Astronomy 330

This class (Lecture 11):

Origins of Life
Yi Sun
Cheryl Cwik

Next Class:

Life Alternatives
Dale Sormaz
David Luedtke

HW 4 is due

Music: *Bring me to Life* – Evanescence

Lunar Eclipse

- Lunar Eclipse on Wednesday night!
- Shadow of Earth on Full Moon.
  - Enter the penumbra at 1840
  - Enter the umbra at 1943
  - Enter totality at 2100
  - Exit totality at 2150
  - Exit umbra 2309
  - Exit penumbra at 0016

http://spacsun.rice.edu/~has/images/RB_Lunar-Eclipse-Phases-Center_10_29.jpg

HW #3

- **Racquel & Allison & Tanya & Andrew & Dale**
  http://www.stopabductions.com

Presentations

- **Yi Sun**: SETI
- **Cheryl Cwik**: Interstellar Travel

Outline

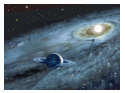
- The beginning of life.
- The Miller-Urey experiment

Drake Equation

Frank Drake

That's 0.67 Life-liking systems/year







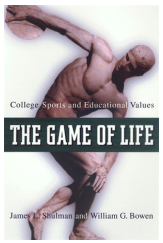

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that commun-icate	Lifetime of advanced civilizations
	19 stars/ yr	0.4 systems/ star	1.25 x 0.07 = 0.0875 planets/ system	life/ planet	intel./ life	comm./ intel.	yrs/ comm.

Life

- The most crucial monomers required for life are:
  - Amino acids (20 flavors) for **proteins**
  - The nucleotides: sugar, phosphates, and nitrogenous bases for **DNA/RNA**.
- How did they occur in a useful configuration so **fast** on the early Earth?
  - Remember the early Earth is not a fun place.
    - Poisonous gas atmosphere, hot, lots of meteorites, and cable TV is still 3.8 billion years away.

Synthesis of Monomers

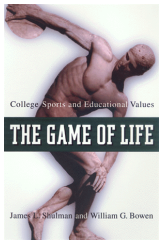


Life arose under the following conditions

- Liquid water
- Some dry land
- Energy sources, including UV light, lightning, geothermal.
- A neutral or slightly reducing atmosphere (This is somewhat new). Remember no OXYGEN, mostly methane (CH_4) and CO_2.

http://origins.jpl.nasa.gov/habitable-planets/images/ra6-early-earth-th.jpg
http://www.pupress.princeton.edu/titles/6903.html

Reducing/Oxidizing?

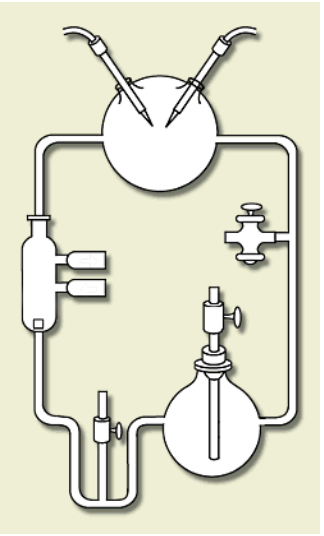


- Reducing atmosphere has elements that *give up* electrons, e.g. hydrogen. A good example is the atmosphere of Jupiter: CH_4, NH_3.
- Oxidizing atmosphere has elements that *take* electrons, e.g. oxygen. A good example is the atmosphere of Mars or modern Earth.
- Neutral is neither.

http://origins.jpl.nasa.gov/habitable-planets/images/ra6-early-earth-th.jpg
http://www.pupress.princeton.edu/titles/6903.html

Miller and Urey Experiment

- In 1953, Miller and Urey (UC) tried to duplicate conditions that they believed existed on the Early Earth– a heavily reducing atmosphere.
- They Mixed CH_4, H_2, and NH_3 gases in a flask for the atmosphere, and connected that to a flask with water for the oceans. A spark was used in the atmosphere flask to simulate lightning.
- They found interesting organic molecules in the "ocean".



http://www.vobs.at/bio/evol/e05-millerurey.htm

Miller and Urey Experiment

- 4 amino acids were made: glycine, alanine, aspartic acid, and glutamic acid. Also some nucleotide bases and acetic acid.
- It has been shown that **ALL** 20 amino acids needed for life can form in this way.
- Does not produce directly all monomers of nucleic acids, but intermediates were produced.

http://physicalsciences.ucsd.edu/news_articles/miller-urey-resurrected051903.htm

Miller and Urey Experiment

http://www.ucsd.tv/miller-urey

Early Monomers

The Miller-Urey experiment legitimized the scientific study of life. The production of amino acids under the presumed conditions of the early Earth was exciting.

Early Monomers

- But the assumptions of the experiment have been questioned.
  - Early notions of methane-rich reducing atmosphere are wrong; Earth's early atmosphere was more likely CO_2, N_2, and H_2O vapor.
  - We still don't know early atmospheric composition well enough to make stronger case
  - We still don't know how this leads to DNA, the basis of all terrestrial life
- Recently, a group in Japan has showed that with enough energy, one can still get significant yields of amino acids in a mildly reducing environment.

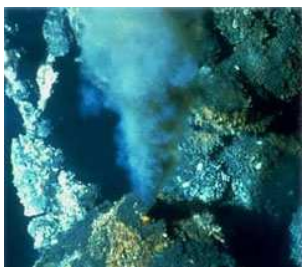
Early Monomers

- We do not have a detailed theory of how all the monomers arose on the early Earth.
- General conclusion is that many of the monomers needed for life can be produced in a strongly reducing atmosphere, but that different environments are needed to get specific monomers.
- Don't forget that after the monomers are formed they MUST come together to form the polymers of life.

Other places

- Maybe if we require (still not sure) a strongly reducing environment, we have to look elsewhere.
  - Area around undersea hot vents, some of which have CH_4, NH_3, and other energy-rich molecules like hydrogen sulfide.
  - Interstellar space.

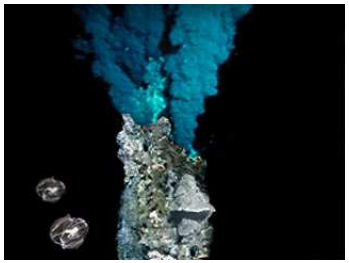
http://www.noaanews.noaa.gov/magazine/stories/mag114.htm



http://www.chl.chalmers.se/~numa/photo/keyhole-small.jpg

The Underwater Vents

- Miles below the ocean surface, life lives on the edge! Places were sunlight never reaches.
- From regions of volcanic spreading of the floor, hydrothermal vents or black smokers, underwater geysers, spew mineral-rich superheated water.
- No plant life, but life thrives. So what does life live on?



The Underwater Vents

- Chemical reactions or chemosynthesis to produce food instead of the Sun.
- Some life is bacteria, some eat the bacteria, some eat those that eat the bacteria, and some have bacteria inside them in a symbiotic relationship.
- http://www.xenon.com/ventsmovie.htm