

Topics

- ◆ today, next time Mars, Chapter 9
- ◆ Course grades posted on web site
- ◆ Final exams:
 - Sec 1 (Dec 11), Sec 2 (Dec 14); both 8AM
 - Review Monday Dec 10, 5-6PM, this room
 - 100 questions, worth 200 points
 - 50% review, 50% last quarter of course

Life's beginnings on Earth

- ◆ Organic molecules => amino acids => proteins => living cells
- ◆ microscopic life
 - microfossils found in ancient rocks
 - life started 3.7 to 3.9 billion years ago,
 - as soon as stable crust had formed
 - symmetry of amino acids suggest may have been a single origin
- ◆ large animal life, fossils, begin with
“Cambrian explosion” 0.6 billion years ago

Origins of life

- ◆ organic molecules, amino acids, were in solar nebula
 - Ices in cold traps will reveal constituents
- ◆ Earth
 - life began as soon as it possibly could
 - may have been destroyed and reborn several times
- ◆ Mars
 - conditions may have been more favorable, since farther from brighter protosun
 - Did life start in Mars' Middle Period?

Is life inevitable or a miracle??

- ◆ Earth: life began as soon as possible
 - when epoch of heavy bombardment ended
 - sample of 1 does not tell us whether life is rare or common
- ◆ if 2 independent samples of life are found, then life probably easy to start
- ◆ if Mars had life, then the universe is teeming with life

Conditions in Mars' Middle Period

- ◆ dense CO₂ atmosphere with greenhouse effect
 - atmospheric pressure about 2x Earth's
- ◆ Earthlike surface temperatures
 - CO₂ is excellent greenhouse effect gas
 - early sun brighter than now
- ◆ rainfall, gently flowing rivers, lakes, oceans
- ◆ similar to Earth at the same time

Microscopic life on Mars (???)

- ◆ several dozen Mars meteorites now known
 - solidification ages 1 to 3 billion years
 - minerals similar to those detected in Martian soil by Viking landers
 - trapped gas bubbles contain Martian air
- ◆ Circumstantial evidence for life
 - minerals suggest rock wet for long time
 - chemical residue of biological activity
 - possible microscopic fossils seen
- ◆ But other interpretations possible

The Fermi Paradox

- ◆ **few 100 billion solar systems in Galaxy**
 - Many 100 millions of Earth-like planets
- ◆ **Life an inevitable part consequence if liquid water exists?**
- ◆ **Galaxy 10 billion years old**
- ◆ **Life on other planets would be billion years ahead or behind us**
- ◆ **if our SS has been visited it was probably 100's millions to billions years ago**
 - Search on ancient surfaces reveals nothing

Search for Extraterrestrial Artifacts

- ◆ **few 100 billion solar systems in galaxy**
- ◆ **galaxy 10 billion years old**
- ◆ **if our SS has been visited it was probably 100's millions to billions years ago**
- ◆ **careful search of ancient surfaces should reveal evidence of prehistoric visits to our solar system**
 - anything left on moon or Mercury will remain undisturbed for billions of years
- ◆ **no evidence of alien visits known today**