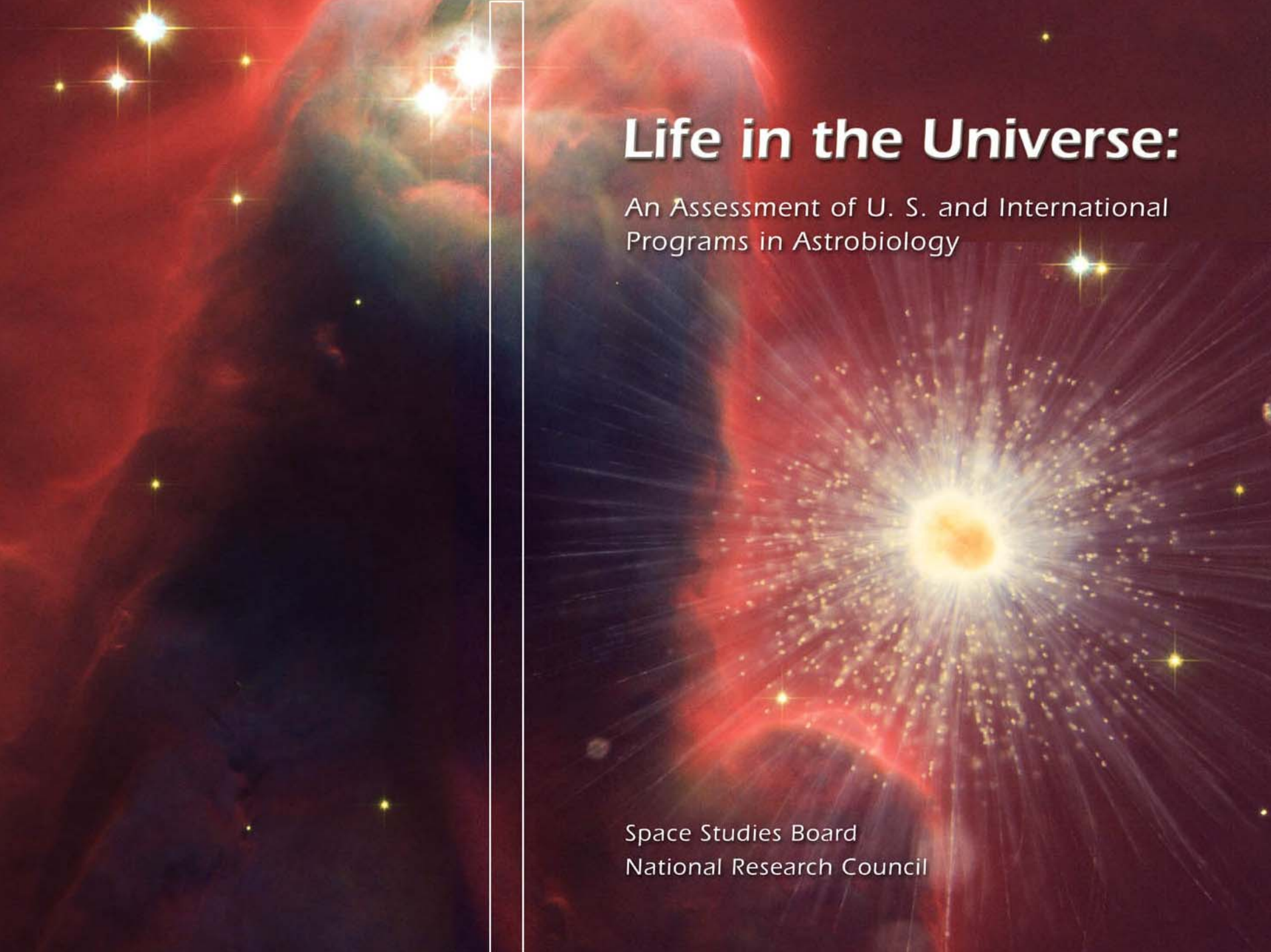


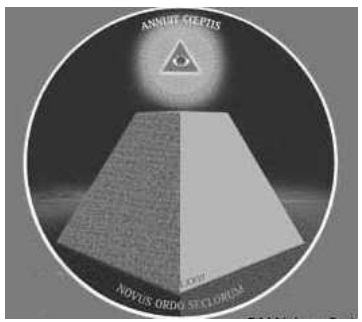
Life in the Universe:

An Assessment of U. S. and International Programs in Astrobiology

Space Studies Board
National Research Council

Origin of Study

- The NASA Authorization Act of 2000 called for an NRC review of programs (NASA and others) looking for life in the universe.
- Congress expressed the belief that NASA's program might be enhanced by coordination and cooperation inside and outside of NASA.

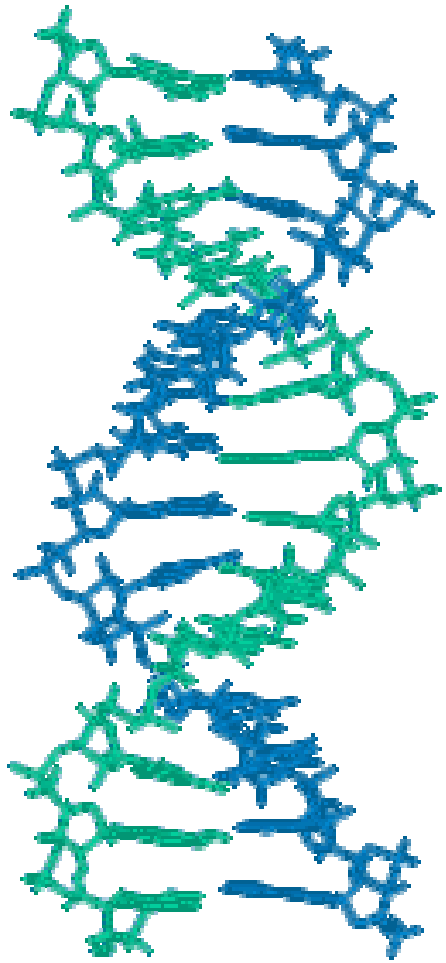


Statement of Task from NASA

- Assess the direction of the NASA Astrobiology Program;
- Survey initiatives for seeking life in the universe conducted by other U.S. Federal and non-governmental groups. Similar activities by foreign space agencies should also be considered;
- Identify enhancements to the U.S. program that might be warranted; and
- Recommend areas for coordination of NASA efforts with those of other parties.

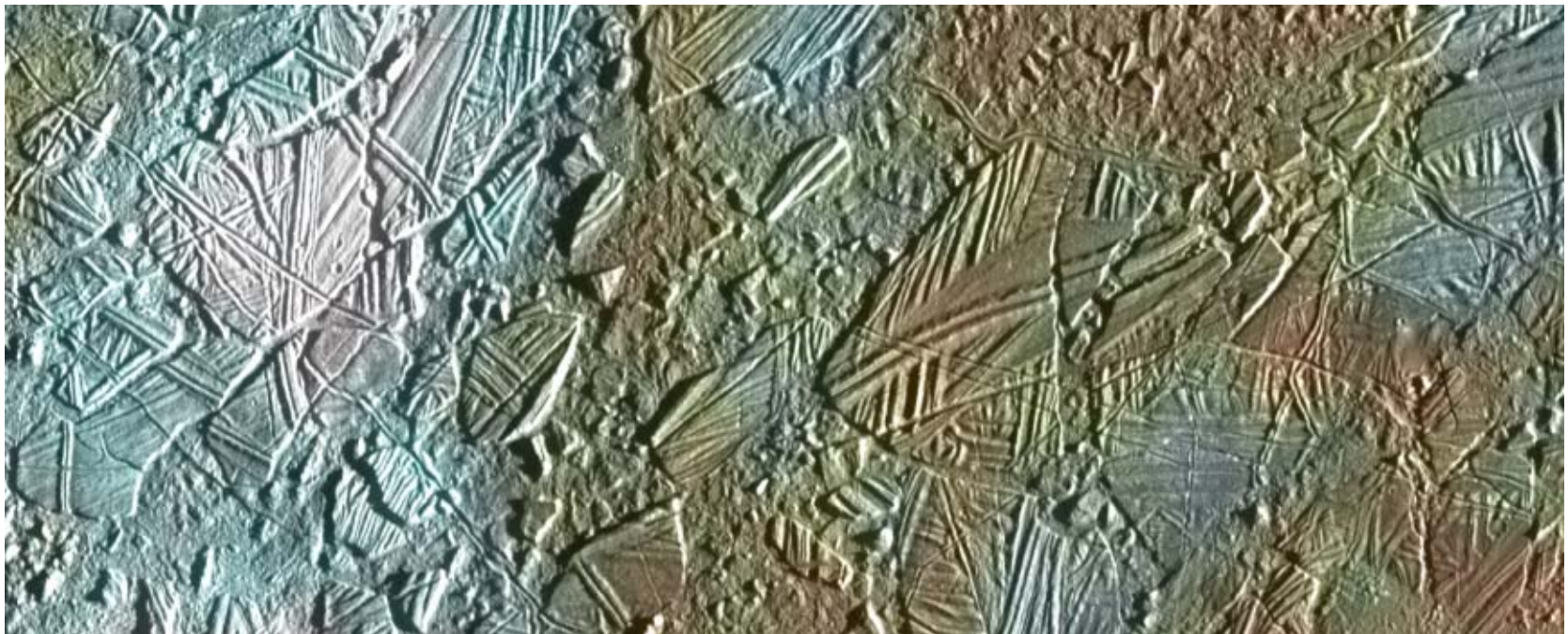
Study Process

- Study initiated February, 2001.
- Received presentations from:
  - NASA, NSF, DOE and NIH officials;
  - PIs and/or representatives from 13 of 15 NAI nodes;
  - Representatives of other groups, including:
    - Space Telescope Science Institute
    - SETI Institute
    - Monterey Bay Aquarium Research Institute
    - Smithsonian Astrophysical Observatory
    - Salk Institute
- Report drafted February-May, 2002



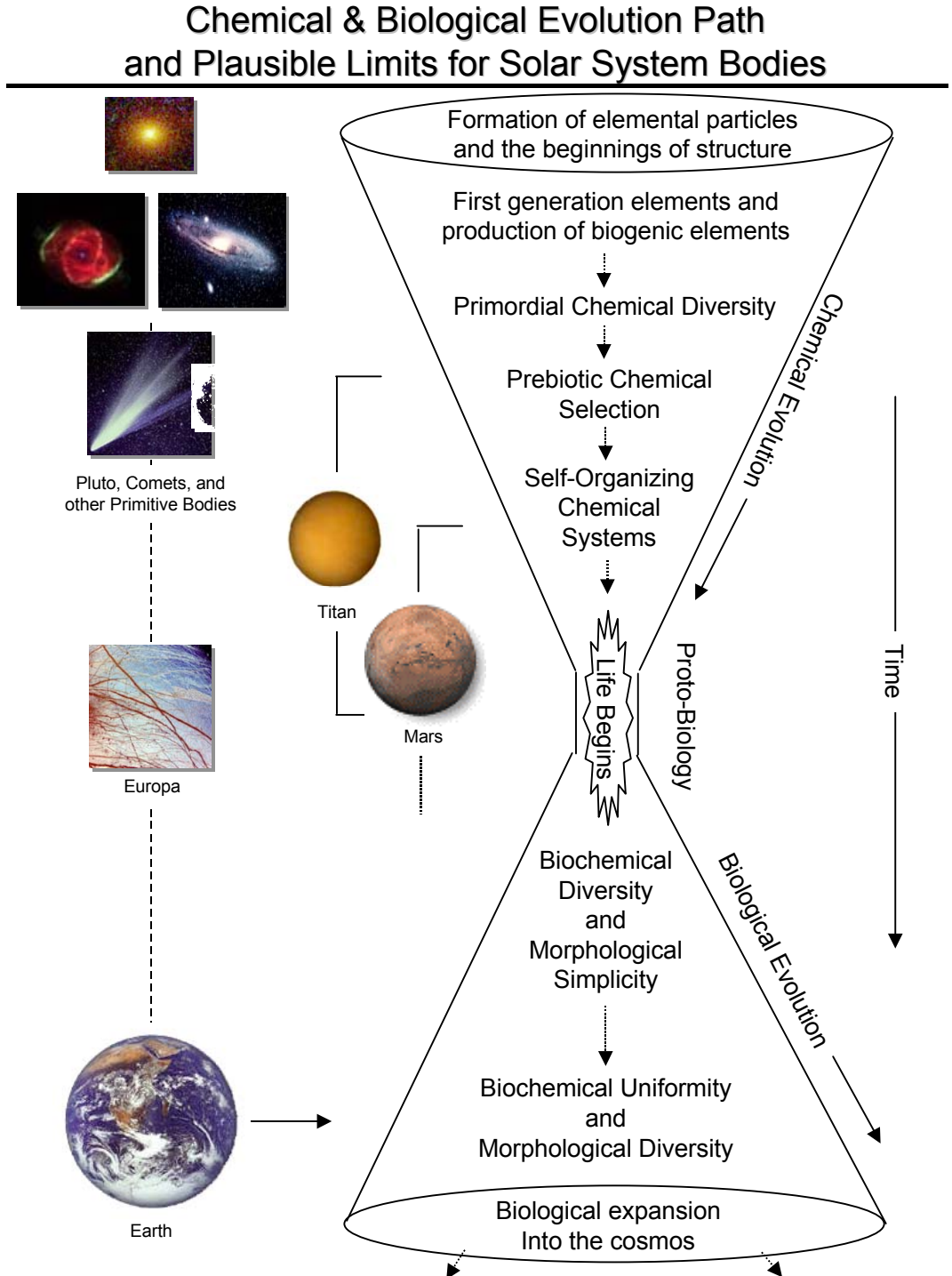
COEL commends NASA for:

- The remarkable progress made in the past 5 years organizing the Astrobiology program.
- Recognizing the high value of R&A programs related to Astrobiology.
- The present level of involvement of the Astrobiology program in flight missions.
- Developing a well-balanced solar system exploration program as a foundation for the central endeavor of astrobiology.



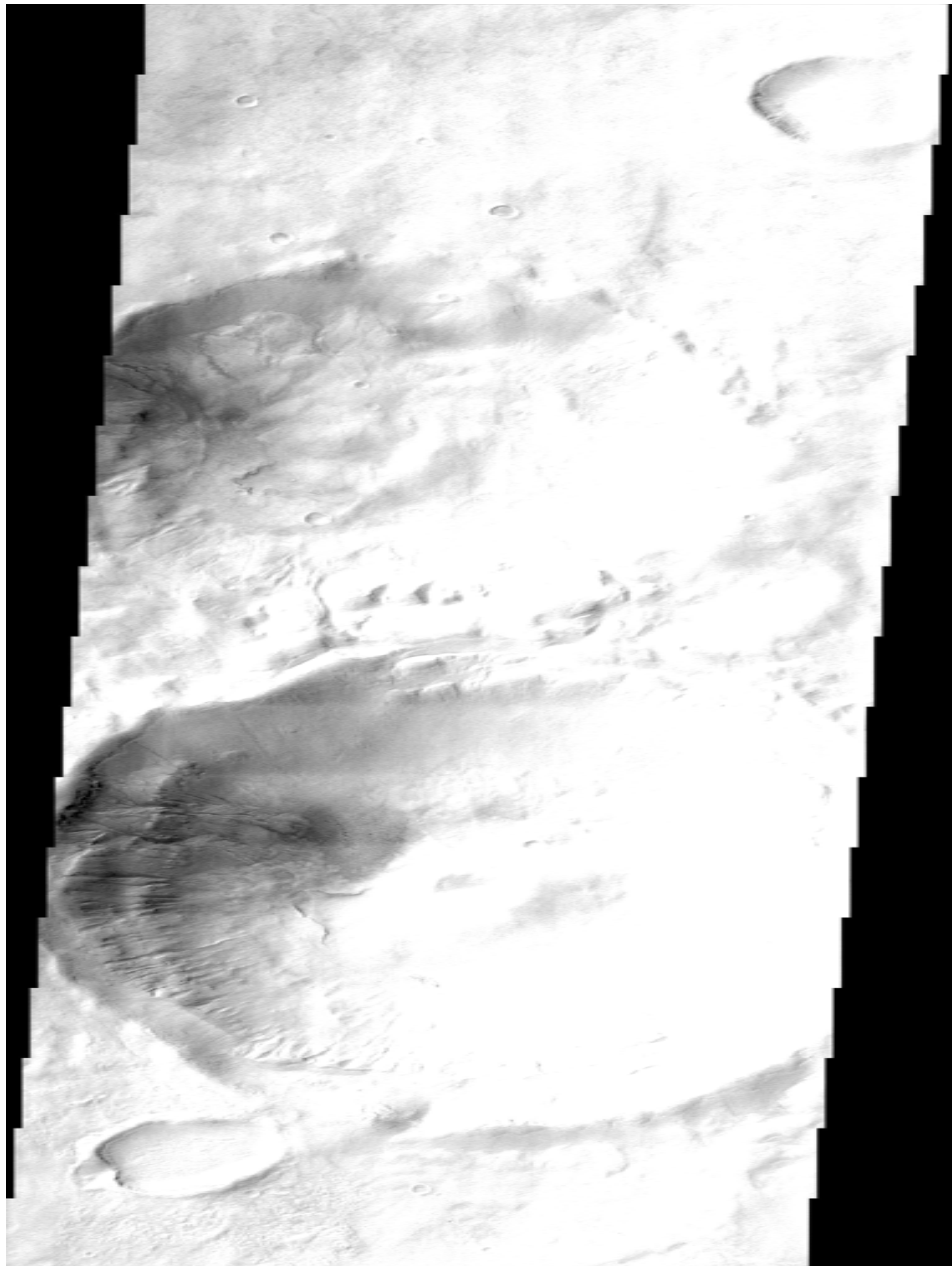
Findings I
The Astrobiology Roadmap

- Current Roadmap is too broad and insufficiently selective in defining the following:
  - 1. Central research goals of astrobiology
  - 2. Peripheral goals that still may contribute
  - 3. Goals genuinely outside of astrobiology as an intellectually coherent endeavor
- The Astronomical Origins and Astrobiology road-mapping processes needs to identify overlaps in the two programs.



Findings II:What is Astrobiology?

- NASA should tighten definition of astrobiology to focus directly on a selected set of issues relating to the origin, evolution, and ubiquity of life in cosmos.
- An important operational goal of astrobiology is to inform NASA missions with respect to the techniques and targets for the search for life and for the search for clues to steps leading to the origin of life on Earth



Findings III: Review of Program

- It is premature to assess the overall scientific impact of Astrobiology program and, in particular, NAI
- A comprehensive review of the scientific and educational aspects of the program is required no later than 2008 (i.e., after 10 years of operation)
- Internal reviews of NAI nodes required to ensure that they remain centered on the goals of the NAI.
- NAI nodes should reapply every 5 years, and weaker nodes should be dropped to allow the introduction of new ideas and approaches.

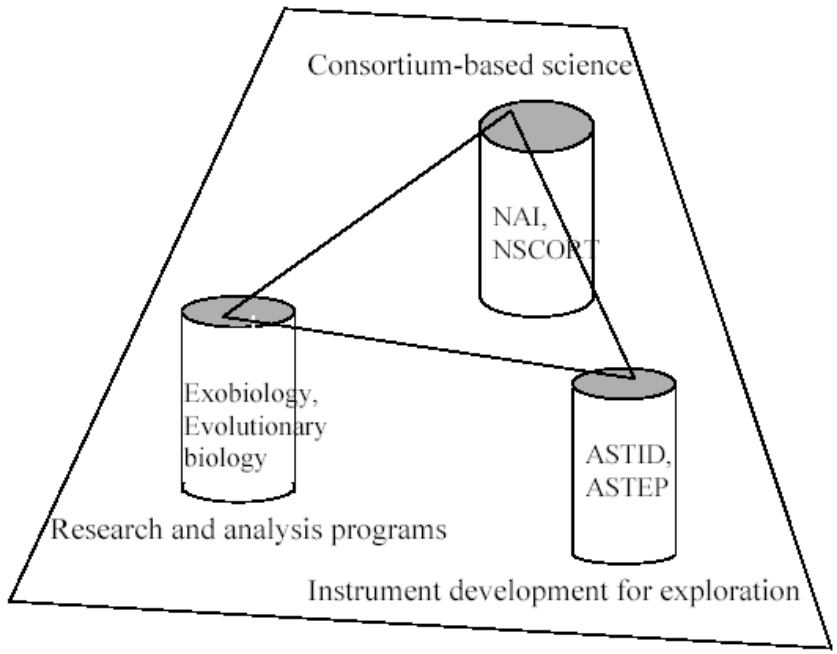
Findings IV: Other Issues

- NASA should implement communications solutions to bring NAI in line with the original institute concept.
- Astrobiology should be integrated into flight missions, but NAI should not be asked to develop “astrobiology missions.”
- NAI members should not be identified or given any preferential status in mission competitions

Enhancements I
Balancing the Program

- The exobiology NSCORTs are important alternative models for doing consortium science. They should continue to run in parallel with NAI
- Research and Analysis should maintain their visibility in the Astrobiology program

•NAI, R&A, and technology (ASTIS and ASTEP) funds should be balanced to ensure a strong program.

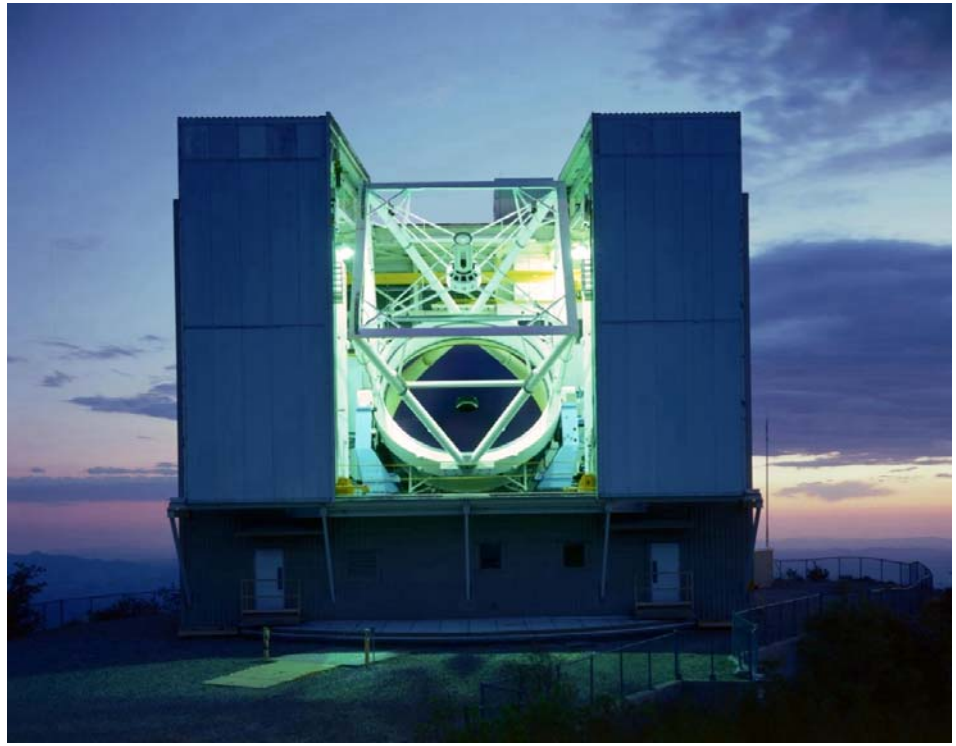


Enhancements II Balancing the Players

- The NAI should broaden its planetary science focus groups beyond those currently devoted to Mars and Europa.

•Panels evaluating NAI membership proposals must be broadly constituted to reflect the diversity of disciplines (i.e., life sciences, geosciences, and astronomical sciences) found outside existing NAI nodes.

Enhancements III: The "Astro" in Astrobiology



- NASA should foster more extensive links between the Astrobiology and Astronomical Origins programs
  - NASA should study the feasibility and desirability of creating and funding an institute, akin to NAI, dedicated to consortium-based science and technology development relating to astronomical origins on the full range of spatial and temporal scales

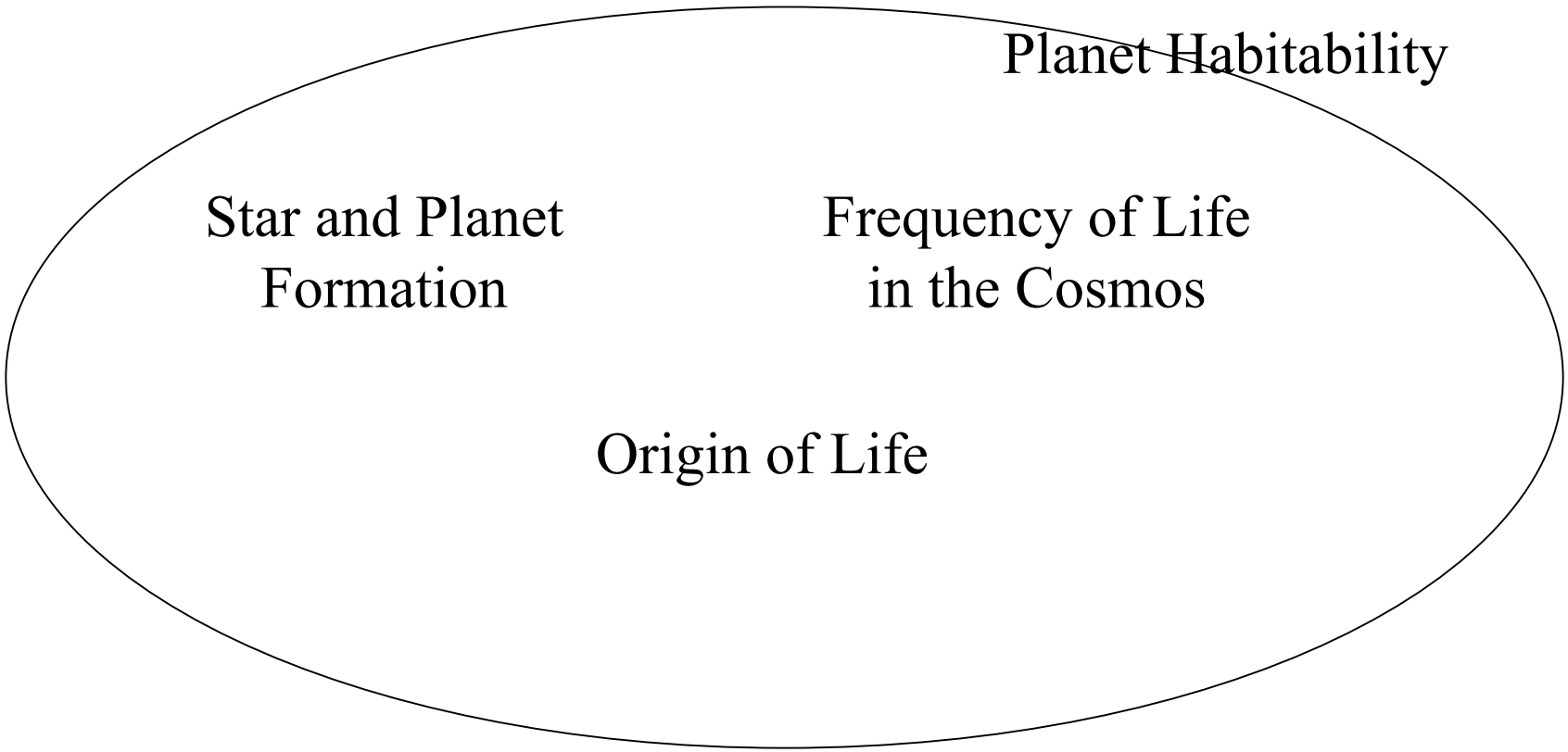
ORIGINS

Cosmology

ASTROBIOLOGY

Gravitational Biology

Galaxy Formation

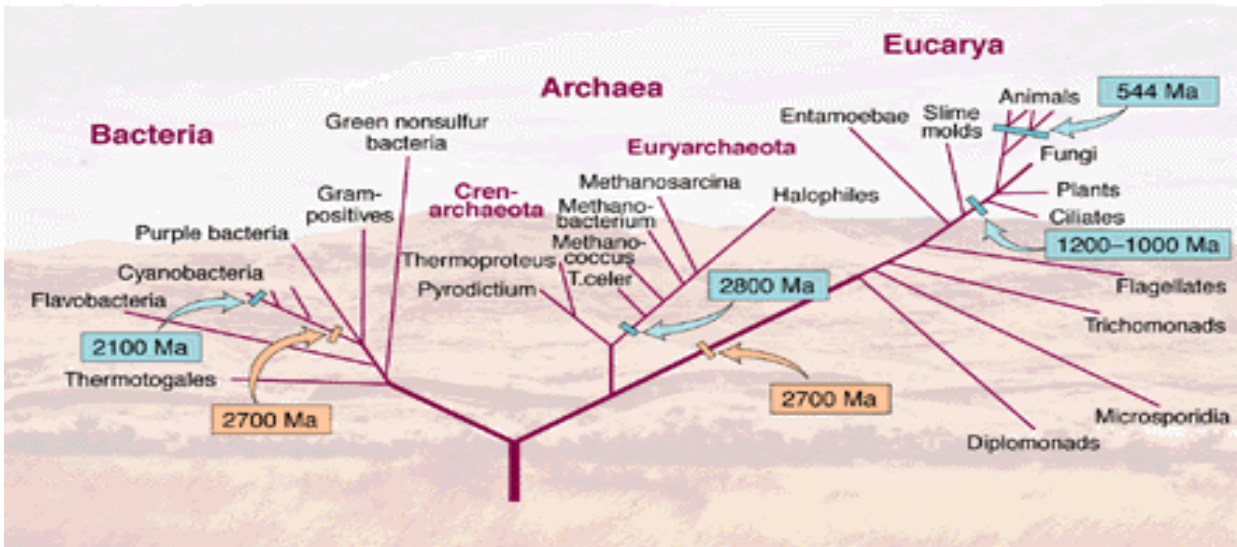


Astrobiology and NSF

- NASA and NSF have different, but complementary, personalities which are important for the advancement of astrobiological research
  - NSF is hypothesis driven and discovery-based proposals fare poorly
  - NASA is mission oriented, takes an exploratory approach, and discovery based proposals are encouraged

Astrobiology, DOE, and NIH

- DOE has a uniquely productive gene-sequencing program which NASA should find creative ways to leverage.
- NIH has resources far beyond NASA's, however discovery-based research is not encouraged. As a result, NIH has overlooked many insights into astrobiology that might be gained from NASA's non-reductionist approach.



Astrobiology and USDA

- Genomes of agriculturally important organisms reflect the response of ancestoral organisms to historical changes in physical and biological environment--including mass extinctions and major climactic variations.
- NASA should cooperate with USDA to enable astrobiologists to use and interpret these genetic records.

Astrobiology Abroad

- The formation of the NAI has had a galvanizing effect on Astrobiology research worldwide.
- The Centro De Astrobiologia in Spain is the sole NAI Associate organization.
- NAI Affiliates are:
  - The UK Astrobiology Forum & Network
  - The Australian Centre for Astrobiology
  - The Groupement de Recherche en Exobiologie.

Astrobiology Abroad II

- Unaffiliated astrobiological groups include:
  - The European Exo/Astrobiology Network Consortium
  - The Russian Astrobiology Center
- Astrobiology is an example of the United States leading the rest of the world into a new discipline area and new forms of research.

SETI and Astrobiology

- The leadership of the SETI Institute has forged a unique endeavor out of private and public funds, maintained a high standard of scientific research through its peer-reviewed research activities, and articulated clearly and authoritatively the rationale for approaches to a comprehensive search for extraterrestrial intelligence.

Conclusions

- NASA scientists and managers deserve credit for implementing a broad program in an era of tight budgets.
- NASA's Astrobiology program is well poised to catalyze fundamentally important discoveries concerning the origin of life, its distribution in the cosmos, and the long-term fate of life on our own home world.