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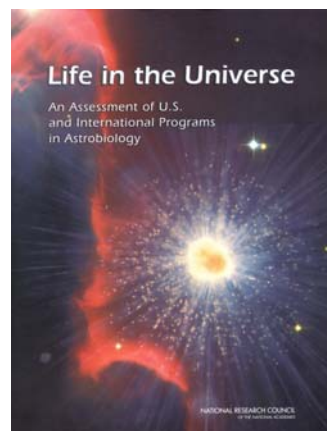
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Life in the Universe: an Examination of United States and International Programs in Astrobiology - Summary

SPACE STUDIES BOARD BOARD ON LIFE SCIENCES

Background. In 1996, NASA began to define a multidisciplinary program in astrobiology to consolidate research into the origins, distribution, and fate of life in the universe. In 1997, the agency formed an entity, the National Astrobiology Institute (NAI), to coordinate and fund this research. The NAI made use of advanced telecommunications technology to join several research centers called nodes into a virtual institute format. In 1998-1999, NASA developed a roadmap for astrobiology research to guide the NAI's efforts. The roadmap addressed three main questions: How does life begin and evolve? Does life exist elsewhere in the universe? What is life's future on Earth and beyond?



In anticipation of the program's fifth anniversary, NASA requested the National Research Council (NRC) for a review of the agency's astrobiology research program. In particular it asked the NRC to assess the direction of the NASA Astrobiology program, survey other domestic and international efforts for seeking life in the universe, identify how the U.S. program may be improved, and recommend any coordination efforts. The study was originally mandated by Congress in the National Aeronautics and Space Administration Authorization Act, 2000, 2001, and 2002 (P.L. 106-391).

Status. While the field of astrobiology is early in its development, the committee (the Committee on the Origins and Evolution of Life) finds that NASA has made much progress in defining key questions, initiating research, and developing collaborative efforts. Diversity of techniques and breadth of disciplines have come to characterize this field, and these attributes must be maintained.

While the 1998-1999 research roadmap was a strong effort that did much to shape the field and provide research objectives, it is too broad and not selective enough in defining research goals. The committee recommends that NASA define astrobiology more carefully and focus on issues directly linked to the origin and evolution of life. A new roadmap is needed, and one of its goals should be to reduce the overlap and strengthen the interaction between NASA's astronomical origins and astrobiology activities.

The committee noted that the field of astrobiology is developing rapidly and that the drive and enthusiasm of the researchers, particularly of the NAI, is impressive. The committee also found that the startup of the NAI has been impressive and recommends

that a comprehensive review of the scientific and educational aspects of the program and the institute be undertaken on their tenth anniversary in 2007-8.

At the same time, the committee argued that the virtual institute aspect of the NAI has not kept pace with the rest of the program. NASA needs to review the technical and cost requirements of the virtual institute and make the necessary upgrades.

The committee found that NASA has done an excellent job of incorporating the NAI into its planning for astrobiology space missions. It recommended, however, that NASA should expand non-institute astrobiology research funding. These efforts are important if astrobiology is to mature as a field of science and if opportunities are to be created outside the NAI centers for new graduates. In this connection, collaboration between NAI and non-NAI research has not been adequate to date.

The NAI should reward virtual institute nodes for establishing collaborative ventures with researchers beyond the institute. While long periods are required for the full benefits of research programs to be realized, the NAI should consider establishing new nodes and retiring others in order to stimulate new ideas. A careful review of the nodes after five years would be important in this context.

Program Enhancement. The astrobiology program's research and analysis activity, now centered on exobiology, is essential to the continued health of the program. NASA should add evolutionary biology to the research and analysis ensemble.

The committee recommended that NASA maintain a balance in the astrobiology research program among its research and analysis programs, technology development programs, and the NAI. The program should also add a technology development program focused on instrumentation for both space and terrestrial use.

Currently, there is an insufficient contribution to astrobiology research from planetary sciences and astronomy relative to the biological and geological sciences. More exchange of ideas between astrobiology and the traditional space sciences is needed. The committee recommends more focus groups, beyond those currently centered on Mars and Europa, with the astrobiology and planetary sciences community to create a deeper level of understanding between those two fields. In addition, stronger links should be formed between the Astrobiology and Astronomical Origins programs, and NASA should explore the creation of an astronomical origins institute analogous to the NAI.

Other Public and Private Programs. NASA needs to establish and strengthen connections with the Department of Energy (DOE), the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Department of Agriculture (USDA) to make use of research carried out by those agencies that is relevant to the Astrobiology program. The gene sequencing work supported by DOE and USDA should be of particular interest. The biological research sponsored by NSF – especially the Life in Extreme Environments program – has already made a major contribution to the NASA Astrobiology program.

The committee also notes the privately supported search for extraterrestrial life (SETI), which is centered at the SETI Institute. The committee commends the Institute for developing a strong, well-crafted research program with a stable private funding base.

International Programs. The committee notes that there are growing international efforts in astrobiology and that NASA has played an important role in encouraging those efforts. Particularly noteworthy is the contribution of the NAI to the formation of the Centro de Astrobiologia (CAB) in Spain. NASA and NAI should continue these “seed” efforts but in a way that does not give the impression it is pressuring other countries to embark on astrobiology research.

An important concern for international cooperation is the International Traffic in Armaments Regulations (ITAR). It is possible that ITAR could act to limit the exchange of technical information and hinder the development of international agreements in astrobiology research. The committee notes that recent changes to ITAR have lessened this possibility, but cautioned NASA to continue monitoring the situation.

Conclusion. NASA’s Astrobiology program is in a good position to stimulate important discoveries about the origins of life, its distribution in the universe, and its fate on Earth. To help ensure these goals are met, NASA needs to maintain its efforts to involve a range of disciplines and a diversity of methods in the research program.

For Further Information

Copies of the complete report *Life in the Universe: An Examination of United States and International Programs in Astrobiology*, can be obtained on the National Academy Press Web site <www.nap.edu/>.

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