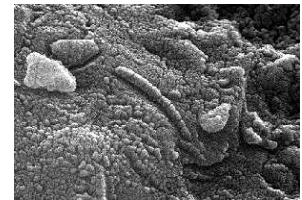
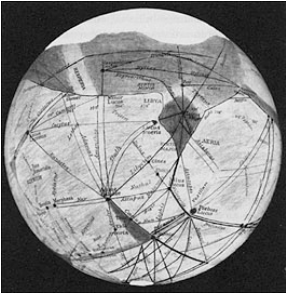


**From Little Green Men to Microbes** — The study of hypotheses of extraterrestrial life is called *exobiology* or *astrobiology*. Due to its vast size and consistent physical laws, it would be unlikely for life to NOT exist throughout the universe, however, our hopes of finding *intelligent* life have evolved from A: expecting to find industrious Martians building canals on Mars or that Martians might soon attack, to Z: hoping to find the smallest evidence that microbial life might exist anywhere other than Earth or that we might even find strong evidence that other habitable planets merely exist.



### Possible Alien Life Forms

1. Organic compounds (CHNOPS)
2. Microbial (single cellular) life
3. Multicellular organisms (fungi, hydra)
4. Plants
5. Animals
6. Intelligences

### How does Life Originate?

There is evidence of life on earth in the fossil record from 3.5B YA. Organic compounds have been found on meteorites possibly originating from Mars, were likely formed in the protoplanetary disk around our young Sun, and have been detected on Mercury, Venus, Mars, and moons of larger planets. Water and carbon are required to support life as we know it.

### Searching for Alien Life

1. Examining (Earth-based) evidence (fossil record, meteorites, extremophiles)
2. Looking for signs (Early telescopes, Hubble, Kepler)
3. "Feeling" for signs (planetary probes)
4. Listening for signs (SETI)

### Consider Alien Morphology

- Habitat: land (soil, rocks, regolith, ice), sea, air, and space
- Form: size, shape, composition, locomotion, articulation, sight, hearing.
- Behavior: survival mechanisms, intelligence, hostile?!
- Communication: visual, vocal, telepathic, other?

## Extraterrestrial Theories

- **Exogenesis:** the possibility that life on Earth came from somewhere else. Where?
- **Terraforming:** perhaps we could transform a planet so that it is able to support human life.
- **Alien abductions:** reports of individuals kidnapped and experimented upon by aliens.
- **Aliens among us:** theories of reptilian humanoids secretly controlling humanity.
- **Ignored by aliens:** perhaps we are simply not interesting to extraterrestrial intelligences.

## Astrobiology timeline

450 BC Greeks ponder existence of other worlds and panspermia  
1543 Nicolaus Copernicus proposes heliocentric theory  
1609 Galileo discovers moons of Jupiter  
1698 Christiaan Huygens publishes *Cosmotheoros* theorizing life on other worlds  
1906 Percival Lowell publishes *Mars and Its Canals*  
1938 H.G. Wells radio broadcast of *War of the Worlds*  
1947 Roswell, New Mexico UFO incident  
1961 Frank Drake creates equation for potential nearby intelligent civilizations (2.31)  
1961 Betty and Barney Hill alien abduction case  
1966 First broadcast of *Star Trek* introducing exoplanets and alien worlds to public  
1976 The Viking Mars landers detect chemical signatures indicative of life  
1977 *Close Encounters of the Third Kind* (film)  
1977 "Wow!" signal detected by Ohio State University radio telescope  
1986 astronomer Fred Hoyle and others publish *Viruses from Space*  
1987 Whitley Streiber publishes *Communion: A True Story* about alien abduction  
1996 Martian "fossils" discovered in meteorite ALH80041 from Antarctica  
2001 "Drake equation" interpretation suggests x100Ks Milky Way civilizations  
2001 Proposed that red tinge Europa due to frozen bits of bacteria  
2002 Russians argue that a radiation-proof microbe may have evolved on Mars  
2002 Chemical hints of life are found in old data from Venus probes and landers  
2003 Sulphur traces on Europa may be the waste products of bacterial colonies  
2004 Methane in the Martian atmosphere hints at microbial metabolism  
2004 SETI hears extraterrestrial signal on three occasions from same region of space

## Recent News

ESA <http://www.esa.int/esaCP/Life.html>

io9 <http://io9.com/astrobiology>

NASA <http://astrobiology.nasa.gov/>

New Scientist <http://www.newscientist.com/topic/astrobiology>

PlanetQuest <http://planetquest.jpl.nasa.gov>

SETI <http://www.seti.org>

Space.com <http://www.space.com/search-for-life/>

**The Drake Equation** — a calculation composed by astronomer Frank Drake in 1961 that attempts to estimate the number of intelligent extraterrestrial civilizations that we might be capable of coming in contact with. His estimate for  $N$  was 2.31, it has since been re-interpreted to be from 0 to hundreds of thousands.



### Further Reading

- *Life in the Universe (2nd Edition)* by Jeffrey O. Bennet and G Seth Shostak
- *Life Everywhere: The Maverick Science of Astrobiology* by David J. Darling
- *Is Anyone Out There?* by Frank Drake and David Sobel
- *Astrobiology* (Smithsonian's Natural World Paperback) by Monica Grady
- *Lonely Planets: The Natural Philosophy of Alien Life* by David Grinspoon
- *Astrobiology: A Multi-Disciplinary Approach* by Jonathan Lunine

### Challenges for you!

1. How would you greet extraterrestrial intelligence?
2. How would you design a probe intended to initiate "exogenesis" elsewhere?
3. How would you design a transmitter that might survive even if humanity did not?
4. How might you detect the presence of extraterrestrial intelligence in our midst?