THE HISTORY OF LIFE ON EARTH

EARLY THOUGHT

- Spontaneous Generation – living things arise from nonliving things spontaneously
- Based on observations and conclusions
- Disproved later with Biogenesis (living organisms come from other living organisms)

EXAMPLES OF SPONTANEOUS GENERATION

1. FROGS IN THE NILE

- Observation: Every year the Nile River floods leaving muddy soil. Immediately after the flood, large numbers of frogs would appear that weren't there before.
- Conclusion: Muddy soil gives rise to frogs.

2. FLIES AND ROTTING FOOD

- Observation: Before refrigeration, a trip to the butcher shop meant dealing with the flies around the carcasses.
- Conclusion: Rotting meat produced flies.

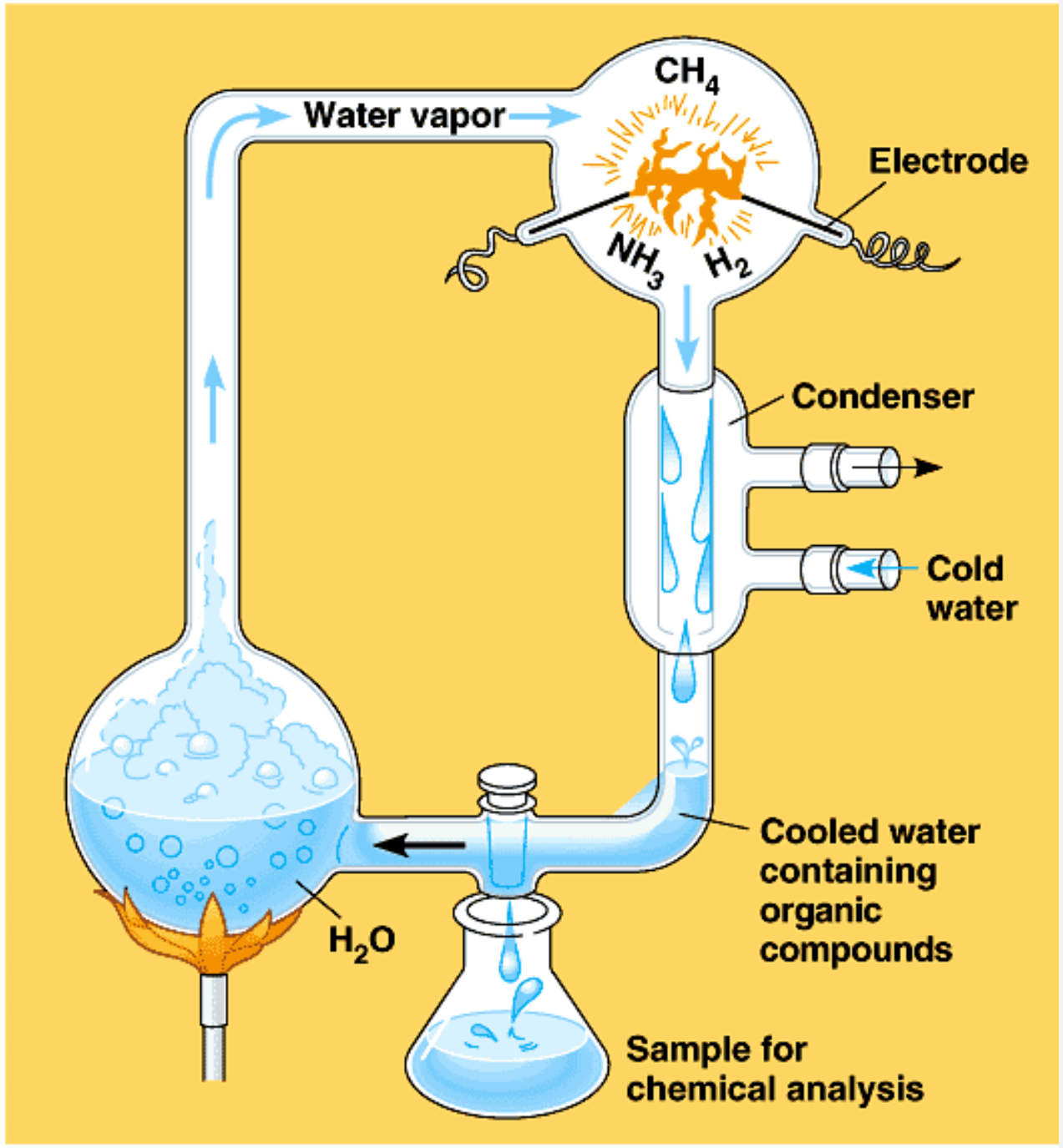
EARLY EARTH

- Earth formed about 4.65 bya; unsuitable for life at first
- Eventually Earth becomes tilted on its axis creating seasons and cooler temperatures (also, warm days and cool nights)
- Initial gases: CO_2, NH_3, water vapor, and H_2S
  - No O_2
- How does life appear when there is none initially?

https://www.youtube.com/watch?v=NNijmxsKGbc

EVIDENCE OF SYNTHESIS OF ORGANIC COMPOUNDS: MILLER-UREY EXPERIMENT

- (1953) Created an apparatus designed to replicate conditions of early Earth to see how organic compounds could have formed
  1. Water mixture ("sea") heated; vapor carried to "atmosphere" flask
  2. "Atmosphere" contained mix of hydrogen, methane, ammonia, and water vapor
  3. Sparks added to simulate lightning
  4. Cold water condensed gas to liquid (precipitation)
  5. Molecules collected for analysis

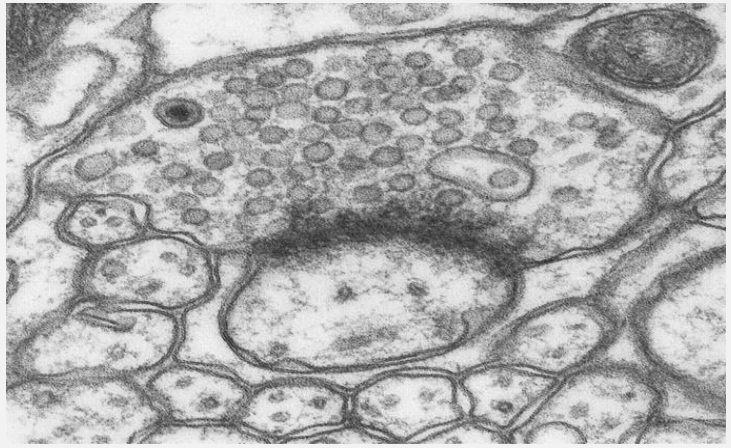


MILLER-UREY RESULTS

- Miller and Urey found simple compounds like formaldehyde (CH_2O) and hydrogen cyanide (HCN)
- Also found more complex molecules like **amino acids** and **hydrocarbons**
- **Provided evidence that organic compounds could be created from abiotic conditions**
- Miller and Urey performed a similar experiment adding the effects of a simulated volcanic eruption
- Volcano test performed again in 2008 using newer technology for analysis. More amino acids formed in newer test than the original.

NEXT DEVELOPMENT

- Vesicles
  - Membrane-bound fluid-filled structures
  - Form spontaneously when hydrophobic compounds are added to water
  - Function like a membrane (semipermeable)



- RNA
  - Precursor to DNA
  - Simpler structure than DNA (single vs double strand)
  - Less stable than DNA (backbones on DNA protect nucleotides inside)
  - Less accurate during replication

A vesicle containing RNA begins to resemble a cell = Protobiont

FOSSIL RECORDS

One of the best pieces of evidence for the history and development of life is the fossil record combined with radiometric dating

Radiometric dating- the decay of one isotope to another measured in half-life

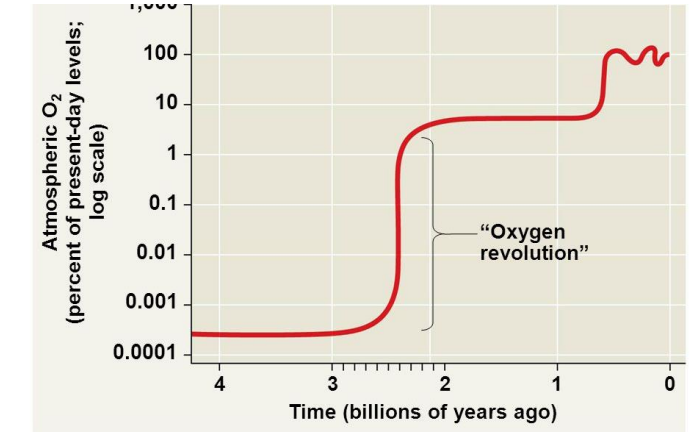
Can obtain semi-accurate age of fossil

Not perfect

- Fossils only form in sedimentary rock
- Fossils can be destroyed by geologic processes
- Fossil record benefits species that existed a long time

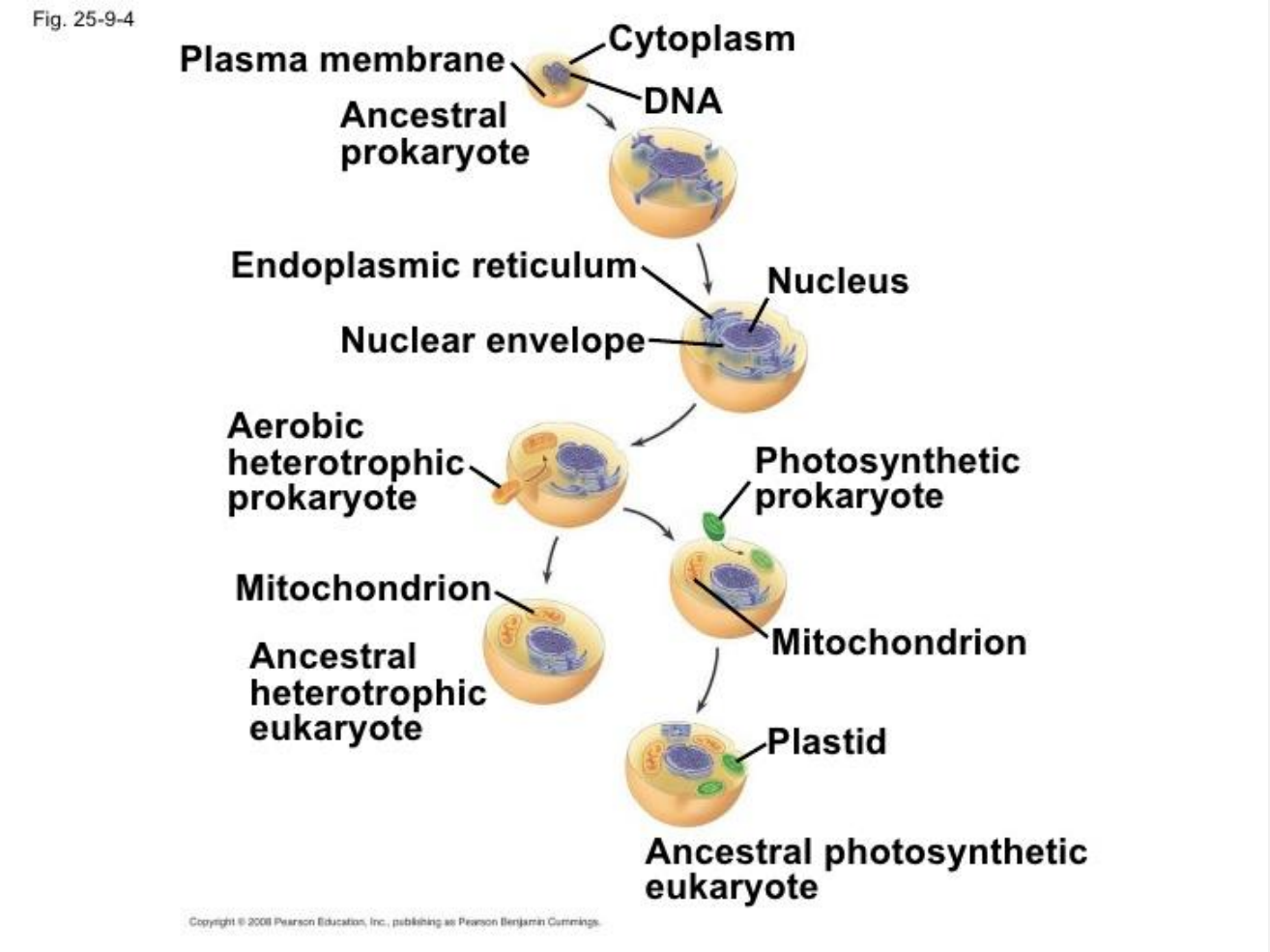
THE FIRST ORGANISMS

- The first organisms were prokaryotes (single-celled) ~3.5 bya
- Evidence seen in stromatolites (layered rocks formed from prokaryotes binding sediments together)
- Early prokaryotes utilized photosynthesis creating most of atmospheric O_2 during the **Oxygen Revolution** (2.5 bya)



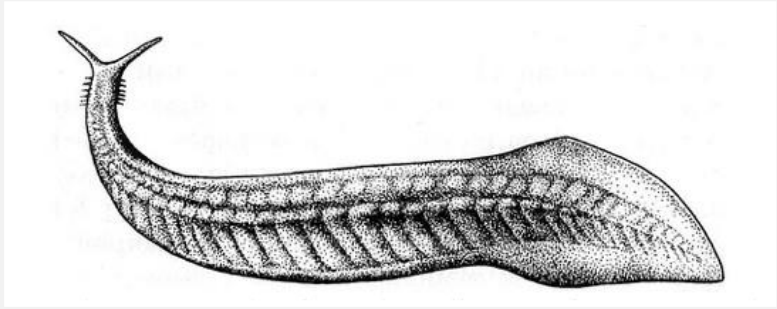
EUKARYOTES

- Review- Eukaryotes are:
  - Larger than prokaryotes
  - Have a nucleus and membrane-bound organelles
- Originated ~2.1 bya
- **Endosymbiotic Theory**- mitochondria and plastids were once prokaryotic organisms that were engulfed by a larger single-celled organism

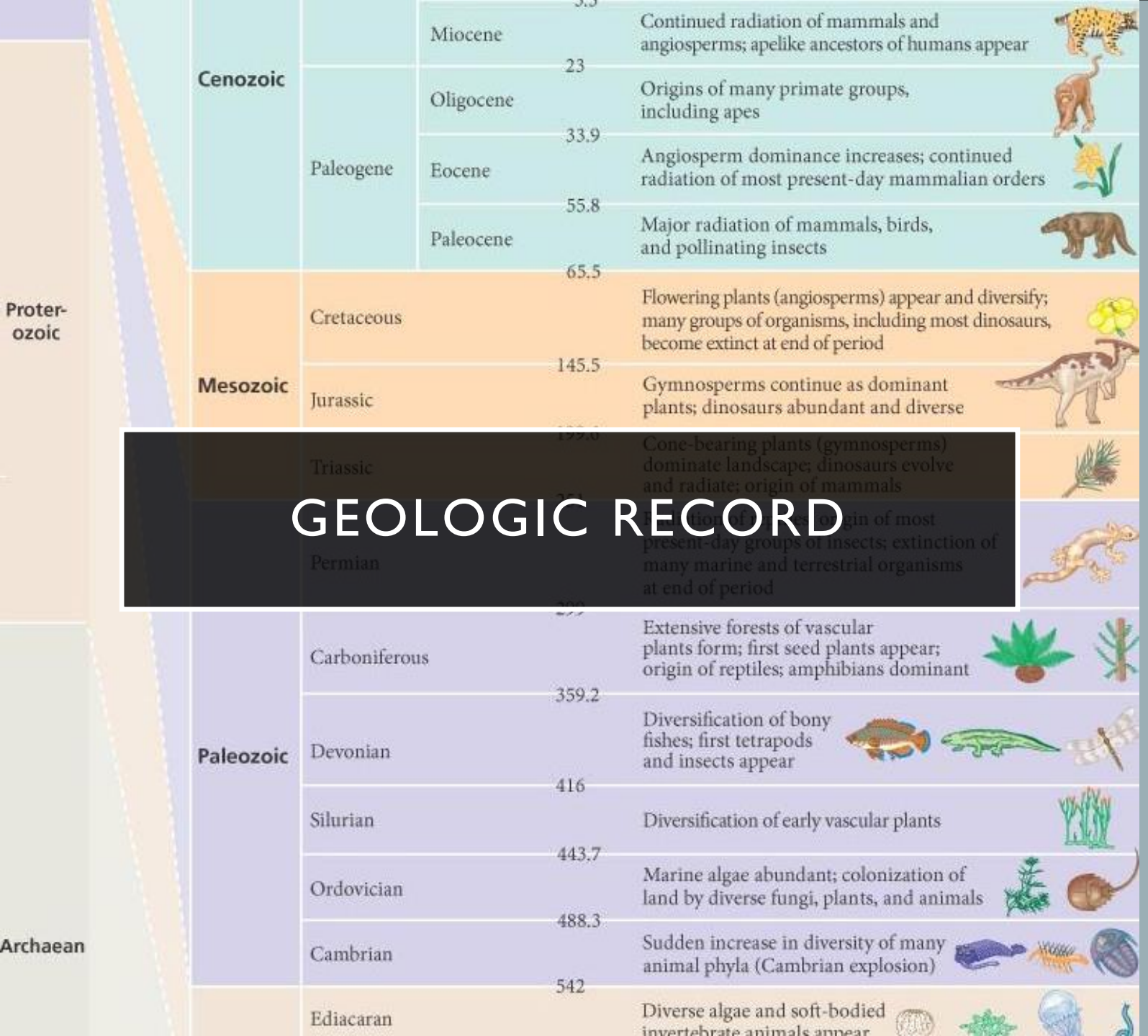


ORIGIN OF MULTICELLULARITY

- ~1.5 bya
- Composed of eukaryotic cells
- Complex and differentiated cells allowed for greater morphological diversity
- First fossils of multicellular organisms are algae
- Animals were soft-bodied non-predators



GEOLOGIC RECORD



Comprised of 3 main eons: Archaean, Proterozoic, and Phanerozoic

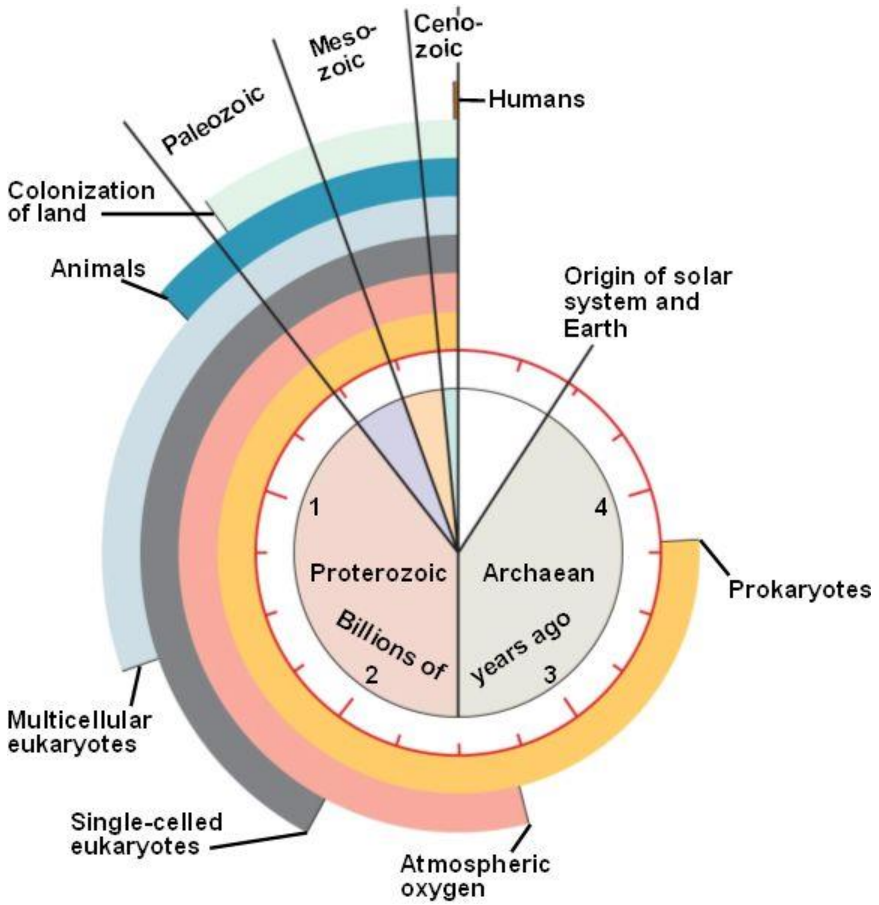
Distinct eras within each eon

Breaks between eras signal extinction events

Archaean	Paleozoic	Permian	251	Radiation of reptiles; origin of most present-day groups of insects; extinction of many marine and terrestrial organisms at end of period 
		Carboniferous	299	Extensive forests of vascular plants form; first seed plants appear; origin of reptiles; amphibians dominant 
		Devonian	359.2	Diversification of bony fishes; first tetrapods and insects appear 
		Silurian	416	Diversification of early vascular plants 
		Ordovician	443.7	Marine algae abundant; colonization of land by diverse fungi, plants, and animals 
		Cambrian	488.3	Sudden increase in diversity of many animal phyla (Cambrian explosion) 
		Ediacaran	542	Diverse algae and soft-bodied invertebrate animals appear 
			635	Oldest fossils of eukaryotic cells appear 
			2,100	
			2,500	
			2,700	Concentration of atmospheric oxygen begins to increase
			3,500	Oldest fossils of cells (prokaryotes) appear
			3,800	Oldest known rocks on Earth's surface
			Approx. 4,600	Origin of Earth

Tiktaalik roseae

Relative Duration of Eons	Era	Period	Epoch	Age (Millions of Years Ago)	Some Important Events in the History of Life
Phan-erozoic	Cenozoic	Neogene	Holocene	0.01	Historical time
			Pleistocene	1.8	Ice ages; humans appear
			Pliocene	5.3	Origin of genus *Homo*
			Miocene	23	Continued radiation of mammals and angiosperms; apelike ancestors of humans appear
		Paleogene	Oligocene	33.9	Origins of many primate groups, including apes
			Eocene	55.8	Angiosperm dominance increases; continued radiation of most present-day mammalian orders
			Paleocene	65.5	Major radiation of mammals, birds, and pollinating insects
Proter-ozoic	Mesozoic	Cretaceous		145.5	Flowering plants (angiosperms) appear and diversify; many groups of organisms, including most dinosaurs, become extinct at end of period
		Jurassic		199.6	Gymnosperms continue as dominant plants; dinosaurs abundant and diverse
		Triassic		251	Cone-bearing plants (gymnosperms) dominate landscape; dinosaurs evolve and radiate; origin of mammals



GEOLOGIC RECORD

- Most of the time was spent in the Archaean and Proterozoic Eons
- Biodiversity exploded in the Phanerozoic Eon (particularly the Cambrian period)
- Humanity has existed for a relatively small amount of time