

What is astrobiology and why do we care?

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WHAT IS ASTROBIOLOGY AND WHY DO WE CARE?

- 1. Is extraterrestrial life likely to be rare or widespread in our solar system and in the universe?**
- 2. What is the nature of astrobiology and planetary science as historical sciences?**
- 3. Why are we so interested in the exploration of the planets and the search for life elsewhere?**
- 4. What would be the philosophical significance of finding life elsewhere?**
- 5. What is the nature of science in society today?**
- 6. How has the role of science changed in the last fifty years?**

1. Is extraterrestrial life likely to be rare or widespread in our solar system and in the universe?

- **Scientific revolutions in the last twenty years that drive our view of life in the universe:**
 - **Rapid origin of life on Earth**
 - **Diversity of life in extreme environments**
 - **Genetic reconstruction of “tree of life” –possible extremophile origin of life**
 - **Planetary environments capable of supporting life**
 - **Discovery of planets around other stars**
- **Environmental conditions required for an origin or continued existence of life elsewhere**
 - **Liquid water**
 - **Access to biogenic elements**
 - **Source of energy to drive chemical disequilibrium**

Are we deluding ourselves?

- **Aren't statistics of one wonderful?**
- **This chain of logic is based on presently available observations and inferences. This does not mean that it is correct.**
- **It does indicate, however, that a search for life in the most-suitable environments on Mars or Europa is appropriate, and that the outcome will be a valid test of this chain of hypotheses.**
- **Whatever the outcome of such a search, it will tell us much about our understanding of the origin of life on Earth and the likelihood of life being widespread throughout the galaxy.**

2. What is the nature of astrobiology and planetary science as historical sciences?

- **Historical narratives and science in general**
 - Use of historical narratives is different from canonical philosophical views of science, based on “physics” model.
 - We cannot determine the distribution of life in the universe or the history of Mars from first principles.
 - We cannot repeat the experiment with different constraints (except to extent that different planets and solar systems are repetitions of an experiment).
- **Examples of historical narratives in astrobiology**
 - Origin and evolution of life on Earth
 - Whether there is life on Mars or Europa
 - Distribution of extrasolar planets, Earth-like planets
 - Occurrence of intelligent life elsewhere
- **In fact, the “Big Questions” in science can be addressed *only* through historical narratives:**
 - Fate of the universe
 - Origin of galaxies, stars, and planets
 - Origin of life on Earth (and Mars or Europa?)
 - Nature of intelligence and psychology of the mind
 - Are we alone?

3. Why are we so interested in the exploration of the planets and the search for life elsewhere?

RELEVANT OBSERVATIONS ABOUT THE SCIENCE:

- **Astrobiology, planetary science, and astrophysics have few if any practical applications. Those that do exist (e.g., saving the world from *ARMAGEDDON* and *DEEP IMPACT*) certainly are not the program drivers.**
- **Specific scientific results are superseded or demonstrated as wrong very quickly.**
- **We will never have answers to all of our questions; each new answer raises questions at a deeper level.**

INFERENCES:

- **Clearly, we are not “doing” planetary exploration for the specific new knowledge that we obtain.**
- **We likely are doing it for the exploration value, as a *search* for knowledge, in order to find out what is in the world around us.**
- **The driver behind much basic science is not the new information that is obtained but, instead, the process of deriving new results. Copernicus and Newton, for example, are of lasting importance for their roles in affecting philosophical and scientific thought and process rather than the lasting value of what they specifically discovered.**
- **By learning about the world around us we are learning about what it means to be human.**

4. What would the philosophical significance be of finding life elsewhere?

A SCIENTIST'S PERSPECTIVE:

- **Finding any life elsewhere that had an origin independent of that on Earth would be philosophically profound.**
- **Finding microbes would be just as significant as finding intelligent life for what it tells us about the nature of life and its distribution in the universe.**
- **Finding either would suggest that life was just another form of chemistry (albeit an interesting one) in a planetary environment.**
- **This would be as profound as the discoveries by Copernicus and Darwin.**

- **Finding bacteria elsewhere would be scientifically interesting, but only finding extraterrestrial intelligence would be truly profound.**
- **It won't really make any difference to most people; their lives would go on pretty much as before.**
- **We should solve our own problems on Earth before we even go looking for life elsewhere.**
- **Extraterrestrial intelligence will help us to save the world by solving all of our current problems.**
- **Extraterrestrial life will destroy our civilization, either by intent or by accident.**
- **The existence of extraterrestrial life or intelligence would be inconsistent with the view of modern religions.**
- **Modern religions have adapted to deal with scientific discoveries and societal changes in the past, and they probably can adapt to deal with the discovery of life elsewhere (if there's even a conflict).**
- **We've already discovered extraterrestrial life and the government is hiding it, probably in a hangar near Roswell, New Mexico.**
- **We may not have discovered it yet, but the government is covering up anyway.**

5. What is the nature of science in society today?

Science consists of two very different concepts:

- It is a collection of facts that describe the world around us.**
- It is the activity of trying to understand the nature of the physical world by discovering facts and the underlying principles that explain them.**

It is with the latter that science makes its most fundamental contribution. It says that the world is inherently understandable, and that we can understand it by observing it.

Is the search for life elsewhere a valid research focus for NASA?

- **Determining whether we are alone in the universe is of profound importance for how we view ourselves as a species, as a society, and even as a biosphere. These are questions that we have been asking for, literally, thousands of years.**
- **Major revolutions in terrestrial biology, paleontology, astrophysics, and planetary science have brought us to the verge of a possible discovery of extraterrestrial life on Mars or Europa. We may get an answer within our lifetimes and conceivably within a decade.**
- **One of the hallmarks of western civilization is the desire to understand the world around us. Certainly, we have been an “exploring” society for most of the last two thousand years. Looking for our place in the universe is one major activities that give life its meaning.**

6. How has the role of science changed in the last fifty years?

- **Vannevar Bush's 1945 report on "Science: The Endless Frontier"**
 - **Science and technology are good.**
 - **Creation of National Science Foundation to promote science, technology, and graduate training.**
- **Segue to Cold War, 1955-1989**
 - **Science and technology still valued for basic contributions.**
 - **Sense of international competition, with science and technology determining the victor.**
- **Post-Cold-War (modern) era**
 - **Science and technology still valued (Ehlers report).**
 - **Addressing modern problems and education are seen as high priorities.**
 - **Science often seen by Congress as just another constituency.**

How should we respond to this change in the nature of science?

- **We need to educate the public on the nature of science and how it differs from, say, religion.**
- **We need to change our mindset that science should be supported solely because it is “good”.**
- **We need to engage *scientists* in a discussion on the value and role of science in society.**
- **We need to value the “exploration” and “philosophical” aspects of planetary science and astrobiology.**
- **We need to enter into a dialog with the public on the role and significance of astrobiology, rather than devaluing their perspectives and telling them what they should value.**
- **We need to recognize the importance of outreach and education in the broadest sense and value the contributions of those who engage in it.**
- **We have to do these things while continuing to do the highest-quality science.**

“We shall not cease from exploration, and the end of all our exploring will be to arrive where we started and know the place for the first time.”

T. S. Eliot