

# Journal of Astrobiology and Outreach



□ **Dr. Barbara Cavalazzi**

**Editorial Board member**



Assistant Professor  
Department of Biological and Environmental  
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ITALY



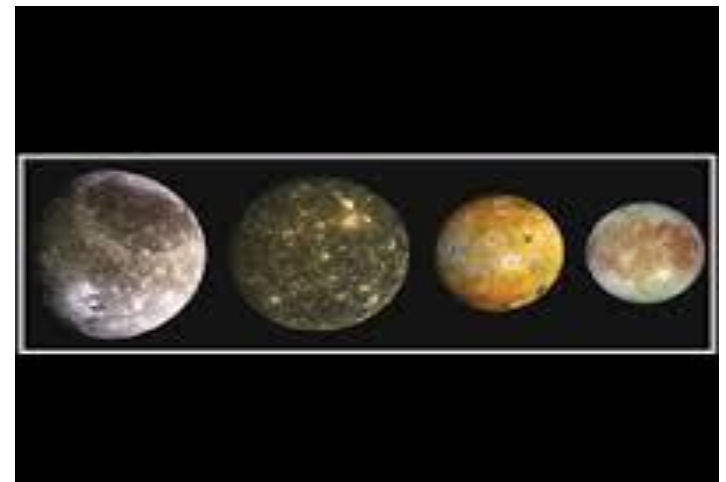
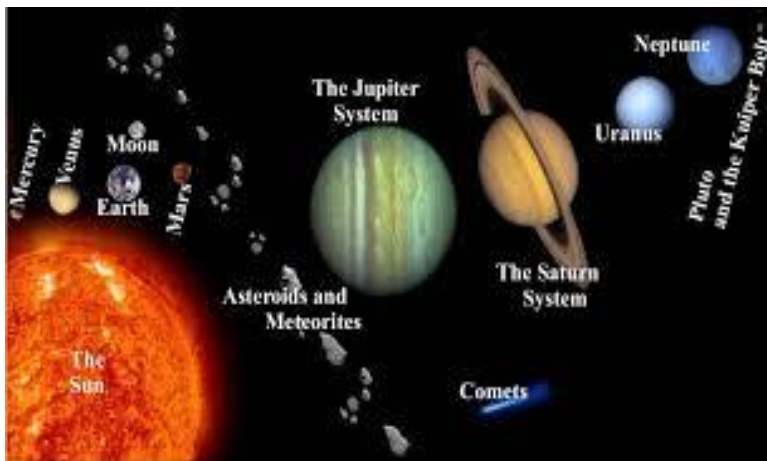
## Biography

### □ Dr. Barbara Cavalazzi

- ✚ Dr. Barbara Cavalazzi obtained her Ph. D. in Paleontology at the University of Modena and Reggio Emilia in 2005, and continued her research at the University of Bologna, Portland State University (US), Centre de Biophysique Moléculaire-CNRS (France), and University of Johannesburg (South Africa).
- ✚ Since 2012 she is Assistant Professor at University of Bologna and Adjunct Professor at the University of Johannesburg. In 2013 she was visiting professor at the PNNL-Environment Molecular Sciences Laboratory (US).
- ✚ Dr. Cavalazzi scientific interests include aspects related to microbial paleontology, preservation and characterization of ancient carbonaceous materials, geobiology and astrobiology.
- ✚ She was recently awarded a FP7-CIG in Environmental and Geosciences by the European Research Council Ideas Programme.

## Research Interests

- ❖ Geo- And Paleo-biology,
- ❖ Astrobiology,
- ❖ Biosignatures In Extreme Environments,
- ❖ High-resolution Microscopies Applied To The Study Of Microbial Fossils.





# What is Astrobiology?

“Astrobiology is the study of life in the universe. It investigates the origin, evolution, distribution, & future of life on Earth, & the search for life beyond Earth.”

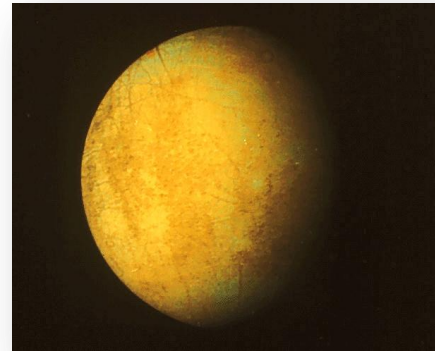
Astrobiology addresses three fundamental questions:

- 1) How does life begin & evolve?
- 2) Is there life beyond Earth & how can we detect it?
- 3) What is the future of life on Earth & in the universe?”

Astrobiology addresses the question of whether life exists beyond Earth, and how humans can detect it if it does!!

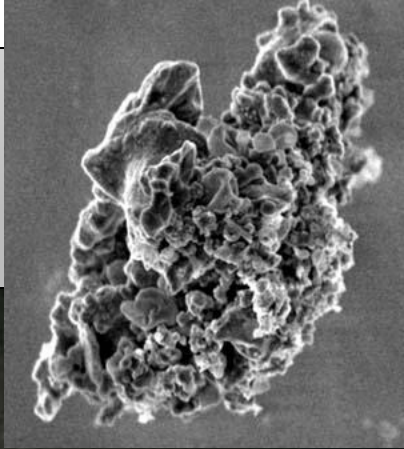
# Life Elsewhere

- Studies of life in extreme environments on Earth have led us to focus on some prime places to look for life
- Mars
- Europa (moon of Jupiter)
- Titan (moon of Saturn)



# Life in the Universe

*Hubble Space Telescope  
image of Sedna-  
takes 10,500 years  
to circle the Sun!*



*Interplanetary Dust  
Particle -10  $\mu$ m across  
made by dying and exploded stars*

**Our Solar System has planets, dwarf planets, moons, asteroids, comets, and interplanetary dust.**

**Milky Way galaxy has 100 billion (100,000,000,000) stars.  
Universe has 100 billion (or more) galaxies.**

**Many stars have planets.**

**Some like Jupiter and Saturn.**

**Some may be like Earth.**

**Potential for a large number of Earth-like planets (ELPs).**

# Astrobiology, Incremental Data Accumulation, New Ideas & Understanding, Paradigm Shifts

NOTICE THE TIME FRAMES....

Search for Extrasolar Planets	~ 15 years
Deep Time: Reinterpreting Early Earth	< 5-10 years
Life on the Edge (extreme environments)	Late 70's Vents
The Rock that Started it all- Scientific Process	Mid 90's
Asteroids and Dinosaur Extinction	~ '79
Human Microbiomes	~ 5-10 years

**Astrobiology**  
Searching for life on other planets

Astrobiology makes use of physics, chemistry, astronomy, biology, molecular biology, ecology, planetary science, geography, and geology to investigate the possibility of life on other worlds and help recognize biospheres that might be different from the biosphere on Earth.

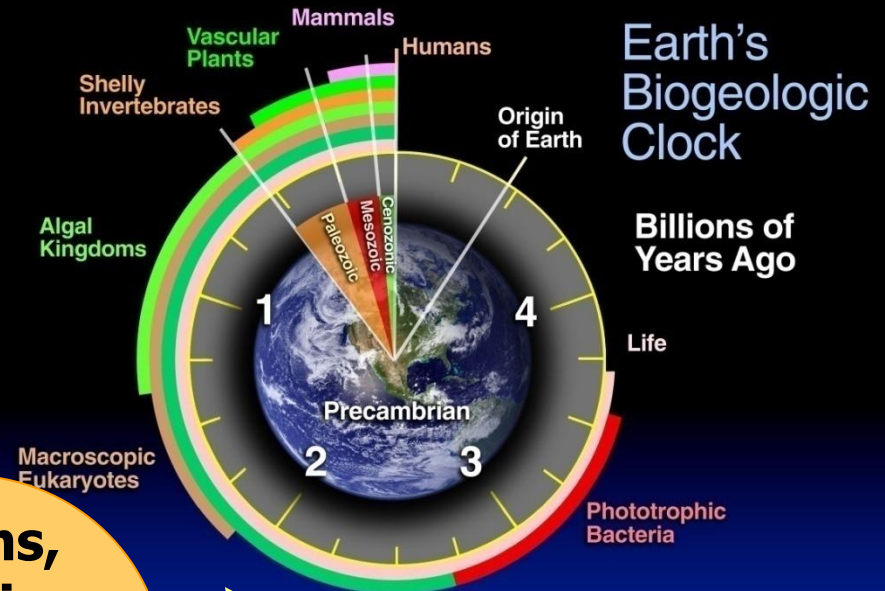
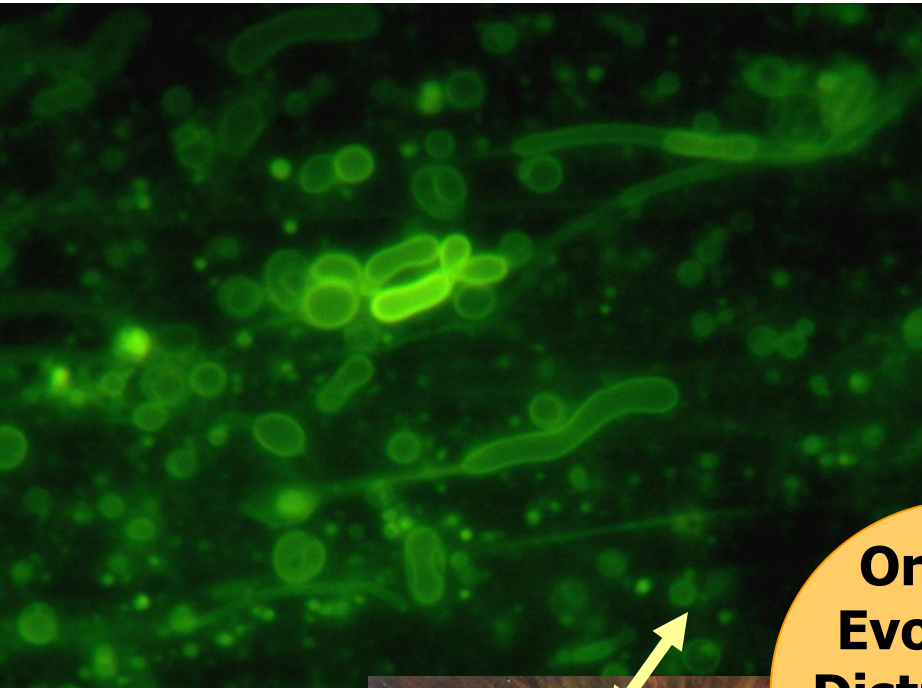
Astrobiology concerns itself with interpretation of existing scientific data; given more detailed and reliable data from other parts of the universe, the roots of astrobiology itself—physics, chemistry and biology—may have their theoretical bases challenged.

Although speculation is entertained to give context, astrobiology concerns itself primarily with hypotheses that fit firmly into existing scientific theories.

It has been proposed that viruses are likely to be encountered on other life-bearing planets. Efforts to discover current or past life on Mars is an active area of research.



# Astrobiology Unites Disciplines to Study Life in the Universe

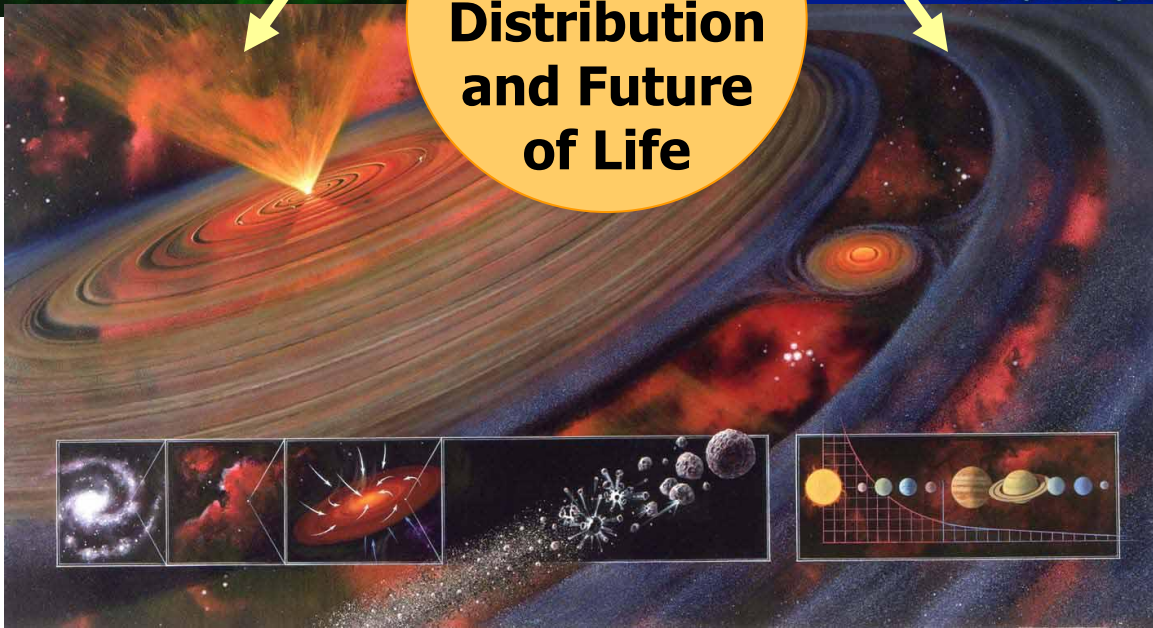


Earth's Biogeologic Clock

Billions of Years Ago

Life

**Origins, Evolution, Distribution and Future of Life**



David Des Marais, Ames Research Center, NASA  
Cheryse Triano, TopSpin Design Works

While it is an emerging and developing field, the question of whether life exists elsewhere in the universe is a verifiable hypothesis and thus a valid line of scientific inquiry. Though once considered outside the mainstream of scientific inquiry, astrobiology has become a formalized field of study.

Earth is the only place in the universe known to harbor life. However, recent advances in planetary science have changed fundamental assumptions about the possibility of life in the universe, raising the estimates of habitable zones around other stars, along with the discovery of hundreds of extrasolar planets and new insights into the extreme habitats here on Earth, suggesting that there may be many more habitable places in the universe than considered possible until very recently.

On 4 November 2013, astronomers reported, based on *Kepler* space mission data, that there could be as many as 40 billion Earth-sized planets orbiting in the habitable zones of sun-like stars and red dwarf stars within the Milky Way Galaxy. 11 billion of these estimated planets may be orbiting sun-like stars.

# The Origin of Life on Earth

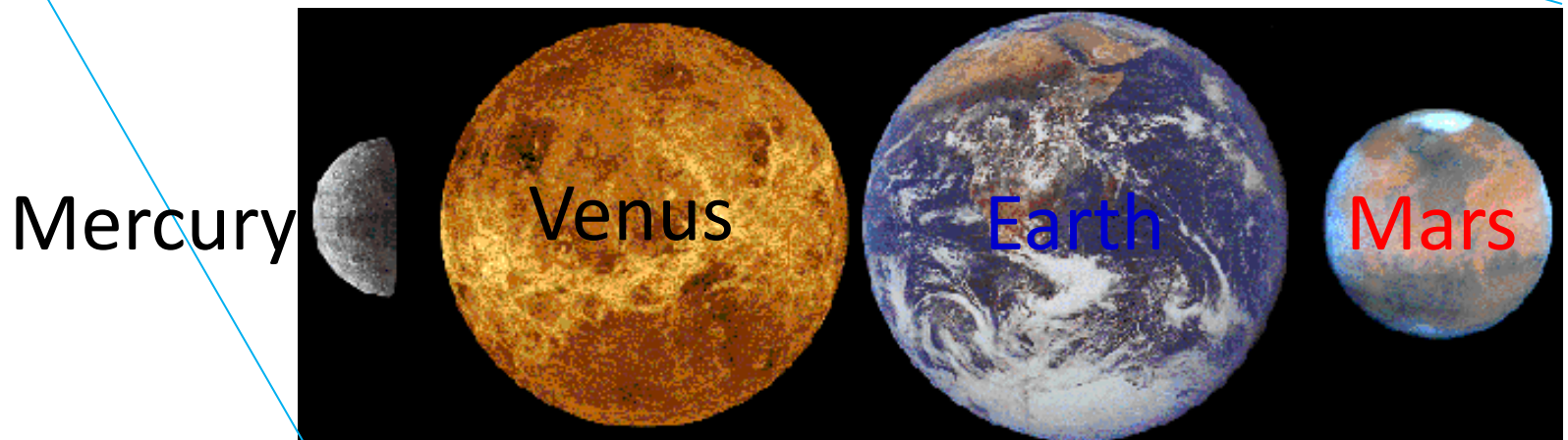
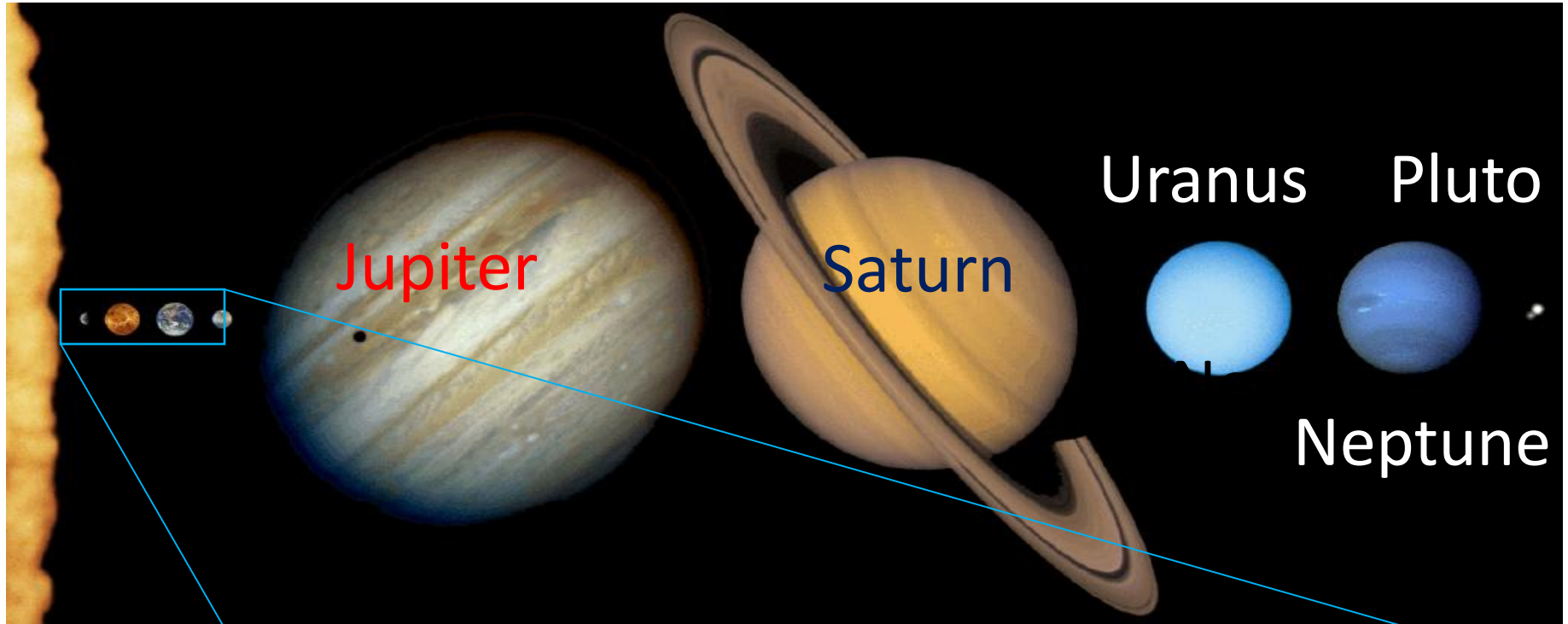
4 billion years ago



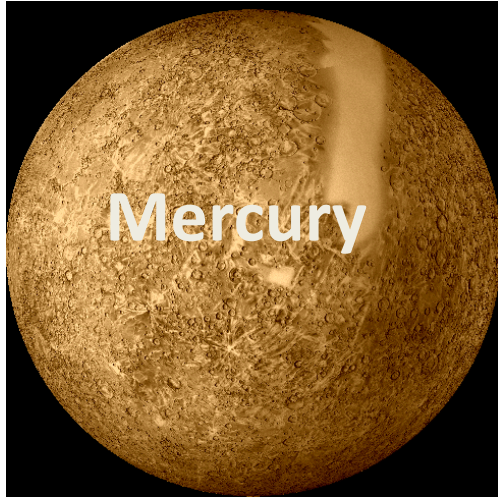
The nearest such planet may be 12 light-years away, according to the scientists.

A particular focus of current astrobiology research is the search for life on Mars due to its proximity to Earth and geological history. There is a growing body of evidence to suggest that Mars has previously had a considerable amount of water on its surface, water being considered an essential precursor to the development of carbon-based life

# Our Solar System

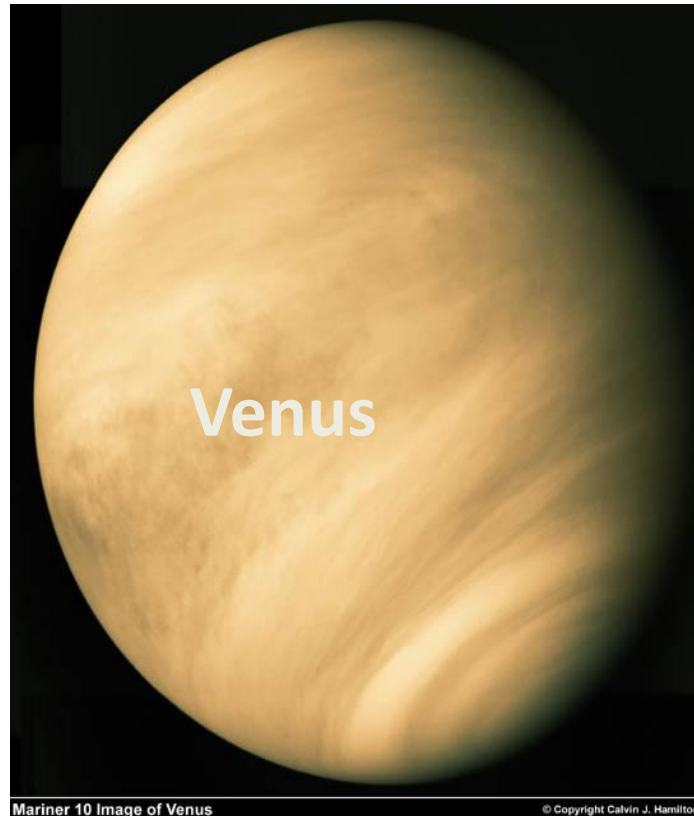


# The Terrestrial Planets



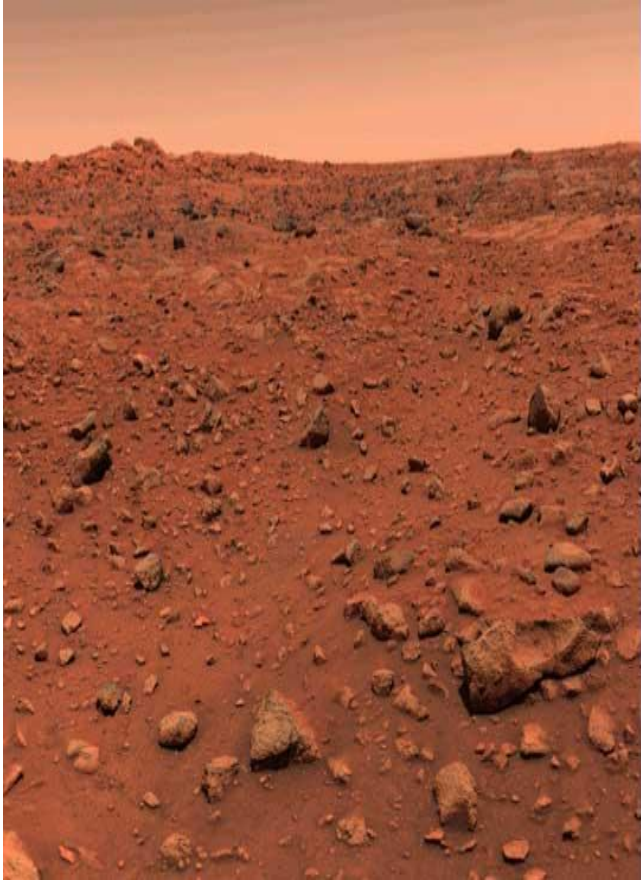
Very near the Sun

Very hot because its atmosphere

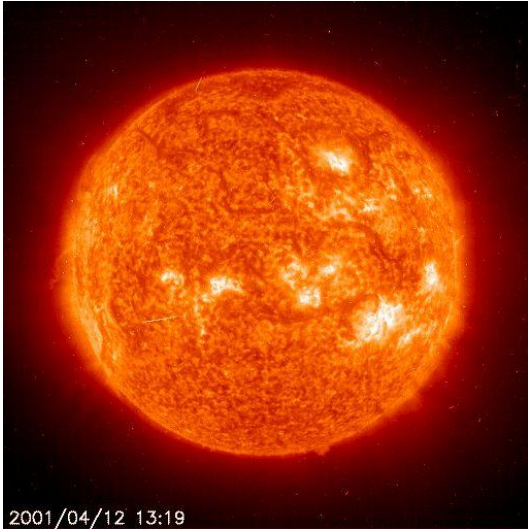


No atmosphere, cold but...

# Mars

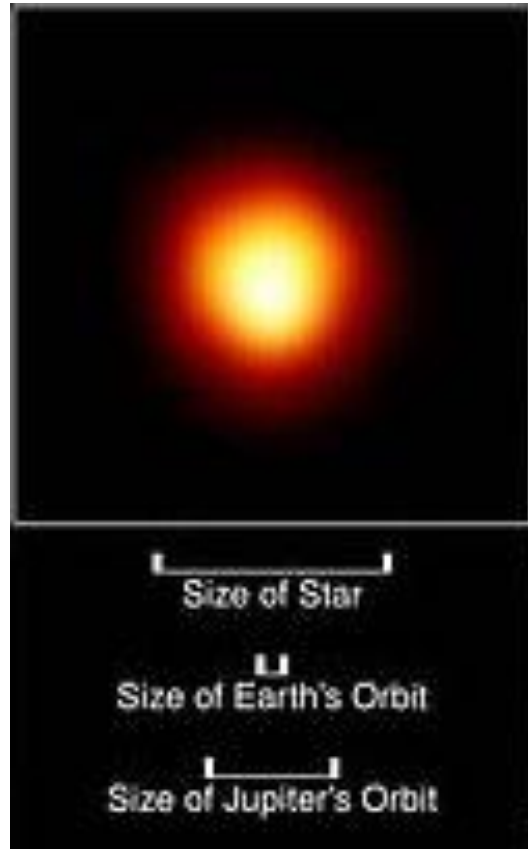


# The life of the stars

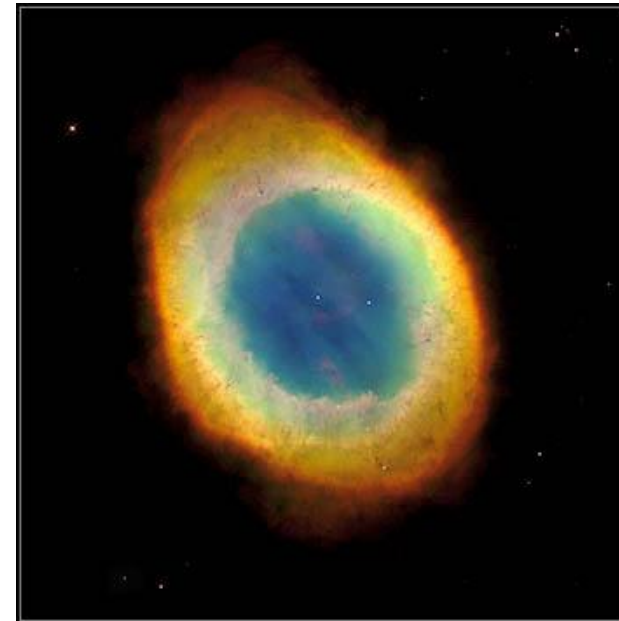


Yellow dwarf  
10 billion years

## Red Giant



## Panetary nebula and white dwarf



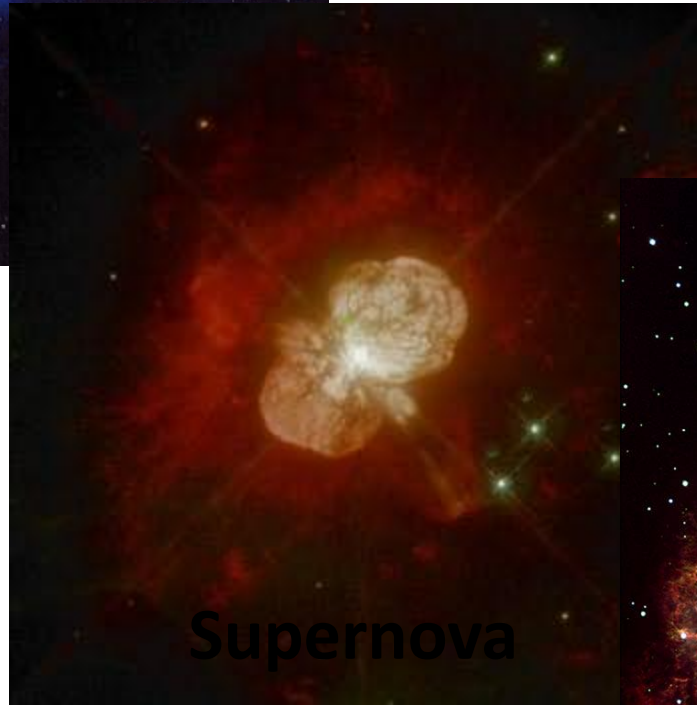
# The life of the stars

Blue giants

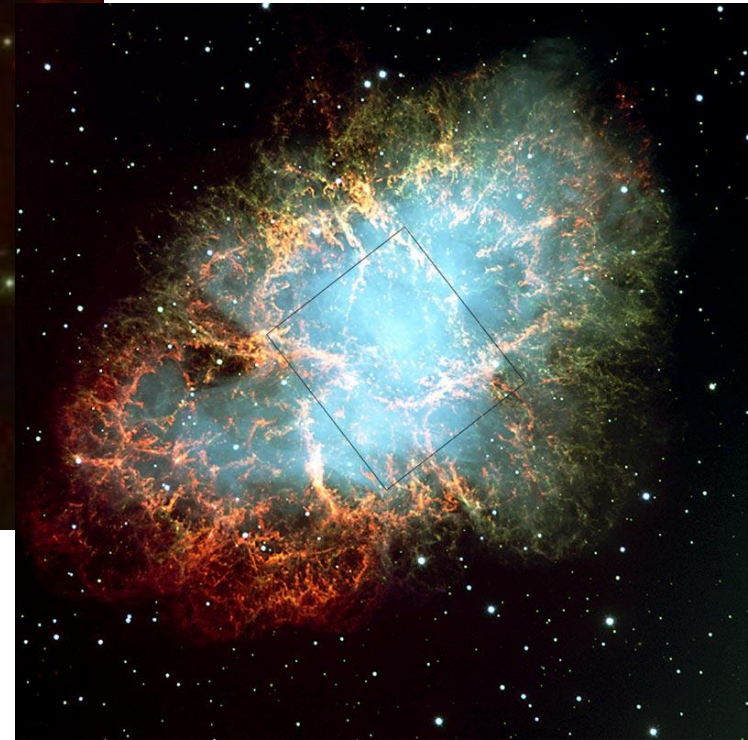
100 million years



Supernova remnant and  
neutron star



Supernova

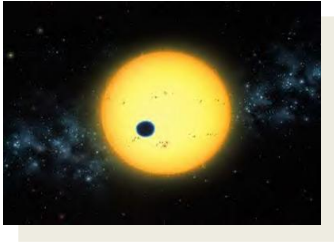




# Multiple Different Search Types



**SETI Searches**



**Extrasolar/Habitable Planets**



**Exobiology in the Solar System**

# Multiple Different Search Types

## SETI Searches



**Radio-telescopes - within Galaxy**

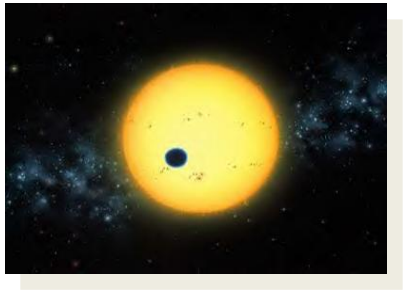
**Discovery: Intelligent Life**

**Unknown Biology or Chemistry**

**Light Years Away (still exist?)**

*Aliens ???*

## Extrasolar/Habitable Planets



**Telescopes - within Galaxy**

**Discovery: Other Solar Systems; Terrestrial Planets?**

**Information on Atmospheres (Composition/Conditions?)**

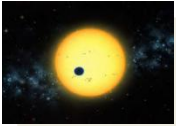
**Maybe Habitable?**

*Life ???*

# Multiple Different Search Types



**SETI Searches**



**Extrasolar/Habitable Planets**

## ➤ **Exobiology in the Solar System \*\***



**Missions -- visits**



**Meteorites -- Fossil Evidence?**



**Cosmochemistry** (Process; Replication)  
**Origin of Life Research** (Lab Experiments)

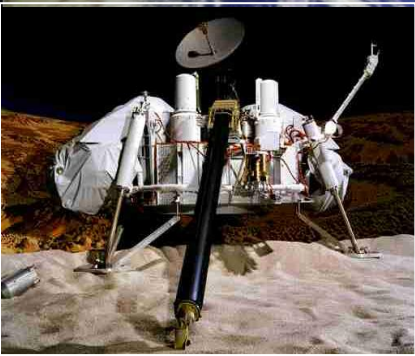


**\*\* Real Time; Potential for Cross Contamination; Biohazards**

# Strategy Has Worked on Mars...

Built Understanding about Mars and its Environment over time...

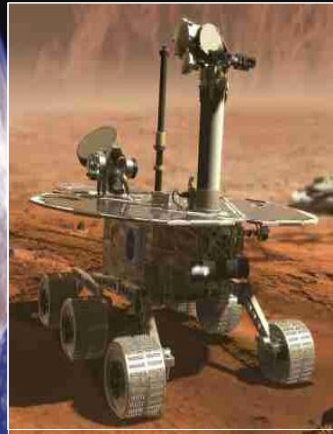
1976



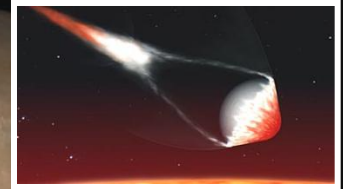
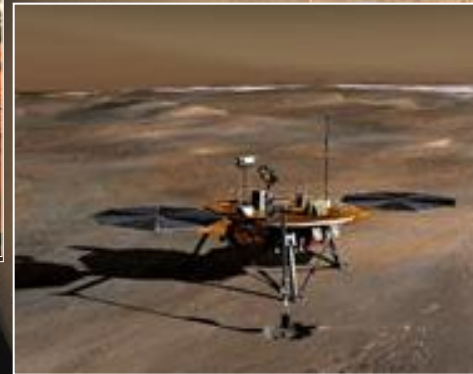
1996



2003



2007



2011



More and more indications of water found...  
Small and large scales...

**Approved By**

**E-signature:**

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