Hadean eon

Whirlpool galaxy M51

Hadean eon.

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Geological time scale and life forms

(Table 1.1 pg xii)

- **Major Eons**
  - **Phanerozoic** (543 Ma to present time)
    - Multicellular organisms
  - **Proterozoic** (2,500 – 543 Ma)
    - Oxygen atmosphere, single celled aerobic organisms
  - **Archaean** (3,800 – 2,500 Ma)
    - Anaerobic bacterial life, oxygen starts to accumulate
  - **Hadean** (4,600 – 3,800 Ma)
    - Formation of the solar system and planet, ends with origin of life

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Geological time scale and building height

(1floor – 60Ma, 72 floors, 12 feet/floor)

- **Major Eons (Ma)**
  - **Phanerozoic**
    - (543 Ma to present time, top 9 floors)
  - **Proterozoic**
    - (2,500 – 543 Ma, 33rd -63rd)
  - **Archaean**
    - (3,800 – 2,500 Ma, 12th – 33rd)
  - **Hadean**
    - (4,600 – 3,800 Ma, 0-12th)

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Very hostile environment, massive bombardments by meteors. The earth is never able to become stable, until a major event in the solar system allowes for the earth to cool and form a crust. This crust allows the formation of an atmosphere. This then causes water to settle on the earth where the first life forms are formed (bacteria). A hallmark of life is to be able to generate energy from the environment that you are in. Bacteria was anaerobic and creating their own ATP from the atmosphere. In the oceans bacteria was diversifying in their ways of harnessing energy to make ATP. Some forms of bacteria figured out how to take that proton mechanisms in order to split the proton from water and makeA ATP. In this process, oxygen is a metabolic waste. This bacterium was getting more energy per transaction than any other bacteria than any other organism since taking the proton from water is the most beneficial. The oxygen that got realized was absorbed into the minerals inn the bottoms of the ocean causing all of the rocks to "rust". Once everything rusted, the oxygen started to move into the air since an equilibrium was reached in the ocean.
This oxygen then built up into tremendously large quantities until a reaction in the upper atmosphere happened creating ozone.
2 billion years pass with only single celled eukaryotes. One of these early cells witch were feeding on bacteria engulfed the bacteria without digesting it. This bacteria then became the mitochondria by continuing to produce ATP. This is still all happening in the ocean
Then cells finally joined each other and finally developed a communication package between each

Geological time scale and life forms

(Table 1.1 pg xii)

- **Major Era**
  - **Phanerozoic** (550 Ma to present time)
    - Cenozoic (65Ma to present time)
      - Dinosaurs disappear, mammals and birds
    - Mesozoic (251-65 Ma)
      - Flowering plants, dinosaurs, even more insects
    - Paleozoic (543-251 Ma)
      - Marine invertebrates, algae, "Cambrian explosion", first land plants and insects.
  - Proterozoic (2,500 – 543 Ma)
  - Archaean (3,800 – 2,500 Ma)
  - Hadean (4,600 – 3,800 Ma)

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Half of the Phanerozoic is the Paleozoic era. After about another 200 million years amphibians came up out of the water and became dinosaurs which dominated the world. Then the mass extinction killed the reptilian domination. The reptiles got replaced by mammies and birds and flowering plants became dominant for plants.

Geological time scale and building height

(1floor – 60Ma, 72 floors, 12 feet/floor)

- **Major Era**
  - **Phanerozoic**
    - Cenozoic (65 Ma to present time, 72nd floor)
    - Mesozoic (251-65 Ma, 65th to 71st)
    - Paleozoic (543-251 Ma, 63th to 65th)
  - Proterozoic (2,500 – 543 Ma)
  - Archaean (3,800 – 2,500 Ma)
  - Hadean (4,500 – 3,800 Ma)

Your life span = 0.0002 inches
Human hair = 0.001 inches

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Galaxies

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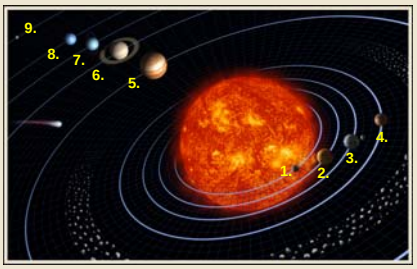
clumbs of stellar matter come together enough that they begin to draw in other matter. Eventually you end up with galaxies. Galaxies are constantly forming and being ripped and pulled apart.

Nat Geo Sun video

Our Solar system

1. Mercury
2. Venus
3. Earth
4. Mars
5. Jupiter
6. Saturn
7. Uranus
8. Neptune
9. ~~Pluto~~



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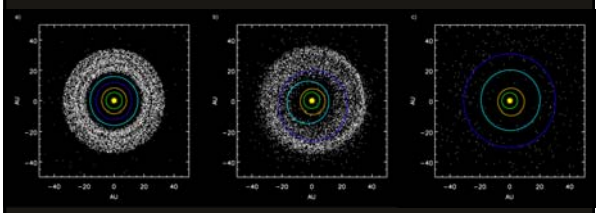
Late heavy Bombardment
The Nice Model



Jupiter Jupiter
Saturn Jupiter

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Nice model explains the period of time when all of the planets where hit with a high number of astroid hits. This all happened in a very short window. They realized that origionally, the solar system had a very dense astroid belt around the planets inside. As the planets continued to grow, jupiter and saturn's orbits change. There was one anomoly that occured where saturna nd jupiter were in a perfect 2:1 ratio. For every time saturn orbited, jupiter went twice. When they werer close to eachtoerh they exerted a super gravitational pull which caused a major disturbence in the positioning of the planetsd. Neptune was very close to them and eventually kicked neptume out of its orbit and sent it out beyond uranus. The other thing that happened was that the massive astroid belt surrounding the atmosphere was shaken up and shot out of our solar system into our galaxy. This

Habitable zone

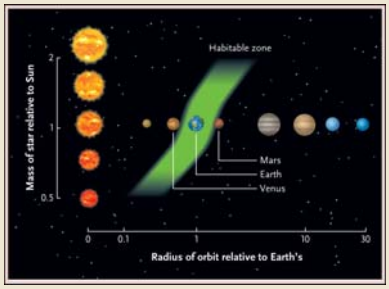

Figure 3.8

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Hadean eon

- Building phase
- Stabilizing phase

Orion nubula (NASA)

Earth 4,000 Ma

Figure 3.7

All of the water on the planet was being sterilized since it was steam and then became water again, covering the planet in the stabilizing phase.

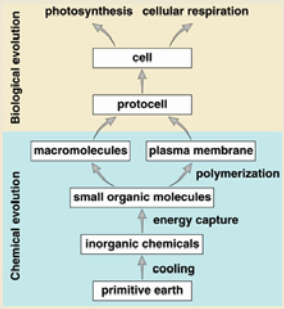
Origins of life on earth

- Special creation
- Extraterrestrial origins (Panspermia)
- Chemical evolution

© NASA

Special Creation: October 24th 4004 BCE.
Extraterestrial: Life evolved on other planets and was carried on the astraoids that bombarded the planet.

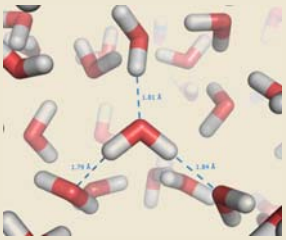
Origins of life on earth



Chemicle evolution depends on water since it has very unusual properties. If you take another compound such as methane, and treated it like water, water will behave very differently

Wacky water

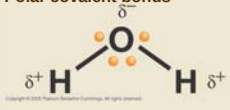
- Cohesion, adhesion and surface tension
- Solvent properties
- Ice formation
- Temperature



Wacky water
Polar bonds and hydrogen bonding

Nonpolar covalent bonds

Polar covalent bonds



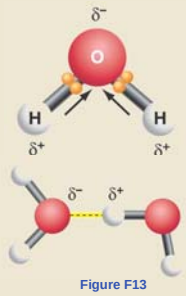


Figure F13

Wacky water
Surface tension

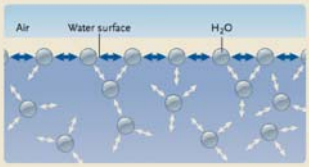


Figure F-16

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There is a skin on the top of water, that if an organism is small enough it cannot get through the surface tension.

Wacky water
Solvent properties

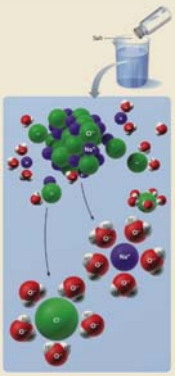

Figure F-17

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Water tends to pull apart other molecules. It can disassociate charged molecules and surround them, creating independant copies of that protein or enzyme. They can them function independantly without interferance with other objects

Wacky water
Ice and water formation

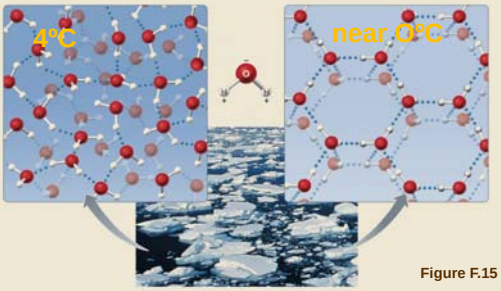

Figure F.15

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When you heat up water, the molecules get further and further apart until they vaporize and get water vapour. The same thing happens when you cool it and the molecules basicalkly stop and a solid is formed. As you cool water down at 4C, the molecules all form a crystal latice, like a sponge structure. the water stabilizes in this strong latice and it will never get any denser than that. solid water is less dense than liquid water just before it solidifies, causing water to float.

Wacky water

Temperature

Specific heats of some liquids (joules)	
Liquids with high levels of hydrogen bonding	
Ammonia (NH_3)	4.70
Water (H_2O)	4.18
Liquids with moderate levels of hydrogen bonding	
Ethanol (CH_3CH_2OH)	2.44
Ethylene glycol ($HOCH_2CH_2OH$)	2.22
Liquids with low levels of hydrogen bonding	
Benzene (C_6H_6)	1.80
Zylene (C_8H_{10})	1.72
Sulfuric acid (H_2SO_4)	1.40

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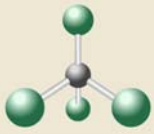
Water is resistant to changes in temperature.The oceans are all usually around 6C. The life in the oceans exist at a fairly stable environment because water does not like change.

Organic evolution

"Carbon is central to life...carbon atoms link in chains, bind with other atoms to make the array of organic chemicals that constitute life itself, from DNA to toenails" – Richard Fortey – Life



Carbon molecule

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When dead suns disintegrate, they release carbon. looking at the molecule of carbon you see that is its a perfect tetrahedral. thiis perfect for stiching carbons together. It is THE fundemental element. Silica could have probably done the exact saem thing.

Miller-Urey Apparatus

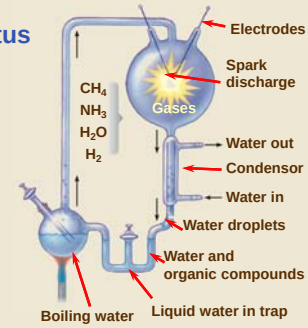

Figure 3.9

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Interested in how life could evolve. they then tried to make a miniture version of the earth with its conditions in a closed system. They then heated up water so it was constantly vapourizing, provided electrical charge like lightnigg. they allowed it then to cool and "rain" back down into the "ocean". They ended up finding about after a week that the carbons would start to come together. After more time they began to find amino acids, nucleotiide rings, acetyl compounds. When you repeat this experiment you can actually get every sinmgle amino acid and every single nucleotide base. For a

Chemical evolution

Origins of organics (monomer)

- Prebiotic soups
- Hydrothermal vents
- Interstellar organics

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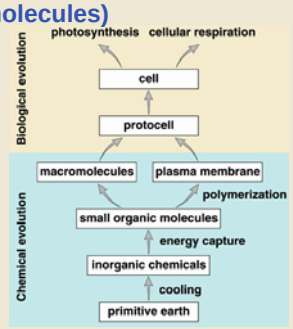
Where the earth crust is being pulled apart you find another precure cooker of chemicle reactions. the weight of the water above compressed the water at the bottom, it then takes more heat for the water to vapourize. It needs to be at about 110C for these reactions to actually happen. We fins that all of those same building blocks are stilll being formed. Theres also bacteria that can survive that heat and pressure and feeing off of these building blocks that were being formed. 2 sources for organic molecules. The water in the interstellar bodies are contaminated with 2-3 carbon substances.

Chemical evolution

Biopolymers (macromolecules)

- Proteins
- Nucleic acids
- Carbohydrate
- Lipids



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The question is how do we get to the macro molecules.

Central Dogma of Biology

1. Replication
2. Transcription
3. Translation

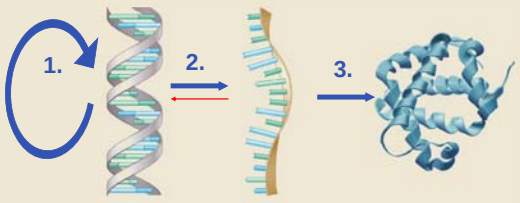

Figure 3.14

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That DNA is self replicating, contains the elements to make proteins, proteins are the functionality of life. This is a situation where the protein does the work. the code for the protein is in the dna and the rna is the transporter of this message.
AIDS is an RNA virus that turns itself into DNA to copie itself and infect the cells.

Biotic chemistry (Polymers)

- Panspermia
- The RNA world
  - Ribozymes
- Proteins first
- Clays

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The first self repilcating polymer was the RNA
A ribosome is a pure RNA molecule.

Evolution of information flow from an RNA world

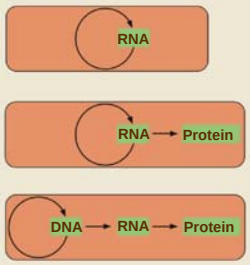

Figure 3.16

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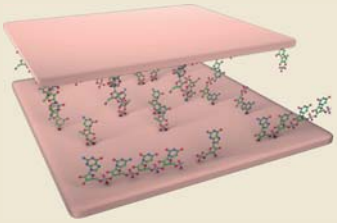
At some point the RNA molecule stiched together proteins which became the functional molecule causing RNA to become simply a messanger molecule. if you take conditions and allow for spontaious essembly f polymers youll get a bunch of amino acids and everything will fall out of solution. because it cant fold on itself to get a nicely bonded structure in wtaer. This means they could not get chain length.

Biotic chemistry (Polymers)

- Panspermia
- The RNA world
  - Ribozymes
- Proteins first
- Clays



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Clays are minerals that are charged are basically act like charged grids.

Bubble hypothesis for cells

- **Microsphere**
- **Micelles**
  (Liposomes)
- **Protobionts**
  (Protocells)

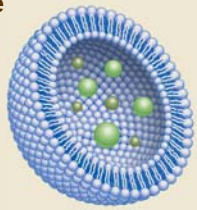

Figure 3.13

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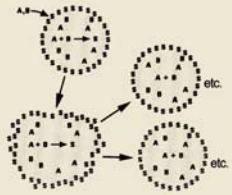
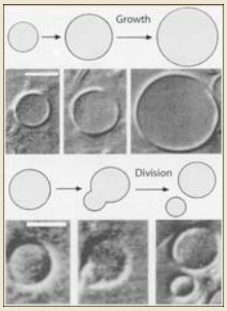
Micelle replication





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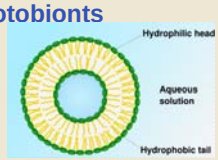
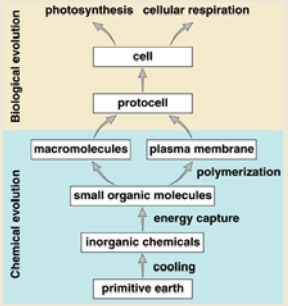
A and B are water soluable, but when they come together they form s, which is insoluable.

Biological evolution:
Protobionts





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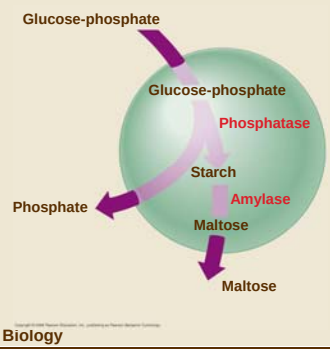
We can replicate the simpliscity of a plasma membrane in an aquaus environment

Biological evolution:
Protobionts



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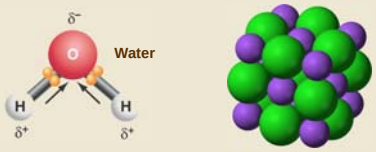
starch is sucha large molecule that it is unable to get out of the membrane. The glucose molecule is small enough to get through the membrane and provide what the cell needs.

What is life and emergence?

- **Organicists (1930) – vital force replaced by genetic program and the importance of emergence.**
- **Emergence - More than the sum of the parts**



Water

Sodium chloride

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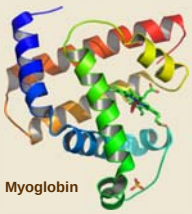
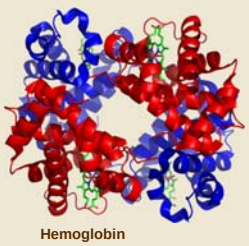
What is life and emergence?

- **Emergence - More than the sum of the parts**



Myoglobin



Hemoglobin

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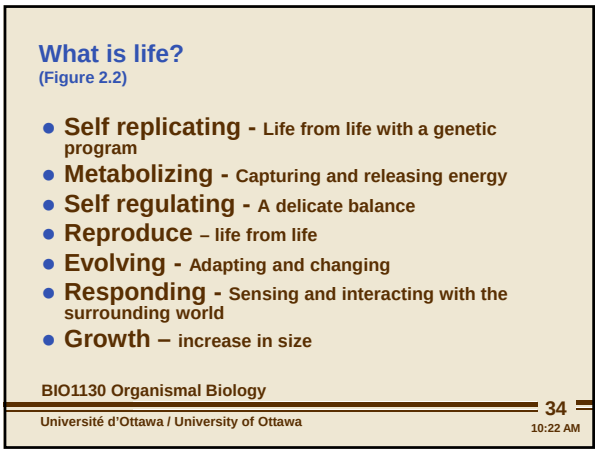

Organized- with the cell as the functional unit.
Self regulating- They have some way to monitor what they need and try to get it