Origins of Life in the Universe
OCN201 Fall 2008

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# Lecture Schedule

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Major Concepts

• Life started early, but not at the beginning, of Earth’s history
• Abiogenesis is the leading hypothesis to explain the beginning of life on Earth
• There are many competing theories as to how this happened
• Some of the details have been worked out, but most have not
• Abiogenesis almost certainly occurred in the ocean

TIMETABLE

Big Bang!

Milky Way (and other galaxies formed)

Formation of Earth

20-15 15-9 4.7 Today

Billions of Years Before Present
Building Bl

- Universe is mostly hydrogen (H) and helium (He); for example – the sun is 70% H, 28% He and 2% all else!

- Most elements of interest to biology (C, N, P, O, etc.) were produced via nuclear fusion at very high temperature reactions in large stars after Big Bang

TIMETABLE

- Big Bang!
- Milky Way (and other galaxies formed)
- Formation of Earth

Billions of Years Before Present

20-13  13-9  4.7  Today
ORIGIN OF LIFE ON EARTH

Divine Creation

Spontaneous Generation

Panspermia

Abiogenesis

Abiogenesis: 3 stages

1. Origin of biological monomers
2. Origin of biological polymers
3. Evolution from molecules to cells
Abiogenesis: The primordial soup

*Miller-Urey experiment / Oparin-Haldane hypothesis*

- Start: H$_2$O, CH$_4$, NH$_3$, H$_2$ + spark
- End: Amino acids (13/22)*, complex sugars

Abiogenesis: The primordial soup

*Miller-Urey experiment / Oparin-Haldane hypothesis*

- Only produced some of the amino acids
- No RNA or DNA produced (but later experiments did)
- Conditions used are not necessarily representative of those of early Earth
Abiogenesis: required components

- CH4 – methane
- NH3 – ammonia
- H2O – water
- H2S – hydrogen sulfide
- CO2 – carbon dioxide
- PO4 – phosphate
- And no O2 (oxygen)
Abiogenesis: 3 stages

1. Origin of biological monomers
2. Origin of biological polymers
3. Evolution from molecules to cells

Abiogenesis: next steps...

1. Nucleotides polymerize into random RNA molecules – some self-replicate (ribozymes)
2. Selective pressures lead to ribosomes
3. Proteins outcompete ribozymes
4. Phospholipids form lipid bilayers (cell membranes)
Abiogenesis: alternative hypotheses

1. Genes First – original form of ‘life’ was naked genes (ex. Clay hypothesis, RNA world)

2. Metabolism First – redox chemical reactions can synthesize organic molecules (ex. Iron/Sulfur world)

3. Bubble Theory – concentration of organic molecules

4. Others...

Life evolved after the earth and oceans formed: life requires water. Regardless of the precise mechanism, life evolved relatively quickly. Photosynthesis, (especially oxygenic photosynthesis) evolved much later. Early life was probably heterotrophic (used organics).
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