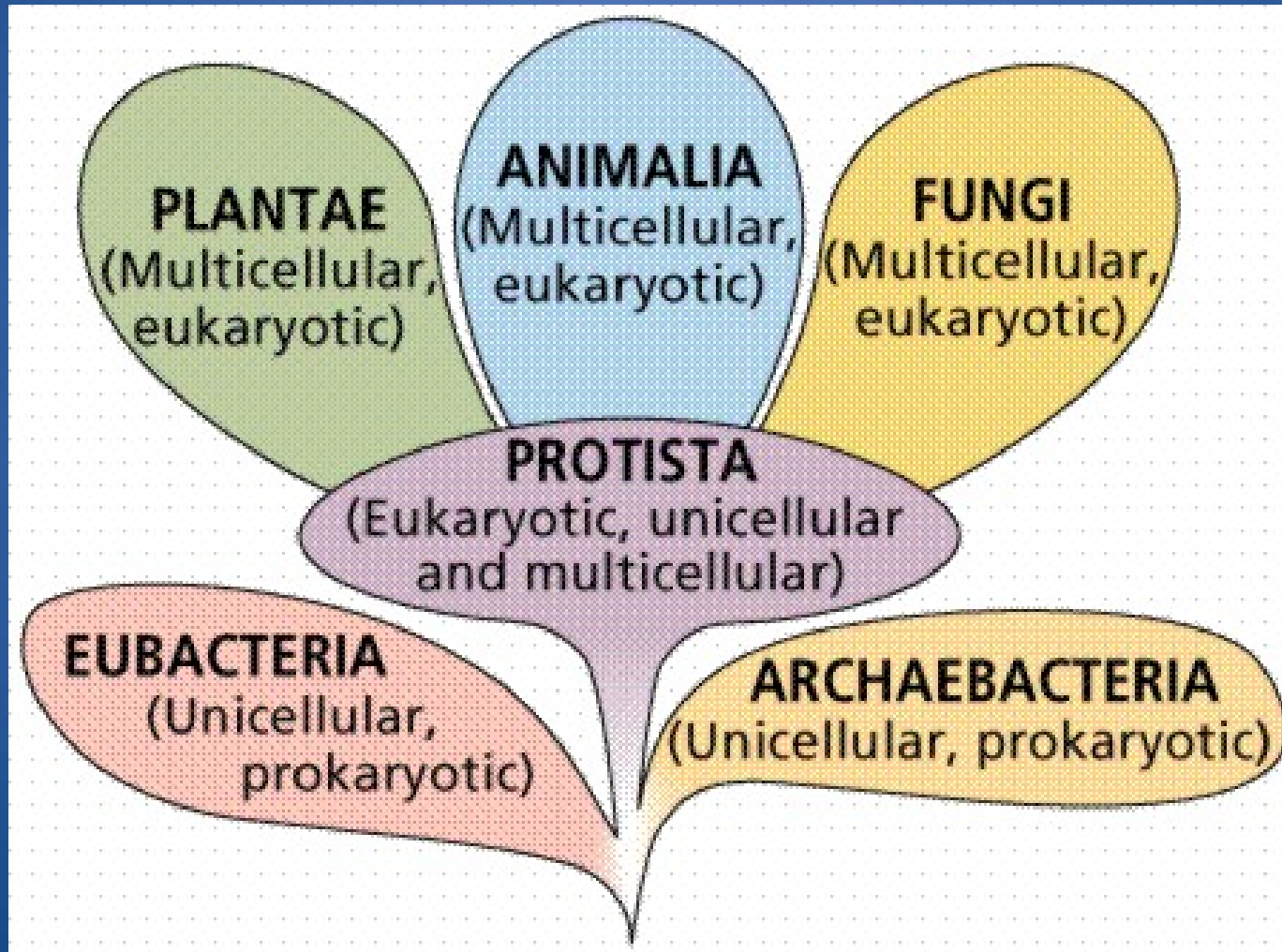
Taxonomy and Identification

- Kingdom: Animalia
 - Phylum: Chordata
 - Class: Mammalia
 - Order: Primates
 - » Family: Hominidae
 - Genus: Homo
 - *Species: Homo Sapiens
- Is the Fossil Record Complete???

The Diversity of Life

- In the course of geologic time many of the organisms that have inhabited the earth have left a partial record in rock of their presence called Fossils.
- Not easy to define life but two attributes:
 - The ability to self replicate
 - The capacity for self regulation

Six Kingdoms of Life

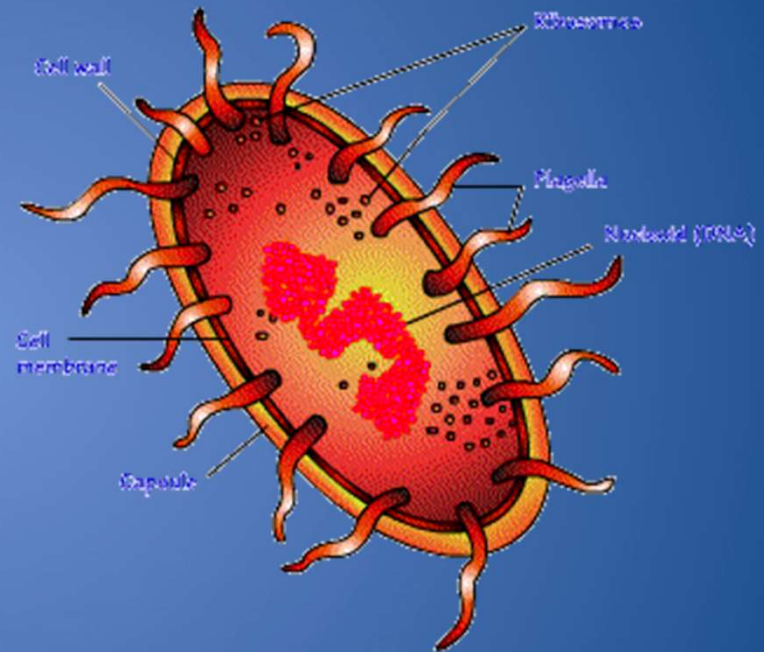


Six Kingdoms of Life



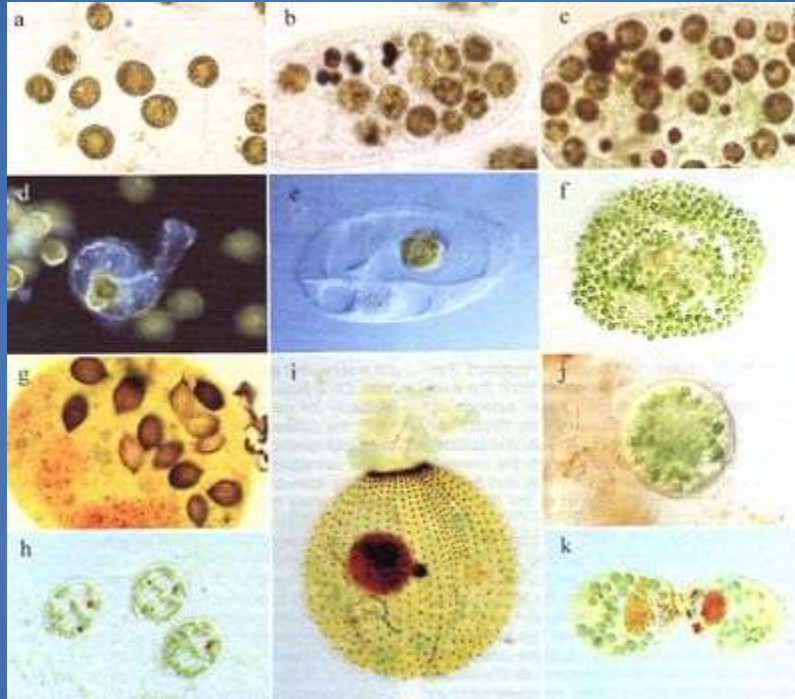
EUBACTERIA – E. Coli, Cyanobacteria

Six Kingdoms of Life



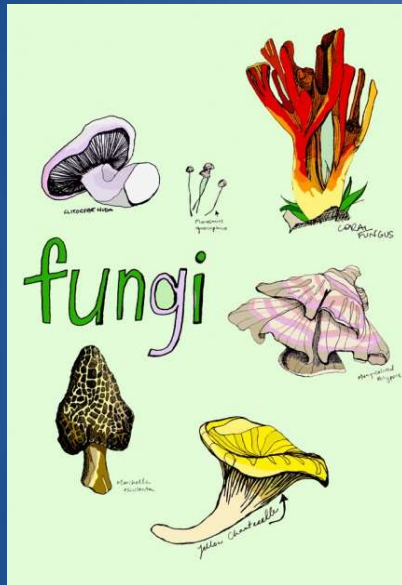
ARCHAEBACTERIA – Heat tolerant bacteria

Six Kingdoms of Life

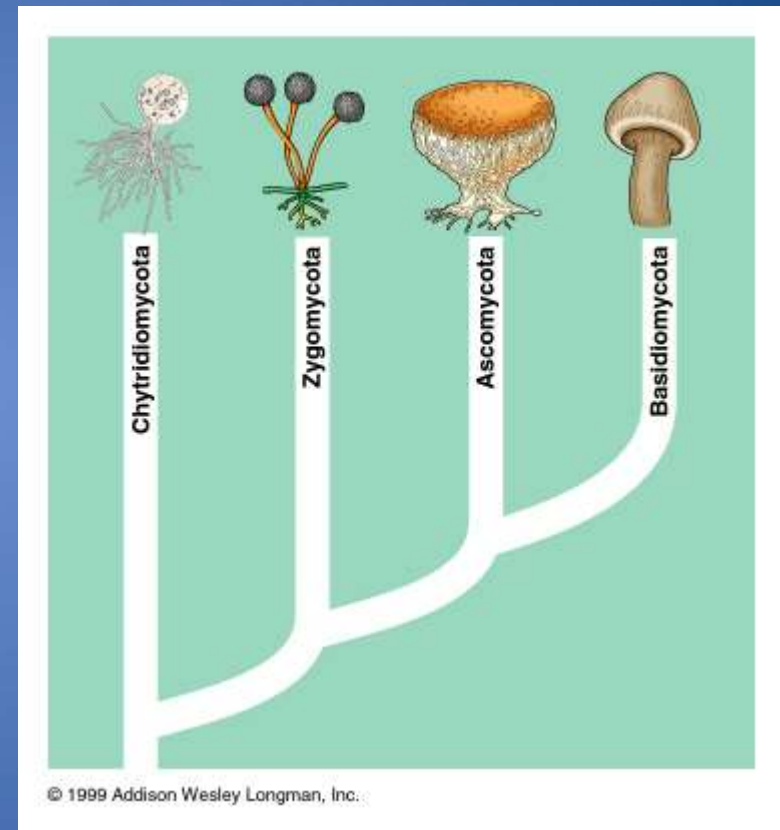


PROTISTS-Protozoan, plant-like protists and fungi-like protists

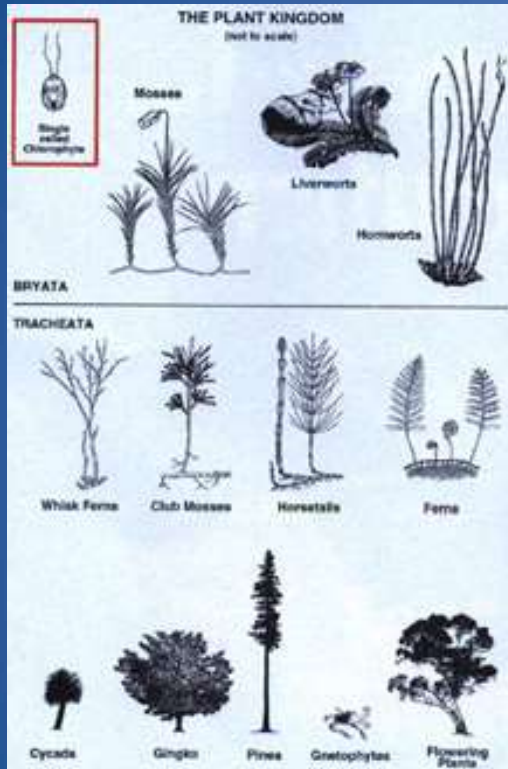
Six Kingdoms of Life



FUNGI-Mushrooms

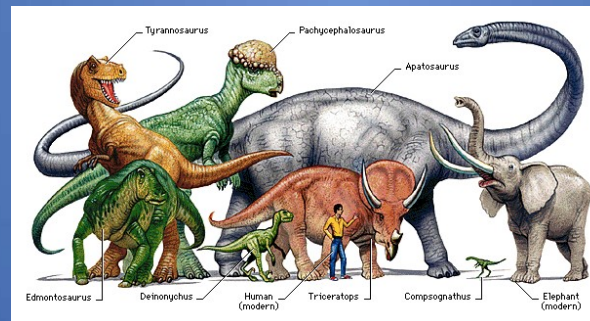
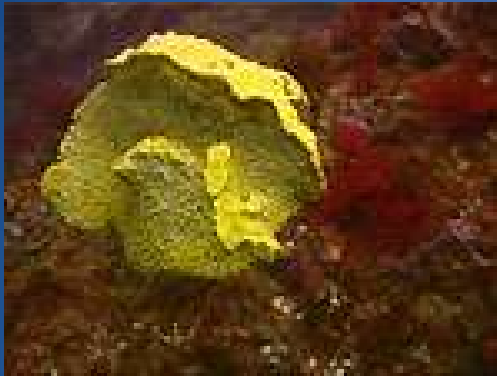


Six Kingdoms of Life



PLANTS-Algae, ferns, flowers, grasses, trees

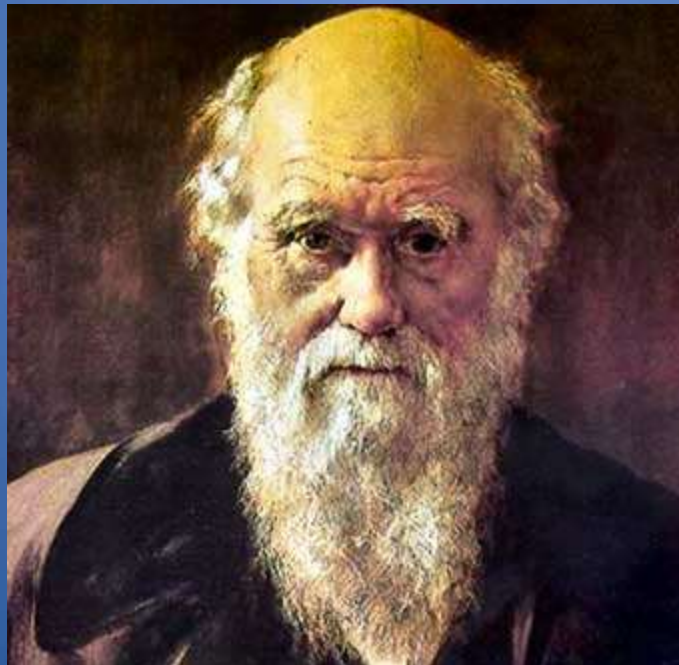
Six Kingdoms of Life



ANIMALS-Sponges, trilobites, fish, reptiles, dinosaurs, birds, mammals

Charles Darwin's Grand Idea

- Voyage of the Beagle provided geographic evidence.

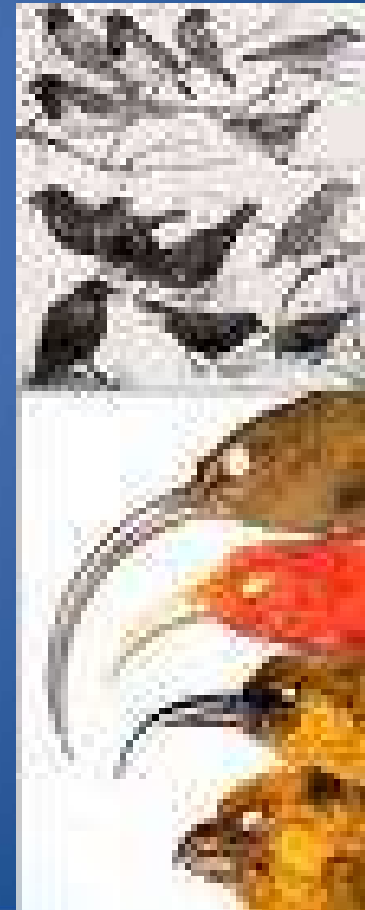
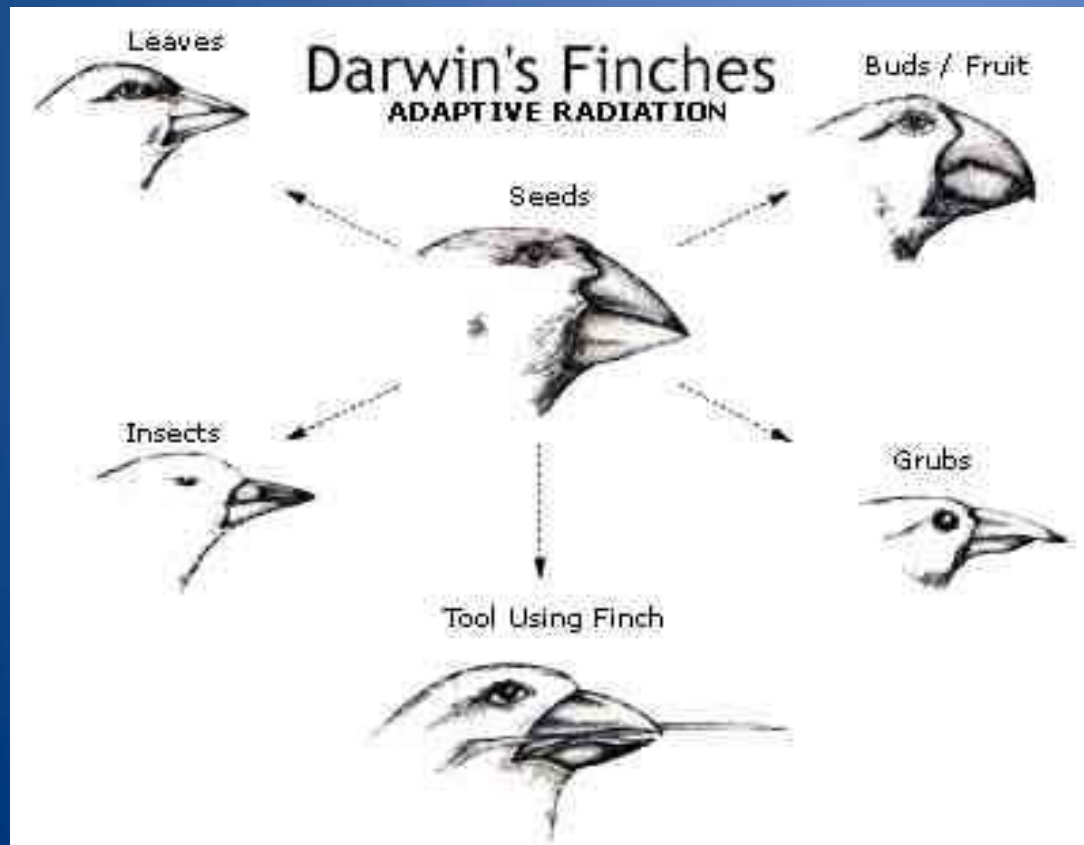


Charles Darwin's Contribution



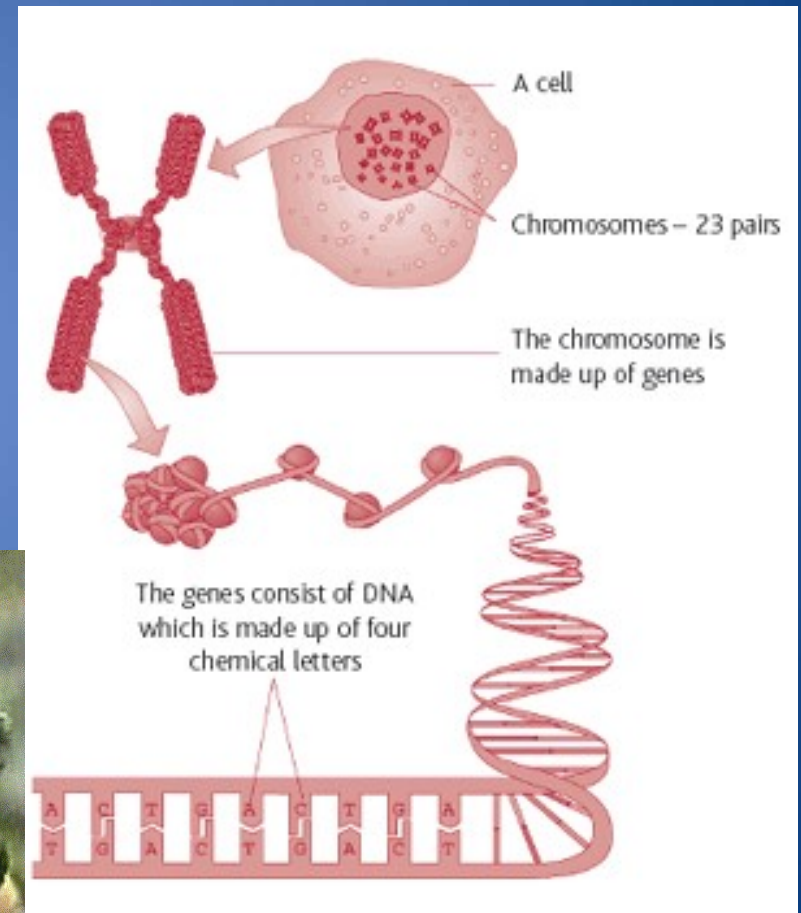
Homology

The presence of two different groups of animals or plants of organs that have the same ancestral origin but serve different functions



Genes, DNA, and Chromosomes

- Particulate Inheritance
- Genes
- Mutations
- Chromosomes



Natural selection is the mechanism of evolution

- Survival of the Fittest

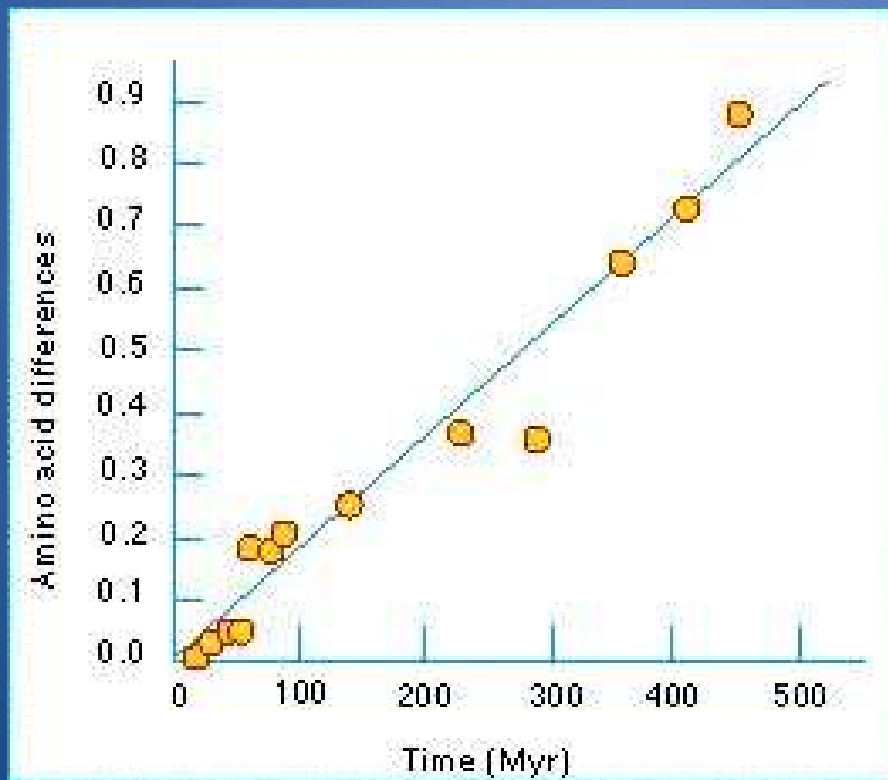


Rates of Origination

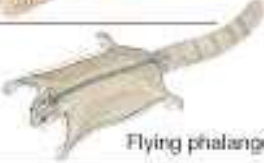
- Evolutionary Radiations-Rapid expansion of new genera or species from ancestral progenitor.
- Adaptive breakthroughs-hexacorals-porous skeleton-algae
- Symbiotic relationships (mutually beneficial) hexacorals and algae

Molecular Clock and Times of Origination

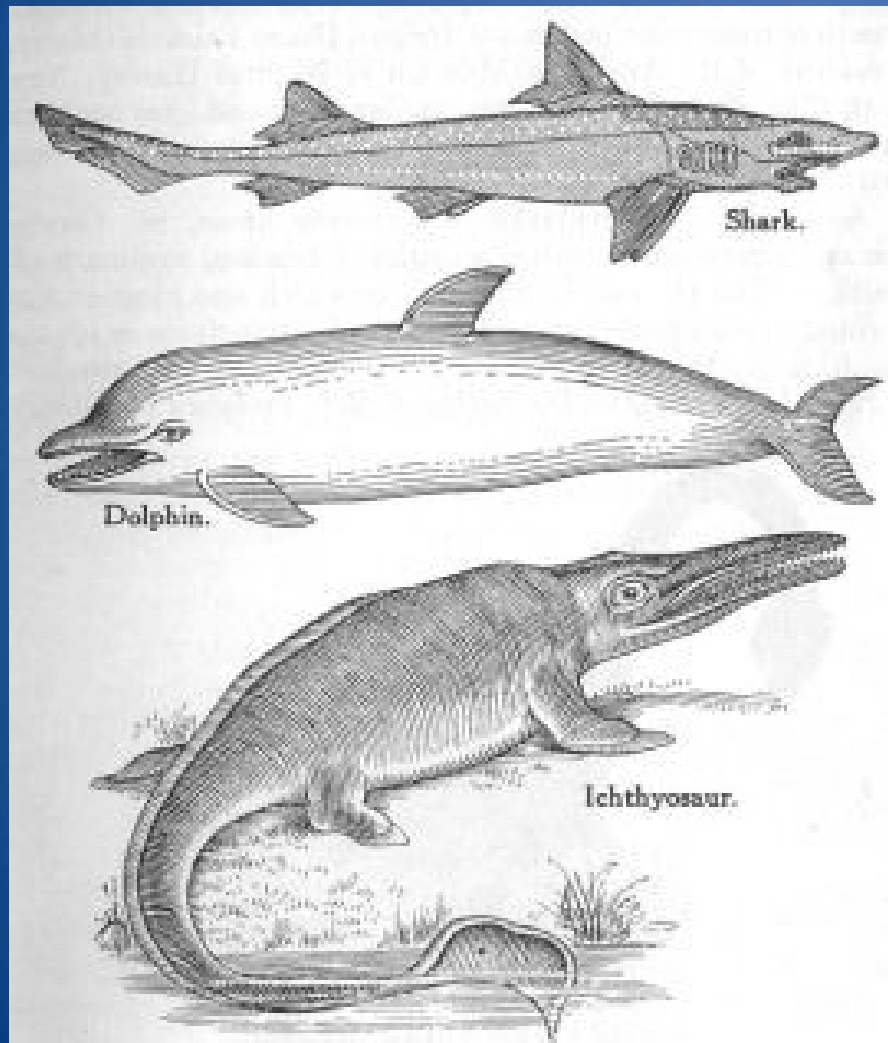
- Molecular clock-the accumulation of mutations at a fixed rate



Evolutionary Convergence

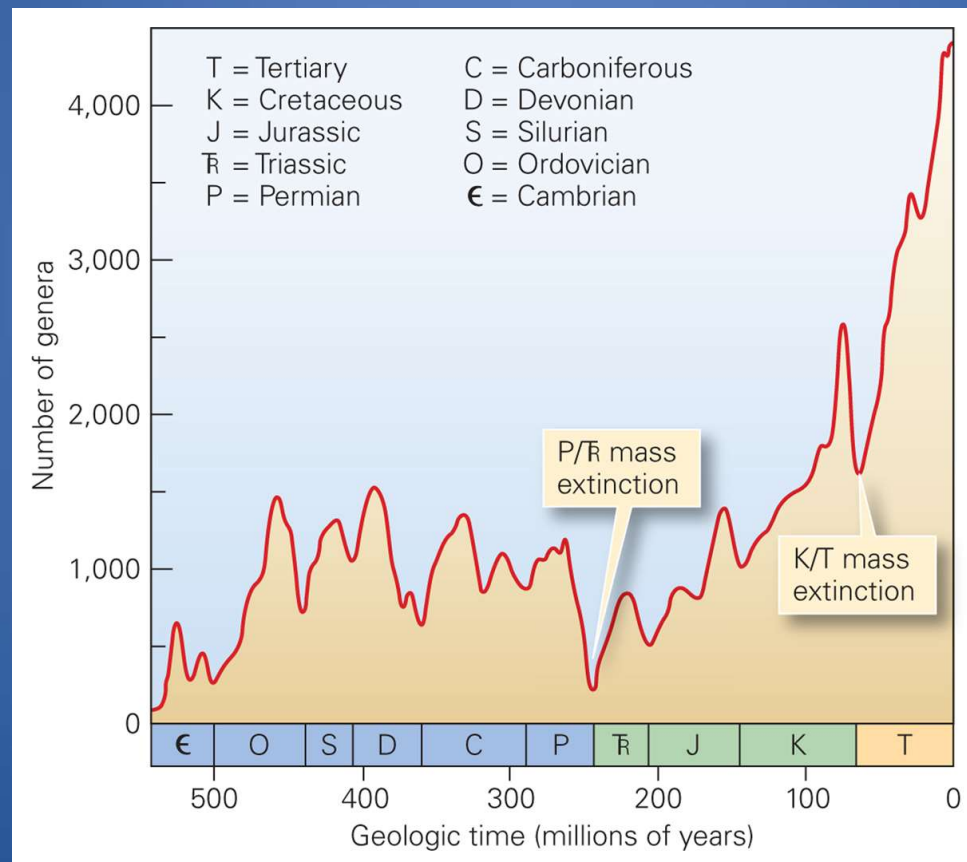
Niche	Placental Mammals	Australian Marsupials
Burrower	 Mole	 Marsupial mole
Anteater	 Anteater	 Numbat (anteater)
Mouse	 Mouse	 Marsupial mouse
Climber	 Lemur	 Spotted cuscus
Glider	 Flying squirrel	 Flying phalanger
Cat	 Bobcat	 Tasmanian "tiger cat"
Wolf	 Wolf	 Tasmanian wolf

Evolutionary Convergence



Extinction

- Rates of extinction vary greatly



Extinction

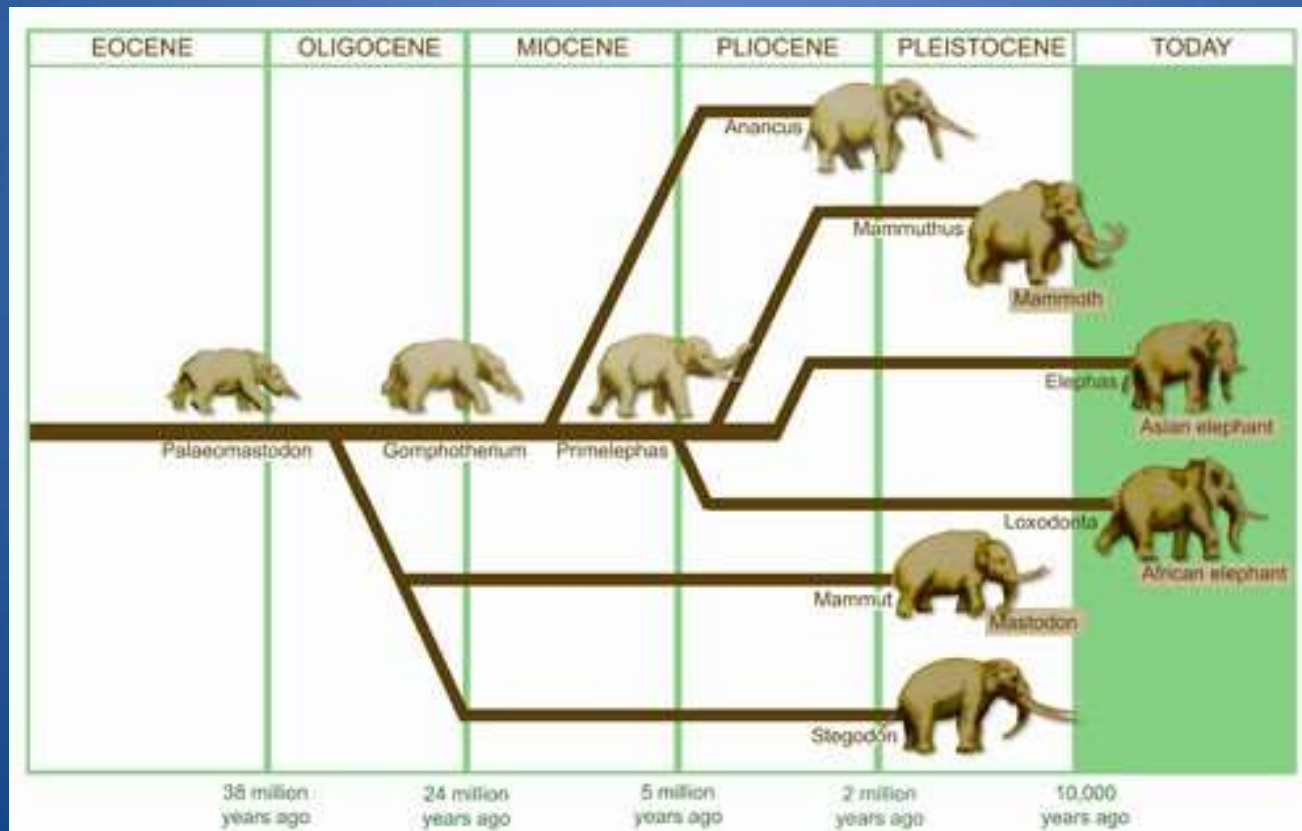
- Mass Extinctions



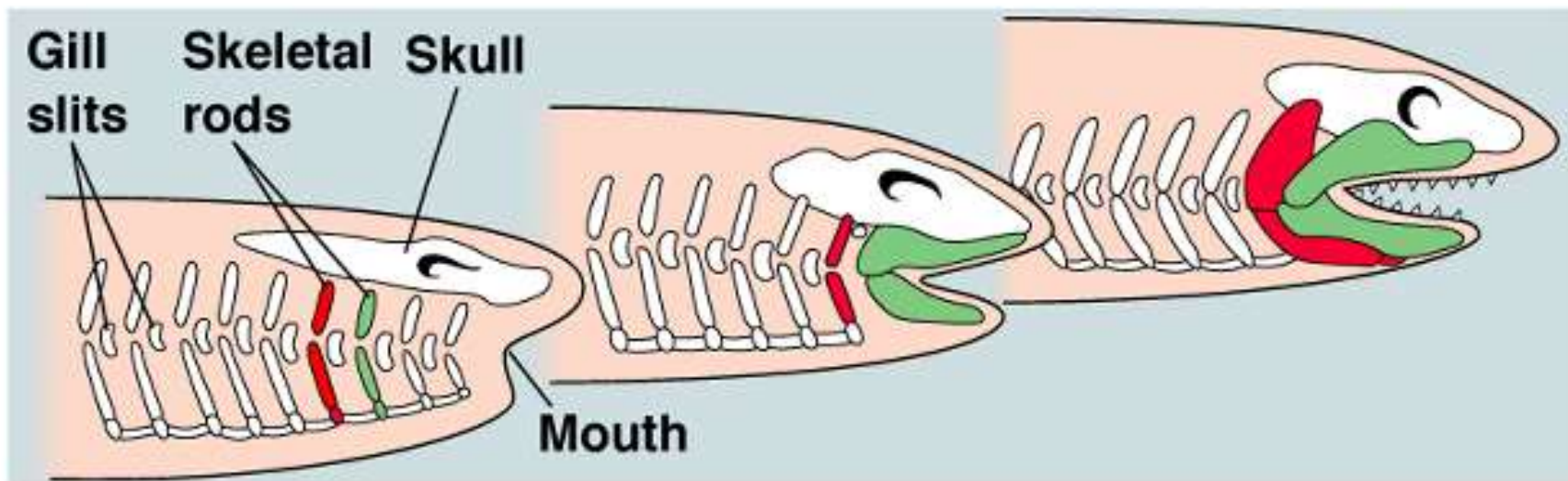
- Mass Extinctions occurring today

Evolutionary Trends

- Cope's Rule-Animals tend to evolve toward larger body size

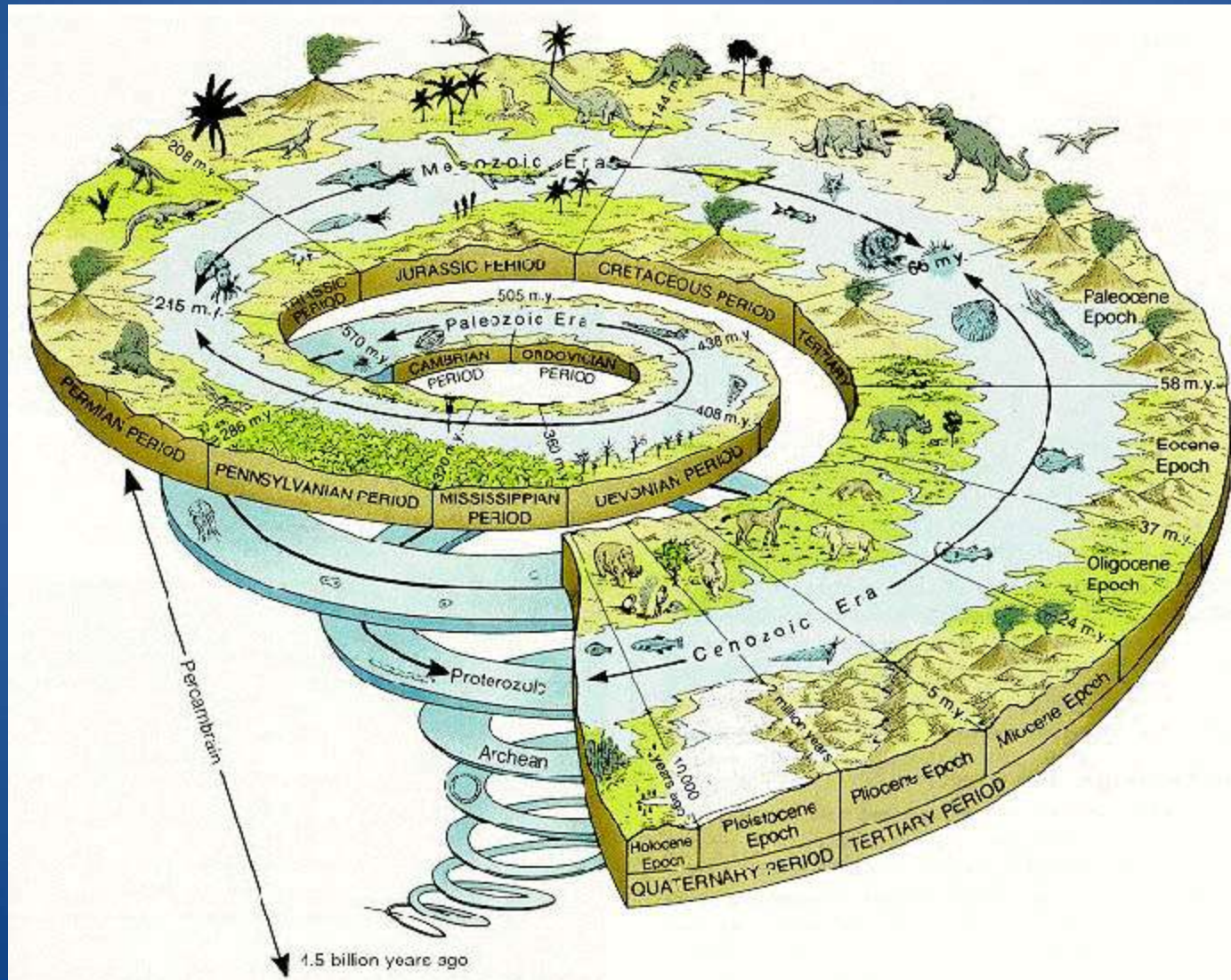


Evolutionary trends can be simple or complex



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Directional Changes in Earth's History



Evolution is Irreversible

