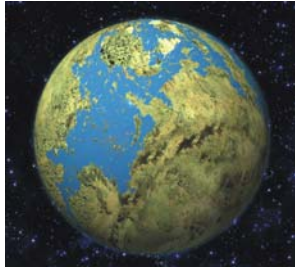
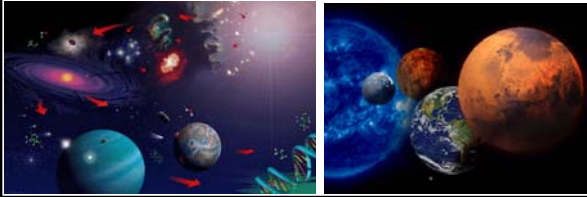


Class 29: Astrobiology

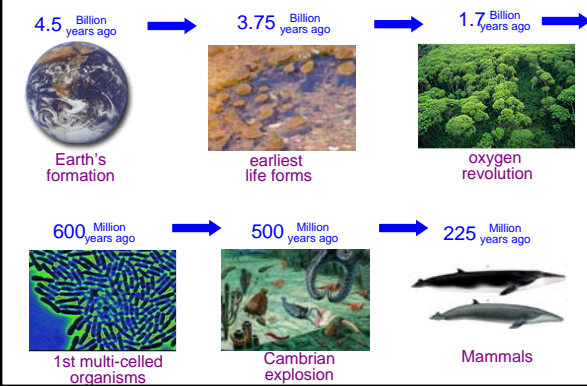


Astrobiology

- Def.: study of life in the universe
- Applications: water on Mars
global ocean on Europa
ESPs
experiments in microgravity



Life's Sequence on Earth



Life As We Know It

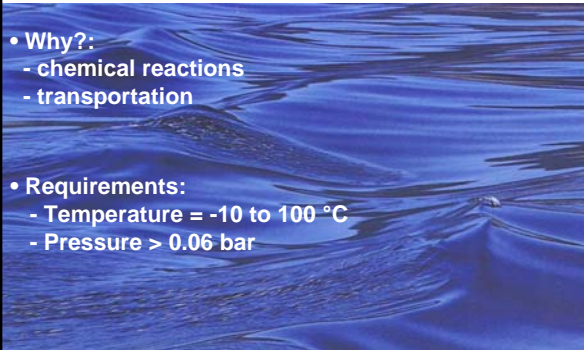
- **Conditions for life:**
 - liquid water
 - + carbon (organic) chemistry
 - + energy source
 - + environmental stability



Conditions for Life (I)

Liquid water

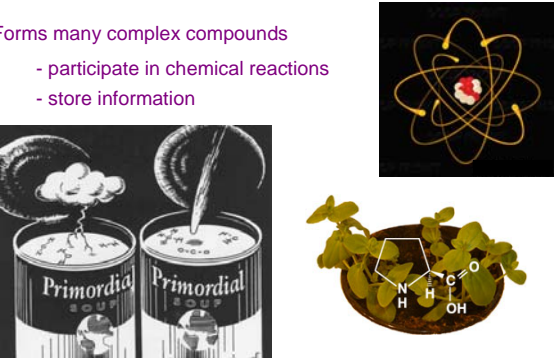
- **Why?:**
 - chemical reactions
 - transportation
- **Requirements:**
 - Temperature = -10 to 100 °C
 - Pressure > 0.06 bar



Conditions for Life (II)

Carbon

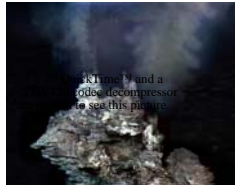
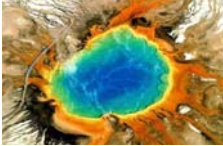
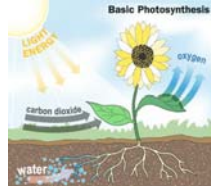
- **Forms many complex compounds**
 - participate in chemical reactions
 - store information



Conditions for Life (III)

Energy

- **Sunlight** (photosynthesis)
 - extracts chemical energy from sunlight
- **Hydrothermal energy**
 - chemical energy from minerals dissolved in heated water



Conditions for Life (IV)

Stable Environment

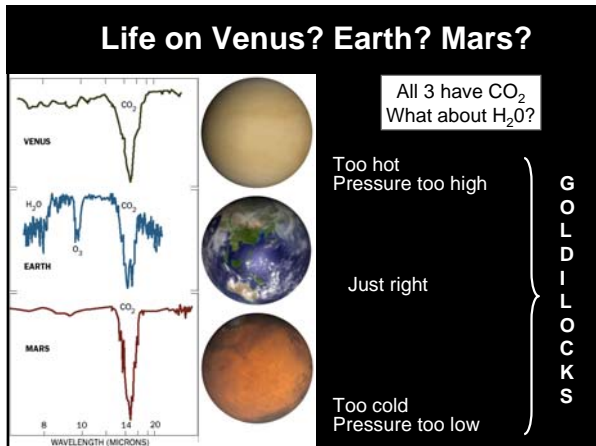
- formation & persistence of life
- found on planet with:
 - ~ circular orbit
 - stable parent star
 - no more heavy bombardment

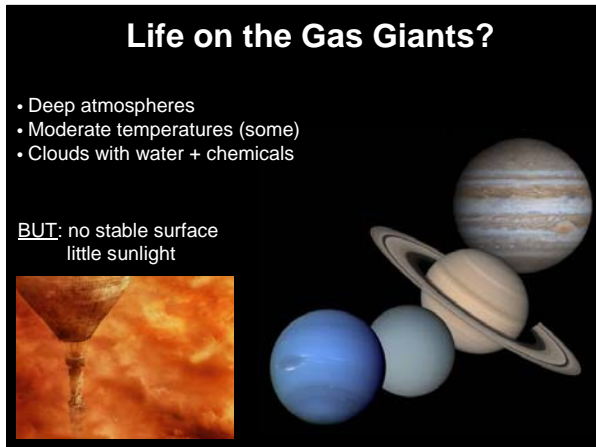


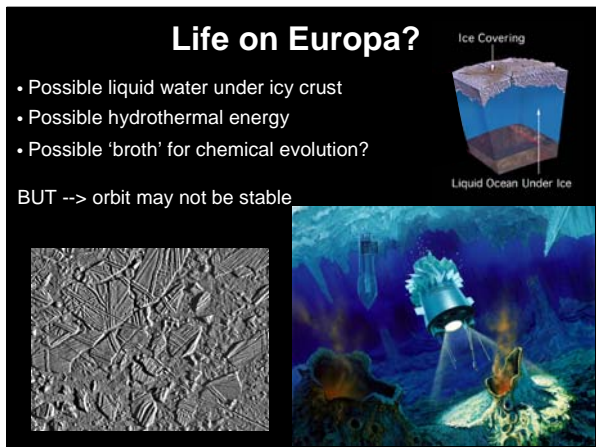
Life on Mercury? Moon?

- both airless
- no liquid water on surface



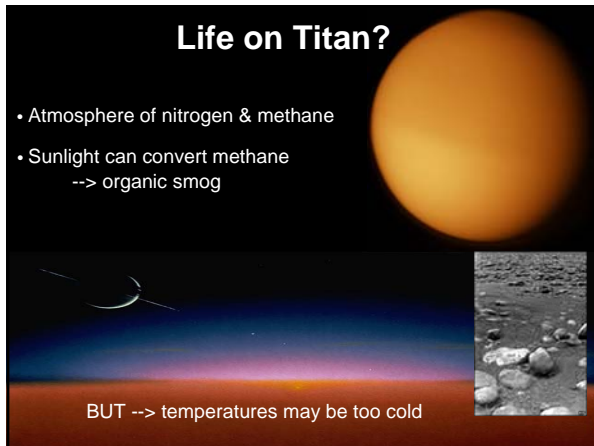






Life on Titan?

- Atmosphere of nitrogen & methane
- Sunlight can convert methane
--> organic smog

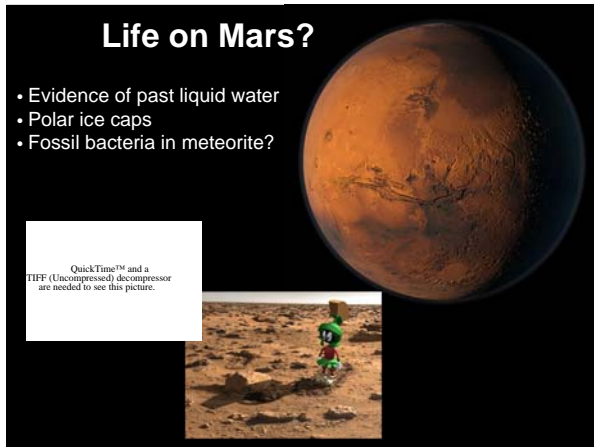


BUT --> temperatures may be too cold

Life on Mars?

- Evidence of past liquid water
- Polar ice caps
- Fossil bacteria in meteorite?

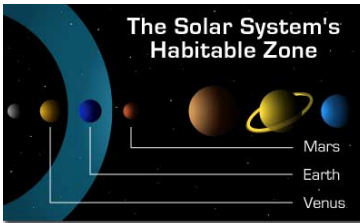
QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.



The Habitable Zone

Def.: region within a planetary system where liquid water could exist

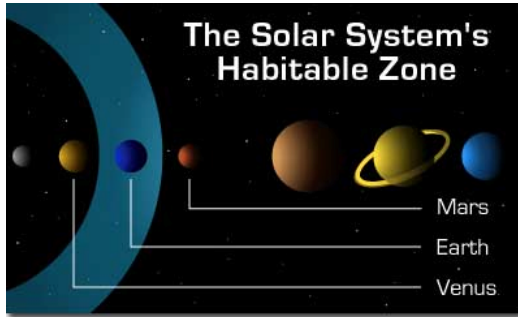
The Solar System's Habitable Zone



Mars
Earth
Venus

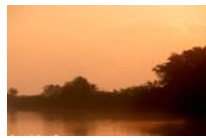
- Distance from star: 0.8 AU - 1.8 AU
- Size: 0.3 - 3 x M_{Earth}

Tour of the Habitable Zone



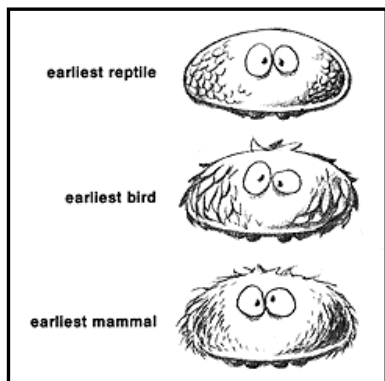
Searching for Life: Biomarkers

- **Def.:** global signature of life
- **Example:** gas emissions (chemical disequilibrium)
 - atmospheric oxygen
 - methane gas



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H-ITT Question



SETI Telescopes

- Operation: 2 in north + 2 in south hemispheres



Big Ear



Haystack



scope lsberg



Arecibo



Square Kilometer Array
