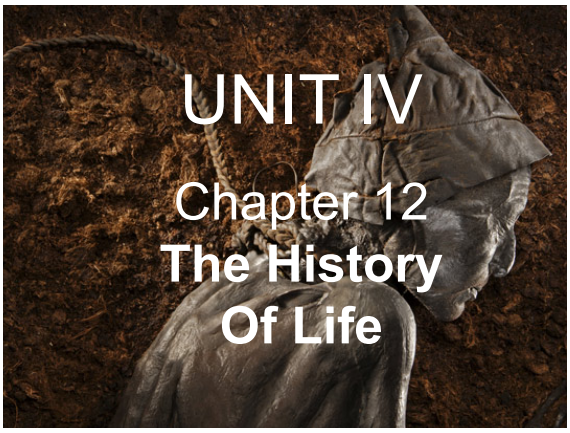


UNIT 4: EVOLUTION
Chapter 12: The History of Life

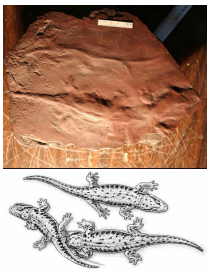
I. The Fossil Record (12.1)

A. Fossils can form in several ways

1. **Permineralization**- minerals carried by water are deposited around or replace the hard structure

Petrified wood

2. **Natural casts**- form when flowing water removes all of original bones, leaving impression in sediment. Minerals fill in the mold



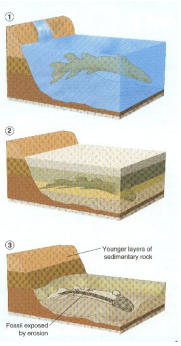
Archaeopteryx

3. **Trace fossils**- record activity of organism. Include nests, burrows, imprints of leaves, and footprints

4. **Amber-preserved fossils**- organisms trapped in tree resin that hardens into amber

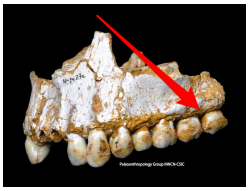
5. **Preserved remains**- form when entire organism becomes encased in material such as ice, volcanic ash, or immersed in bogs.


B. Most fossils form in **sedimentary rock**



1. Most common fossils result from permineralization
2. Best environments for fossilization include wetlands, bogs, rivers, lakebeds, and floodplains

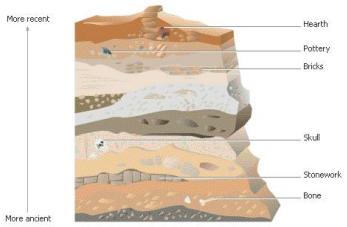
The **plaque** that coated **Neanderthal** teeth is shedding new light on how our ancestors ate, self-medicated and interacted with humans. Neanderthals used a natural form of aspirin for pain relief, according to a recent analysis of DNA from the hardened dental plaque of our nearest extinct relatives.

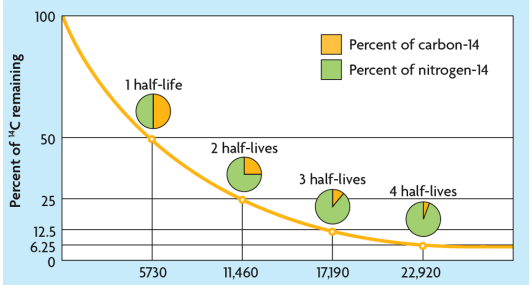
C. Only tiny percentage of living things become fossils

D. Radiometric dating provides an accurate estimate of fossil's age

1. **Relative Dating-** estimate of date by comparing placement of fossils in rock layers.



2. **Radiometric dating**- technique using natural decay rate of unstable isotopes

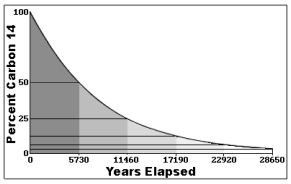


a. **Radiocarbon dating**- Isotope of Carbon (^{14}C) used with half-life of 5700 years

1). Organisms consume carbon by **eating** and **breathing**.

2). When organism dies, ^{14}C begins to decay

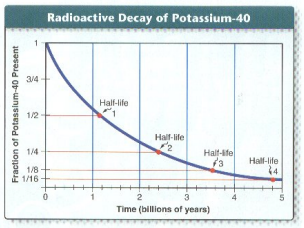
3) Look at ratio of ^{14}C to ^{12}C



b. Determining Earth's Age

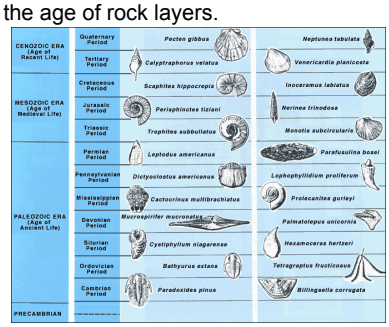
1). Use decay of **uranium** to determine age (long half-life)

2). Earth's age about **4.5 billion years**

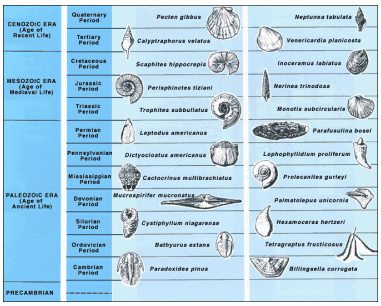


II. The **Geologic Time Scale** (12.2)

A. Index fossils are another tool to determine the age of rock layers.

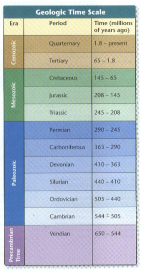


1. **Index fossils**- organisms that existed only during specific spans of time over large geographic area
2. Estimate age of rock layers by fossils they contain



B. The geologic time scale organizes Earth's history

1. **geologic time scale**- representation of the history of Earth



a. Organizes by major **changes** or **events**

b. Uses evidence from fossil and geologic records

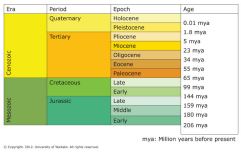
2. Divided into **three** basic units of time

a. **Eras**- lasts tens to hundreds of millions of years.

1). Separated by periods of **mass extinction**

2). leads to periods of **adaptive radiation** of species

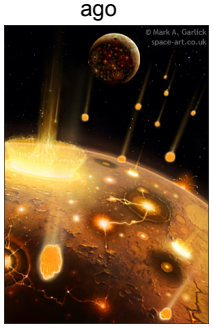
b. **Periods**- most common used units. Lasts tens of millions of years



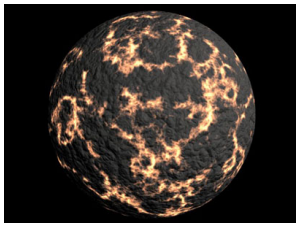
c. **Epochs**-smallest units

III. Origin of Life (12.3)

A. Earth was very different billions of years ago

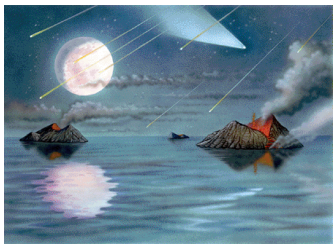


1. Earth was extremely **hot** first 700 million years



2. **Atmosphere** formed when **cooled** (no oxygen at first)

3. When cooled more, water vapor condensed and fell as rain.

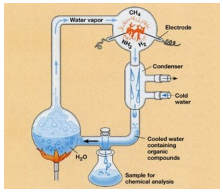


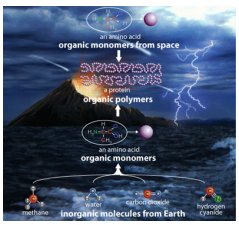
4. **Organic compounds** formed from inorganic materials once water was present

B. Several sets of hypotheses propose how life began on Earth

1. Organic Molecule Hypotheses

a. **Miller-Urey experiment** (1953)- demonstrated that organic compounds could be made by simulating conditions on early Earth

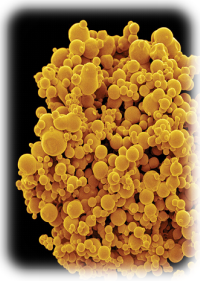




b. **Meteorite hypothesis**- organic molecules may have arrived on Earth through meteorite or asteroid impacts

2. Early Cell Structure Hypotheses
   a. **Iron-sulfide bubbles hypothesis**- biological molecules formed in chimneys of hydrothermal vents

b. Lipid membrane hypothesis- evolution of lipid membranes crucial step for origin of life.



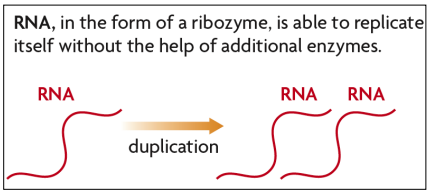
1).**Lipid** molecules spontaneously form membrane-enclosed spheres.

2). These formed around organic molecules forming cell-like structures

3. **RNA** as early genetic material

a. hypothesis that **RNA** instead of **DNA** was original **genetic material**

b. **RNA** can **self-replicate**

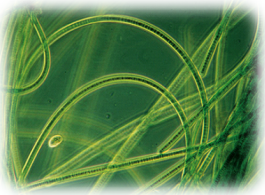


IV. Early Single-Celled Organisms (12.4)

A. Single-celled organisms changed Earth's surface by depositing **minerals**

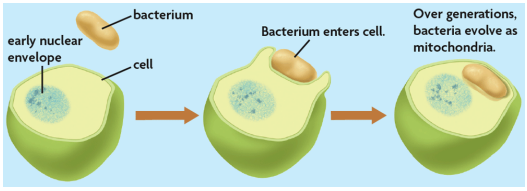
B. Changed **atmosphere** by giving off oxygen

1. **3.5 billion** years ago **photosynthetic** life evolved (cyanobacteria)
2. Higher **oxygen** levels in atmosphere and oceans allowed evolution of aerobic prokaryotes.



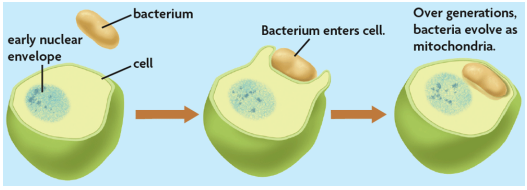
C. **Eukaryotic** cells may have evolved through **endosymbiosis**

1. **Endosymbiosis theory**- one organisms lives within body of another, and both benefit from relationship



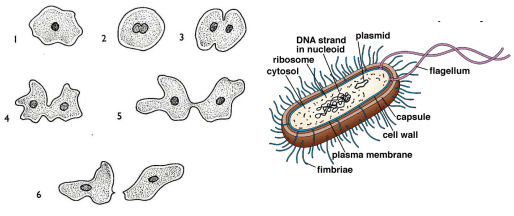
a. Early **mitochondria** and **chloroplasts** were once simple prokaryotic cells taken up by larger prokaryotes 1.5 billion years ago

b. Based theory on fact that mitochondria and chloroplasts have their own **DNA** and **ribosomes**



D. The evolution of **sexual reproduction** led to increased diversity

1. First prokaryotes and eukaryotes reproduced **asexually**

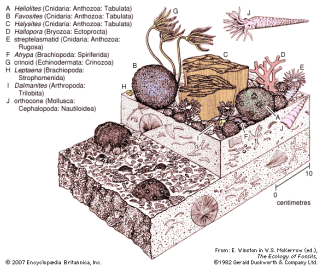


2. Sexual reproduction increases **genetic variation** which lets a population adapt quickly to new conditions

3. First step in evolution of **multicellular life.**

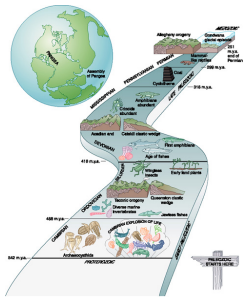
V. Radiation of Multicellular Life (12.5)

A. One of most important transitions in history of life



1. First appeared during **Paleozoic era** (544 million years ago)

2. Huge **diversity** of animal species evolved



a. At first all life was found in **ocean**

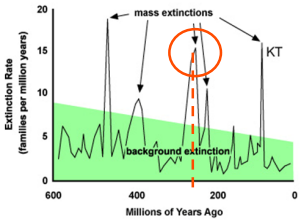
b. Eventually life moved onto **land**

c. Dead remains of organisms from this era changed into **coal** and **petroleum**

3. Paleozoic Era ended with **mass extinction**

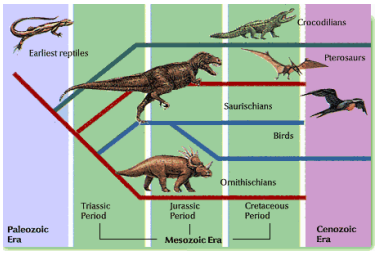
Era	Period	Time (millions of years ago)
Cenozoic	Quarternary	1.8 – present
	Tertiary	65 – 1.8
Mesozoic	Cretaceous	145 – 65
	Jurassic	208 – 145
	Triassic	245 – 208
Paleozoic	Permian	290 – 245
	Carboniferous	363 – 290
	Devonian	410 – 363
	Silurian	440 – 410
	Ordovician	505 – 440
	Cambrian	544 – 505
Precambrian Time	Vendian	650 – 544

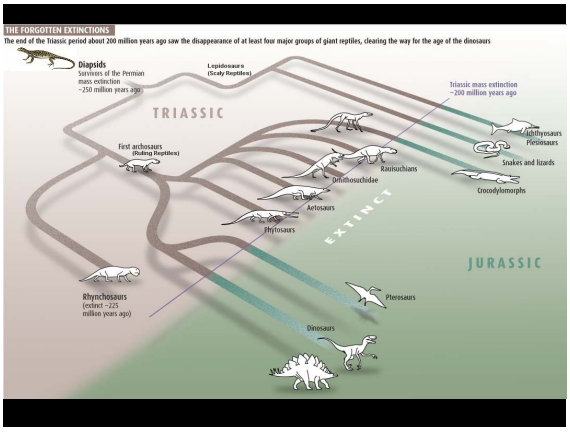
Geologic Time Scale



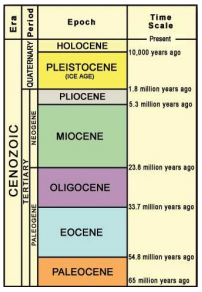
B. Reptiles radiated during the **Mesozoic era.**

1. **Age of reptiles**
2. First **mammals** appeared
3. Era ended with **mass extinction** caused by **meteorite** impact





C. **Mammals** radiated during the **Cenozoic era**



VI. Primate Evolution (12.6)

A. Humans share a common ancestor with other primates

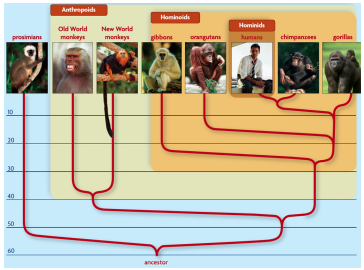
1. **Primates**- category of mammals with flexible hands and feet, forward looking eyes, and enlarged brains relative to body size.

2. Primate evolution- **two** main branches

a. **Prosimians**- oldest living primate group

b. **Anthropoids**- human-like primates

1). includes **hominids**-all species of human lineage)



2). **Bipedal**- two legged or upright walking led to evolutionary success

B. There are many fossils of extinct hominids

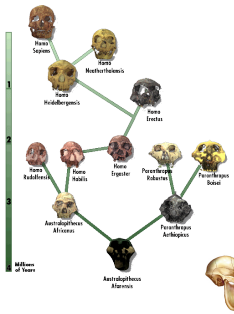
1. **Australopithecus afarensis** (3 to 4 millions years ago in Africa)

2. **Homo habilis** (2.4 to 1.5 million years ago) - “handy man”- used crude stone tools

3. **Homo Neanderthalensis** (200,000 to 30,000 years ago)

4. **Homo sapiens**- modern man *(“man-wise”)*

C. Modern humans arose about 100,000 years ago



1. Evidence points to origin in Ethiopia 100,000 years ago
2. Human evolution was influenced by **culture**- **tools** are key markers in human evolution
3. Increased skull and **brain** size gave humans a **selective advantage**

Australopithecus afarensis **Homo habilis** **Homo neanderthalensis** **Homo sapiens**