

LIFE IN THE SOLAR SYSTEM

Either we are alone or not in the Universe. Either way, the thought is incredible.

- A simple definition: a single or multiple cell organism that feeds on nutrients and is capable of reproduction.

Basic components of life (as we know it): H, O, C, N

Amino Acids

- Basic molecular component of proteins.
- Amino acids have been found in the interiors of carbonaceous meteorites.
- Earth biology based on left-handed amino acid structure. (handedness decides)
- Amino acids=> life (how?)
Fossil records show first life forms occurred on Earth > 3.5 Ga ago.
- DNA is made up of amino acids and is key to understanding life.
- **ALL** living things on Earth (except viruses) use the same system.

Sites for Life Elsewhere in the Solar System

The key factor? Liquid H₂O

➤ Venus? Europa? Titan? Mars?

Ideas for life on Mars from early observations and interpretation => reality

Viking Landers on Mars (1976): Searching for remnants of Life

Tests:

- Gas Chromatograph/Mass Spectrometer
- Pyrolytic release
- Labeled Release
- Gas Exchange

Meteorites from Mars: Evidence for Life?

- How do we know some meteorites come from Mars?
- What is the evidence for life in probing them?
- Are there alternative explanations?

History of ALH84001

Evidence

- Fractures in the rock contain globules of carbonate (younger than the rock) indicating that liquid water percolated through the rock in the past.
- Magnetite and FeS found on surfaces of globules.
- PAH's (polycyclic aromatic hydrocarbons) found inside the rock on fracture surfaces, concentrated near carbonate globules.
- Peculiar microbe-like structures photographed (typical size 20-100 nm)

Evidence	Biogenic Explanation	Chemical Explanation	Terrestrial Contamination
Carbonate Globules	Life process known to alter chemical environments .	Non-biogenic chemical process can cause condensation	Unlikely, globules show shock fractured by impact ejection from Mars.
Magnetite and FeS	Bacteria known to cause such precipitates. Magnetite particles resemble magnetosomes.	Magnetite and FeS precipitate in high pH. BUT, observed implies low pH. "	Concentric rinds rule out contamination.
PAH's	Natural decay product of biogenic matter.	Common in other meteorites (but not SNC's). Can be formed by non-biogenic reactions.	Other Antarctic meteorites don't show contaminate. Concentration increases w depth.
"Microfossil" Structures	Fossils of single cell bacteria. 1000x smaller than terrestrial microfossil.	Caused by chemical dissolution of carbonate. Can result from other chemical precipitates.	Unlikely. Freshly cut samples. Lunar samples subjected to same procedures show no such structures.

Where do we go from here? Is There Life Out There? Key constraints.

The Drake Equation

=> How to estimate the number of civilizations within the galaxy capable of making contact.

$$N = n^* \times f_p \times f_h \times f_l \times f_i \times f_s \times f_c$$

Symbol	Definition	Pessimistic	Optimistic
n*	# Stars in our Galaxy	10 ¹¹	10 ¹¹
F(p)	Fraction of stars with planets	0.01	0.3
F(h)	Fraction of planets habitable	0.1	0.7
F(t)	Fraction of long-term habitable planets	0.1	1.0
F(L)	Fraction of planets where life evolves	0.1	1.0
F(i)	Fraction of life developing intelligence	10 ⁻⁴	1.0
F(s)	Fraction where intelligent life survives	10 ⁻⁷	0.1
F(c)	Fraction of lifetime contact attempted	10 ⁻³	1.0
N		10 ⁻⁸	2 x 10 ⁹

Can we communicate?

☼ SETI: Search for Extraterrestrial Intelligence

☼ Interstellar Spacecraft

A Perspective: Timescale for Earth origin and life...