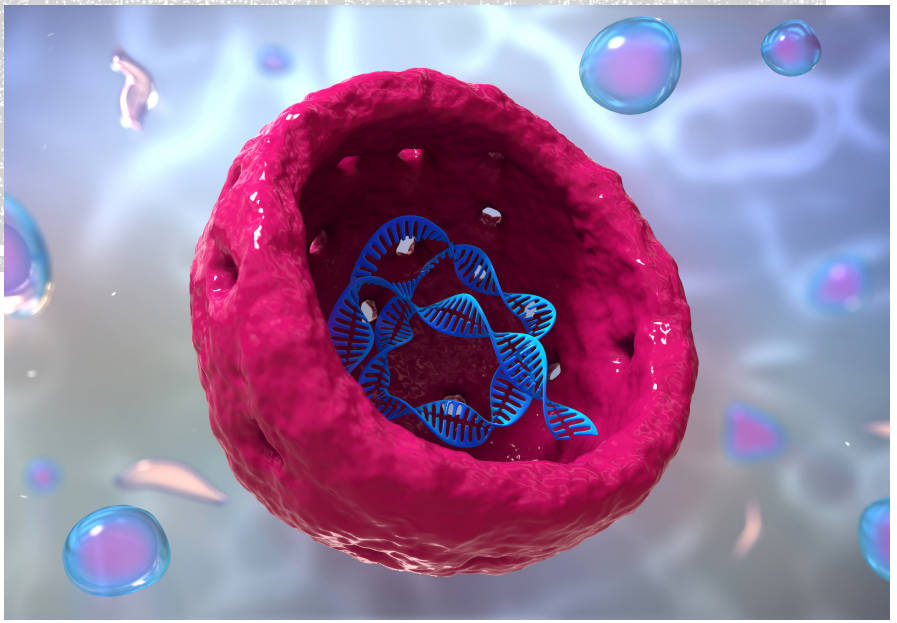
ORIGIN OF LIFE

Dr. Manu S Singh

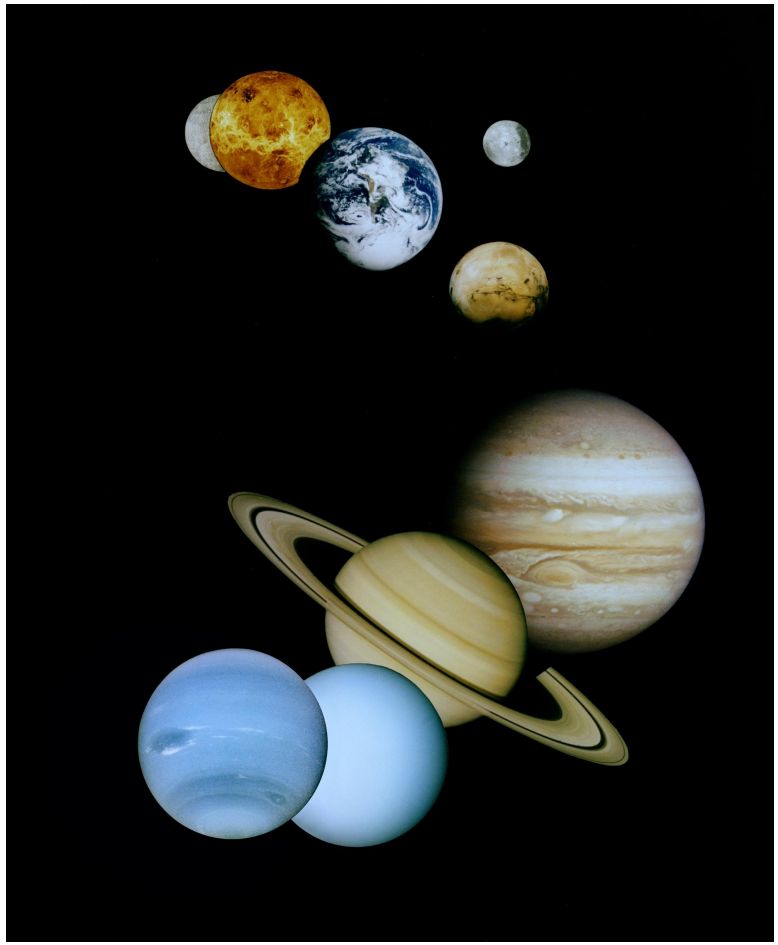
Department of Biotechnology

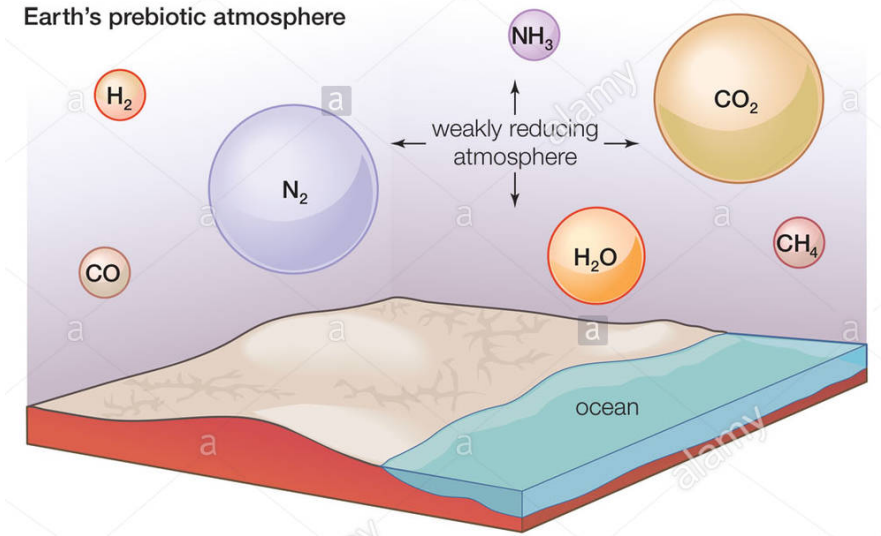
Bennett University

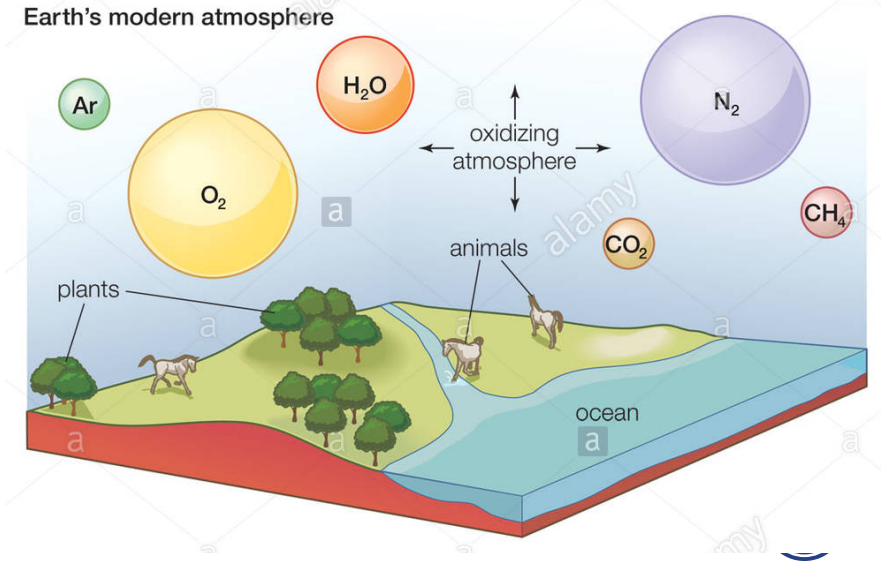


THE PALE BLUE DOT

-Earth, as referred by Carl Sagan



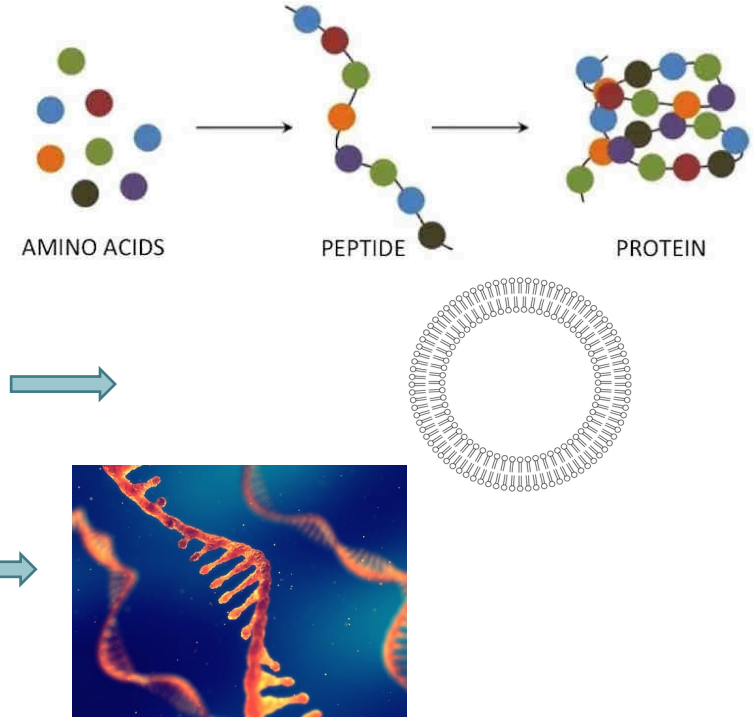




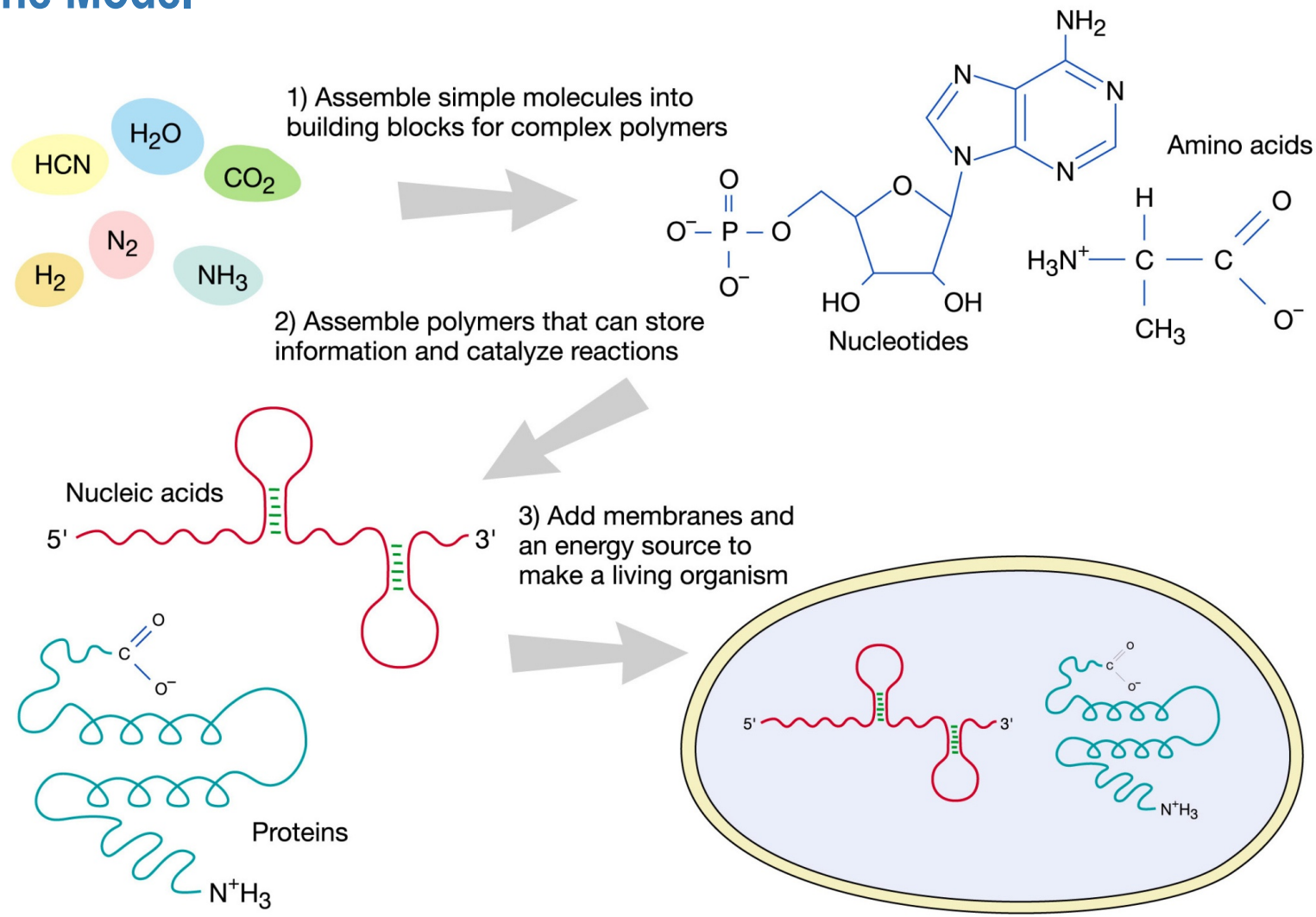
CELL THEORY

- As stated in the cell theory, cells can only arise from pre-existing cells. However, early Earth was harsh and no life was present.
- Consequently, first cells must have emerged from non-living materials that were present on Earth.
- In order for life to have emerged, scientists hypothesize that four smaller complex structures must have formed first.

1. Carbon compounds (amino acids, fatty acids, etc.) must be produced as they are the building blocks of life.
2. Carbon compounds must be able to assemble into polymers (proteins, polysaccharides, etc.) which contribute to cell structures.
3. Membranes must form from carbon compounds. This creates a space for internal chemistry to occur
4. There must be a mechanism for inheritance, which passes genes on to offspring. It has been determined that RNA was most likely this molecule.



Oparin-Haldane Model

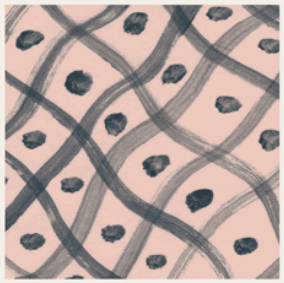


CELL THEORY

1. All living organisms are made of cells

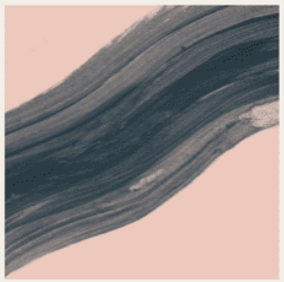
3. Cells arise from pre-existing cells

5. All cells have the basic chemical composition



2. Cells are the basic unit of life

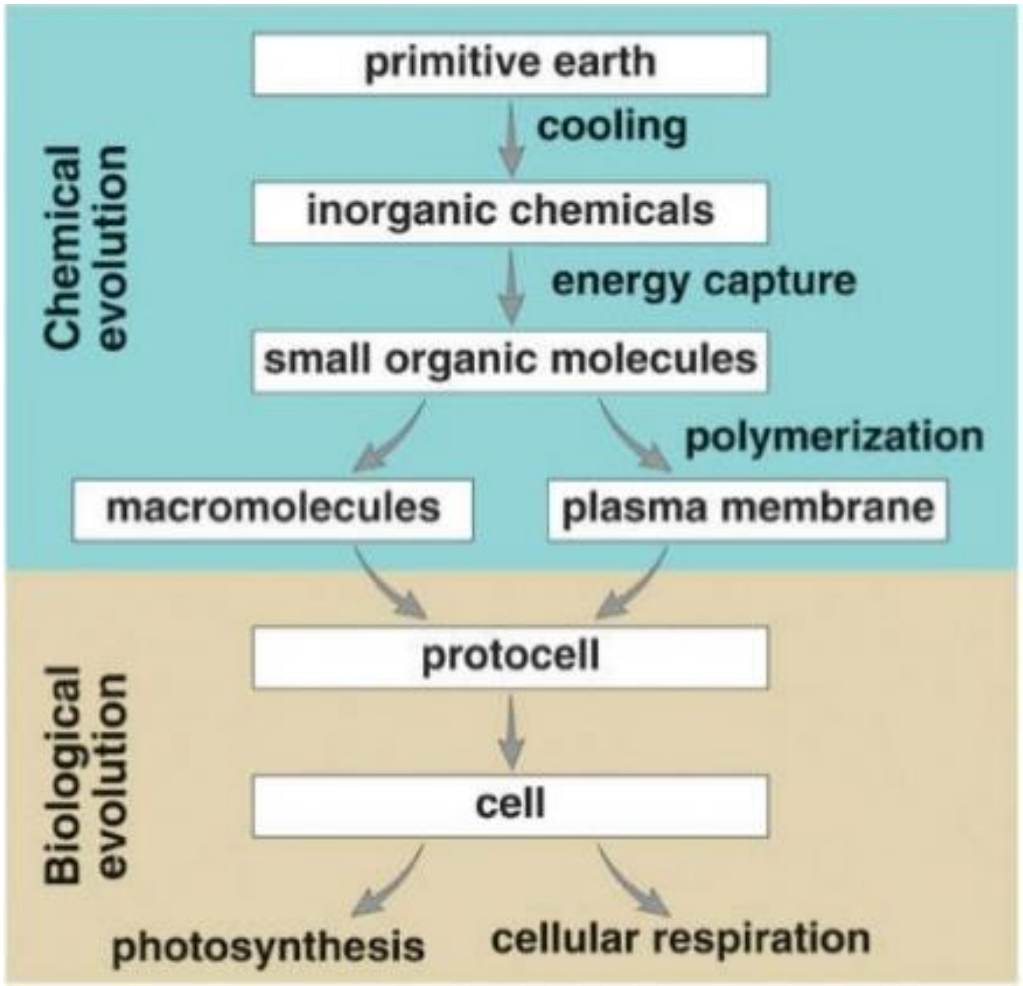
4. Hereditary information is passed from cell



6. Energy flow occurs within cells

OVERVIEW

In order for life to have emerged, there are several stages of development that would have had to occur.



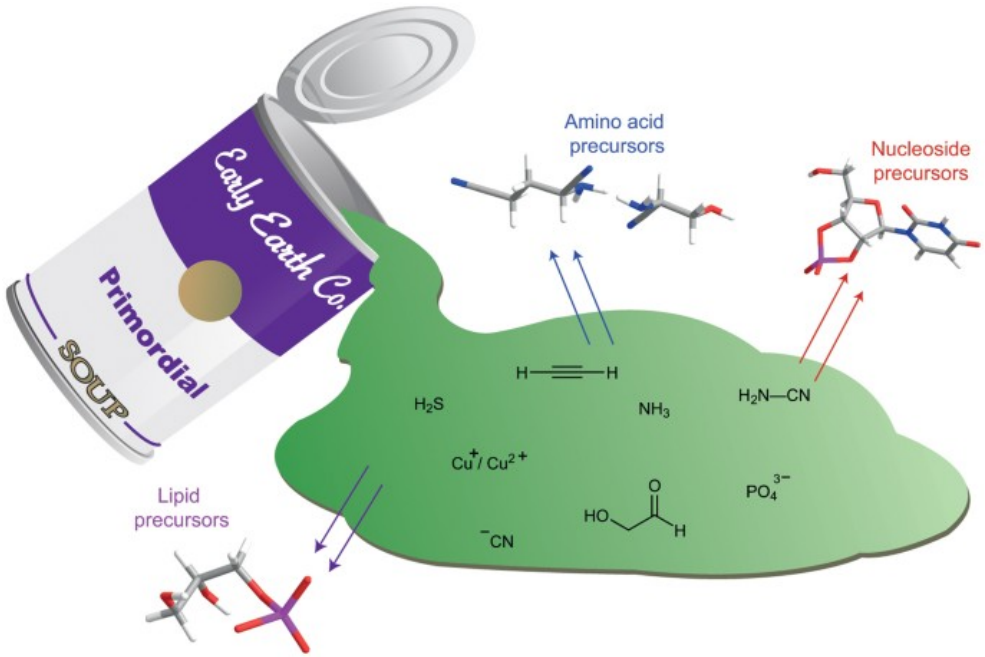
BASIS

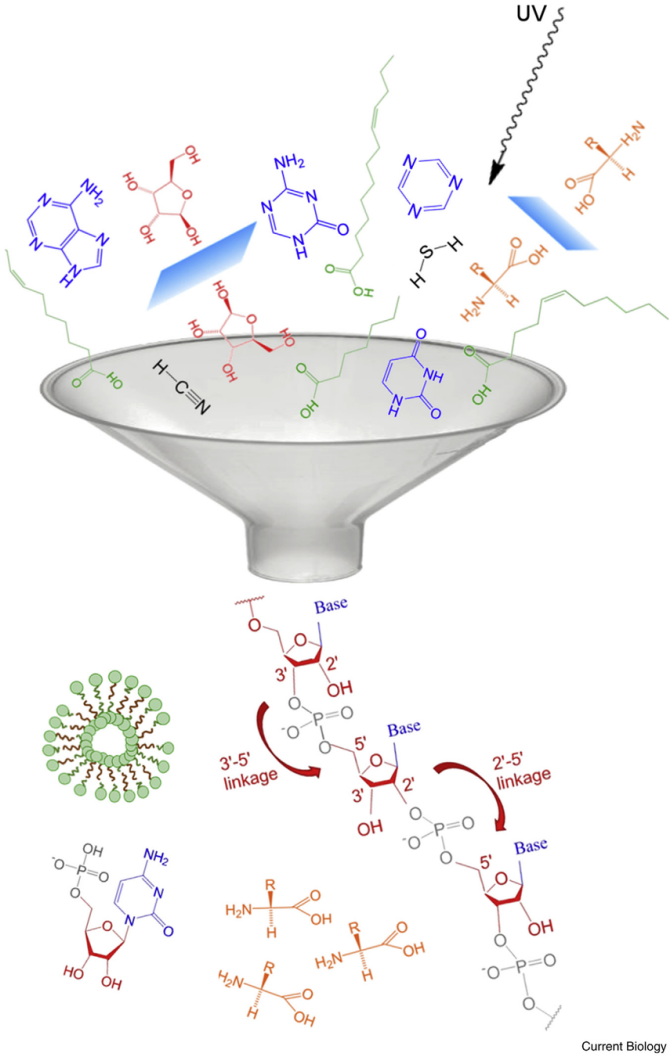
- Further evidence for a common origin of life on Earth is that all organisms use the same genetic code with minor gene variations. This similarity implies that the all life has a common ancestor.
- The code determines the nature and structure of proteins that an organism synthesizes.

Second Letter

1st letter	U	C	A	G	3rd letter
U	UUU Phe UUC UUA Leu UUG	UCU UCC Ser UCA UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC Leu CUA CUG	CCU CCC Pro CCA CCG	CAU His CAC CAA Gln CAG	CGU CGC Arg CGA CGG	U C A G
A	AUU AUC Ile AUA AUG Met	ACU ACC Thr ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
G	GUU GUC Val GUA GUG	GCU GCC Ala GCA GCG	GAU Asp GAC GAA Glu GAG	GGU GGC Gly GGA GGG	U C A G

PRIMORDIAL SOUP



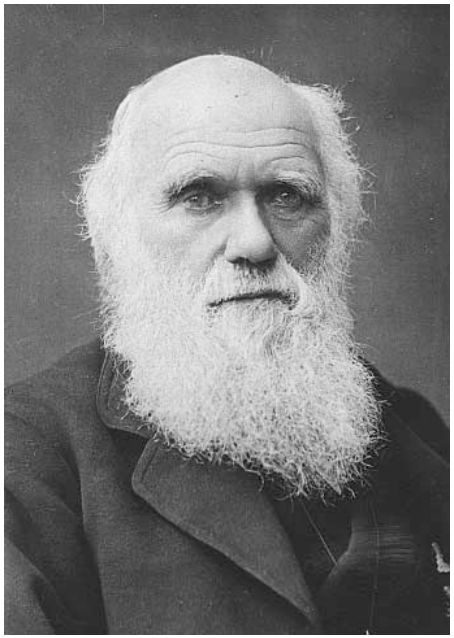


Current Biology

UNANSWERED QUESTIONS IN ORIGIN-OF-LIFE RESEARCH

- How did the “primordial soup” acquire the simple **monomeric building blocks** essential for the production of information bearing polymers?
- What conditions are necessary for the initial(pre-biotic) **assembly** of such polymers?
- Can a polymer be produced that is capable of **self-replication** as well as information storage?
- How did **compartmentalization**, necessary for self-recognition during replication and for the diffusion of gene products, evolve?
- **Which came first**---DNA, RNA, protein, or something else, or did complex systems involving all of these emerge simultaneously?

DARWIN'S THEORY OF EVOLUTION



Darwin's theory of evolution explains and describes how organisms on earth have changed over time and acquired a diversity of new forms.

On the Origin of Species by Means of Natural Selection

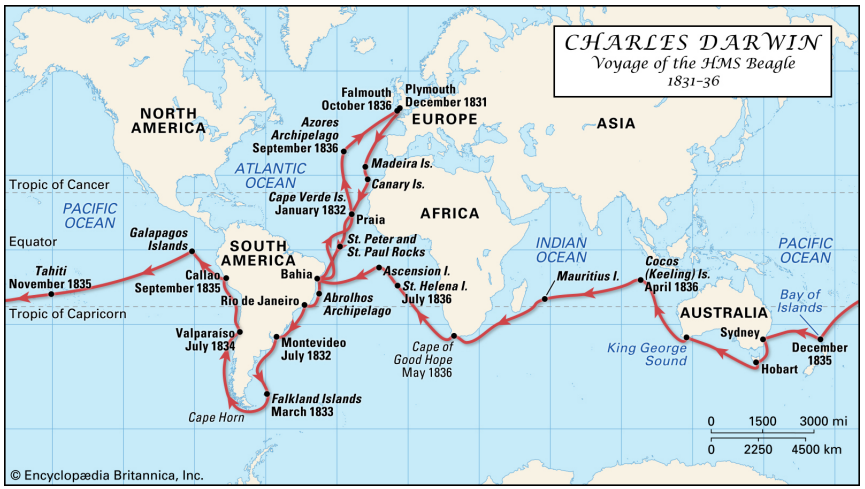
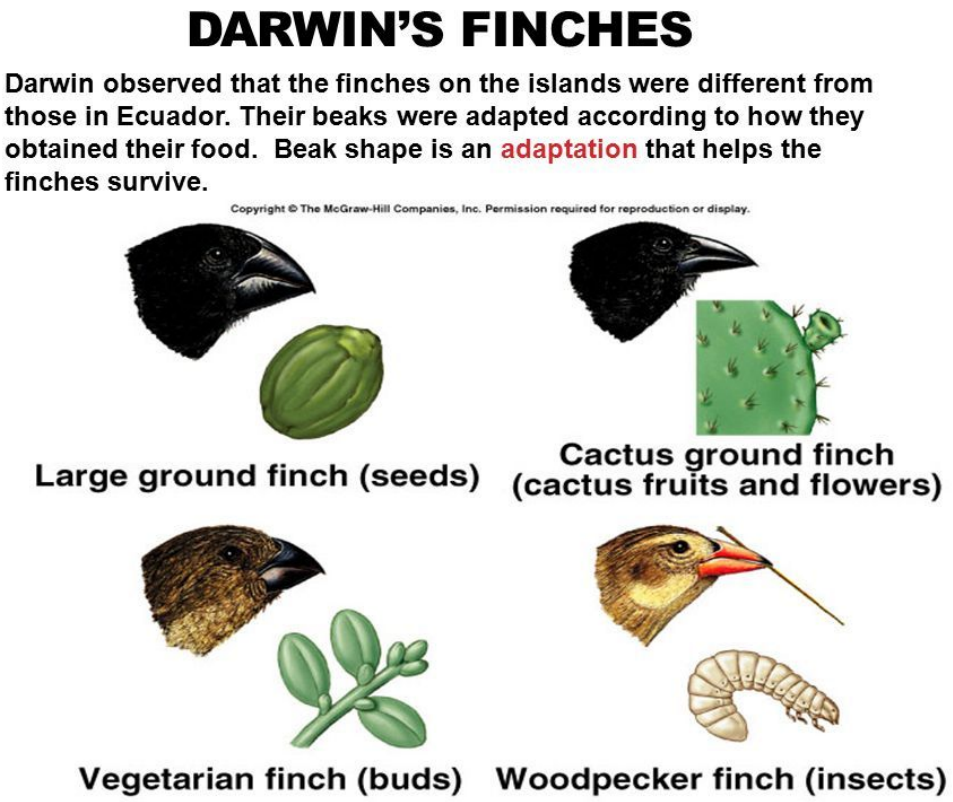


FIGURE 1.11
Darwin greets his monkey ancestor. In his time, Darwin was often portrayed unsympathetically, as in this drawing from an 1874 publication.

DARWIN'S THEORY OF EVOLUTION

Darwin's finches are a classical example of an adaptive radiation.
Their common ancestor arrived on the Galapagos about two million years ago. During the time that has passed the Darwin's finches have evolved into 15 recognized species differing in body size, beak shape, song and feeding behaviour.
Changes in the size and form of the beak have enabled different species to utilize different food resources such as insects, seeds, nectar from cactus flowers as well as blood from iguanas, as postulated by Darwin.

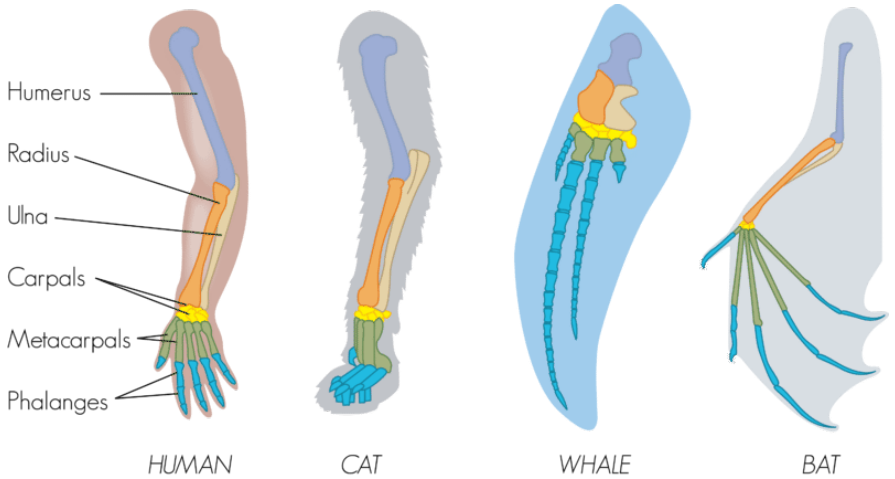


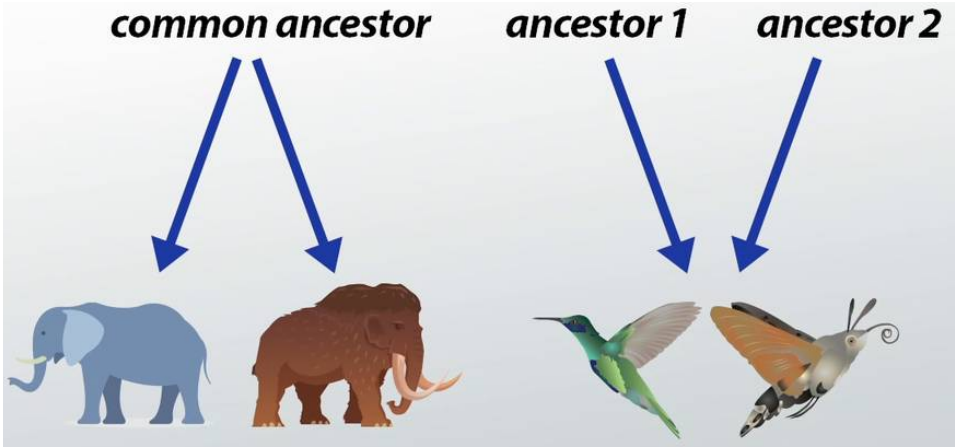
EVOLUTION

Comparative studies of animals have provided strong evidence for Darwin's theory.

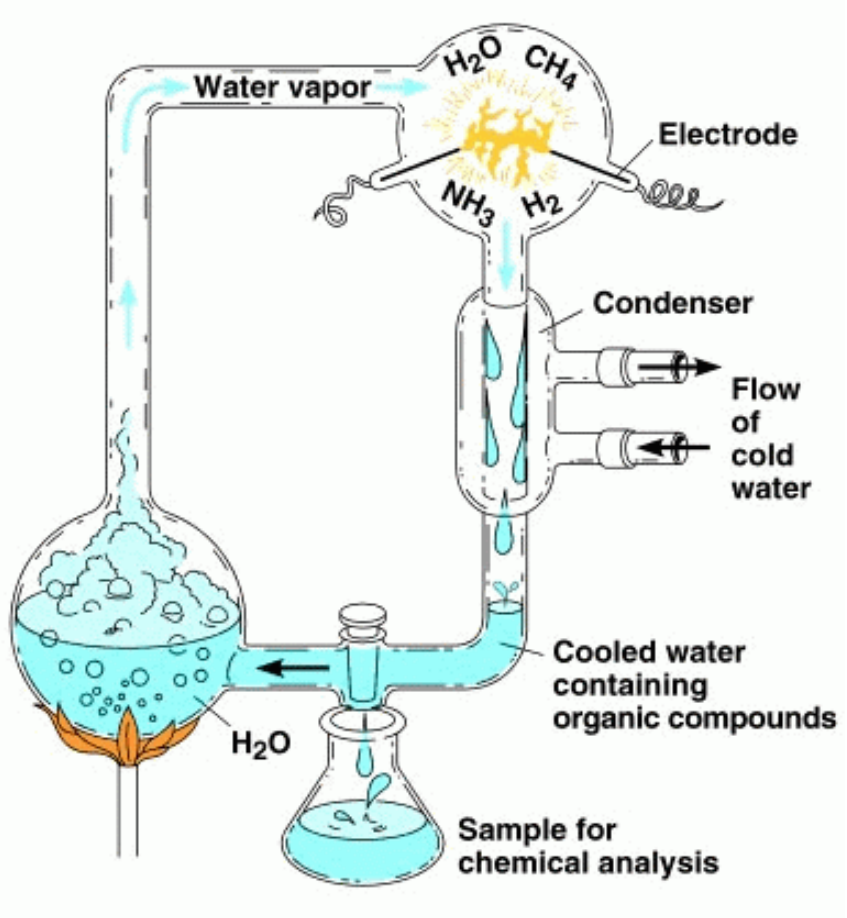
HOMOLOGOUS: In different vertebrates bones have undergone the same evolutionary origin, but they now differ in structure and function. The forelimbs are all constructed from the same basic array of bones, modified in one way in the wing of a bat, in another way in the fin of a whale, and in yet another way in the leg of humans.

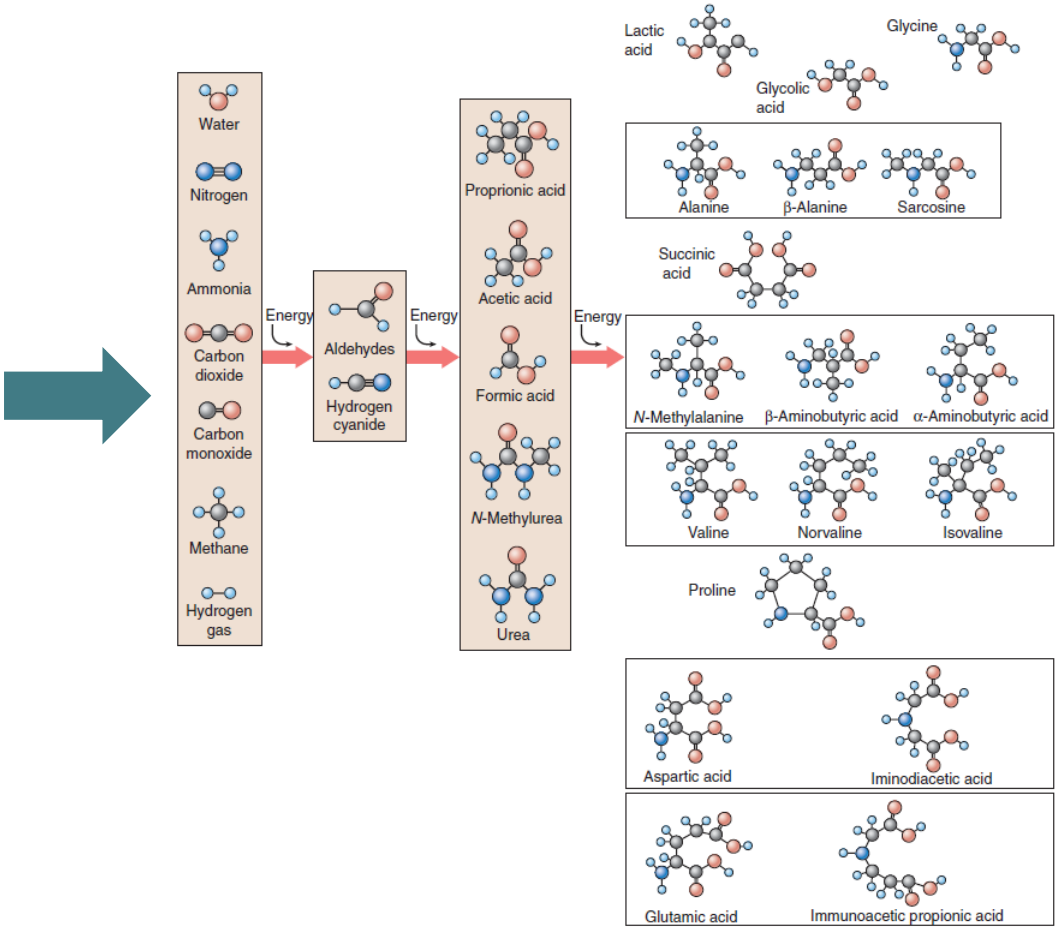
ANALOGOUS: Such as the wings of birds and butterflies, have similar structure and function but different evolutionary origins.



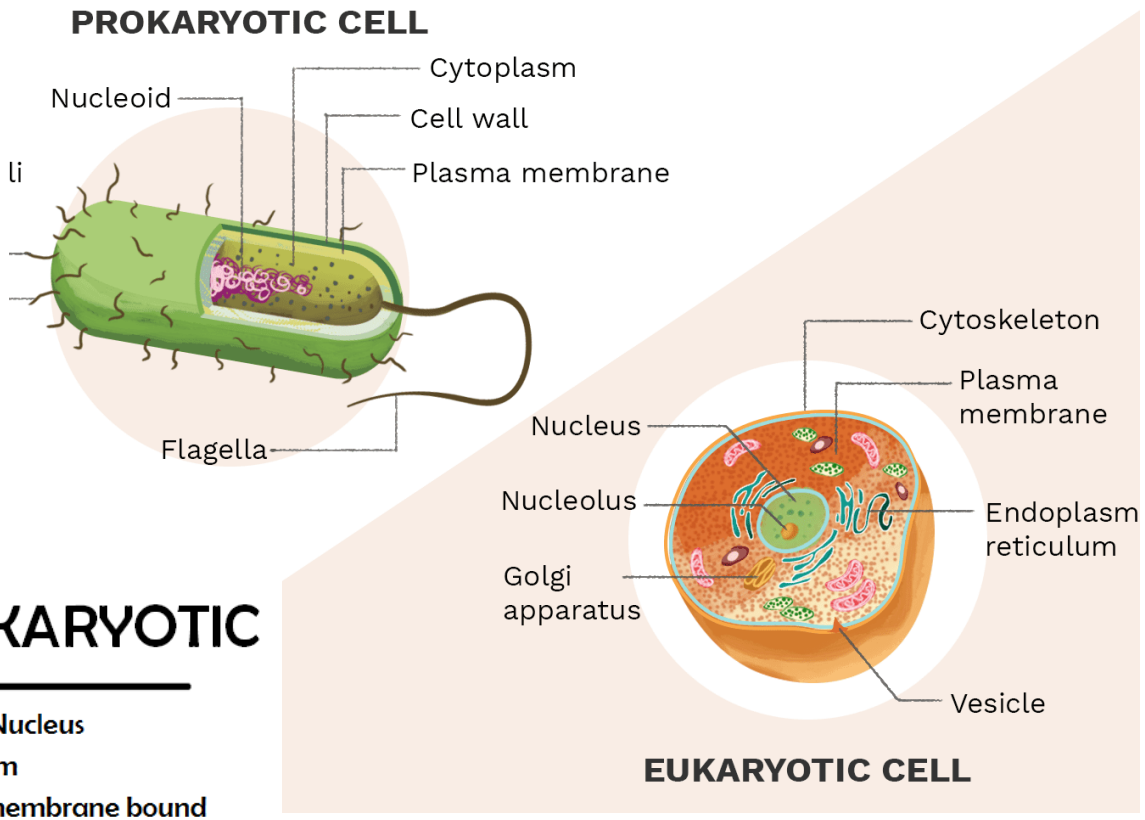


UREY–MILLER EXPERIMENT (1952)



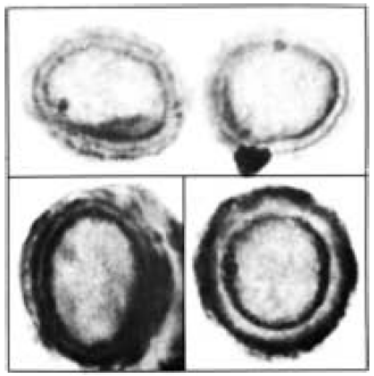


PROKARYOTE VS EUKARYOTE

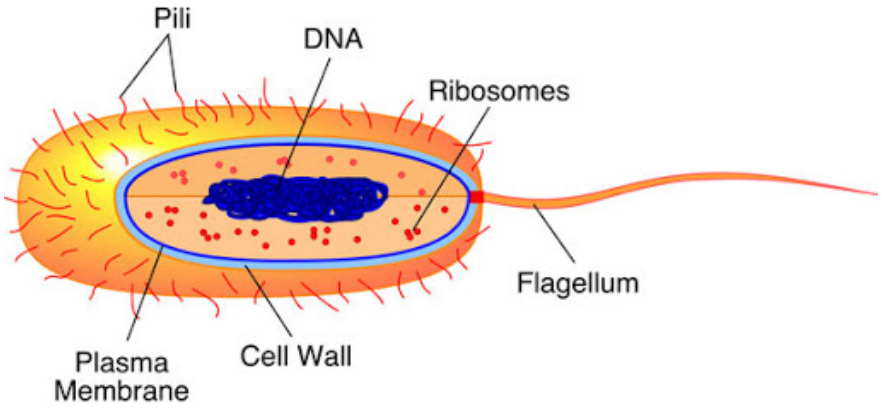


EUKARYOTIC	BOTH	PROKARYOTIC
• Has nucleus • 10-100μm • Makes big, multicellular organisms • Complex single-celled organisms also • Plants and Animals • Uses DNA • No membrane bound organelles. • Mitochondria	• Both might have cytoskeleton • Both cannot be seen with the naked eye (need microscope). • Both contain ribosomes	• NO Nucleus • 1-10μm • No membrane bound organelle. • Simple single celled organisms • Bacteria • Uses RNA not DNA • No Mitochondria

THE EARLIEST CELLS TO ARCHAEBACTERIA



Cross-sections of fossil bacteria. These microfossils from the Bitter Springs formation of Australia are of ancient cyanobacteria, far too small to be seen with the unaided eye. (Electron Micrograph)



Archaebacteria (Ancient Bacteria)
Rigid cell wall
Extreme conditions-

- Halophiles
- Methanogens
- Thermoacidophiles

EUKARYOTES

Many bacteria have infoldings of their outer membranes extending into the cytoplasm and serving as passageways to the surface. The network of internal membranes in eukaryotes called Endoplasmic Reticulum (ER) is thought to have evolved from such infoldings, as is the Nuclear Envelope- an extension of the ER network that isolates and protects the nucleus.

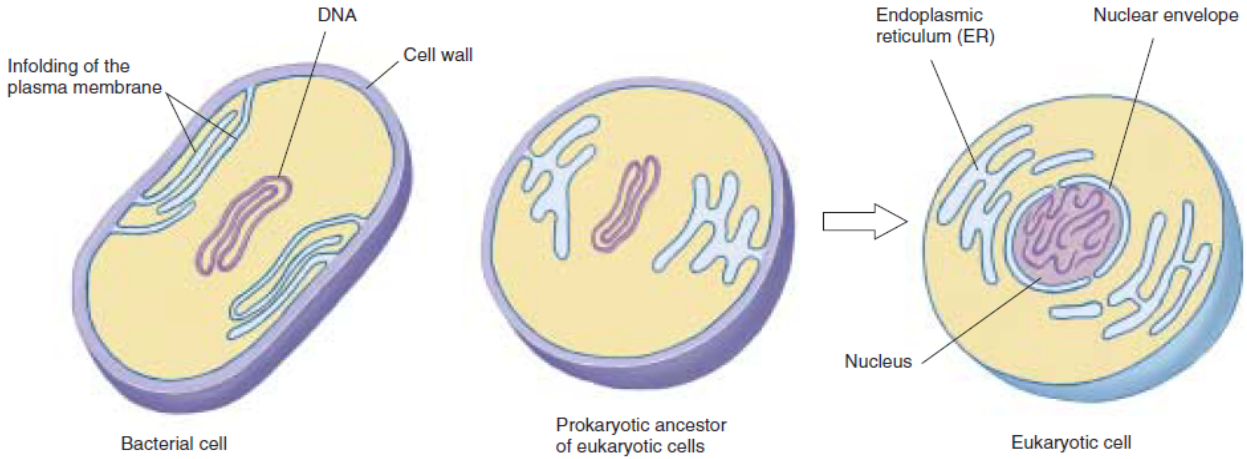
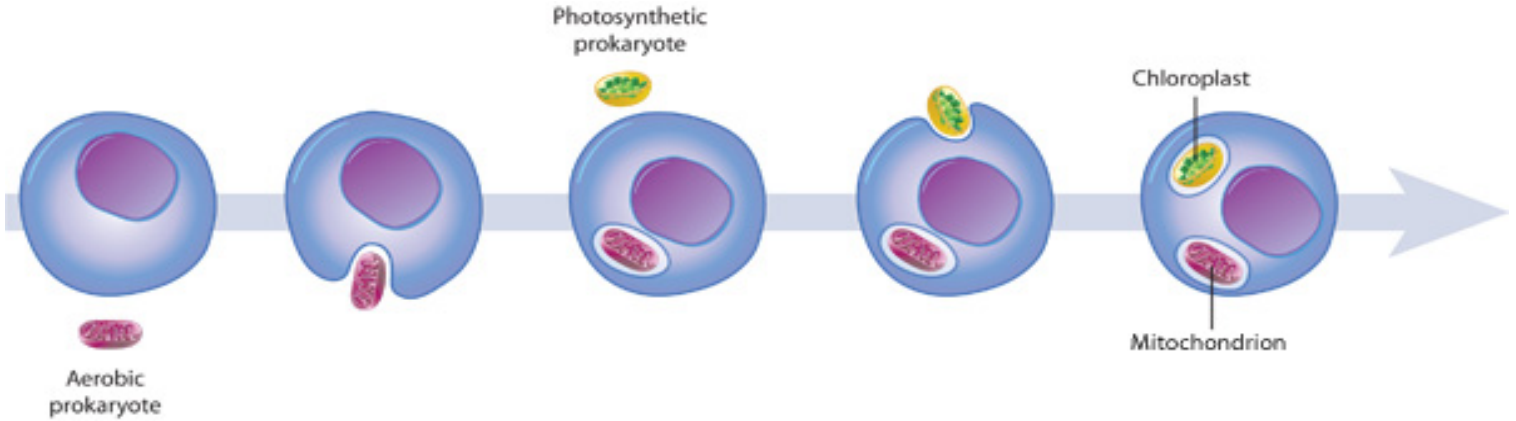


FIGURE 4.14
Origin of the nucleus and endoplasmic reticulum. Many bacteria today have infoldings of the plasma membrane (see also figure 34.7). The eukaryotic internal membrane system called the endoplasmic reticulum (ER) and the nuclear envelope may have evolved from such infoldings of the plasma membrane encasing prokaryotic cells that gave rise to eukaryotic cells.

EUKARYOTES

Bacteria that live within other cells and perform specific functions for their host cells are called endosymbiotic bacteria.
According to endosymbiotic theory, energy-producing bacteria may have come to reside within larger bacteria, eventually evolving into Mitochondria.
Similarly, photosynthetic bacteria may have come to live within other larger bacteria, leading to the evolution of Chloroplasts- the photosynthetic organelles of plants and algae.



Kingdom Archaebacteria: Prokaryotes that lack a peptidoglycan cell wall, including extreme types.

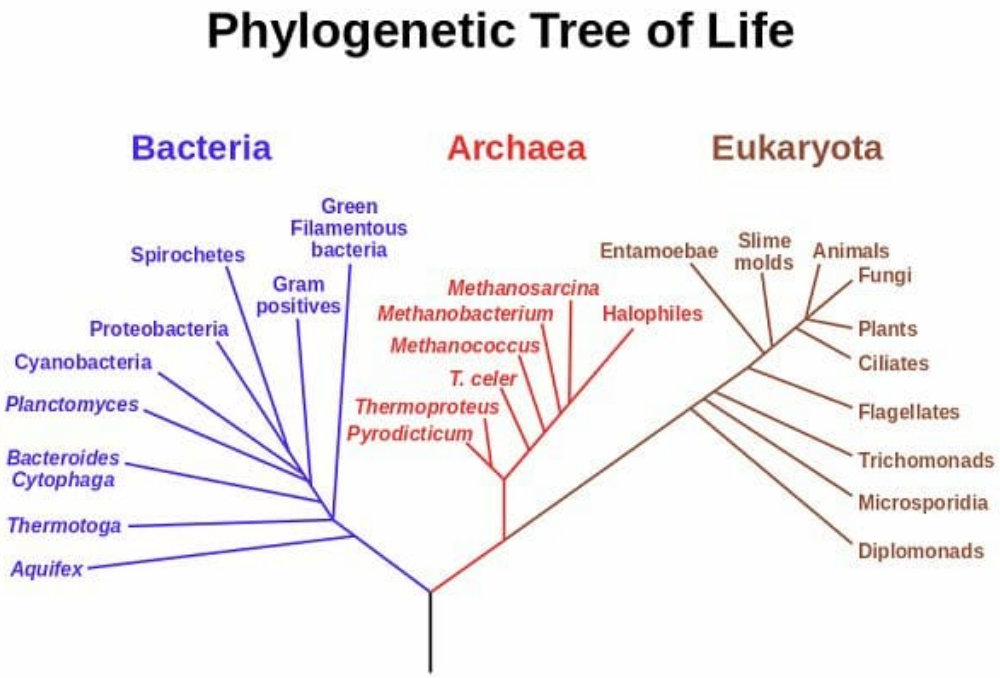
Kingdom Eubacteria: Prokaryotic organisms with a peptidoglycan cell wall, including cyanobacteria, soil bacteria, nitrogen-fixing bacteria, and pathogenic (disease-causing) bacteria.

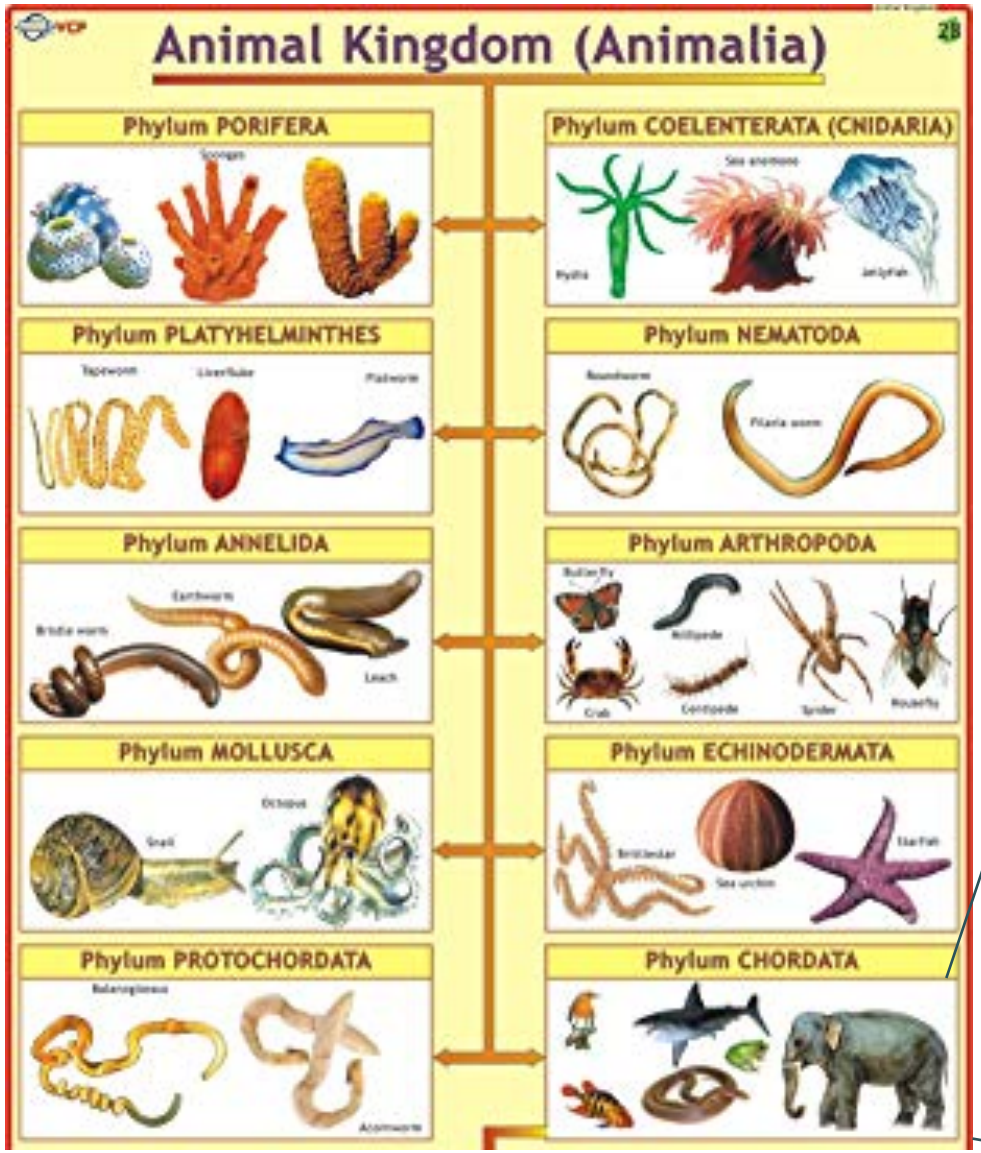
Kingdom Protista: Eukaryotic, primarily unicellular (although algae are multicellular), photosynthetic or heterotrophic organisms, such as amoebas and paramecia.

Kingdom Fungi: Eukaryotic, mostly multicellular (although yeasts are unicellular), heterotrophic, usually nonmotile organisms, with cell walls of chitin, such as mushrooms.

Kingdom Plantae: Eukaryotic, multicellular, nonmotile, usually terrestrial, photosynthetic organisms, such as trees, grasses, and mosses.

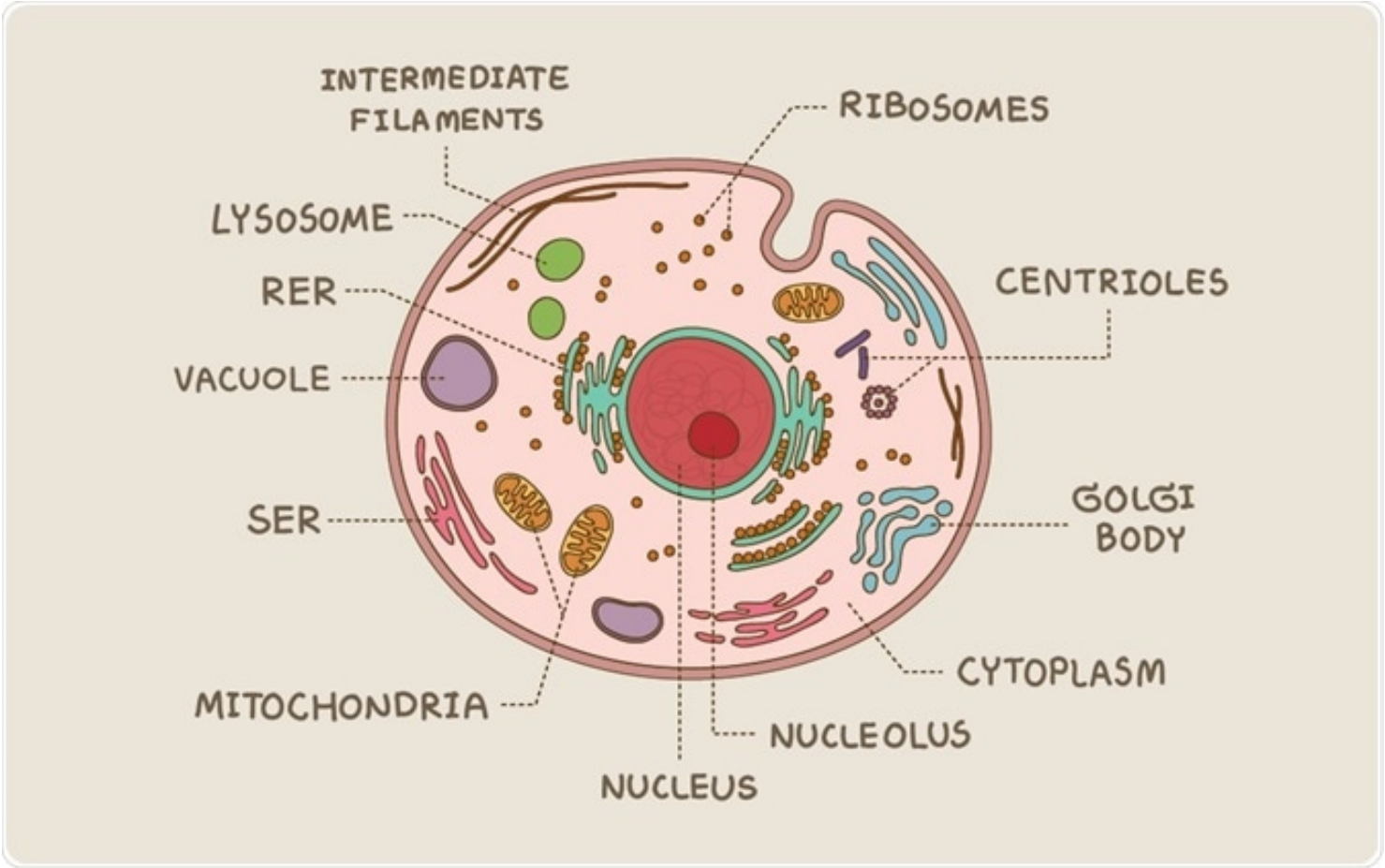
Kingdom Animalia: Eukaryotic, multicellular, motile, heterotrophic organisms, such as sponges, spiders, newts, penguins, and humans.




Animal Kingdom (Animalia)
Phylum PORIFERA
Phylum COELENTERATA (CNIDARIA)
Phylum PLATYHELMINTHES
Phylum NEMATODA
Phylum ANNELIDA
Phylum ARTHROPODA
Phylum MOLLUSCA
Phylum ECHINODERMATA
Phylum PROTOCHORDATA
Phylum CHORDATA


Subphylum VERTEBRATA
Class Chondrichthyes (cartilaginous fish)
Class Amphibia
Class Aves (Birds)
Class Osteichthyes (bony fish)
Class Reptilia
Class Mammalia

EUKARYOTIC CELL

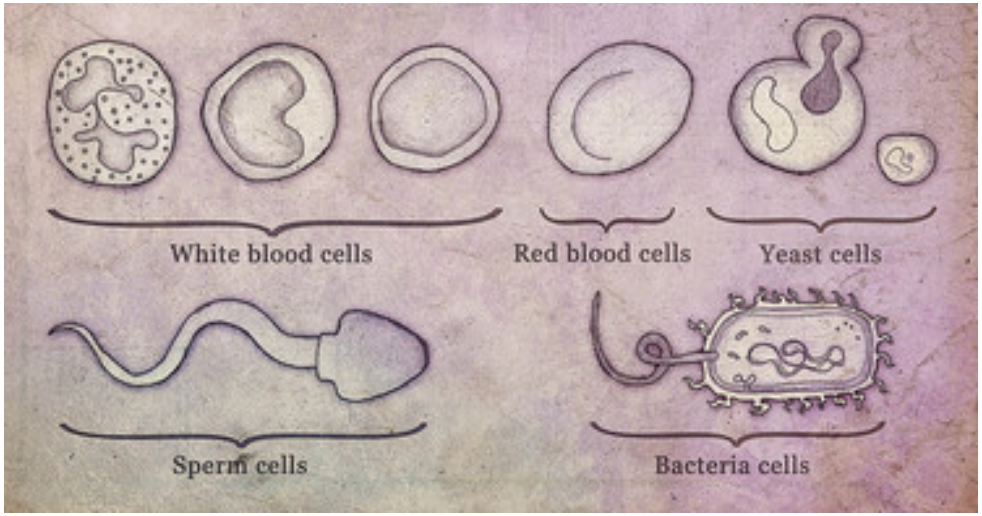


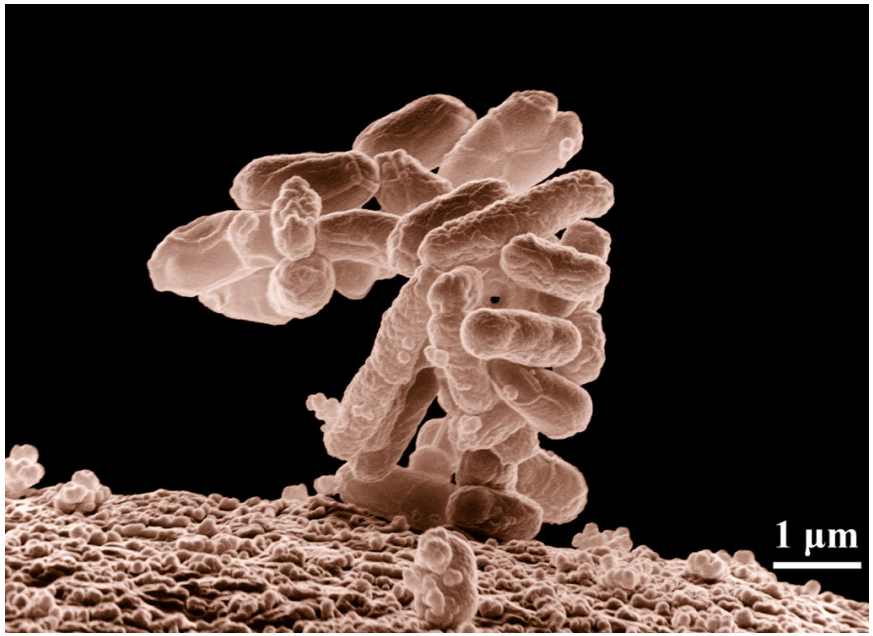
FIRST SINGLE CELL OBSERVED!

Antony von Leeuwenhoek

- Cloth Merchant
- Interested in Microscopy
- Teeth scraping, rain water, mold
- Coined term ‘animalcules’
- Coffee
- Banded pattern of muscle fibres

- Father of Microbiology





Escherichia Coli magnified 10000X