

01 May 03

- Hand in HW#5. Answers will be posted on web right after class.

- Handout Final Exam Review

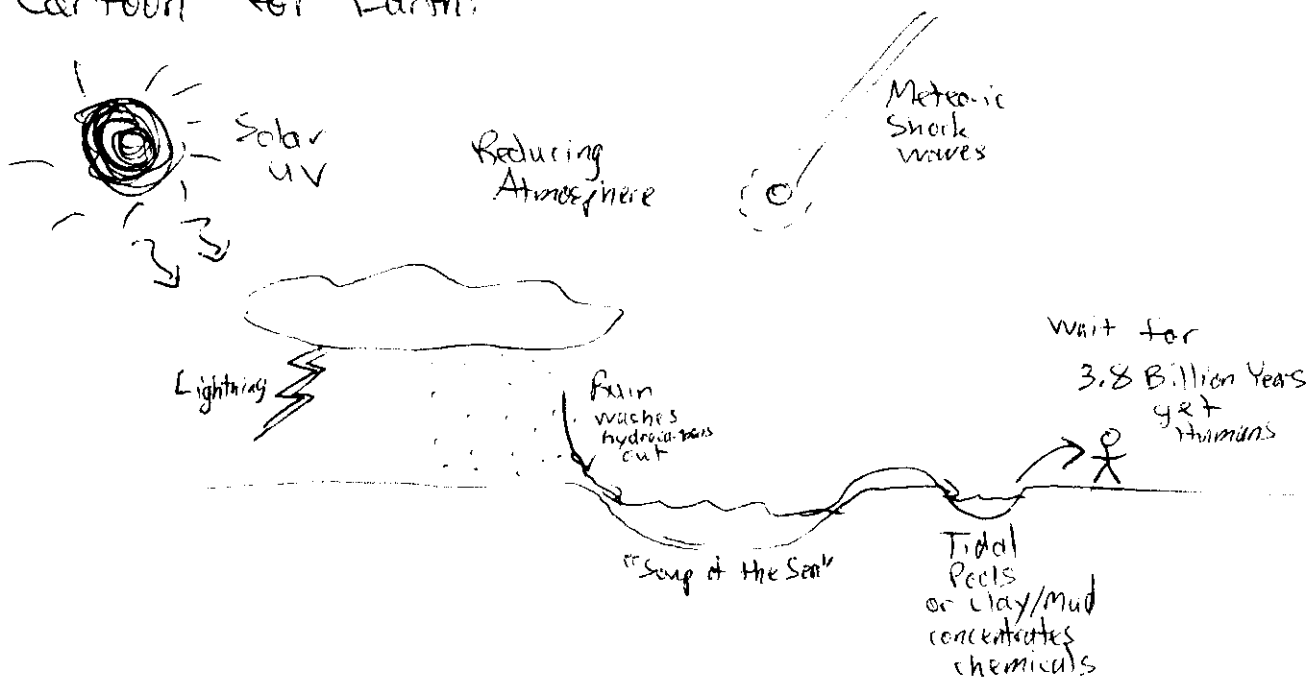
- Show images & videos from last time

Life in the Solar System

Recall, from Miller-Urey Expts & reasoning based on our experiences & theories about Earth, we came up with requirements for life to originate:

- ① Reducing atmosphere
- ② Energy source
- ③ Rain to wash chemicals out of air
- ④ Some method to concentrate chemicals
- ⑤ A surface to react on.

Cartoon for Earth:



## Earth Story continued:

- 3.8 Bya - Chemical life originally probably had lots of "food" (ie other chemicals) around it to eat/use.
- ~~life that~~ Chemicals that "worked together" and formed a stable environment (cells) for chemical reactions to occur had better odds of surviving, ~~life~~
- 2.8 Bya - As "food" became more scarce (eaten by other life) cells which could photosynthesize had better chance of surviving and so algae thrived
- Algae "excrete"  $O_2$ , building up an oxygen ~~atom~~ component to the atmosphere.
- 1.5 Bya { - When enough  $O_2$  has been built up, life which "respires" (uses  $O_2$ ) can survive rather than just photosynthesizing life.
- At all points, life which best passes on information about itself survives.
- 0.5 Bya - Cells that cooperate with each other to provide an even more stable environment for themselves (or the ability to move someplace with better conditions) survive better
- ⇒ multi-celled organisms, plants, animals, etc...
- The Great Diversification of Life.

Going back to our list of requirements for Life to start:

Where in our Solar System is Life possible/probable?

Mercury? No atmosphere, too much energy (breaks apart chemicals)

Venus? Now: No water & pretty hot  
Past: Possible! If there was water ever, and if it lasted long enough.

Earth? Life everywhere

Mars? Now: Difficult - little or no liquid  $H_2O$ , thin atmosphere allows too much UV which breaks apart chemicals on surface. Maybe subsurface water is protected?

Past: Possible! If there was a warm, wet climate that lasted long enough.

Jupiter/Saturn/Uranus/Neptune?

Energy available, reducing atmosphere,  $H_2O$ , but no surface. It's possible to make chemicals, but without concentration and a surface, reactions are slow.

Europa?

Not much atmosphere, but liquid  $H_2O$  under ice layer & heating from tidal forces. Possible! Find life on Earth surviving at bottom of ocean by volcanic vents.

Titan?

Reducing Atmosphere, UV light, ~~no~~ liquid  $CH_4$  and  $C_2H_6$ , but no liquid  $H_2O$  (too cold) and cold temps. Possible, but because of coldness reactions occur more slowly. Has there been enough time for life to get started?

Elsewhere?

★ A hitch in our nice story:

The chemicals of life (amino acids) have been observed in meteorites, comets, and in interstellar clouds!

— Maybe our "story" is too restrictive.

... If the building blocks of life can form in deep space, maybe it's not so hard to start life out.

— But how hard is it to go from amino acids to life? Earth took  $1\frac{1}{2}$  Billion years to produce algae, and 4.3 billion years to produce primates.