The Quest for Extraterrestial Life and Its Impact on Us

I. Categories of Extraterrestrial Life

- Extraterrestrial Intelligent Life (ETI): High Tech and Low Tech
- Advanced Extraterrestrial Life: Eukaryotes (ETE)
- Primitive Extraterrestrial Life: Prokaryotes or virus-like organisms
- Pre-biotic chemical organization and evolution – e. g. on Titan?

II. Searching for Extraterrestrial Life (SETL)

- SETI (Advanced civilization) – Earth-based remote detection
- SETL (probably not intelligent, and probably primitive) – Interplanetary probes (Mars, Europa, Titan, Enceladus, etc.)
- SETL (solar system, primitive) – Earth-based, meteorites/astrobiology (e. g. ALH 84001)
- SETL (extrasolar planets) – astronomical techniques/astrobiology (e. g., spectroscopic signatures of planetary atmospheres)
- SETL (extrasolar planets) – interstellar probes (clusters of "bots," Debra Fischer)

III. Scientific, Cultural, Religious Impact

- Impact of the Prospect of, and the Search for, ETL
- Impact of the Discovery of ETL

IV. Promise and Puzzle

- Universe seems Fine-Tuned for Complexity $\Longrightarrow$ Life (Anthropic Principle): Same laws of physics and chemistry throughout
- Open Question: Evolutionary Processes $\Longrightarrow$ ETL ??

V. Evidence Nourishing the Quest and the Hope for ETL

- Many stellar venues, including many Sun-like stars (G 2)
- Recent discovery of many extrasolar planets, and the imminent prospect of discovering many smaller, rocky planets and moons
- Detection of organic molecules in cool gas clouds, meteorites, comets, etc.
- Discovery of water, and of a history of water, on Mars, Europa, Enceladus
- Discovery and increased understanding of Extremophiles on Earth
- Increased knowledge of the astronomical, physical and chemical conditions

and processes necessary for the emergence of life on Earth and elsewhere

- Advances in the study of the origins of life on earth, and in its evolution and diversification

VI. Two Case Studies (Jonathan I. Lunine, *Astrobiology*, pp. 460-464)

- Viking Lander's search for life on Mars (1976): looked for evidence of photosynthetic activity (-), metabolic transfer and waste (-), possible metabolic gas release (O_2) (+, momentary)
- ALH 84001: Martian origin, detected polycyclic aromatic hydrocarbons (suggestive, but not definitive (SND)), unusual association of magnetite and greigite in carbonate globules (SND), very small bacteria-like structures (SND)

VII. Conceptual Challenges and Difficulties

- What is Life?
- How different could ETL be from terrestrial life – systemically, biochemically, genetically, metabolically? What should we look for?
- Biomarkers and their Ambiguity (see VI. above.) To what extent are the characteristics of life on Earth reliable for SETL?
- ETL that may be present may be in forms much, much smaller than the smallest Earthly bacterium and may be metabolism-based, not gene-based
- signficant pre-biotic chemical systems

may be present, giving evidence of non-instructed and even instructed chemical evolution

VIII. Technical Challenges and Difficulties (Interplanetary Probes)

- Contamination
- Studying, Choosing and Accessing promising sites (locations on a planet, need for shallow or deep drilling, etc)
- Remote analysis of samples
- Returning and Analyzing samples from the planets and moons
- Adequate Conceptualization of a given SETL to offset bio-marker ambiguities and limitations

IX. Scientific Impact of SETL and SETI

- Stimulates astrobiological research, as well as all the disciplines oriented towards understanding the origin, evolution and long-term prospects for life on earth
- Stimulates scientific and philosophical study of and reflection on who we are as intelligent inhabitants of the universe
- Eventual discovery and investigation of ETL or ETI would provide a more secure basis for our study of astrobiology – we would have for the first time instances of life independent of terrestrial life for assessing the frequency, diverse range, and evolution of life forms in the universe

- Eventual resolution to key questions: Is life in the universe abundant or extremely rare? Is ETI likely? Does evolutionary contingency (Gould, Ayala) or evolutionary convergence (De Duve, Conway-Morris) dominate in our universe?

X. Cultural and Religious Expectations and Fears from SETL and SETI

- Fears – contamination, agression, threat to beliefs and image of ourselves
- Myths (ETI and UFO) – Civilizations with vastly superior technology and scientific knowledge, moral superiority to show us the way out of our ignorance, conflicts and dilemmas
- Enriching our knowledge, our wonder and amazement, and our religious, theological and philosophical beliefs and convictions
- Cultural and Religious disorientation

XI. Cultural and Religious Impact of SETL and SETI

- Further openess to the worlds beyond Earth, fuller knowledge, purification and further reliable enrichment of religious and ethical beliefs and convictions
- Deepening our appreciation for the unity and solidarity we have with the rest of the universe – our connections with Nature
- Challenge to more fundamentalist religious beliefs and approaches
- There would be very little difficulty for – in fact there would be acceptance by – the vast majority of religious communities and theologians.