

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

(1 floor – 60 Ma, 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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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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Geological time scale and building height
(1 floor – 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



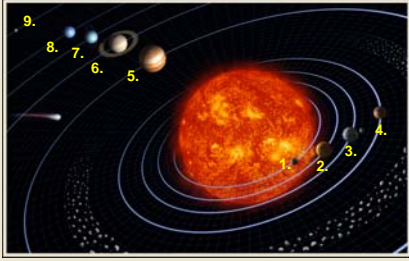
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Our Solar system Nat Geo Sun video

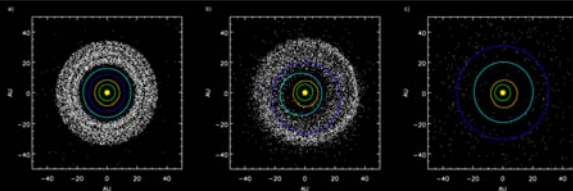
1. Mercury
2. Venus
3. Earth
4. Mars
5. Jupiter
6. Saturn
7. Uranus
8. Neptune
- ~~9. Pluto~~



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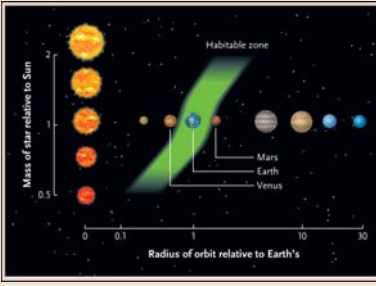
Late heavy Bombardment
The Nice Model



○ Jupiter ○ Jupiter
○ Saturn ○ Jupiter

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Habitable zone



Mass of star relative to Sun

Habitable zone

Mars
Earth
Venus

Radius of orbit relative to Earth's

Figure 3.8

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- Building phase
- Stabilizing phase



Orion nebula (NASA)

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Earth 4,000 Ma




Figure 3.7


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Origins of life on earth

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

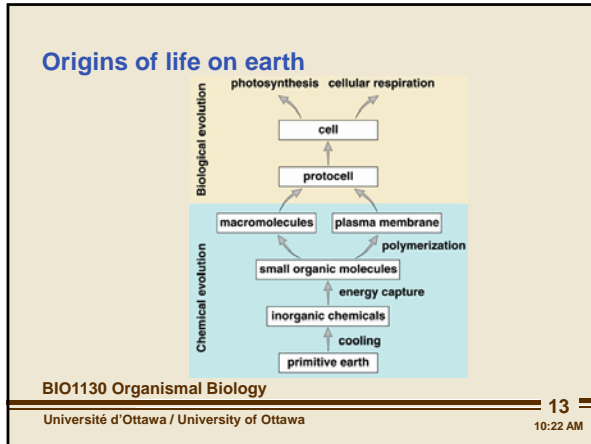


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Wacky water

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

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Wacky water

Polar bonds and hydrogen bonding

Nonpolar covalent bonds

$$\text{H} - \text{H}$$

Polar covalent bonds

The diagram shows a water molecule with a central oxygen atom (red) and two hydrogen atoms (white). The oxygen atom has a partial negative charge (δ^-), and the hydrogen atoms have partial positive charges (δ^+). A dashed line represents a hydrogen bond between the δ^- oxygen of one water molecule and the δ^+ hydrogen of another water molecule.

Figure F13

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Wacky water
Surface tension




Figure F-16

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Wacky water
Solvent properties

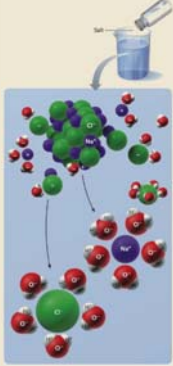


Figure F-17

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Wacky water
Ice and water formation

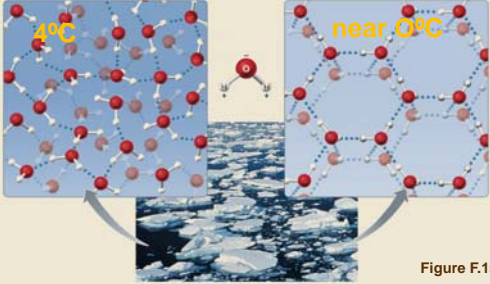


Figure F.15

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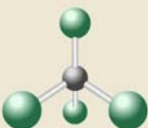
Wacky water
Temperature

Specific heats of some liquids (joules)	
Liquids with high levels of hydrogen bonding	
Ammonia (NH ₃)	4.70
Water (H ₂ O)	4.18
Liquids with moderate levels of hydrogen bonding	
Ethanol (CH ₃ CH ₂ OH)	2.44
Ethylene glycol (HOCH ₂ CH ₂ OH)	2.22
Liquids with low levels of hydrogen bonding	
Benzene (C ₆ H ₆)	1.80
Zylene (C ₈ H ₁₀)	1.72
Sulfuric acid (H ₂ SO ₄)	1.40


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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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Miller-Urey Apparatus


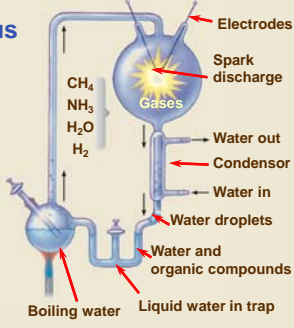



Figure 3.9

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Chemical evolution
Origins of organics (monomer)

- Prebiotic soups
- Hydrothermal vents
- Interstellar organics

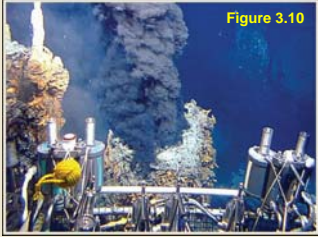


Figure 3.10

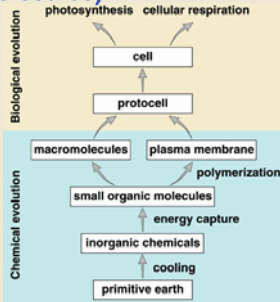
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Chemical evolution
Biopolymers (macromolecules)

- Proteins
- Nucleic acids
- Carbohydrate
- Lipids



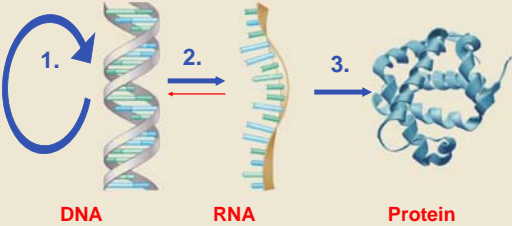
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Central Dogma of Biology

1. Replication
2. Transcription
3. Translation



DNA RNA Protein

Figure 3.14

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Biotic chemistry (Polymers)

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



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Evolution of information flow from an RNA world

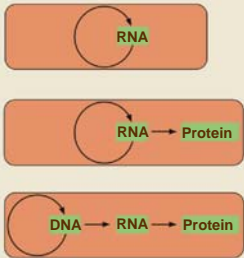


Figure 3.16

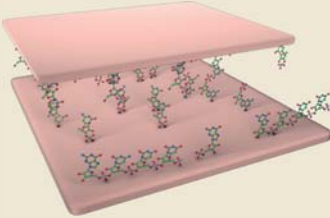
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Biotic chemistry (Polymers)

- Panspermia
- The RNA world
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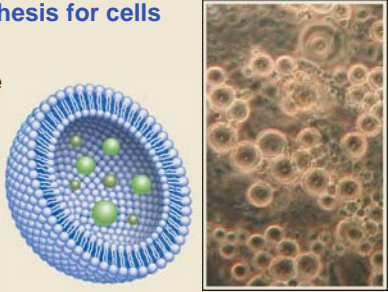
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Bubble hypothesis for cells

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



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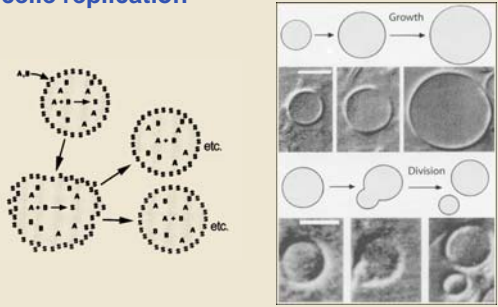
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Figure 3.13

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Micelle replication



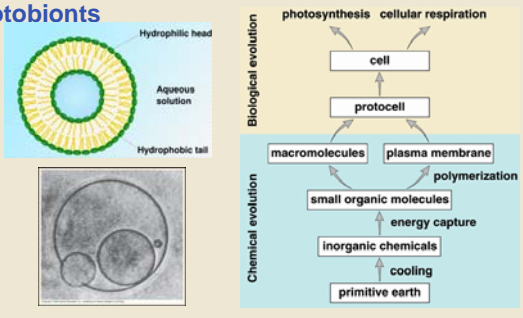
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Biological evolution: Protobionts



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Biological evolution: Protobionts

The diagram shows a green spherical protobiont. A purple arrow labeled 'Glucose-phosphate' enters from the top. Inside the sphere, a pink arrow labeled 'Phosphatase' points from 'Glucose-phosphate' to 'Starch'. Another pink arrow labeled 'Amylase' points from 'Starch' to 'Maltose'. A purple arrow labeled 'Maltose' exits from the bottom. A purple arrow labeled 'Phosphate' exits from the left side.

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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**

The diagram shows two molecular models. On the left is a water molecule (H₂O) with a red oxygen atom (labeled δ⁻) and two white hydrogen atoms (labeled δ⁺). On the right is a sodium chloride molecule (NaCl) represented as a cluster of green and purple spheres.

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What is life and emergence?

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

The diagram shows two protein structures. On the left is Myoglobin, a single chain of blue and red ribbon. On the right is Hemoglobin, a complex of four chains (two blue, two red) in a ribbon representation.

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What is life?

(Figure 2.2)

organized-with the cell as the fundamental unit.

- **Self replicating** - Life from life with a genetic program
- **Metabolizing** - Capturing and releasing energy
- **Self regulating** - A delicate balance
- **Reproduce** - life from life
- **Evolving** - Adapting and changing
- **Responding** - Sensing and interacting with the surrounding world
- **Growth** - increase in size

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