General Biology 1
BIO1101 RM 1001
Syllabus & Textbook: http://goo.gl/rvgdrH

Lecturer: Michael Gotesman, PhD
Email: mgotesman@citytech.cuny.edu

Grade Breakdown:

Lecture (60%)
Exams (4): 20% Each
Pop Quizzes (?): 20% Average
https://web.lrnr.us/login/auth

Lab (40%) – Lab Instructor

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

Recap: Lecture 1

1. Cell Theory

1)All organisms are composed of cells
2)Cells are the basic unit of structure and function of organisms
3)Cells come from preexisting cells because cells are self-replicating

2. Domains of life

Prokaryote versus Eukaryote
did I forget something?

3. Level of sophistication

atoms – molecules –organelles – cells – tissue –organ- organism
organism- population – community – ecosystem - biosphere

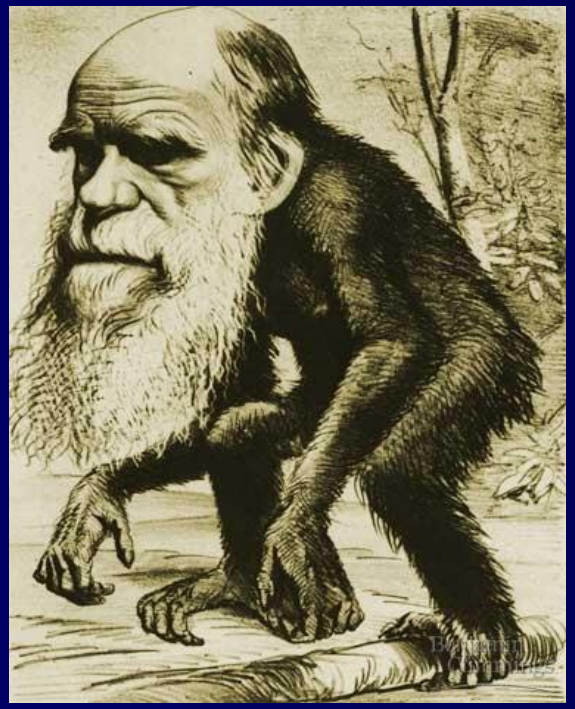
4. Scientific Method

- Observation
- Hypothesis
- Experimentation/Data Collection
- Conclusion
- Scientific Theory

Bio 1101-Lecture 2

Spring 2018

Darwin, Evolution and Life



Michael Gotesman, PhD

Outline

- Darwin's Theory of Evolution
  - Context: History of Evolutionary Thought
  - **Descend with change from a common ancestor**
  - Adaptation to a changing environment
- The Evidence of Evolution
  - Fossil
  - Biogeographical
  - Anatomical
  - Biochemical
- Origin of Life
  - Primitive Earth
  - Origin of First Cells
- Kingdoms and domains

Evolution, the Unifying Concept of Biology

- Despite diversity, organisms share the same basic characteristics
  - Composed of cells organized in a similar manner
  - Their genes are composed of DNA
  - Carry out the same metabolic reactions to acquire energy
- This suggests that they are descended from a common ancestor

History of Evolutionary Thought

- Before Charles Darwin
  - View of nature determined by deep-seated beliefs (*scala naturae*, special creation fixity of species)
  - Held to be intractable truths
  - **Carolus Linnaeus** – father of taxonomy (classification).

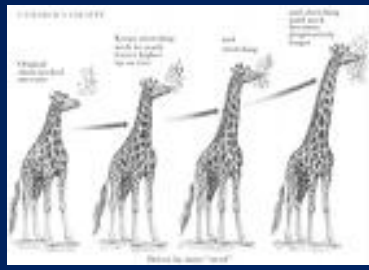
    - Began grouping similar organisms together, larger and larger groups

    (Dear Kids Play Chess On Funny Green Squares)

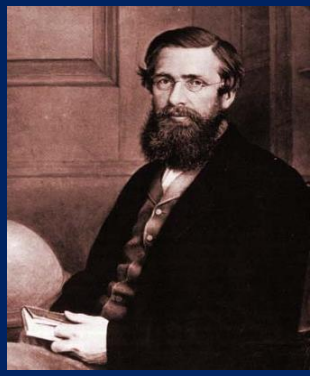
    - Invented **binomial nomenclature**: *Genus species Ursus americanus*
  - Biology thought had slowly begun to accept
    - Various ideas of evolution
    - Similarities between living things reflect recent common ancestry
    - Dissimilarities between living things reflect ancient common ancestry

Work leading up to Darwin

- The discovery of fossils and the notion of extinction
- Cuvier, Hutton, and Lyell – Geology
  - - Provided extensive evidence of geologic change
  - - Discovered "layers" of fossils representing different time periods
- **Thomas Robert Malthus (Early 1800) – Limited resources**
- **Jean-Baptiste Lamarck (Early 1800's)**
  - **Lamarck**'s theory of gradual change (evolution)
  - - theory of "use and disuse" leading to "inheritance of acquired characteristics

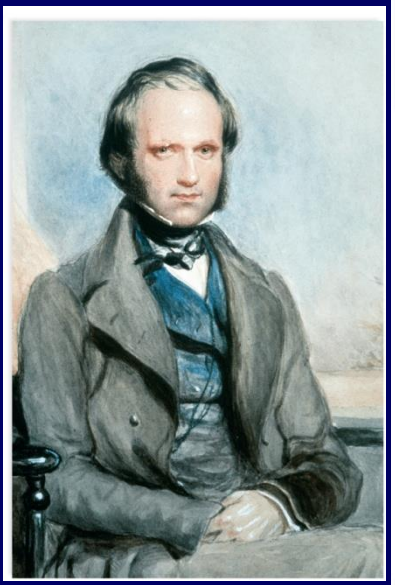


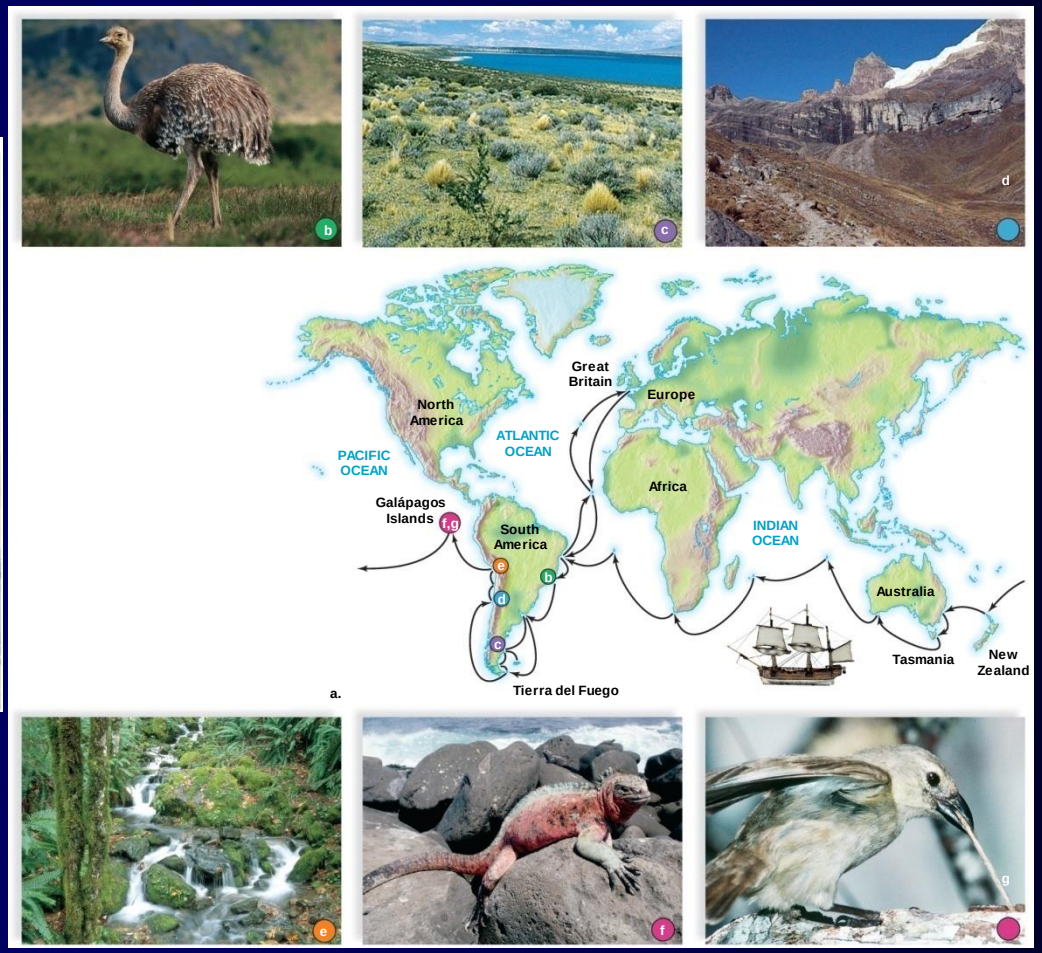
- Darwin and the voyage of the **HMS Beagle**

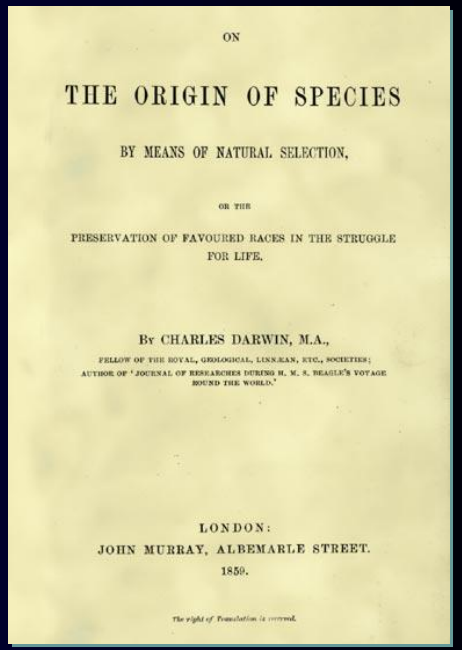


- Alfred Russel **Wallace** reached the same conclusions as Darwin AND published them first.

Voyage of the HMS *Beagle*







ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

November 24, 1859

Galápagos Islands -- Ecuador

- Finches
  - Darwin observed many different species of finches on various islands
  - Speculated they could have descended from a single pair of mainland finch

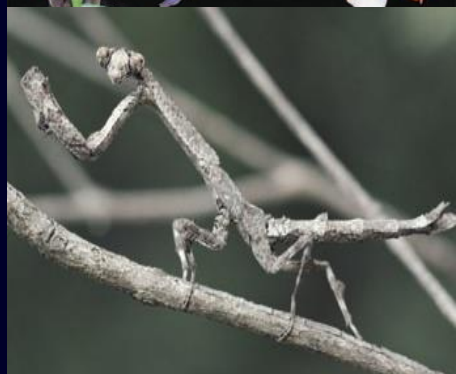
  - Heavy beak suited to a diet of large seeds
  - Beak of the warbler-finch is suited to feeding on insects
  - Longer beak, somewhat decurved, and the split tongue suited to probing cactus for seeds

Darwin's Theory of Evolution

- Biogeographical observations:
  - The study of the geographic distribution of life forms on earth
  - Darwin saw similar species in similar habitats;
  - Reasoned related species could be modified according to the environment

Natural Selection and Adaptation

- Individuals have heritable variations
- More individuals produced each generation than environment can support
- Some individuals have adaptive characteristics
  - Enables increased survival and reproduction
  - Increasing proportion of succeeding generations will have these characteristics
- Populations become adapted to their local environment through change in individuals



Natural Selection and Adaptation

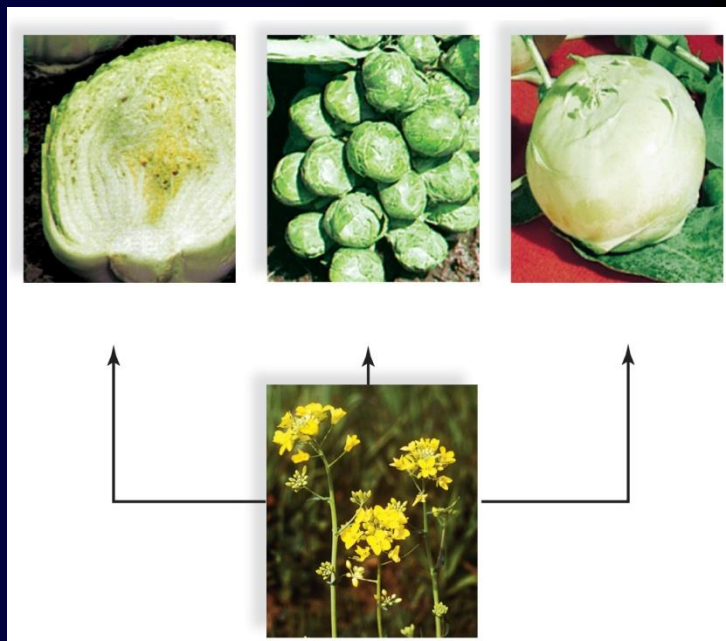
- Organisms Differ in Fitness
  - Fitness is the relative reproductive success of an individual
  - The most-fit individuals in a population capture a disproportionate share of goodies
  - Interactions with the environment determine which individuals reproduce the most

- Adaptation
  - Changes that help a species become more suited to its environment
  - Product of natural selection (favorable characteristics accumulating over generations)

Artificial Selection

- Darwin described artificial selection as a model by which to understand natural selection.
- Following vegetables are derived from one species:
  - Chinese cabbage, brussels sprouts, and kohlrabi.
- Artificial selection of Animals
  - All dogs are descended from the gray wolf

https://www.youtube.com/watch?v=0jFGNQScRNY

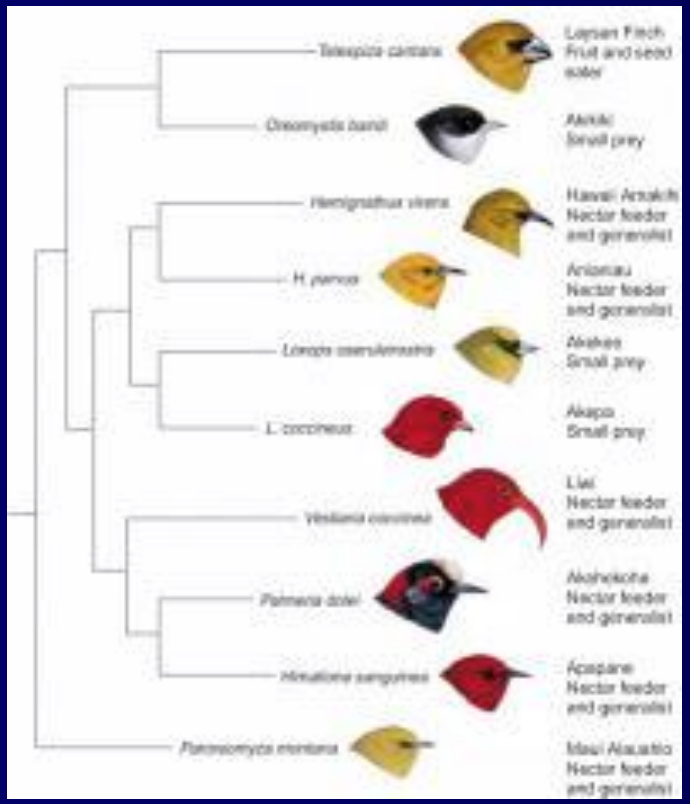


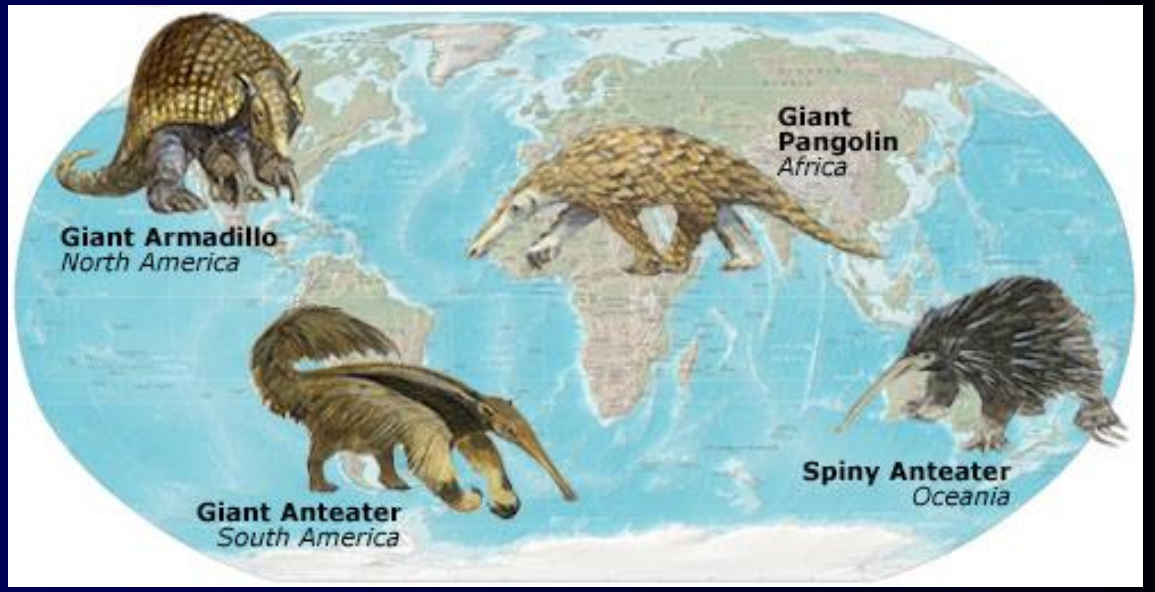
Evidence for Evolution: Fossil Record

- **Fossil evidence**
  - Fossils record the history of life from the past
  - Document a succession of life forms from the simple to the more complex
  - Sometimes the fossil record is complete enough to show descent from an ancestor

Biogeographical Evidence

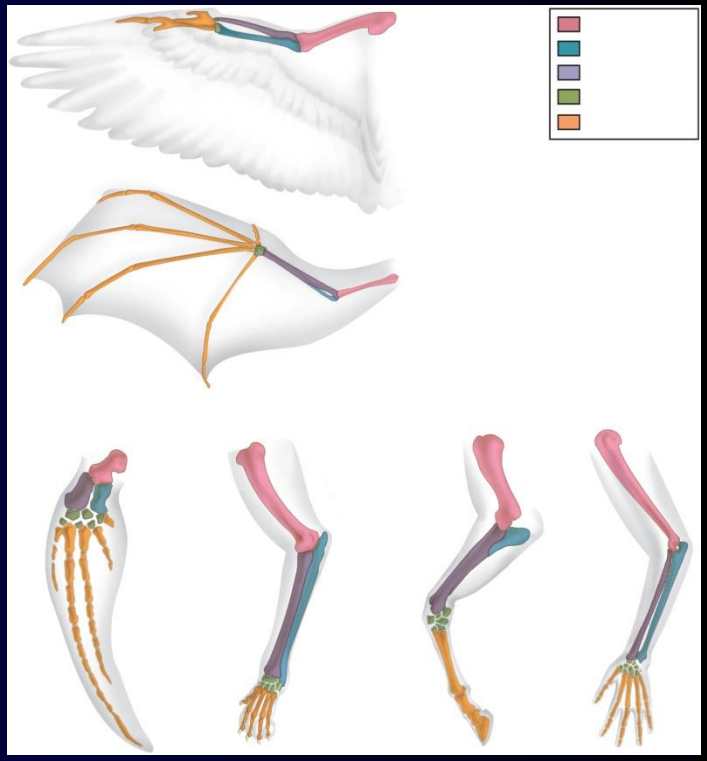
- **Biogeography** is the study of the range and geographic distribution of plants and animals on Earth.





Anatomical Evidence

- Homologous Structures:
  - Anatomically similar b/c they are inherited from a common ancestor
  - May be functionally similar or not

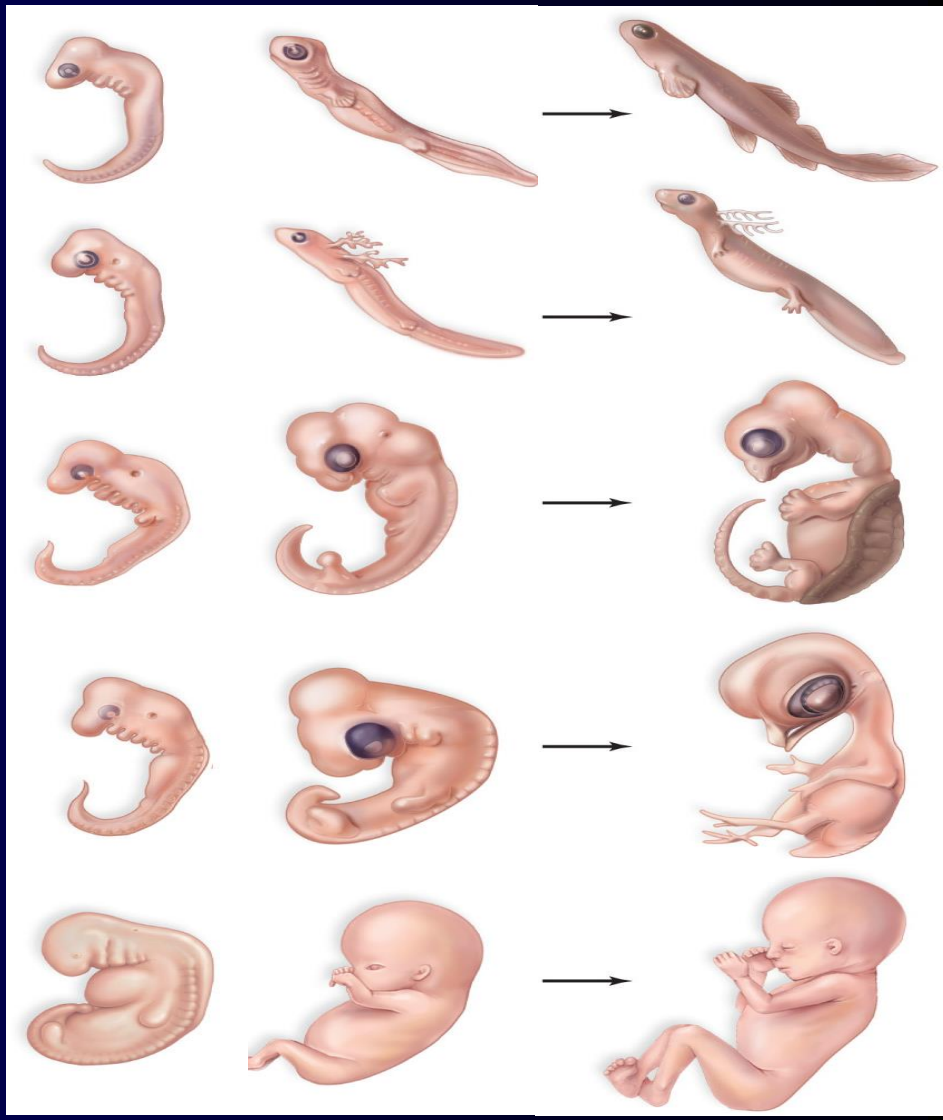


- Analogous Structures:
  - Serve the same function
  - Not constructed similarly
  - Do not share a common ancestor
  - E.g: wing of a bird and wing of an insect
- *Vestigal Structures:*
  - *Fully-developed anatomical structures*
  - *Reduced or obsolete function ("left over from common ancestry)*

Anatomical Evidence

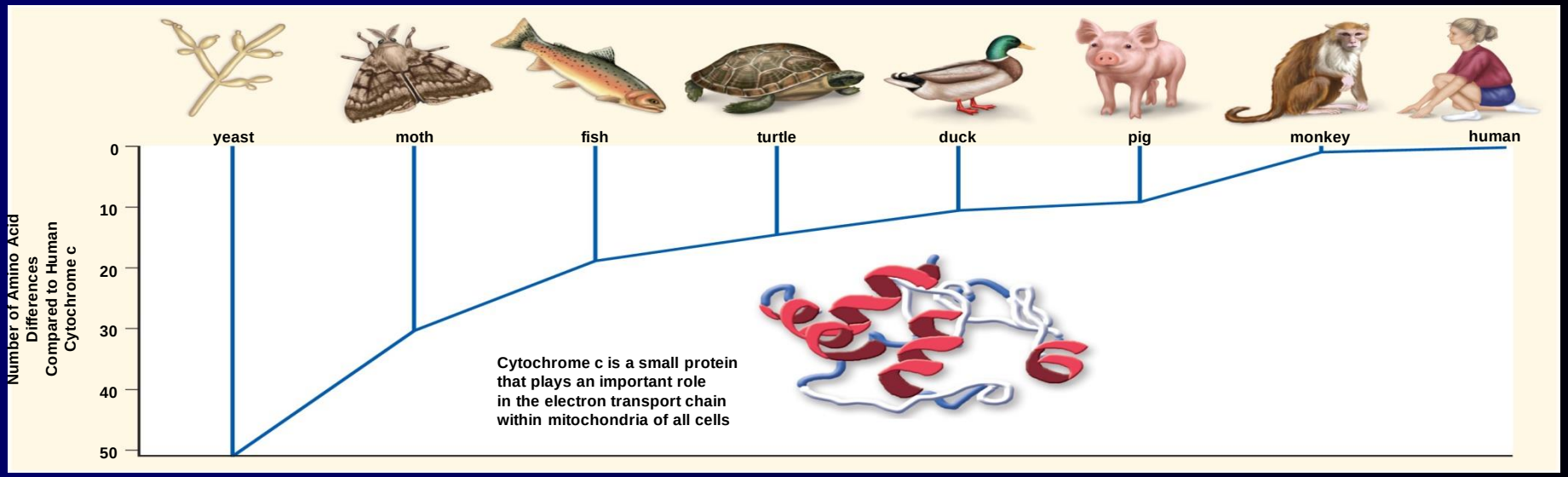
Significance of Developmental Similarities

- Embryological development
  - All vertebrate embryos have:
  - A postanal tail and
  - Paired pharyngeal (gill) pouches



Biochemical Evidence

- Almost all living organisms:
  - Use the same basic biochemical molecules
  - Utilize same DNA triplet code
  - Utilize same 20 amino acids in their proteins
- DNA base-sequence differences:
  - When very similar, suggest recent common descent
  - When more different, suggest more ancient common descent



Brief Timeline of Early Events:

(bya = billion years ago, etc.)

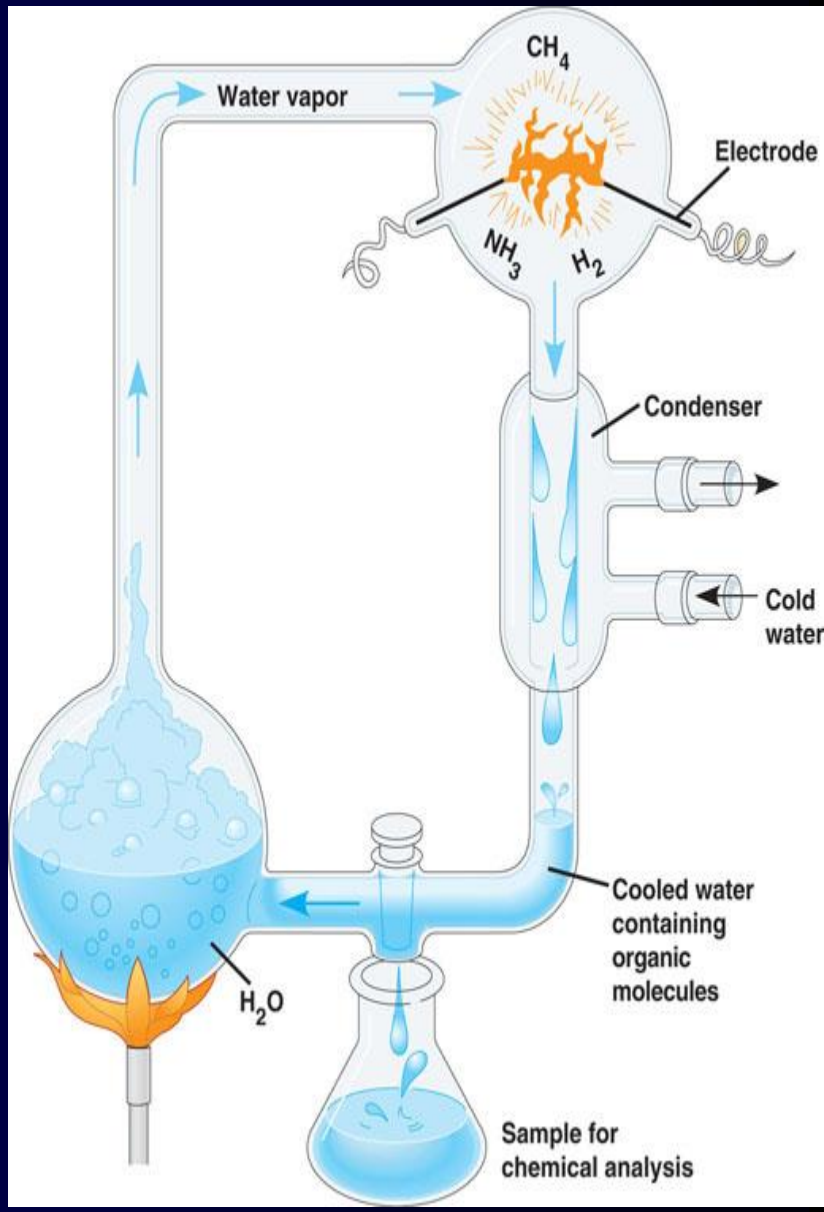
- 4.6bya - The Earth condenses from a cloud of dust and rock
  - At first, there was no atmosphere to burn up the constant bombardment
  - Collisions create heat – the earth was far too hot for liquid water
- 3.9bya – Bombardment slows in our solar system (most mass in the planets)
  - Early atmosphere forms from volcanic gas, dust, ash, and LOTS of water vapor; this further reduces cosmic bombardment
  - Sufficient cooling allows water vapor to condense… oceans form!
- 3.8bya – oldest known rocks. (Some say these indicate early life!)
- 3.5bya – oldest known fossils (stromalites (prokaryotes))
- 2.7bya – emergence of atmospheric oxygen (photosynthesis)
- 2.2bya – oldest fossils of eukaryotes

Formation of Organic Molecules

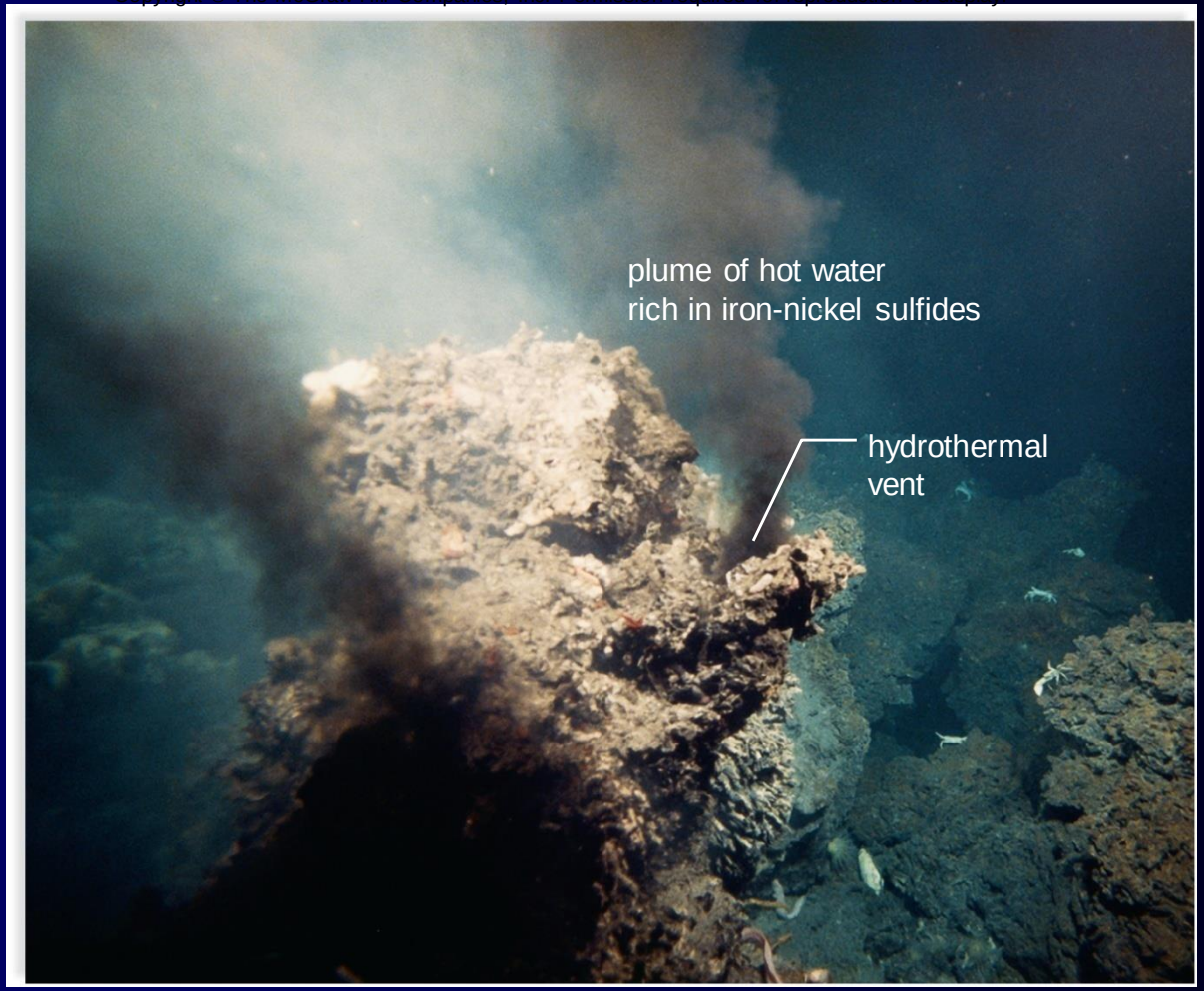
- Following the cooling that occurred as earth acquired an atmosphere:
  - The atmosphere and the ocean comprise the **primordial soup** from which life emerged: high in methane (CH_4), ammonia (NH_3), N_2, H_2, CO_2, NO, N_2O, H_2S
  - There is also evidence that the overall environment was REDUCING (adding electrons)

Formation of Organic Molecules

- In **1953, Stanley Miller and Harold Urey** recreated the **primordial soup** and added sparks (to simulate lightening)
  - Result - creation of many kinds of organic molecules, including many aa's, that are necessary for life!
  - such an atmosphere on early Earth is unlikely
  - Instead of forming in the atmosphere, the first organic compounds may have been synthesized near submerged volcanoes and deep-sea vents



Chemical Evolution at Hydrothermal Vents



Conditions to Support Life

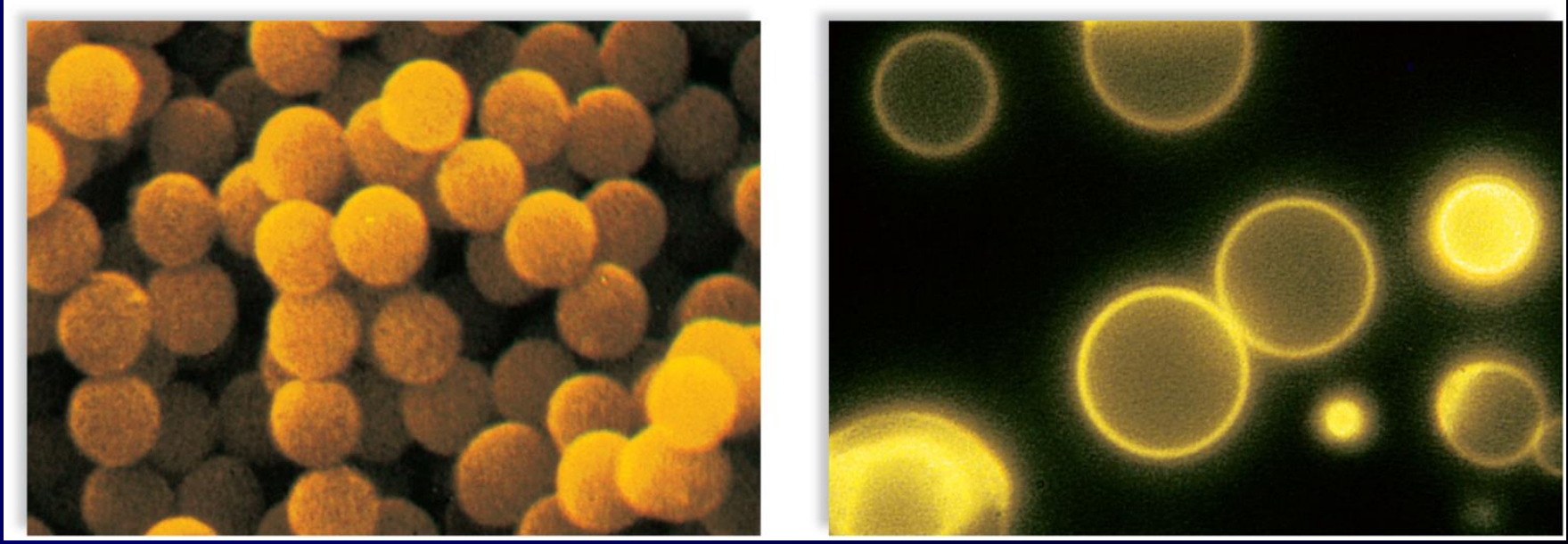
- Conditions on earth have influenced the evolution of all life
- The formation of a life form, a cell, probably occurred in the 4 following stages:
  - 1) **Abiotic synthesis** of small organic compounds (aa's, nucleotides)
  - 2) Joining of small organic **monomers to form polymers** (proteins, nucleic acids)
  - 3) Packaging of polymers into compartments, probably lipid membranes: **protobionts or protocells**
  - 4) **Self-replicating** polymers emerge (eventually making **inheritance** possible)

Protocell Evolves

- Before the first true cell arose, there would have been a **protocell** or **protobiont.**
- A protocell would have a lipid-protein membrane and carry on energy metabolism.

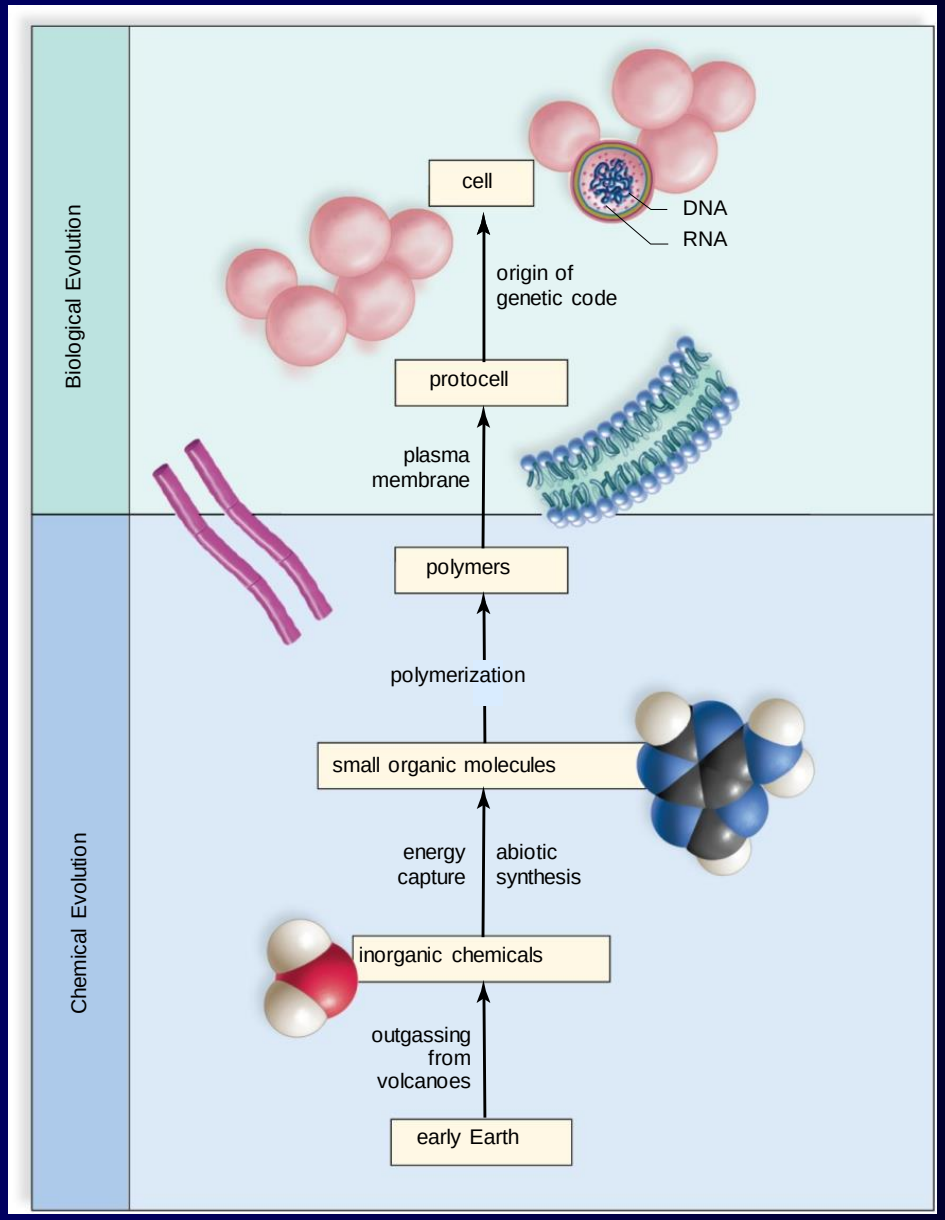
- Protocells
  - Hypothesized precursors to the first true cells

Protocell Anatomy



- Protobionts are aggregates of abiotically produced molecules surrounded by a membrane or membrane-like structure
- Experiments demonstrate that protobionts could have formed spontaneously from abiotically produced organic compounds

Origin of the First Cell(s)



https://en.wikipedia.org/wiki/Timeline_of_the_evolutionary_history_of_life

Paleozoic and Precambrian Time Eras

		Mass Extinction		
	Permian	(299–251)	Gymnosperms diversify.	Reptiles diversify; amphibians decline.
	Carboniferous	(359.2–299)	Age of great coal-forming forests; ferns, club mosses, and horsetails flourish.	Amphibians diversify; first reptiles appear; first great radiation of insects.
		Mass Extinction		
Paleozoic	Devonian	(416–359.2)	First seed plants appear. Seedless vascular plants diversify.	First insects and first amphibians appear on land.
	Silurian	(443.7–416)	Seedless vascular plants appear.	Jawed fishes diversify and dominate the seas.
		Mass Extinction		
	Ordovician	(488.3–443.7)	Nonvascular land plants appear on land.	First jawless and then jawed fishes appear.
	Cambrian	(542–488.3)	Marine algae flourish.	All invertebrate phyla present; first chordates appear.
Precambrian Time		630	Soft-bodied invertebrates	
		1,000	Protists diversify.	
		2,100	First eukaryotic cells	
		2,700	O_2 accumulates in atmosphere.	
		3,500	First prokaryotic cells	
		4,570	Earth forms.	

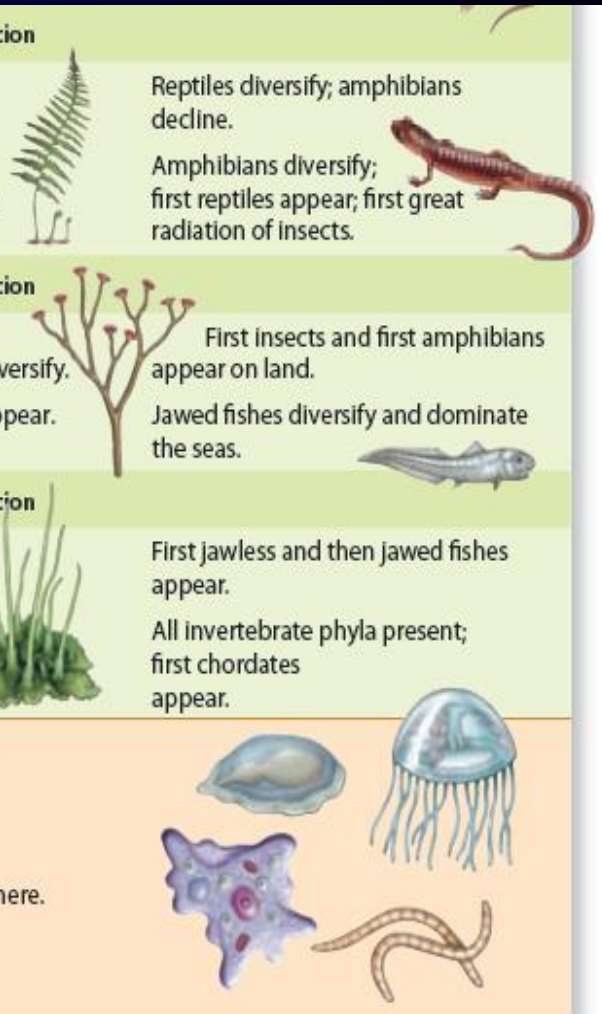


TABLE 18.1

The Geologic Timescale: Major Divisions of Geologic Time and Some of the Major Evolutionary Events of Each Time Period

Cenozoic and Mesozoin Eras

TABLE 18.1

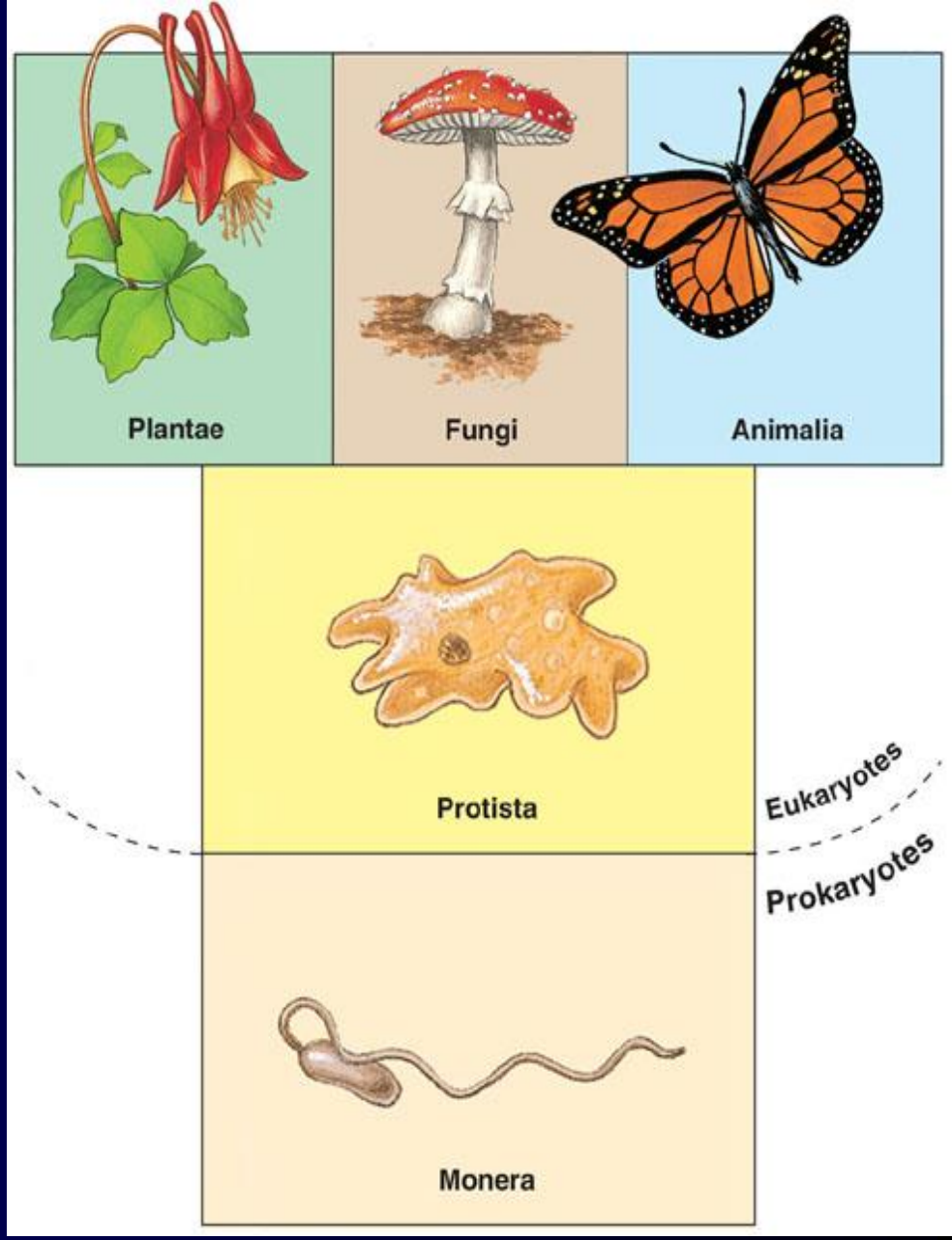
The Geologic Timescale: Major Divisions of Geologic Time and Some of the Major Evolutionary Events of Each Time Period

Era	*Period*	*Epoch*	*Millions of Years Ago (MYA)*	*Plant Life*	*Animal Life*
		Holocene	(0.01–0)	Human influence on plant life	Age of *Homo sapiens*
				Significant Mammalian Extinction	
	Quaternary	Pleistocene	(1.80–0.01)	Herbaceous plants spread and diversify.	Presence of Ice Age mammals. Modern humans appear.
		Pliocene	(5.33–1.80)	Herbaceous angiosperms flourish.	First hominids appear.
		Miocene	(23.03–5.33)	Grasslands spread as forests contract.	Apelike mammals and grazing mammals flourish; insects flourish.
Cenozoic*		Oligocene	(33.9–23.03)	Many modern families of flowering plants evolve.	Browsing mammals and monkeylike primates appear.
	Tertiary	Eocene	(55.8–33.9)	Subtropical forests with heavy rainfall thrive.	All modern orders of mammals are represented.
		Paleocene	(65.5–55.8)	Flowering plants continue to diversify.	Primitive primates, herbivores, carnivores, and insectivores appear.
				Mass Extinction: Dinosaurs and Most Reptiles	
	Cretaceous		(145.5–65.5)	Flowering plants spread; conifers persist.	Placental mammals appear; modern insect groups appear.
Mesozoic	Jurassic		(199.6–145.5)	Flowering plants appear.	Dinosaurs flourish; birds appear.
				Mass Extinction	
	Triassic		(251–199.6)	Forests of conifers and cycads dominate.	First mammals appear; first dinosaurs appear; corals and molluscs dominate seas.

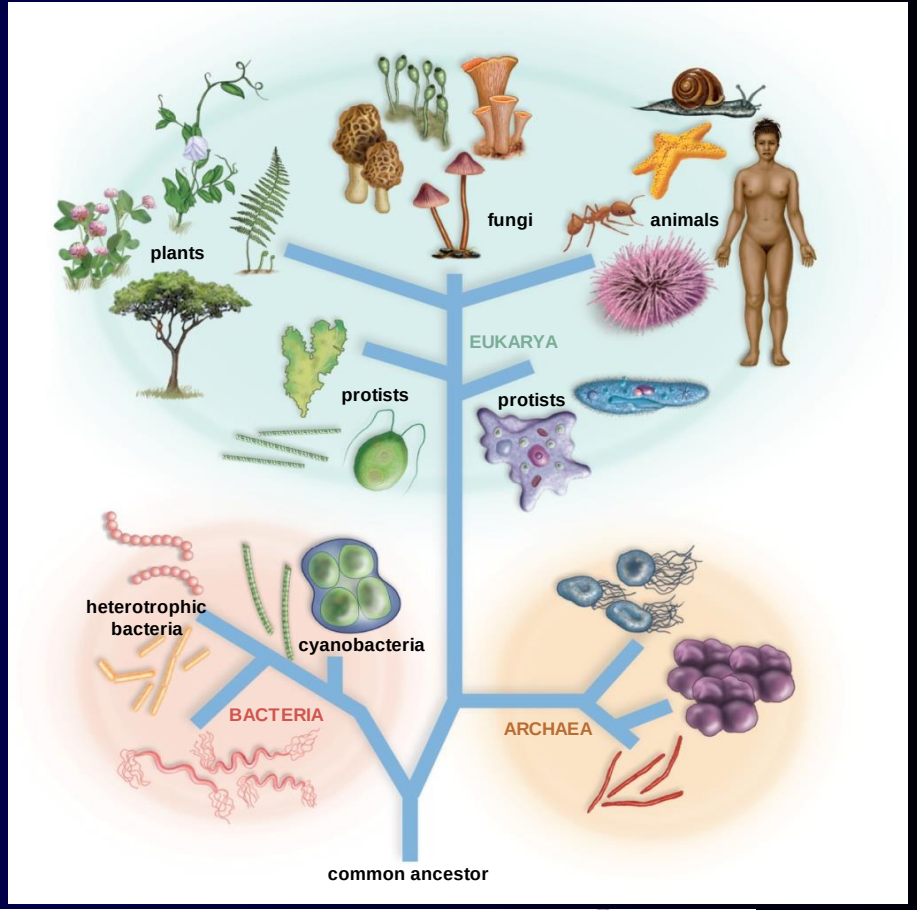
Reconstructing the Tree of Life

- Two kingdom system
- Whittaker's five kingdom system, 1969

  ---->
- Three domain system



Tree of Life Showing The Three Domains



Major Difference of Three Domains

TABLE 19.2

Major Distinctions Among the Three Domains of Life

	Bacteria	*Archaea*	*Eukarya*
Unicellularity	Yes	Yes	Some, many multicellular
Membrane lipids	Phospholipids, unbranched	Varied branched lipids	Phospholipids, unbranched
Cell wall	Yes (contains peptidoglycan)	Yes (no peptidoglycan)	Some yes, some no
Nuclear envelope	No	No	Yes
Membrane-bounded organelles	No	No	Yes
Ribosomes	Yes	Yes	Yes
Introns	No	Some	Yes