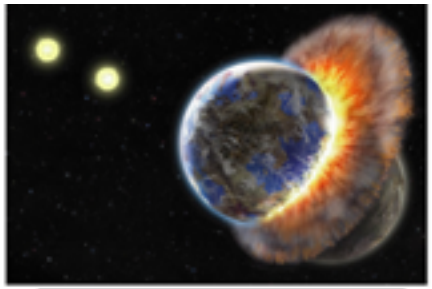
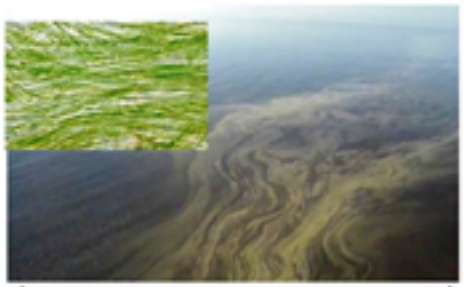
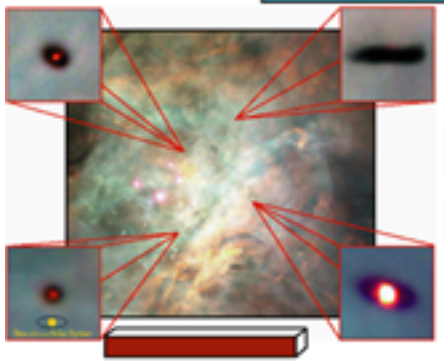


Jorden og Månen dannes, ca. 4.5 Ga



Iltproducerende fotosyntese, 2.5-0 Ga

Landplanter, 0.48-0 Ga

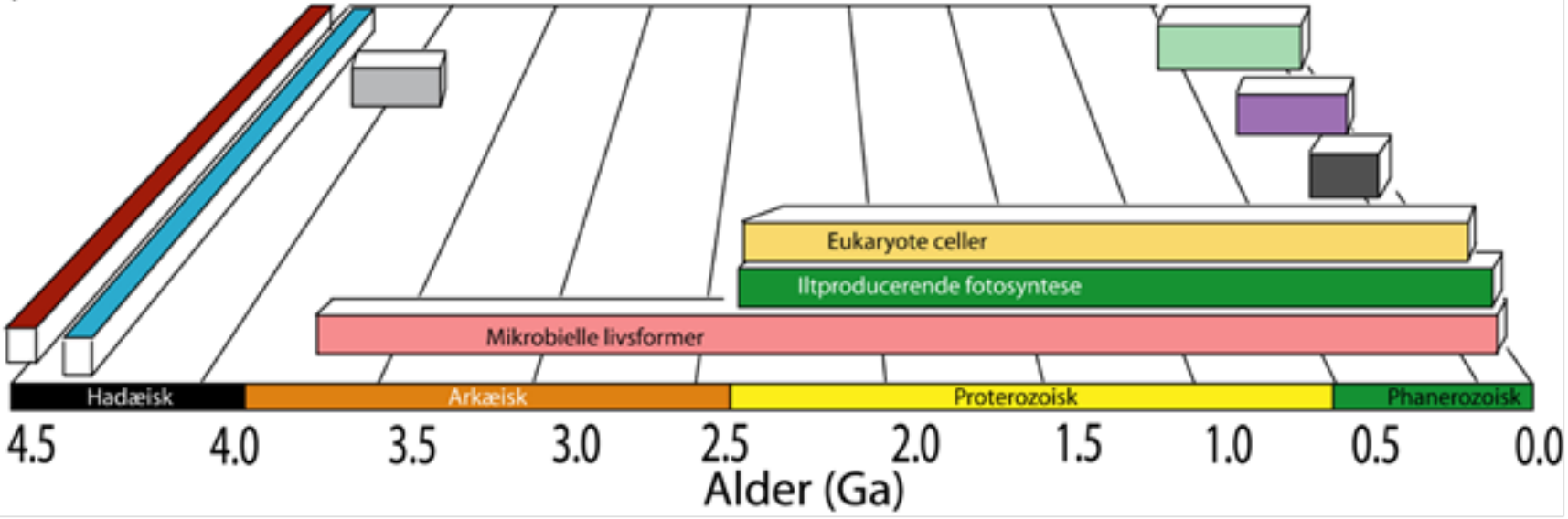


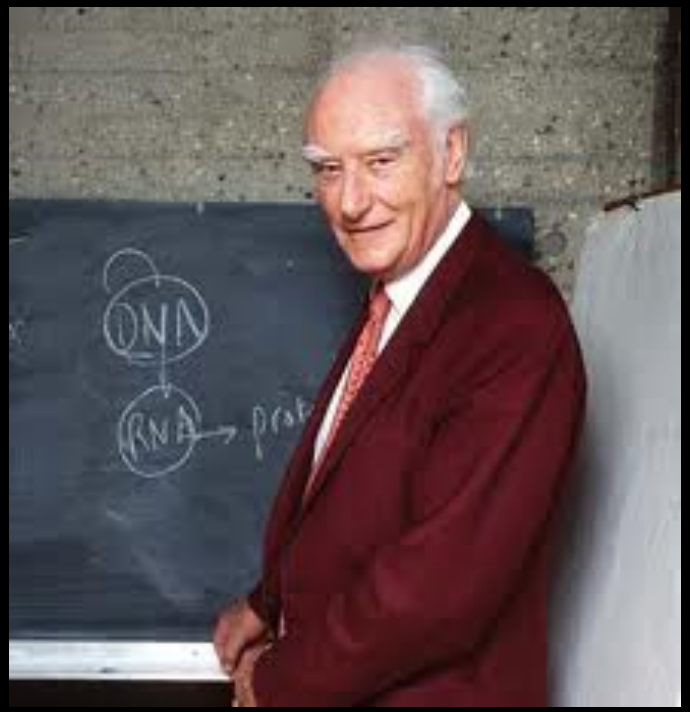
Solsystemet dannes 4.57 Ga

De første bjerge og kontinenter ca. 4.0-3.5 Ga

Dyr, 0.54-0 Ga

Dinosaurer, 0.25-0.06 Ga

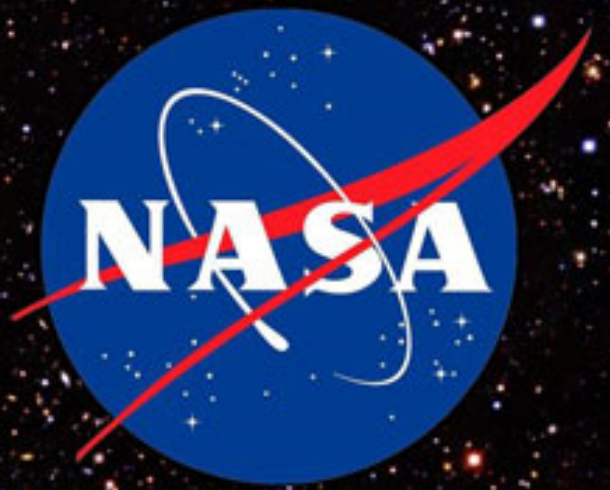



DNA
RNA

Hvad er liv?

NASA definer liv som

"*A self-sustaining chemical system capable of Darwinian evolution*."



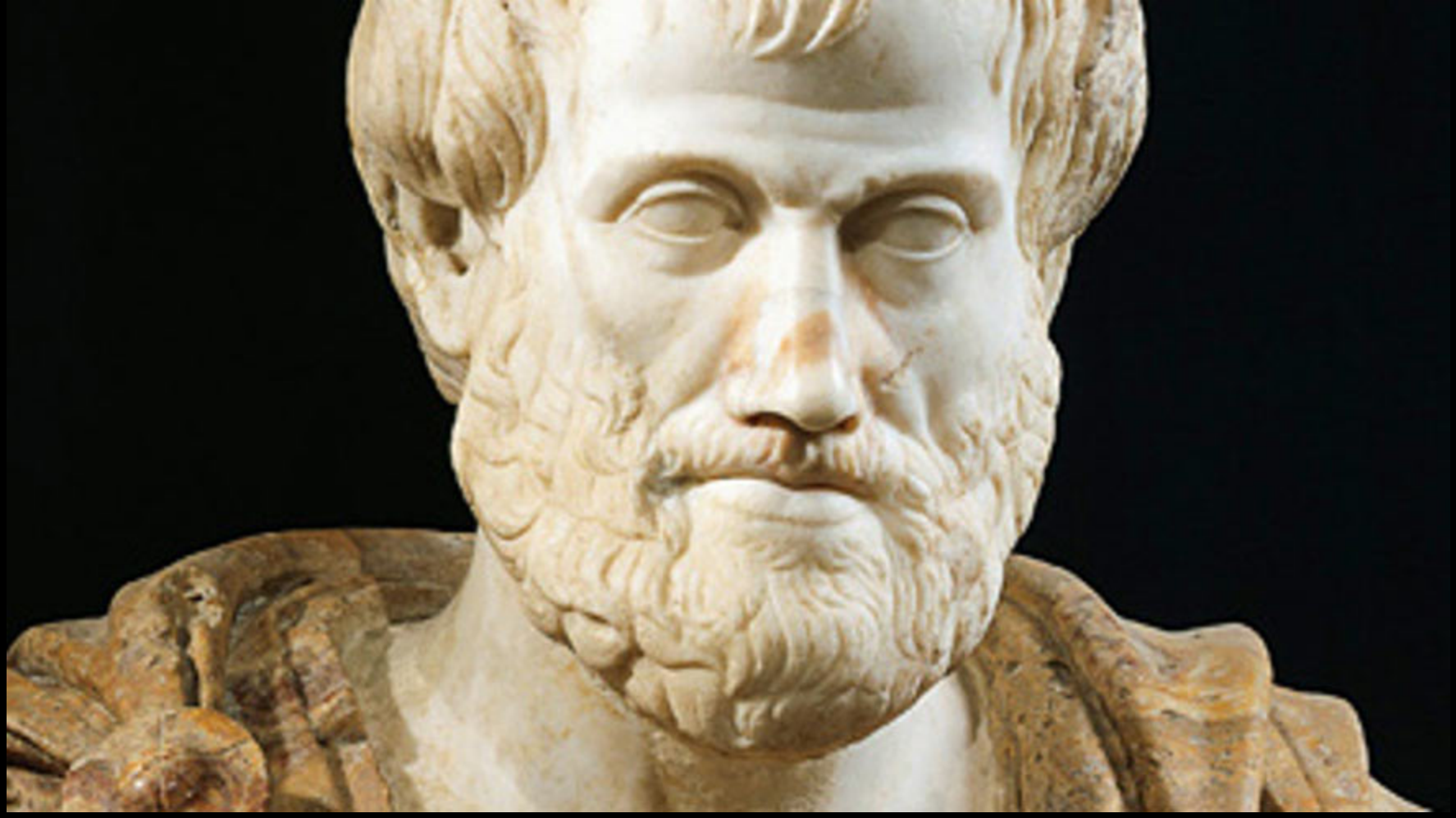
Hvad kræves for liv?

i) En adskillelse fra omgivelserne (cellemembranen), men også en mulighed for at kunne udveksle stoffer med omgivelserne

ii) Homeostase – dvs et regulerende der system der kan fastholde cellens koncentrationer af forskellige stoffer

iii) Et stofskifte til at opbygge nye stoffer, men også til at lave energi for at opretholde homeostase

iv) Mulighed for reproduktion (et arvemateriale)



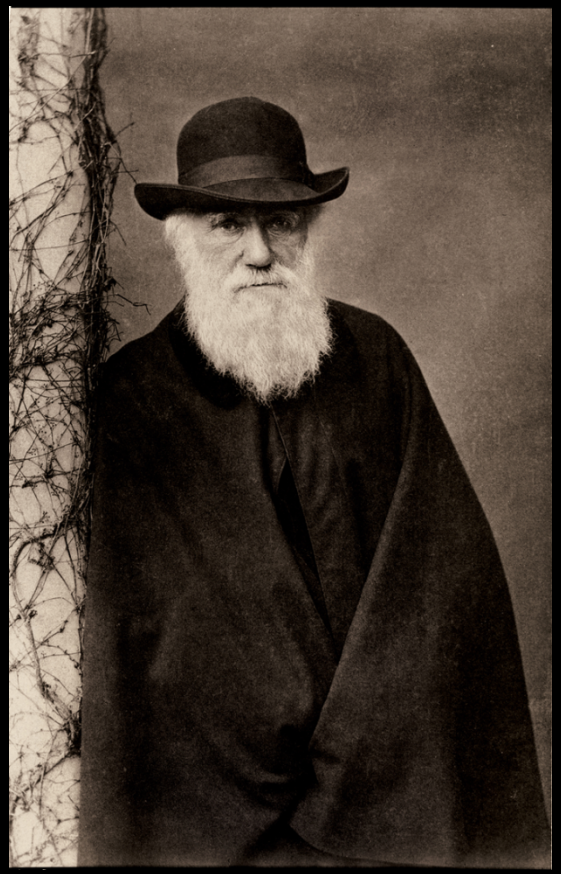
Animals and plants come into being in earth and in liquid because there is water in earth, and air in water, and in all air is vital heat so that in a sense all things are full of soul. Therefore living things form quickly whenever this air and vital heat are enclosed in anything.

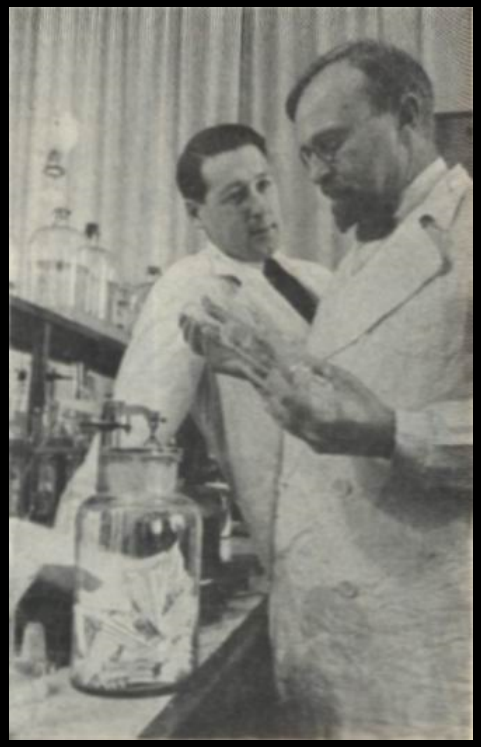
— Aristotle, *On the Generation of Animals, Book III, Part 11*

Jan Baptist van Helmont
(1580 –1644)

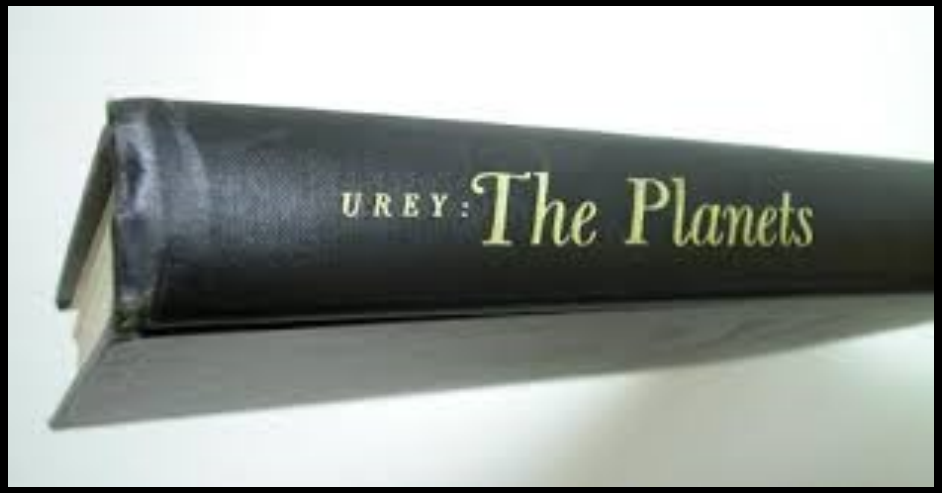
Charles Darwin (1871) til vennen Joseph Dalton Hooker:

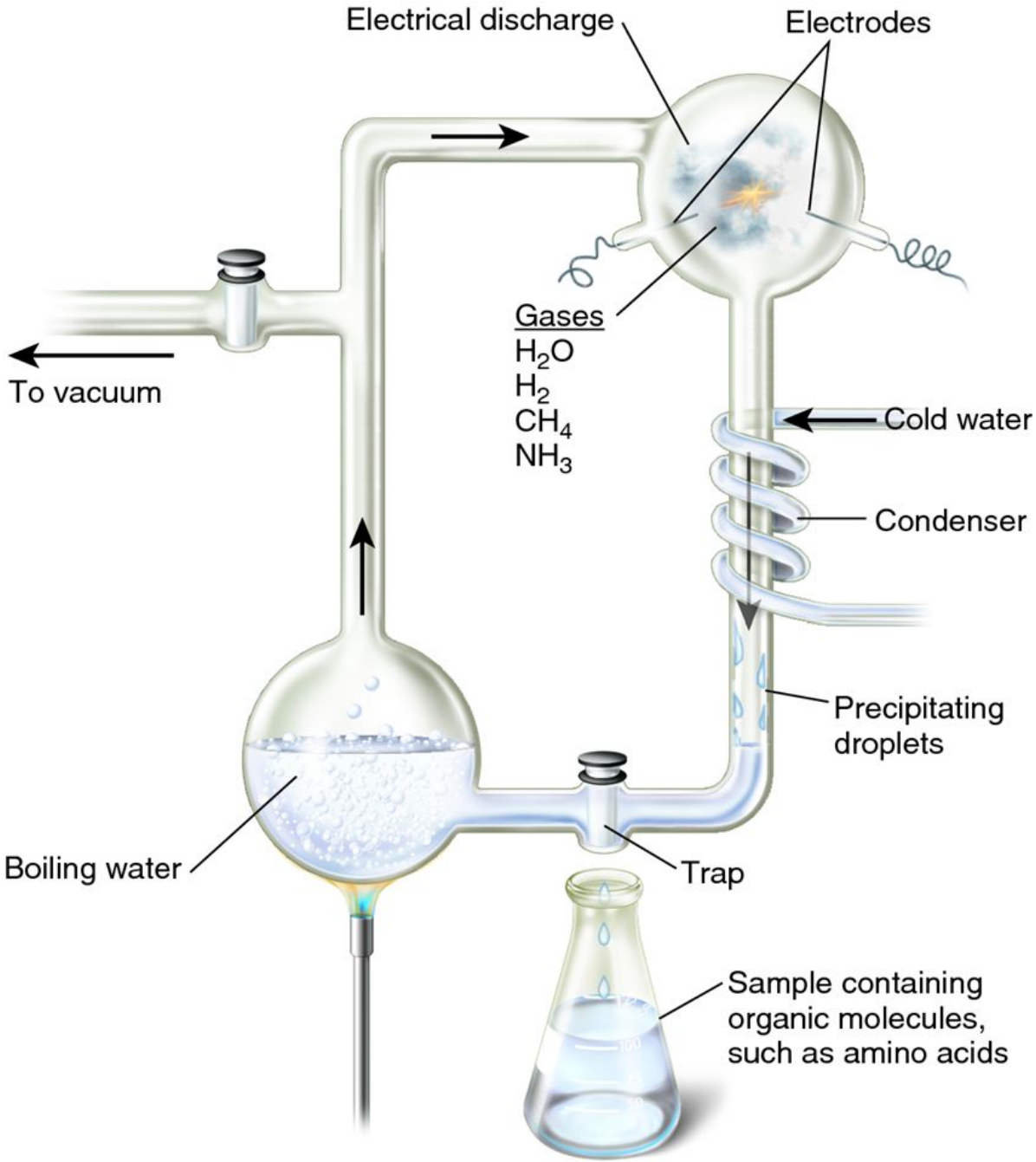
”*Men hvis vi kunne forestille os en varm lille dam med alle mulige slags ammoniak, fosforsalte, lys, varme og elektricitet, hvor et protein blev kemisk dannet, som derefter undergik yderligere ændringer …*”

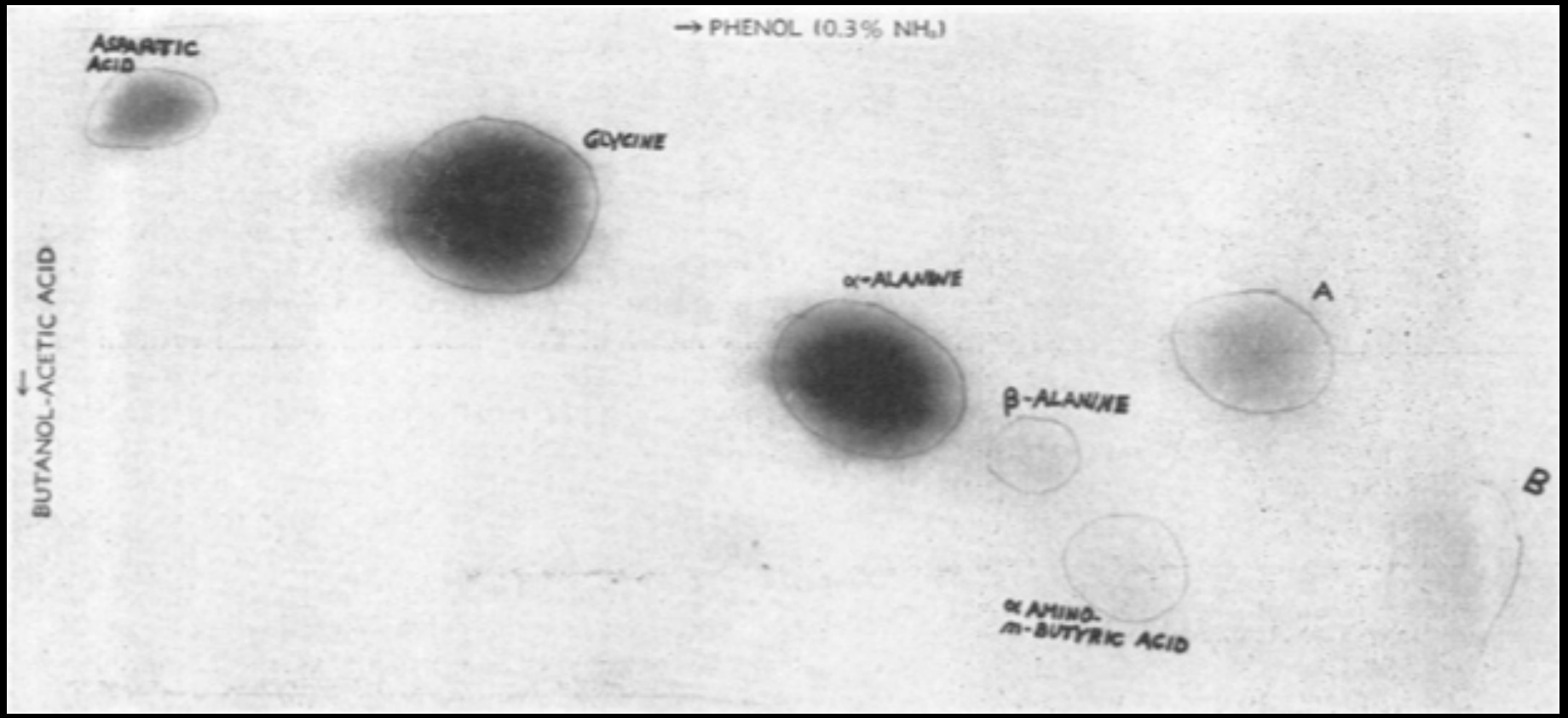


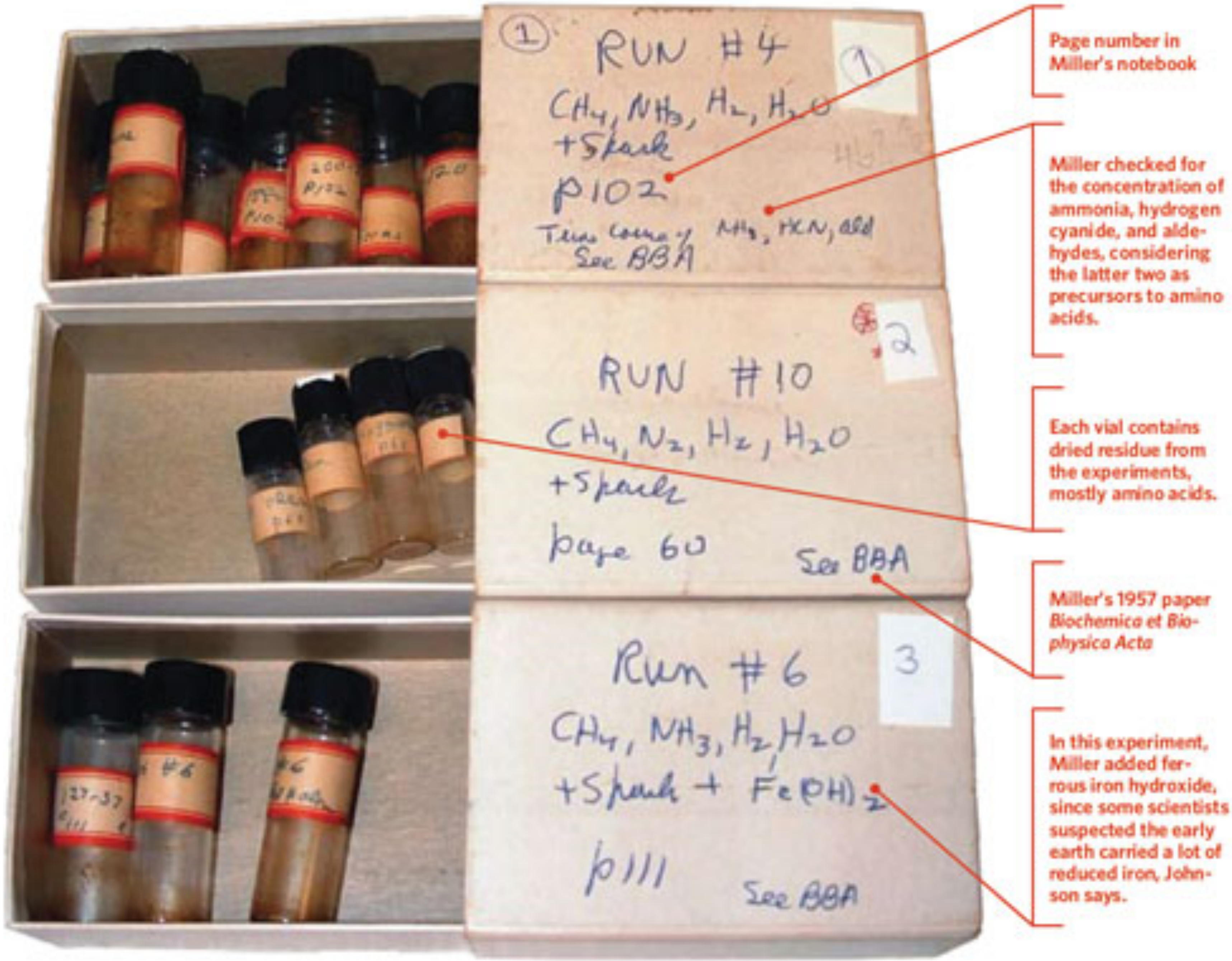


den russiske biokemiker
Alexander I. Oparin (1894-1980)
og engelske evolutionsbiolog
John B.S. Haldane (1892-1964)

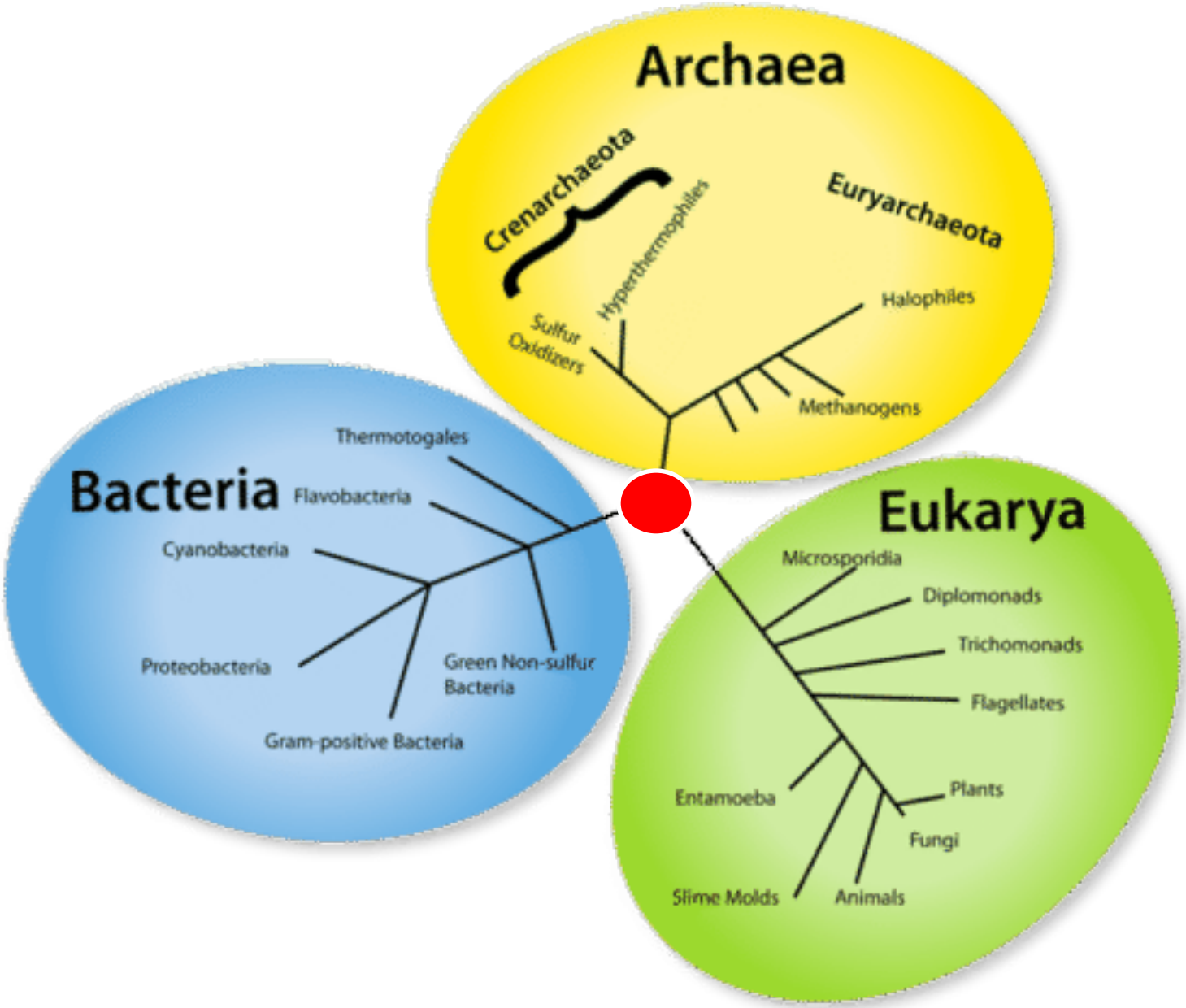

UREY: The Planets


Electrical discharge
Electrodes
Gases
H_2O
H_2
CH_4
NH_3
To vacuum
Cold water
Condenser
Precipitating droplets
Boiling water
Trap
Sample containing organic molecules, such as amino acids


→ PHENOL (0.3% NH_3)
ASPARTIC ACID
GLYCINE
α-ALANINE
A
β-ALANINE
B
α AMINO-n-BUTYRIC ACID
← BUTANOL-ACETIC ACID

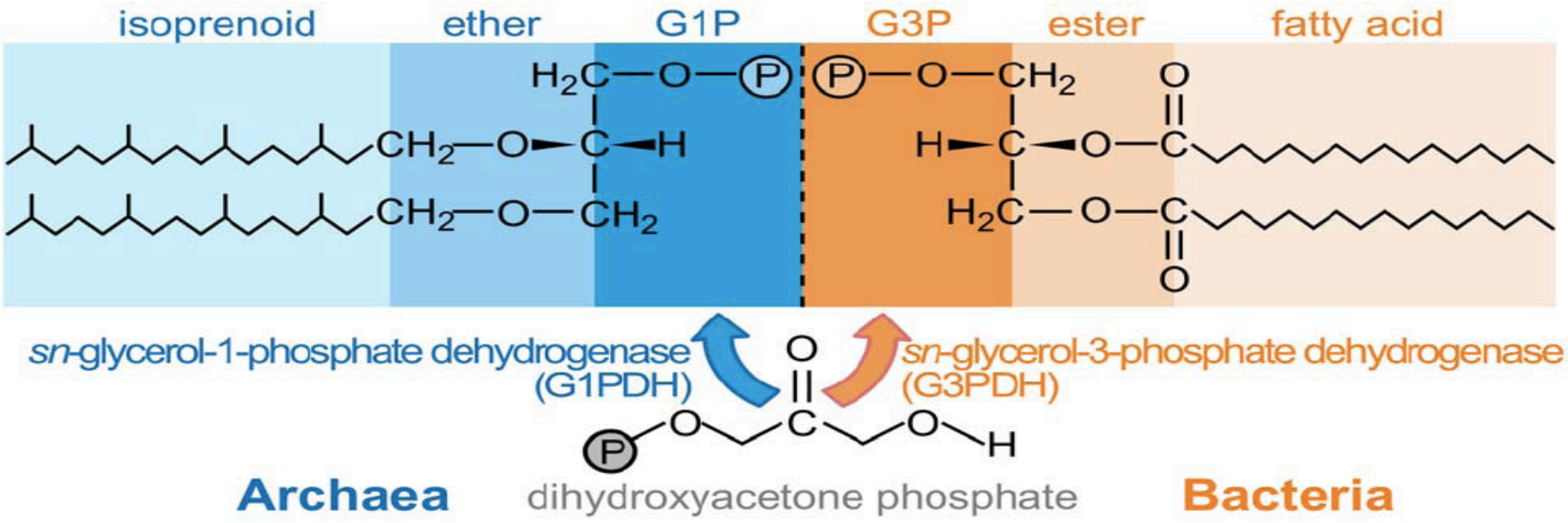

RUN #4
CH4, NH3, H2, H2O
+Spark
p102
See BBA
RUN #10
CH4, N2, H2, H2O
+Spark
page 60
See BBA
Run #6
CH4, NH3, H2, H2O
+Spark + Fe(OH)2
p111
See BBA
Page number in Miller's notebook
Miller checked for the concentration of ammonia, hydrogen cyanide, and aldehydes, considering the latter two as precursors to amino acids.
Each vial contains dried residue from the experiments, mostly amino acids.
Miller's 1957 paper Biochemica et Biophysica Acta
In this experiment, Miller added ferrous iron hydroxide, since some scientists suspected the early earth carried a lot of reduced iron, Johnson says.

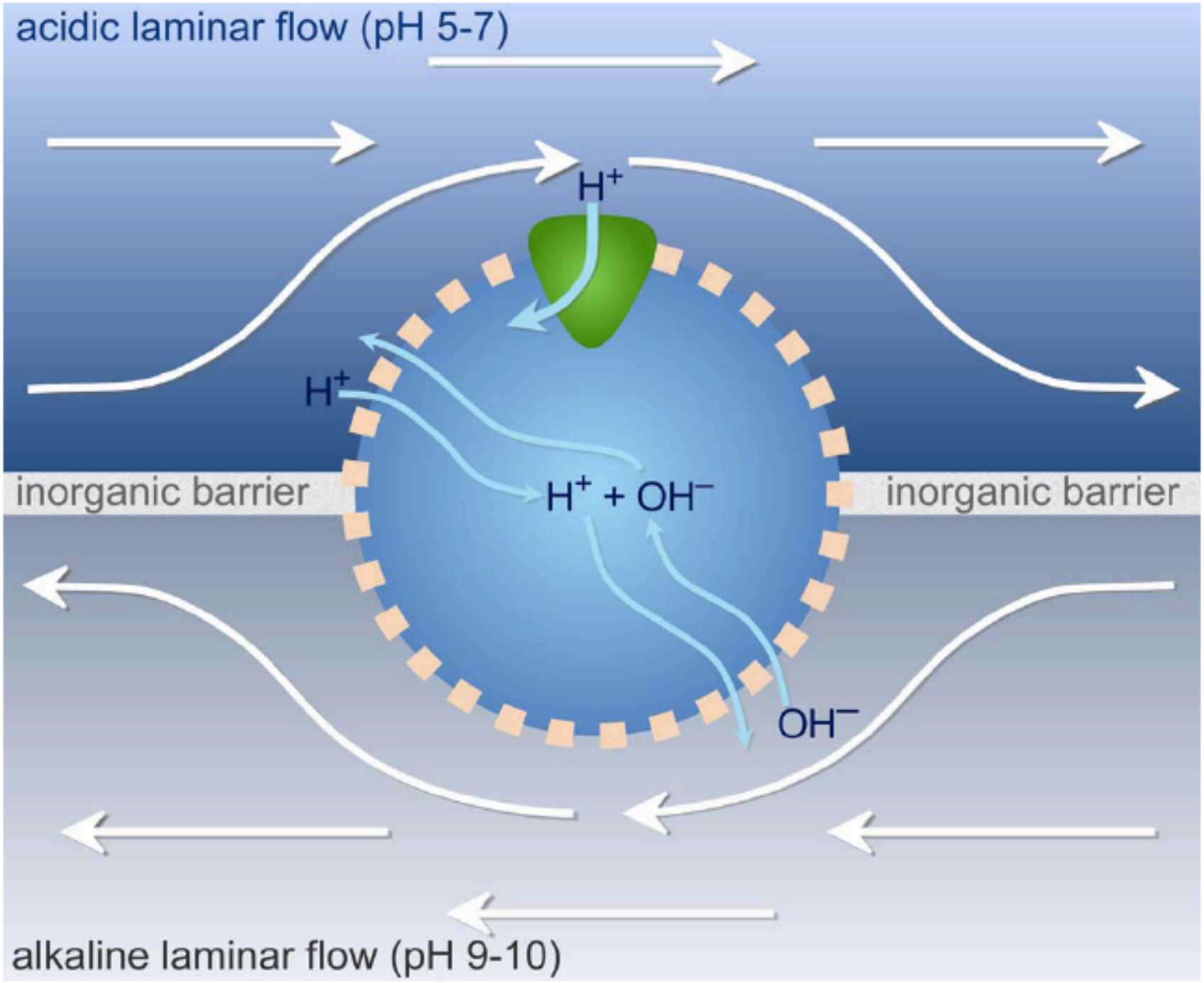
Last Universal Common Ancestor (LUCA)

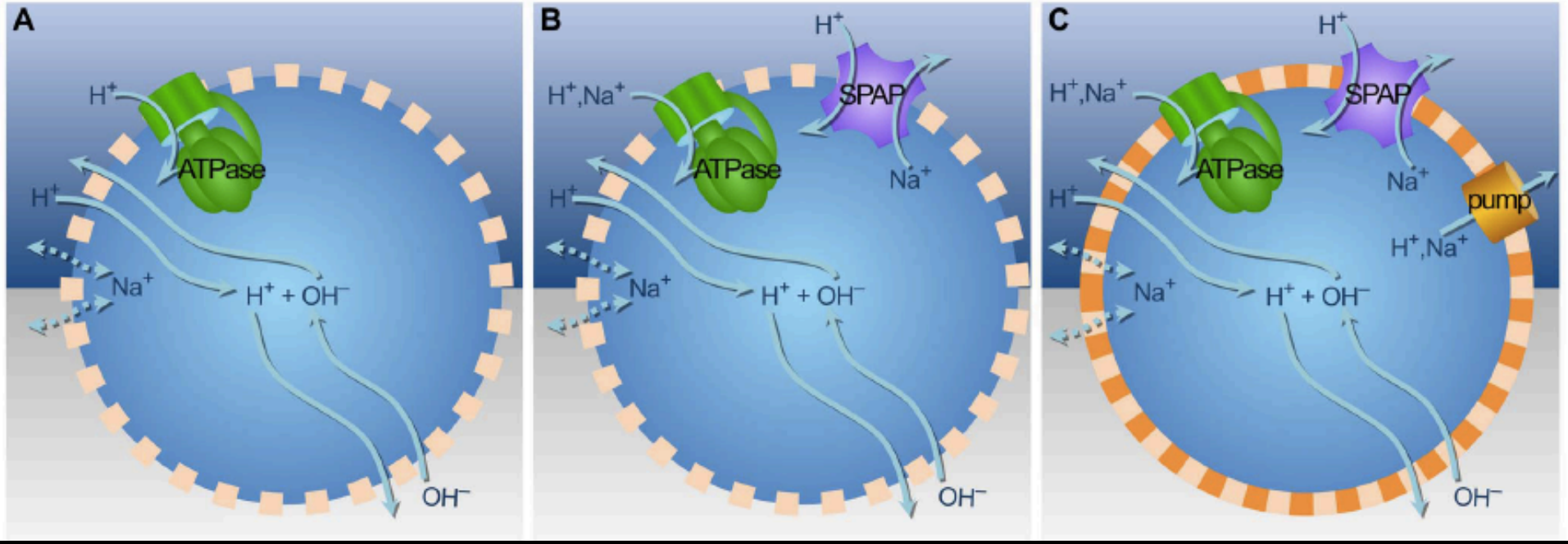


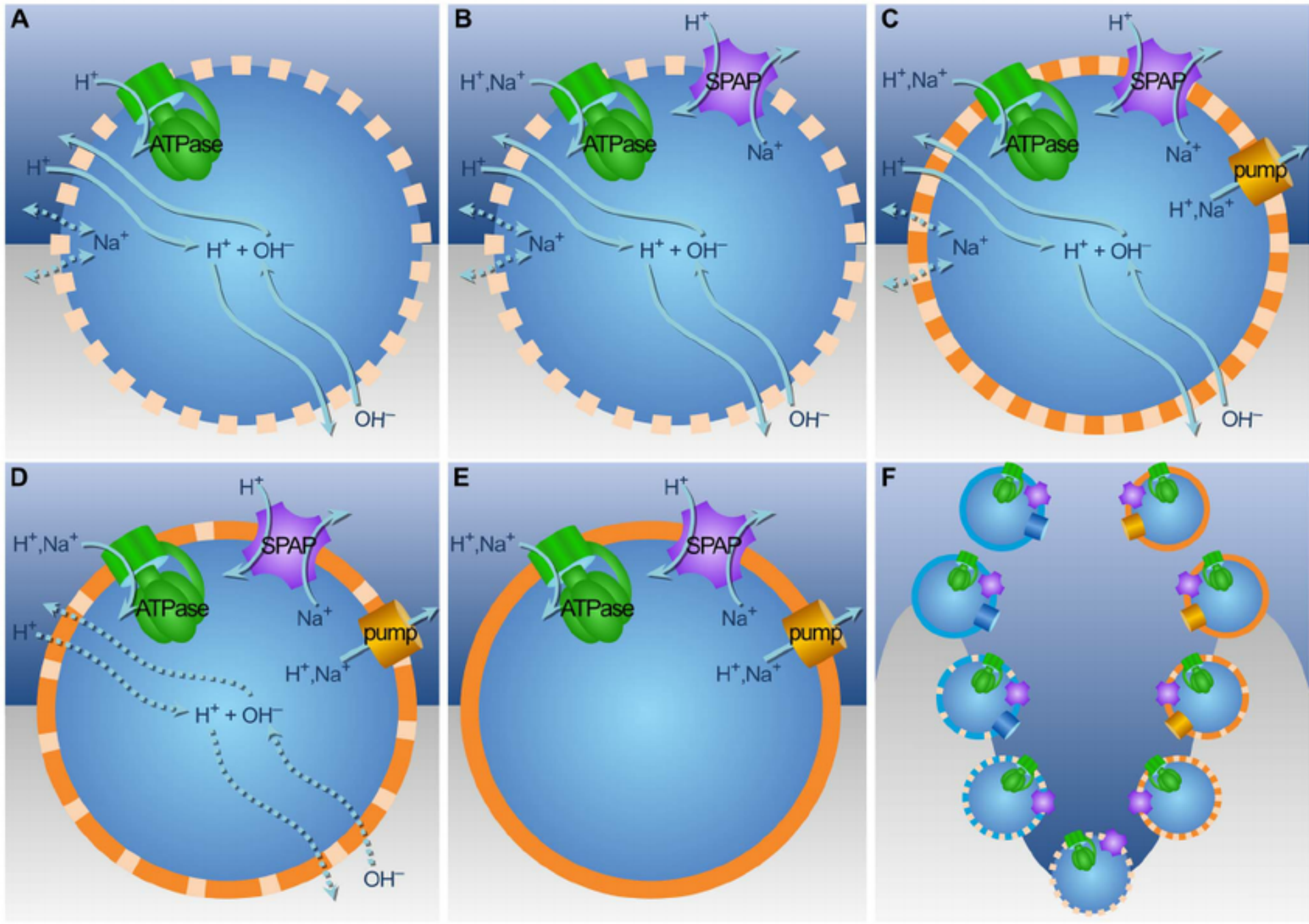
Archea og bakterier er forskellige mht cellemembranen sammensætning og DNA replication

Hvordan kan så centrale dele af livet være forskellige?

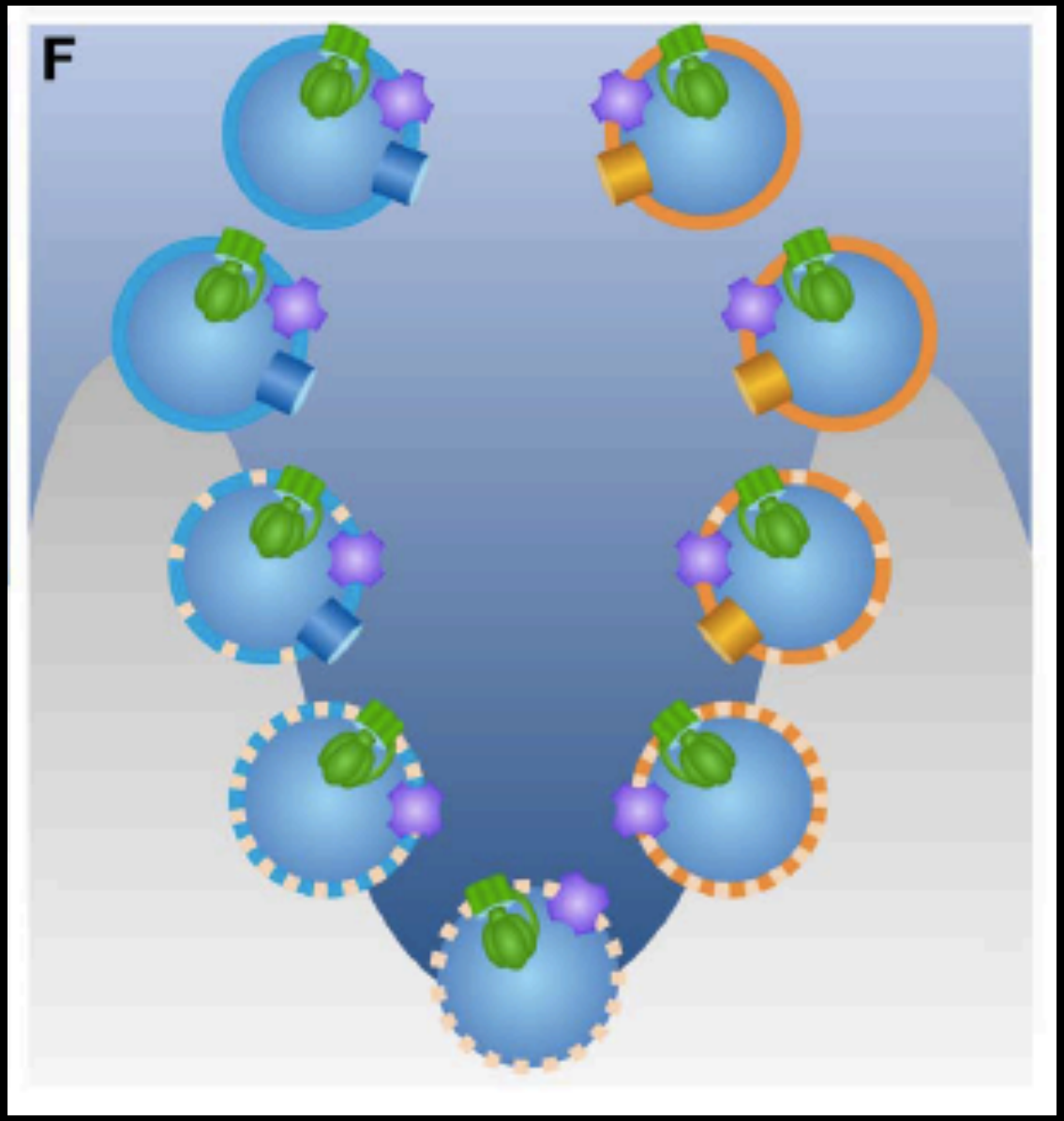


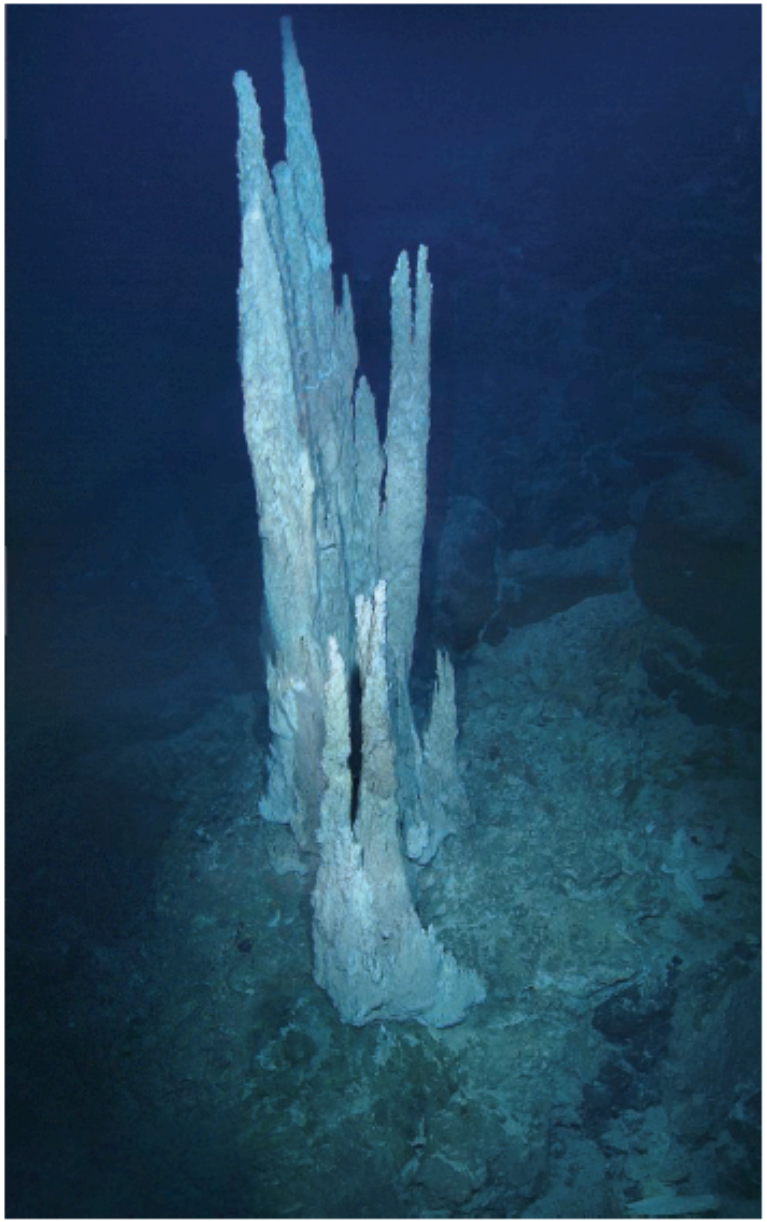

acidic laminar flow (pH 5-7)
H+
H+
inorganic barrier
H+ + OH−
inorganic barrier
OH−
alkaline laminar flow (pH 9-10)


A
H+
ATPase
H+
Na+
H+ + OH−
OH−
B
H+
H+,Na+
SPAP
ATPase
Na+
H+
Na+
H+ + OH−
OH−
C
H+
H+,Na+
SPAP
ATPase
Na+
pump
H+
H+,Na+
Na+
H+ + OH−
OH−

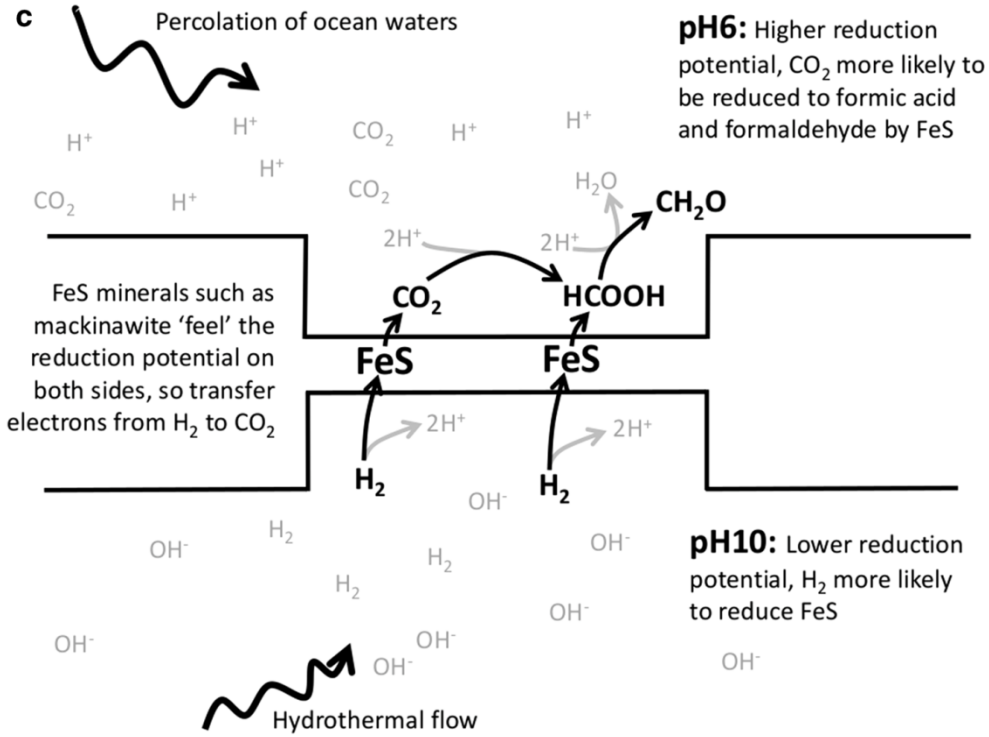

A
H+
ATPase
H+
Na+
H+ + OH−
OH−
B
H+
H+,Na+
SPAP
ATPase
Na+
H+
Na+
H+ + OH−
OH−
C
H+
H+,Na+
SPAP
ATPase
Na+
pump
H+
H+,Na+
Na+
H+ + OH−
OH−
D
H+
H+,Na+
SPAP
ATPase
Na+
pump
H+
H+,Na+
H+ + OH−
OH−
E
H+
H+,Na+
SPAP
ATPase
Na+
pump
H+,Na+
F

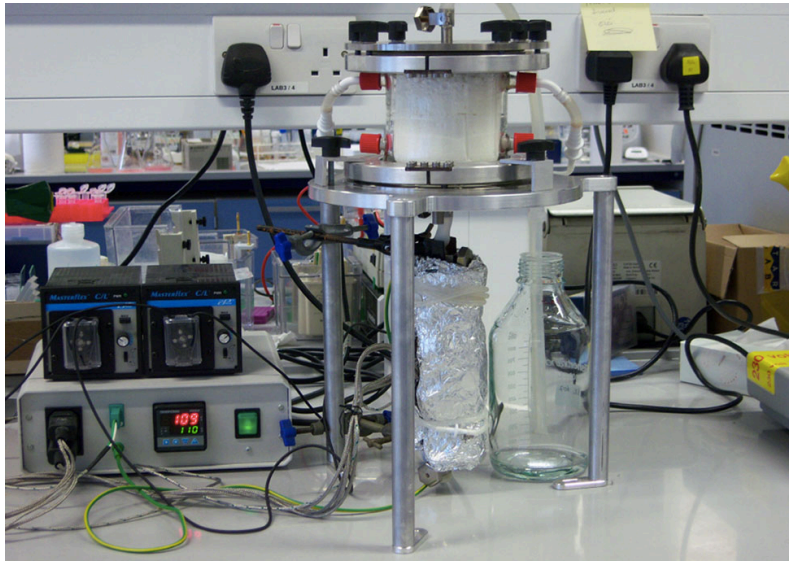
archea *bacteria*

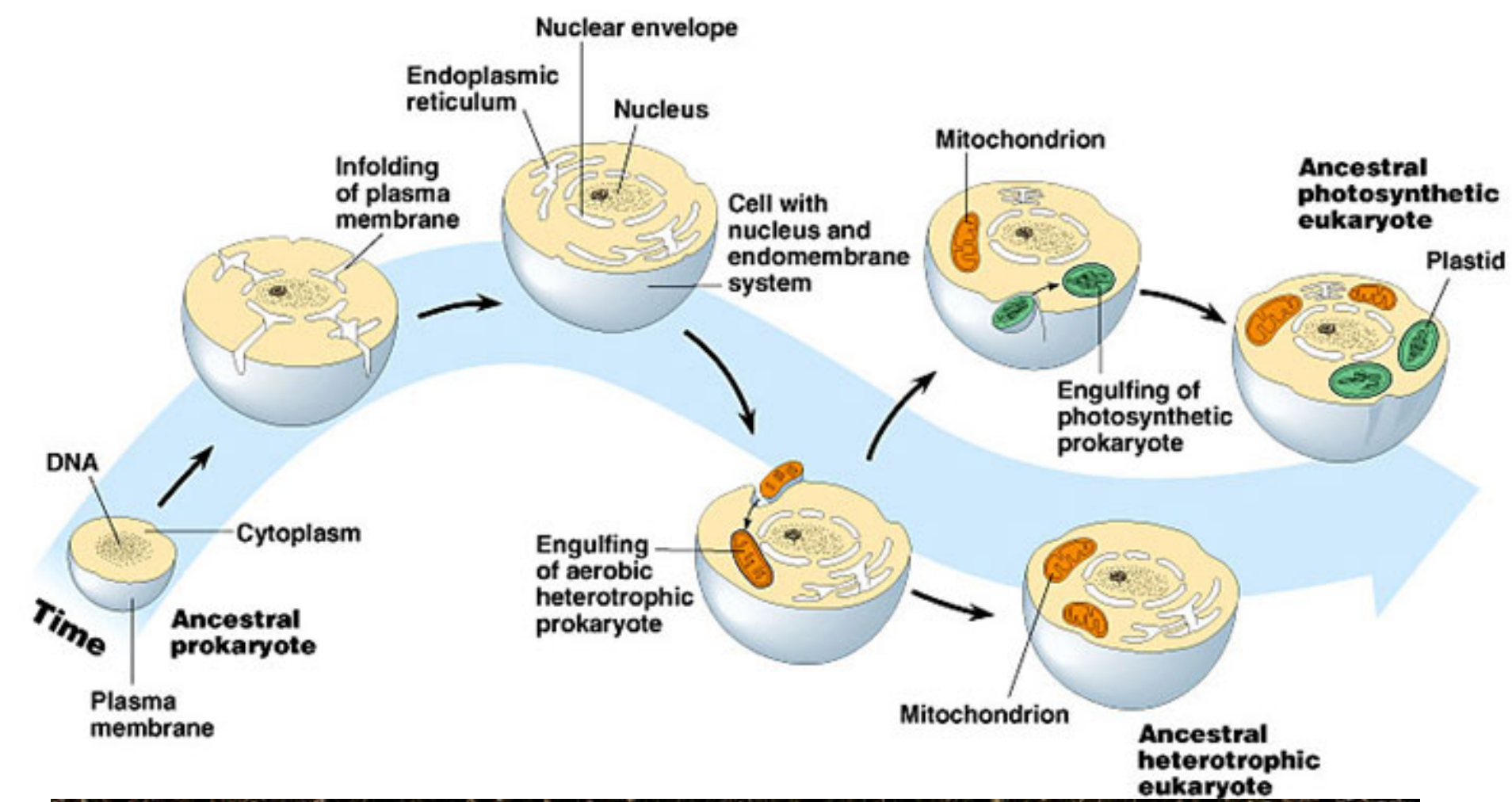


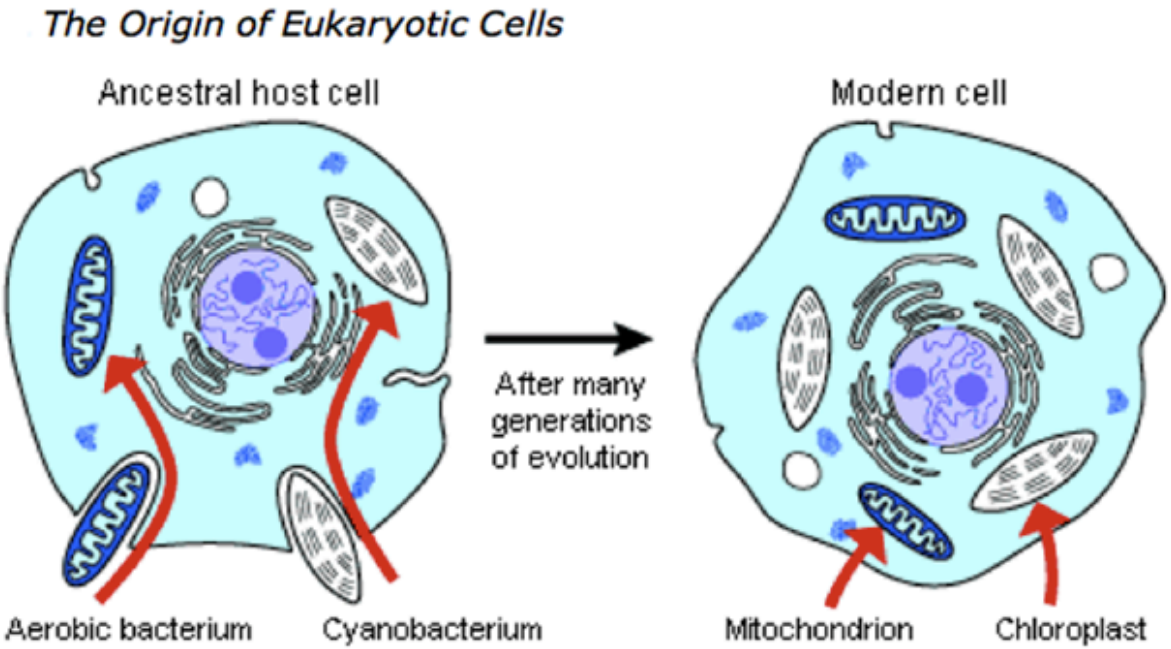


Clues to where life evolved. Similarities between bioenergetic processes and those at hydrothermal vents such as Lost City suggest that life may have evolved at such vents on the early Earth. This photo was taken at Lost City in 2005 using the remotely operated vehicle *Hercules*.

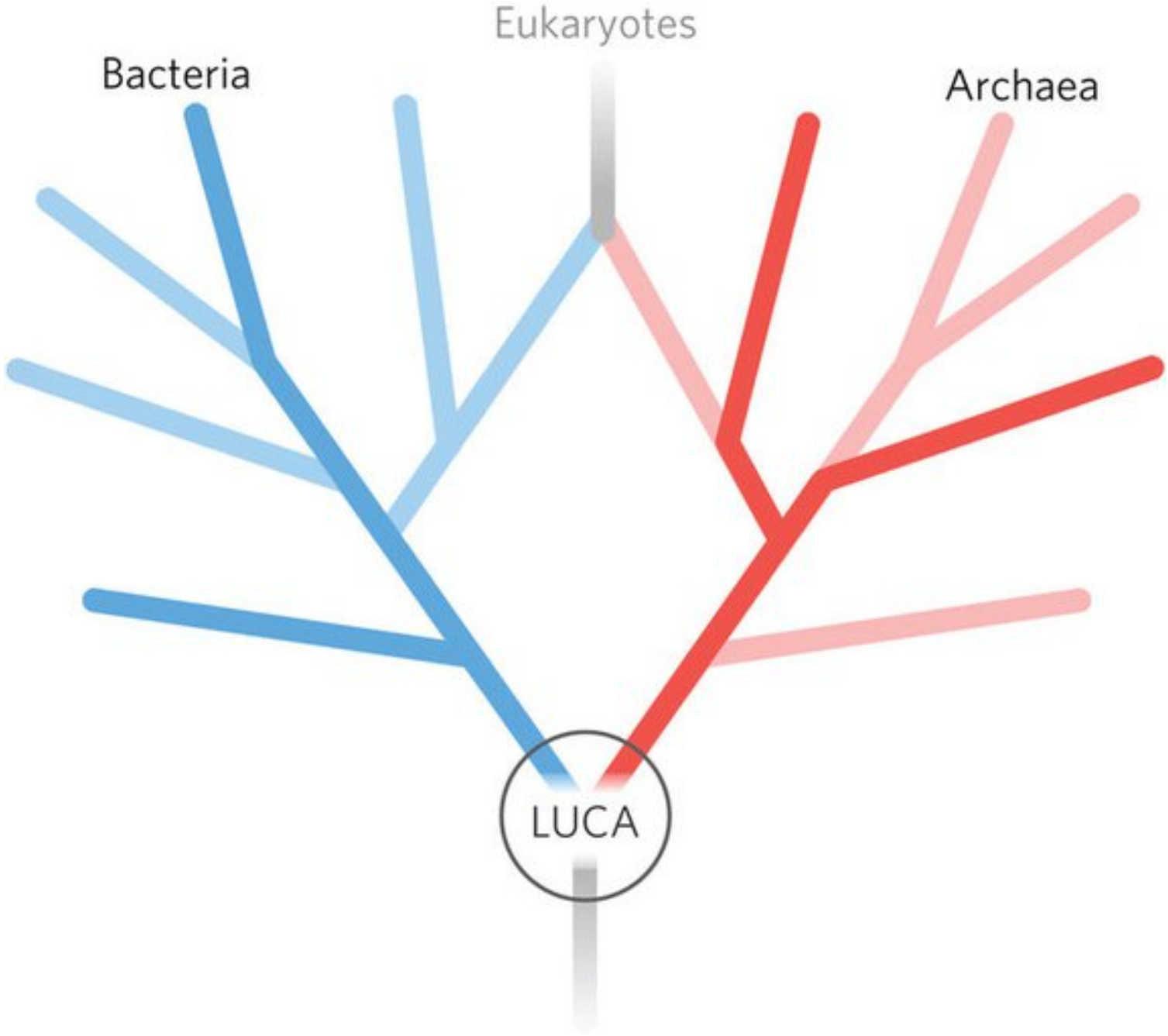


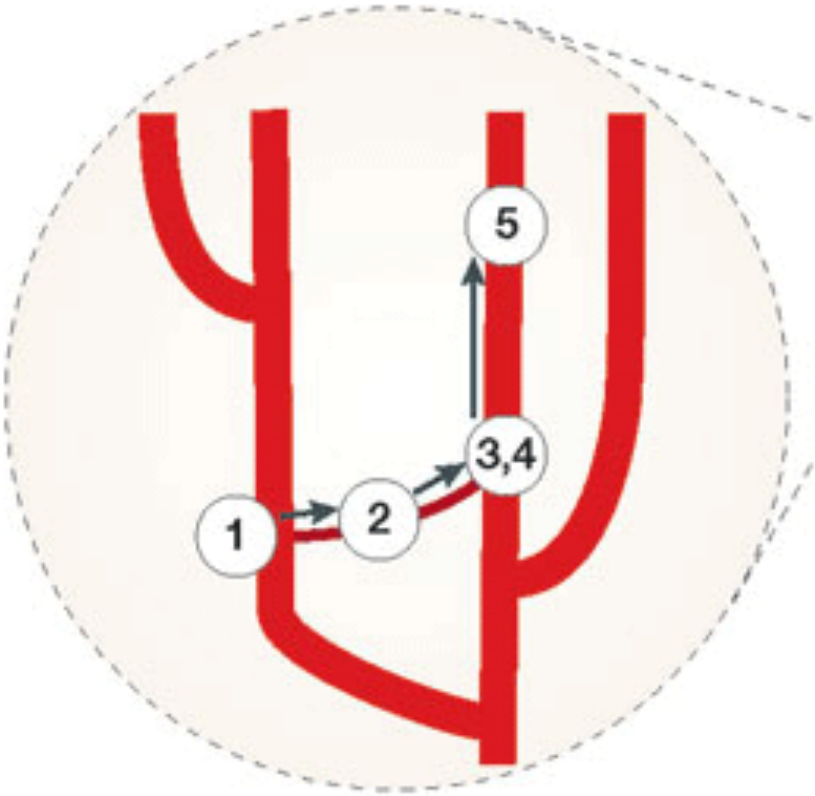


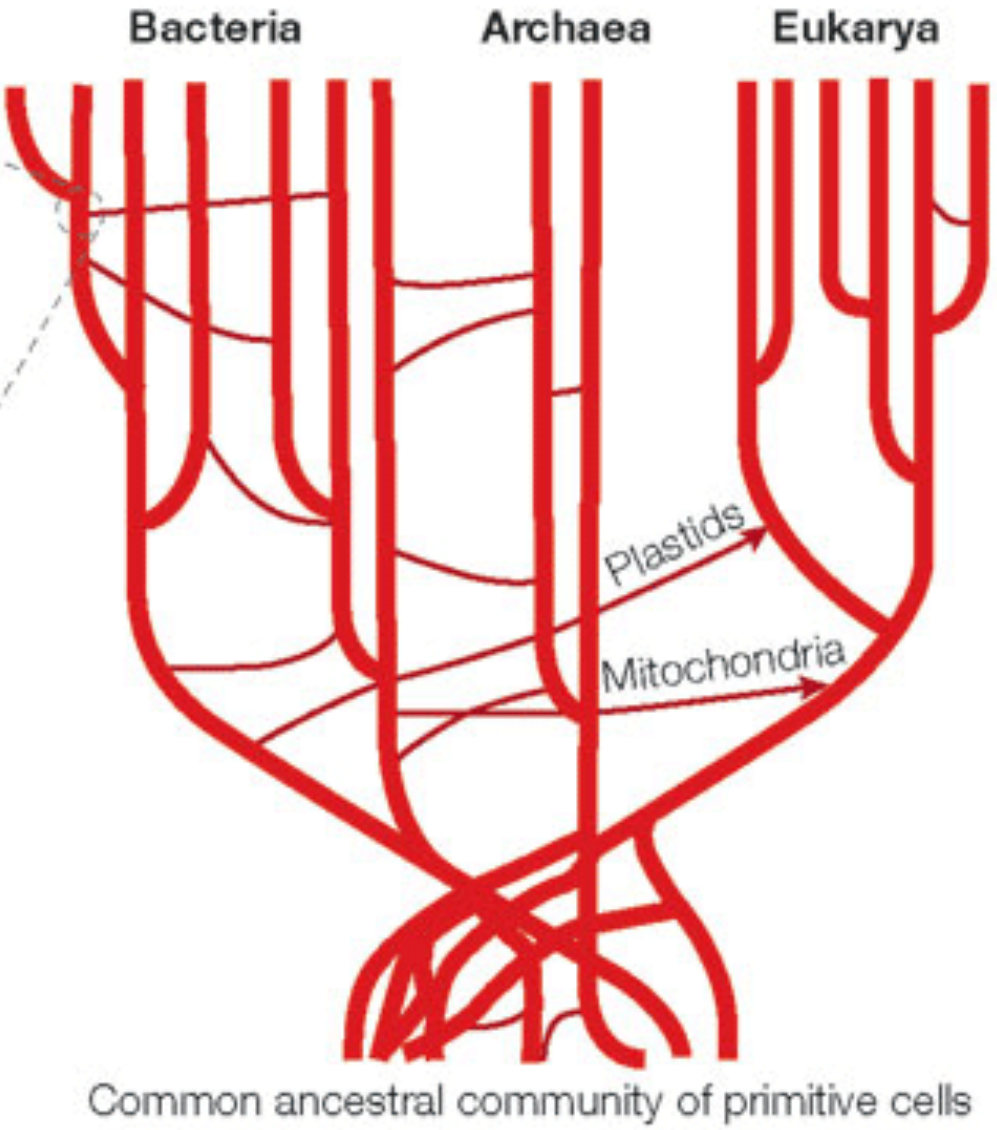

Nuclear envelope
Endoplasmic reticulum
Nucleus
Infolding of plasma membrane
Cell with nucleus and endomembrane system
Mitochondrion
Ancestral photosynthetic eukaryote
Plastid
Engulfing of photosynthetic prokaryote
DNA
Cytoplasm
Time
Ancestral prokaryote
Plasma membrane
Engulfing of aerobic heterotrophic prokaryote
Mitochondrion
Ancestral heterotrophic eukaryote

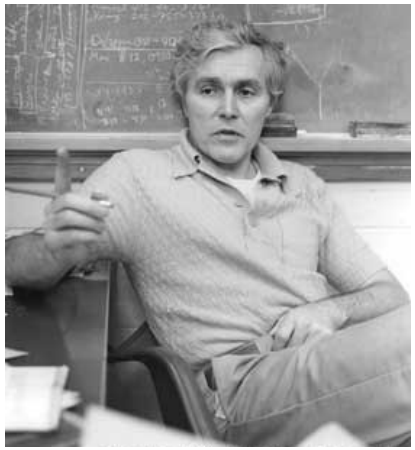


Lynn Margulis
(1938 – 2011)

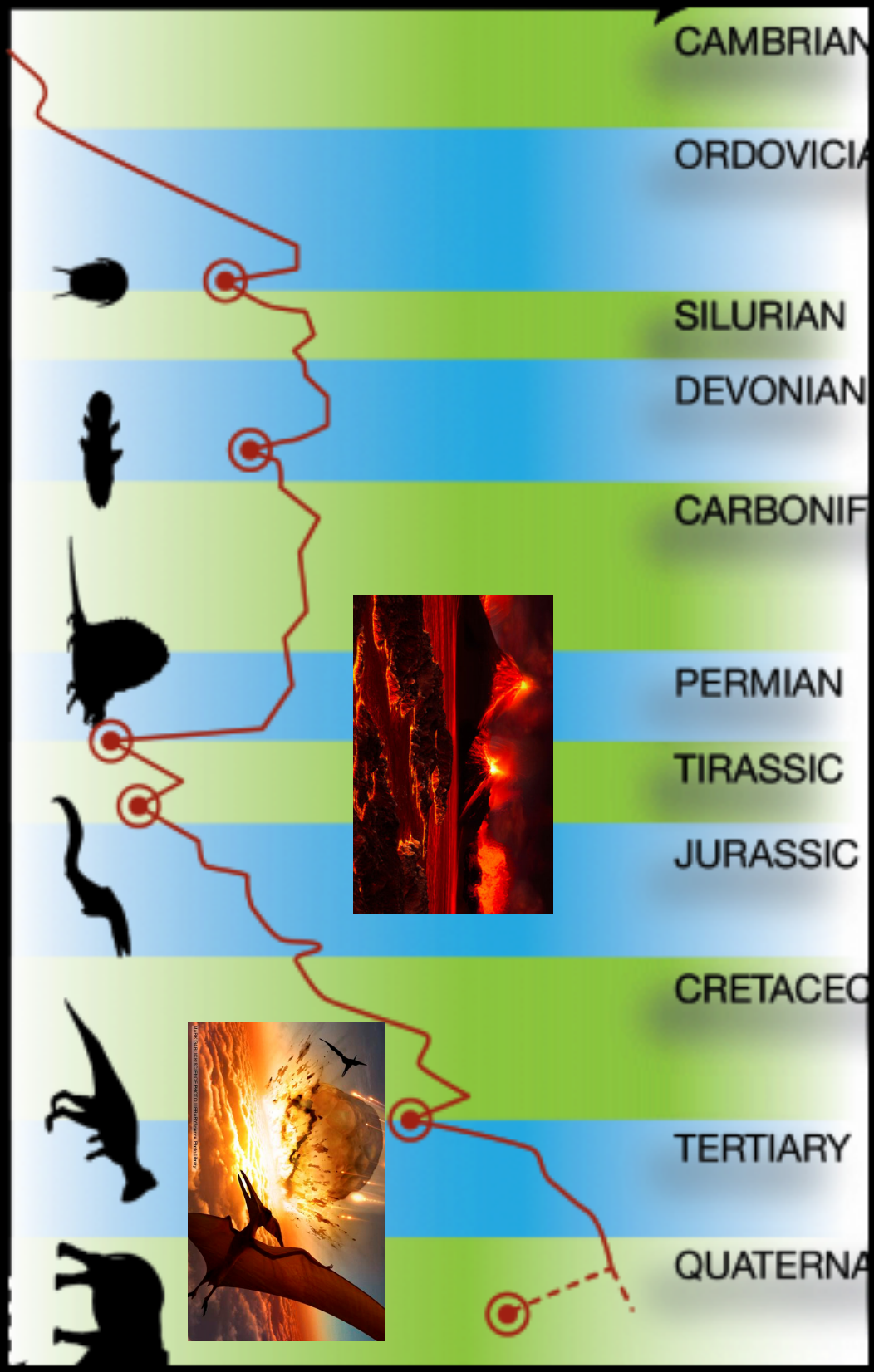

Eukaryotes
Bacteria
Archaea
LUCA

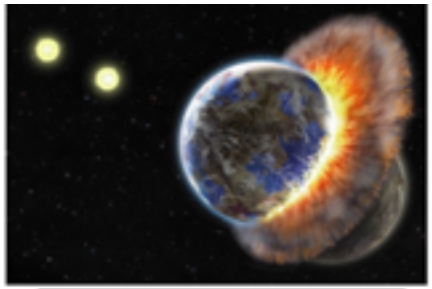

5
3,4
1
2


Bacteria
Archaea
Eukarya
Plastids
Mitochondria
Common ancestral community of primitive cells

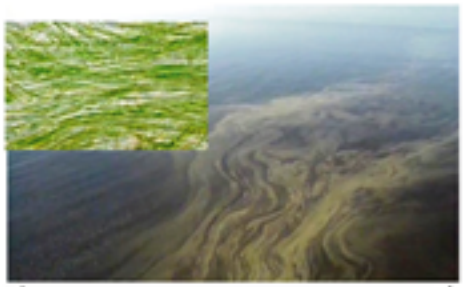


Carl Woese


CAMBRIAN
ORDOVICIA
SILURIAN
DEVONIAN
CARBONIF
PERMIAN
TIRASSIC
JURASSIC
CRETACEO
TERTIARY
QUATERNA

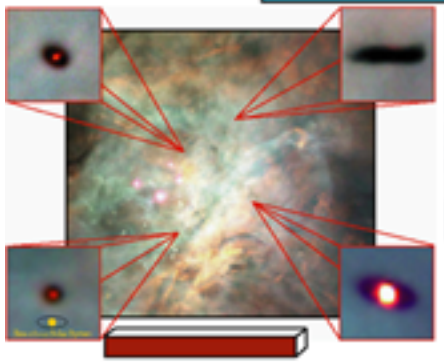


Jorden og Månen dannes, ca. 4.5 Ga



Iltproducerende fotosyntese, 2.5-0 Ga

Landplanter, 0.48-0 Ga

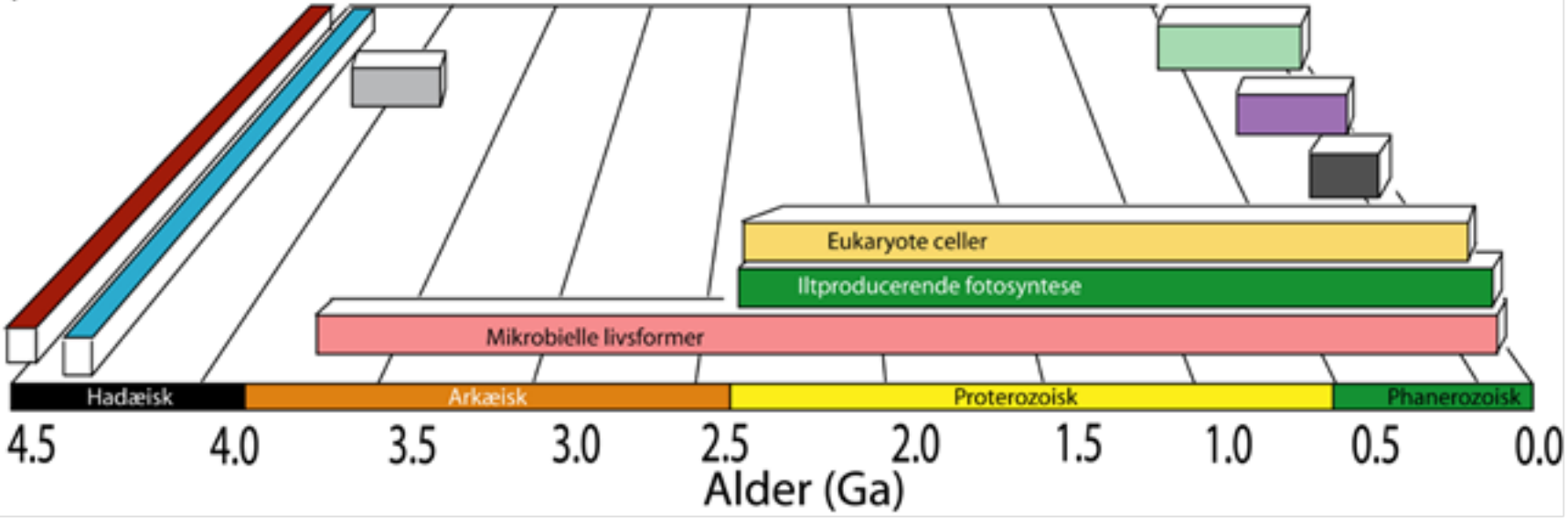


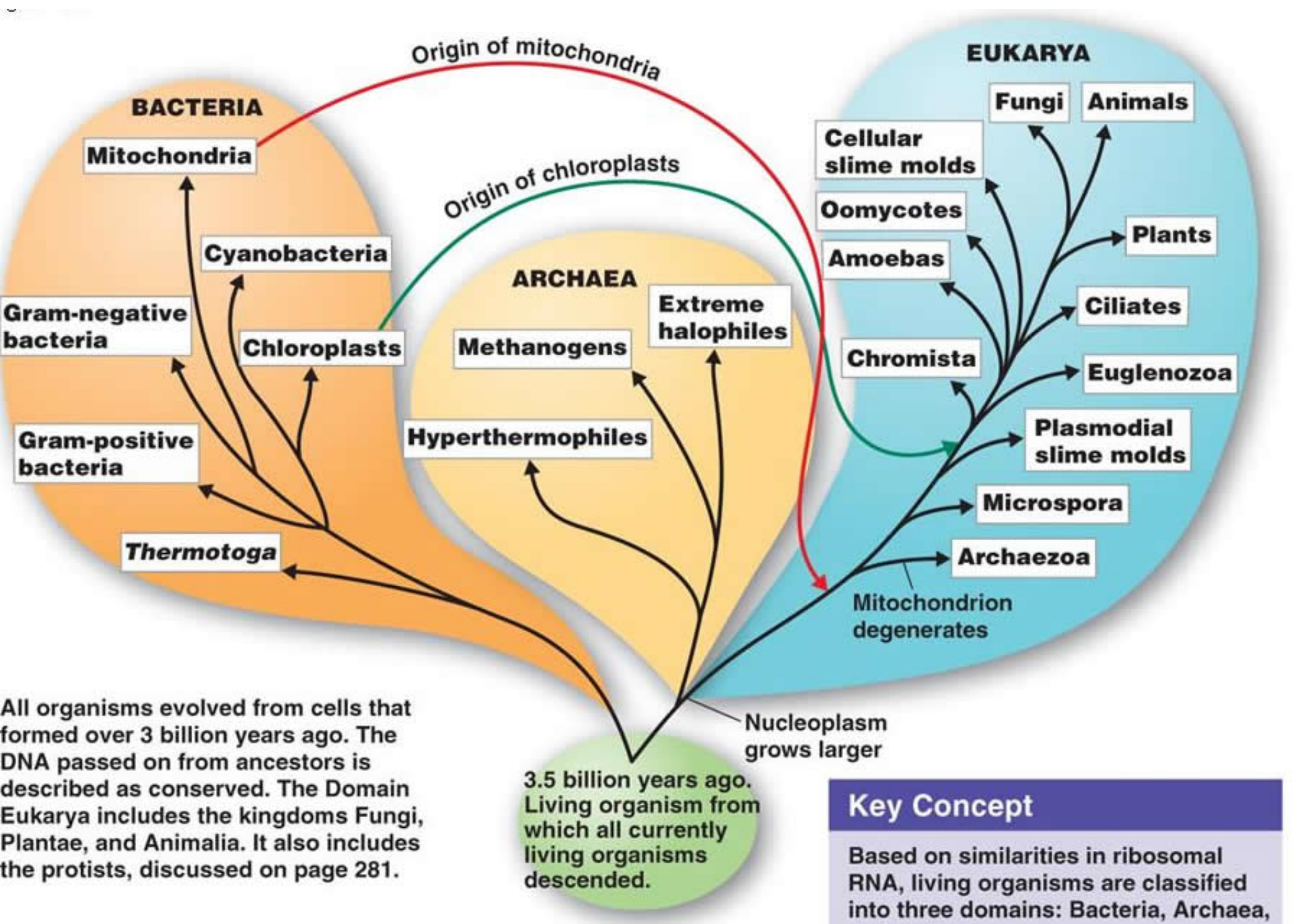
Solsystemet dannes 4.57 Ga

De første bjerge og kontinenter ca. 4.0-3.5 Ga

Dyr, 0.54-0 Ga

Dinosaurer, 0.25-0.06 Ga





All organisms evolved from cells that formed over 3 billion years ago. The DNA passed on from ancestors is described as conserved. The Domain Eukarya includes the kingdoms Fungi, Plantae, and Animalia. It also includes the protists, discussed on page 281.

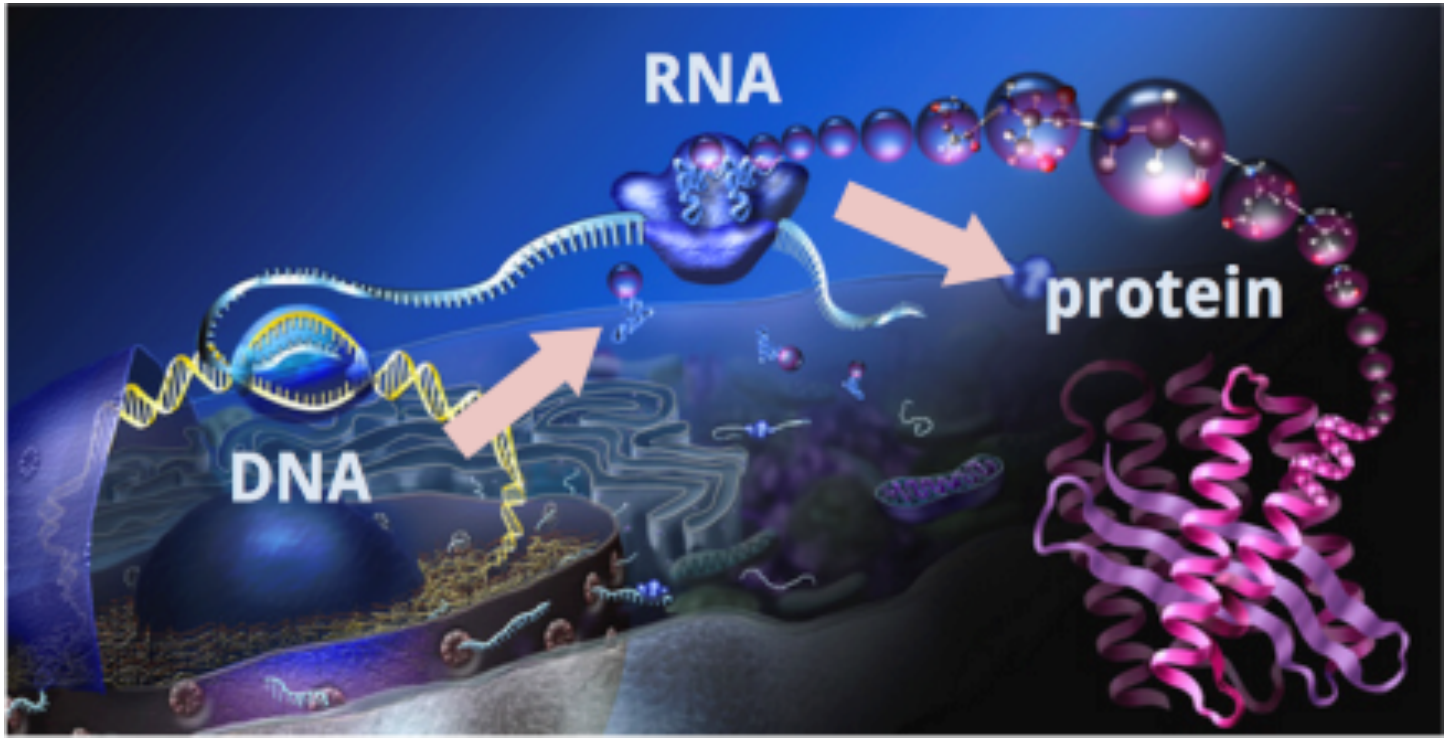
Key Concept

Based on similarities in ribosomal RNA, living organisms are classified into three domains: Bacteria, Archaea, and Eukarya.

(1637 – 1680)

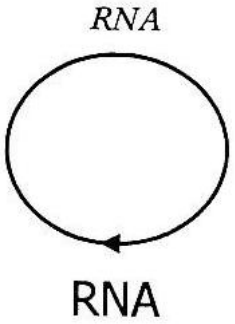
(1638 – 1686)

William Harvey (1578-1657)


RNA
protein
DNA

The RNA World

nucleotides → RNA



amino acids —RNA→ protein

The Transitional Period

RNA —protein→ DNA

The Present World