

LOOKING FOR EXTRATERRESTRIAL LIFE

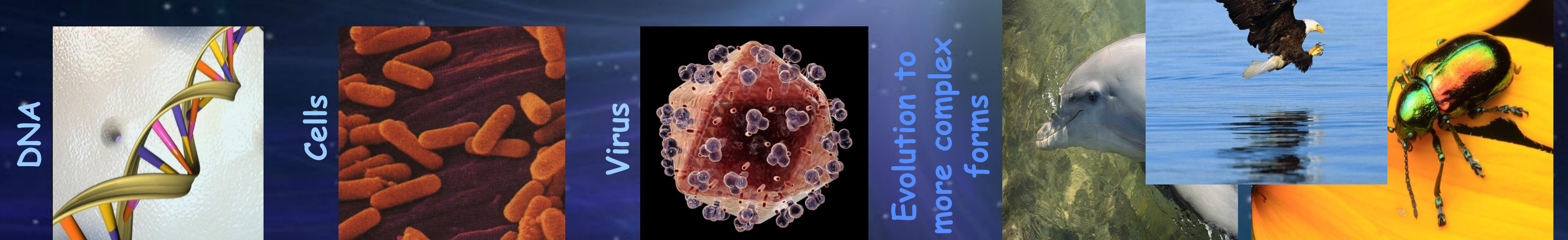
1. SEARCHES FOR ADVANCED CIVILIZATIONS

The Cosmic Hierarchy



There may be around 10^{21} stars in the observable universe... This naturally raises the question: Is the sun alone in hosting life on a planet?

Life on Earth as we know it...



... is based on organic molecules. Do the basic building blocks of life exist in space?

Yes! The existence of complex organic molecules in giant molecular clouds has been revealed by millimeter-wave astronomy. (See Table on right for a partial list of discovered molecules.)



The gas and dust in these clouds serve as raw material to build stars and planetary systems. It is therefore not inconceivable that those complex molecules could end up on the planets (or in comets which could then seed planets), and act as the precursors of life.

This provides circumstantial evidence to support the idea of life beyond Earth.

Number of Atoms in the Molecule	Inorganic Molecules	Organic Molecules
2	H ₂ (hydrogen) OH (hydroxyl) SiO (silicon monoxide) NS (nitrogen sulphide)	CH (methylidyne) CN (cyanogen) CO (carbon monoxide) CS (carbon mono-sulphide)
3	H ₂ O (water) H ₂ S (hydrogen sulphide) SO ₂ (sulphur dioxide)	HCN (hydrogen cyanide) HCO (formyl) HNO (nitrosyl)
4	NH ₃ (ammonia)	H ₂ CO (formaldehyde) HNCO (isocyanic acid)
5		H ₂ CHN (methanimine) HCOOH (formic acid)
6		CH ₃ OH (methanol) HCONH ₂ (formamide)
7		CH ₃ NH ₂ (methylamine)
8		HCOOCH ₃ (methyl formate)
9		(CH ₃) ₂ O (dimethyl ether)

Extraterrestrial Intelligences

Assuming that intelligent life is possible elsewhere, can we estimate the number of extraterrestrial super civilizations in our Galaxy?

The answer varies from scientist to scientist, but a middle opinion centers around a few lakhs.

How do we search for Extraterrestrial Intelligence?

Spaceships with human crew? Not viable; with present day technology, it would take more than a lakh years to reach even the nearest star. Extremely long term.

Unmanned space probes with instruments only? Can send back messages and possibly carry information about us (like the plaque that the Voyager spacecraft carried - see figures on the right) in the hope that it might be intercepted by another civilization. But the likelihood of this is very small.

Sending and listening for radio messages using telescopes?

Most practical means with present day technology, but demands patience! Just one round of two-way communication with even the nearest star system would take 8-10 years.

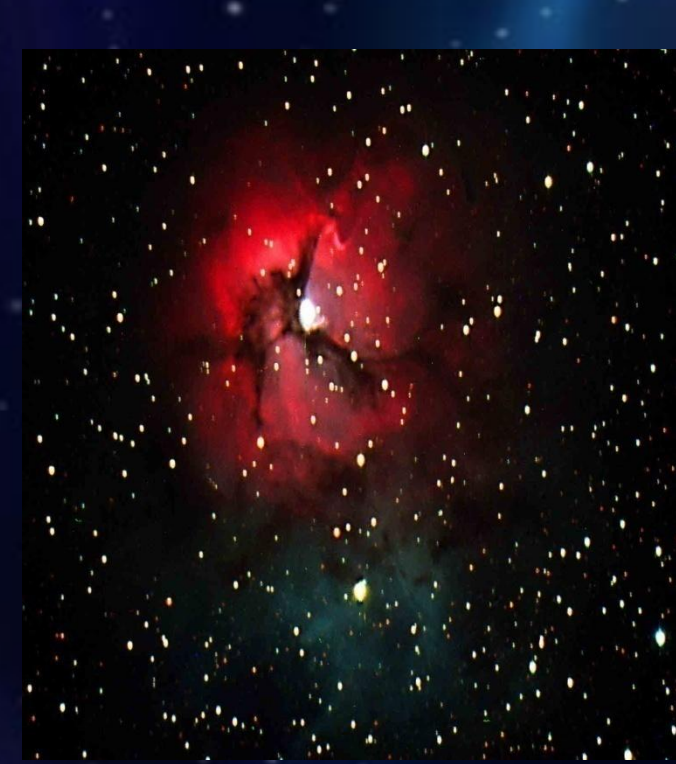


A typical pictorial message which can be constructed from digital signals

All the above are attempts to seek out advanced civilizations, but we can also search for primitive extraterrestrial life. Can the existence of cells, bacteria and other microorganisms beyond the earth be established?

2. SEARCH FOR PRIMITIVE LIFE-FORMS

The Two Theories of Life Origin



We accept the view that life has evolved from bacteria and other primitive life forms. This primitive life form in turn comes from suitable combinations of organic molecules. One theory says that this synthesis happened on earth. Another theory called the H-W Panspermia theory (proposed by Sir Fred Hoyle and N. C. Wickramasinghe) says it could not have happened on earth! Life was introduced by cometary encounters onto Earth in primitive form and that earth's conditions allowed its evolution into the diversity of life we see around today. Interestingly, the Greek philosopher Anaxagoras was the first to have this idea around 500 BC.



Why does H-W theory not believe in life being synthesized on Earth itself?

The oldest bacterial cell dates 3.83 billion years. From 4.3 - 3.8 billion years ago, Earth was going through a phase called Hadean epoch wherein it was constantly bombarded by comets. The conditions could not have favored synthesis of primitive life from building blocks. Microbiologists say that the 0.5 billion years available for formation of primitive life from organic compounds is too less.

How do we test the H-W Panspermia theory of the origin of life?

The primary assertion of the theory is the transportation of primitive life forms through comets from interstellar dust. Lab experiments convince us that bacteria can survive the conditions. Cometary material passing earth's atmosphere can enrich the stratosphere with the bacteria it carries along. So, we look here for bacterial forms.

The ISRO Project

- An ISRO sponsored project was carried out on 20 January 2001 at the TIFR Balloon facility, Hyderabad. It involved using an air balloon to collect air samples from 19-41 kms in groups.
- The samples were collected by highly sterilized and pressure tolerant 16 steel probes whose inlet valves could be controlled remotely from the ground. Utmost care was taken to prevent the contamination of samples collected.



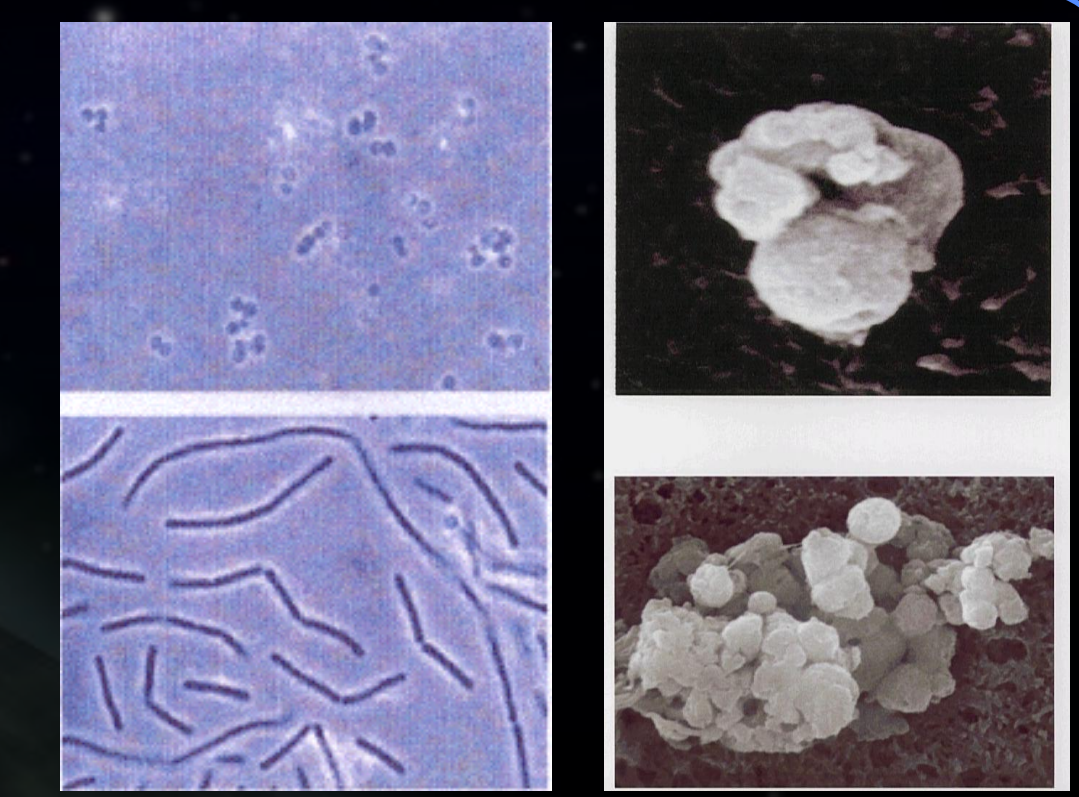
A first experiment

Findings

Serendipitous Discovery of Culture

A scientist from Sheffield, UK succeeded in obtaining cultures from isolates of filters. Taking every possible precaution against contamination, the following cultures of microorganisms were grown:

- The coccus (spherical bacterium, often growing in clumps) 99.8% similar to the bacterium *Staphylococcus pasteurii*.
- The bacillus (rods), 100% similar to *Bacillus simplex*.
- A fungus identified as *Engyodontium album* (Limber) de Hoog.



A second experiment

On April 20, 2005, a 2.67 crore cubic feet balloon carrying a 459 kg scientific payload with 38 kg of liquid neon was flown from the TIFR Balloon Facility, Hyderabad. In the samples collected 12 bacterial and 6 fungal colonies were detected. This included 3 new bacterial species: *Janibacter hoylei* (named after Sir Fred Hoyle), *Bacillus isronensis* (named after ISRO) and *Bacillus aryabhatai* (named after the Indian astronomer Aryabhata). All the three new species were found to be more UV-resistant than their genetic neighbours found on Earth.

What do we conclude ?

- Can these microbes have a terrestrial origin?
- Could volcanic eruptions put them up here? No eruptions occurred for the previous 2 years of experiments. It takes only weeks for volcanic matter to settle back on earth.
 - Could it be lab contamination? No, these are absent from the lab surroundings & are way too uncommon.
 - Debris from spacecrafts? Again, chances are too little for this.
 - Brought there by the balloon itself? No, every precaution was taken to prevent this.

How can we be sure that they are extra-terrestrial?

- The following tests are planned for answering this question.
- Isotope Analysis: If a pristine bacterium from 41 km height can be located on the filter we can check its isotopic composition. If the isotopic composition is different from that of the microorganisms on the Earth...
 - Number-Height Measurement: If the bacterial shower is coming from above, in a steady state there will be a drop in the bacterial density with height in an exponential fashion. Measurements of such densities at heights ranging from 25-41 km will therefore tell us if the idea of extraterrestrial origin holds.