

# HISTORY OF LIFE ON EARTH

Where does life on Earth come from?

- **Spontaneous generation**

principle that living things could arise from non living things

- **Biogenesis**

principle that states that all living things come from other living things

## EXPERIMENTS ON SPONTANEOUS GENERATION

I. early 1700's

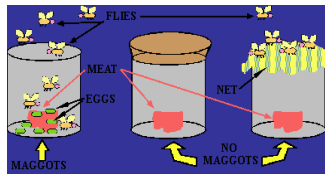
**Francesco Redi** - questioned spontaneous generation  
(said that flies actually came from eggs laid by flies on meat)

Redi's meat experiment

- control: ?
- experimental: ?
- let sit a few days

Results:  
open jar- maggots  
cheesecloth jar- no maggots

Conclusion  
no spontaneous generation



## II. Needham

- believed in spontaneous generation
- attacked Redi's work

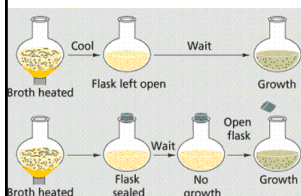
Needham's gravy experiment

- sealed jar with meat gravy and heated it supposedly killed any organisms in jar
- several days later he observed gravy under microscope and found microbes
- concluded that living organisms came from gravy

III. mid 1700's **Lazzaro Spallanzini** (Italian)

- questioned spontaneous generation of maggots/flies coming from rotting meat
- felt Needham did not kill all organisms when heated gravy so retested experiment

Experiment: thoroughly boiled gravy in both jars, one open and one sealed



Results:  
open jar: microorganisms  
sealed jar: no micro.

Conclusion:  
No spontaneous generation

IV. 1864 **Luis Pasteur**

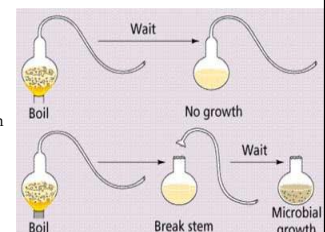
- finally disproved spontaneous generation
- retested gravy experiment

Experiment: boiled nutrient broth in long curve necked flask  
allowed air to enter, but no dust or other airborne particles

Results: after an entire year,  
No microorganisms

Conclusion:  
No spontaneous generation

**BIOGENESIS FINALLY  
BECAME CORNERSTONE  
OF BIOLOGY**



## EARTH'S HISTORY

Earth's age: - about 4.6 billion years old

### Big Bang Theory

- evidence shows 15 billion years ago universe was a dense mass which exploded matter into space
- gravity pulled some matter together to form galaxies and stars
- gravity also pulled matter into orbit around stars
- sun attracted clumps of matter (planets), and planets attracted smaller clumps of matter (moons)
- meteors: thought to be bits of material left over from formation of our solar system.



### • Gas and dust cloud condensed into a sphere

- millions of years afterward volcanic activity and meteorites showers shook the earth
- at about 3.8 billion years earth cooled and was drenched with thundestorms for many thousands of years forming oceans
- water vapor (from meteorites, which contain ice ) in atmosphere cooled to help form oceans (thought this is where life first formed)

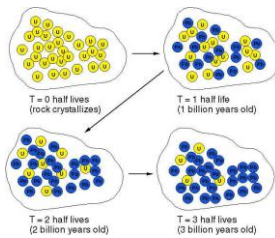
## Determining the Age of the Earth

-radioactive dating: how age of earth determined

-Radioisotope: unstable atom (radioactive)

-decay: charged particles are given off by atoms

- half life: time period in which half the radioactive atoms decay into non radioactive



By knowing the time of the half life and how many have passed, number of years can be calculated by counting number of atoms left in sample.

## FORMATION OF BASIC CHEMICALS OF LIFE

We have a good idea of how old the earth is and how it formed, but what about life on earth?

Simple organic molecules energized by UV light and volcanic heat formed complex molecules that became building blocks of first cells.

## Models of Formation of Life

### 1. Primordial Soup Model

1920's: Oparin (Russian), Haldane (British)

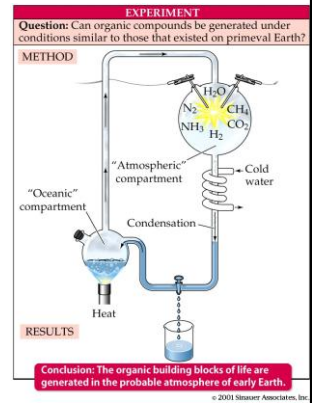
- Atmosphere made of H<sub>2</sub>O vapor, NH<sub>3</sub>, CH<sub>4</sub>, and CO<sub>2</sub> (no free O<sub>2</sub>- atmosphere couldn't sustain life)
- Thunderstorm drenched earth
- Oceans contained large amount of organic molecules (like soup with many vegetables and meats)
- Molecules pushed together by energy of sun and lightening
- Molecules split, and formed new organic molecules (a.a., nucleic acids)

### 1953: Miller, Urey

Tested primordial soup model.

After few days found organic molecules were formed.

Proven incorrect. (no ozone in ancient atmosphere to protect new organic molecules)

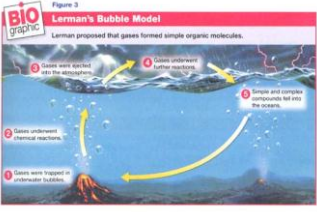


### 2. Bubble Model

1986: Luis Lerman

Process to form life took place within bubbles on ocean's surface.

- CH<sub>4</sub>, NH<sub>3</sub> from undersea volcanoes were trapped in underwater bubbles and protected from UV




**Figure 3 Lerman's Bubble Model**  
Lerman proposed that gases formed simple organic molecules.

- 1 Gases were trapped in underwater bubbles.
- 2 Gases underwent thermal reactions.
- 3 Gases were heated and the atmosphere became more reactive.
- 4 Gases underwent further reactions.
- 5 Simple and complex molecules fell into the ocean.

- bubbles rose and burst releasing molecules into air
- now exposed to UV in presence of O<sub>2</sub> and able to react
- organic molecules then formed

### Organic Molecules become Cell Like Structures

Microspheres- spherical structures composed of many protein molecules organized as a **membrane**



Coacervates- collections of droplets composed of different types of molecules (such as linked amino acids and sugars)

- both can form spontaneously and contain lifelike properties
  - \* growth
  - \* reproduction- budding
  - \* arise without direction from genes

They are not alive because they do NOT have HEREDITY

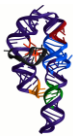
**\*\*\*Microspheres may have led to cells\*\*\***

### FIRST LIFE FORMS/ORIGIN OF HEREDITY

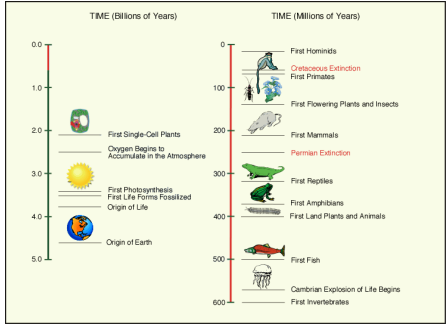
RNA came before DNA – simpler molecule

- Self replicating RNA- new studies indicate that life may have started this way

- it would:
  - a. have heredity: be able to provide hereditary information that cell like structures lack
  - b. be able to respond to natural selection and evolve



### DEVELOPMENT OF COMPLEX ORGANISMS



TIME (Billions of Years) | TIME (Millions of Years)

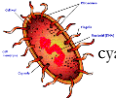
- 0.0: First Homoids
- ~0.5: Cretaceous Extinction, First Primates
- ~1.5: First Flowering Plants and Insects
- ~2.5: First Mammals
- ~260: Permian Extinction
- ~300: First Reptiles
- ~350: First Amphibians
- ~400: First Land Plants and Animals
- 500: First Fish
- 540: Cambrian Explosion of Life Begins
- 600: First Invertebrates

Sea life → Plants & fungi → Arthropods → Vertebrates

### DEVELOPMENT OF COMPLEX ORGANISMS

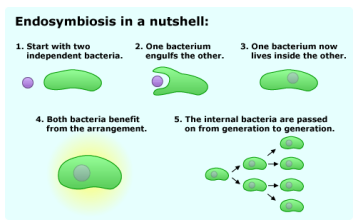
#### I. Prokaryotes

- thrived under harsh environmental conditions
- most likely first organisms on earth
- probably anaerobes (very little oxygen present)
- chemiautotrophs: CO<sub>2</sub> serves as carbon source to make organic molecules
- cyanobacteria: photosynthetic bacteria that released oxygen into the atmosphere (3.5 billion years ago)



### II. Eukaryotes

Endosymbiosis: mutually successful beneficial relationship between two organisms

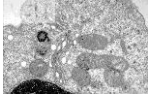


**Endosymbiosis in a nutshell:**


1. Start with two independent bacteria.
2. One bacterium engulfs the other.
3. One bacterium now lives inside the other.
4. Both bacteria benefit from the arrangement.
5. The internal bacteria are passed on from generation to generation.

[animation](#)

mitochondria- evolved from non-photosynthetic bacteria invading bacteria



chloroplasts- evolved from photosynthetic bacteria invading bacteria (closely related to cyanobacteria)



- both have own DNA
- able to replicate on their own (plasmids)

### III. Land life


Formation of ozone in upper atmosphere allowed life on land.

This occurred about 2.5 billion years ago:

- Cyanobacteria added oxygen to atmosphere from photosynthesis.

100 million years ago land became covered with dense forests.

- **Arthropods** were first animals to invade land from sea (hard outer segmented exoskeleton, jointed limbs) ex: lobsters, crabs, insects, spiders, scorpions
- **Vertebrates** came out of sea 370 M years ago
  - fishes (very successful, 1/2 all modern vertebrates)
  - amphibians (smooth skinned, four legs, need H<sub>2</sub>O) ex: frogs, toads, salamanders
  - reptiles (watertight skin, can stay in dry areas) ex: snakes, lizards, turtles, crocs
  - mammals and birds
    - birds evolved from feathered dinosaurs during after Jurassic period



First land life thought to be **plants and fungi** living together. (able to undergo photosynthesis)

**Mutualism:** relationship where both organisms work together and benefit from each other

Plants: evolved from photosynthetic protists (eukaryotes)

- couldn't get minerals from rocks

Fungi: could absorb minerals from rock,

- couldn't make nutrients
- **mycorrhizae:** (fungus/roots) relationship between fungi and plants

