



CAPS Update from NASA Astrobiology Program

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Washington, DC

Dr. Mary A. Voytek
Senior Scientist Astrobiology
NASA Headquarters



Astrobiology

The study of life in the Universe, focusing on three fundamental questions:

- How does life begin and evolve?
- Does life exist elsewhere in the Universe?
- What is the future for life on Earth and beyond?

How did we get here?

Where are we going?

**Are we alone? *or*,
Is there anybody else out there?**

**Knowledge of Space
Environments**

**Knowledge of Earth
Organisms**





Astrobiology Program Funding Priorities

Identified by Gaps in Investment Portfolio

Identified through Topical Workshops

National Academies

NASA

Science Needs in Support of Ongoing and Future Missions

MSL

OSIRIS-Rex

ExoMars

MARS 2020

Europa

Partnerships with Other Agencies

NSF- Center for Chemical Evolution

NSF- Ideas Lab

National Science Priorities

Microbiome Initiative

Ocean Worlds



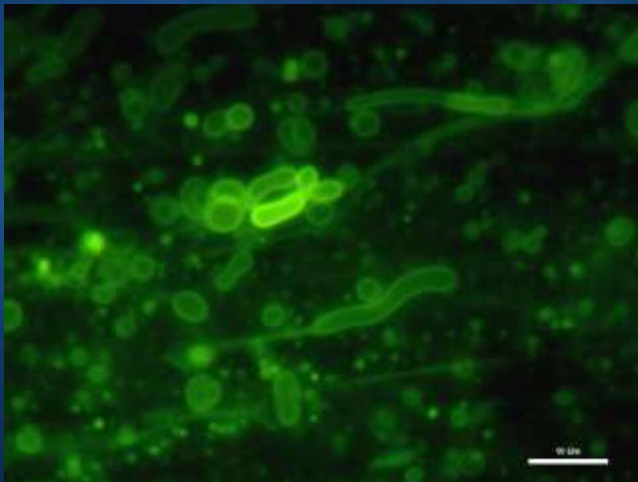
Astrobiology Unites Disciplines to Study Life in the Universe

Origins and distribution of habitable planets



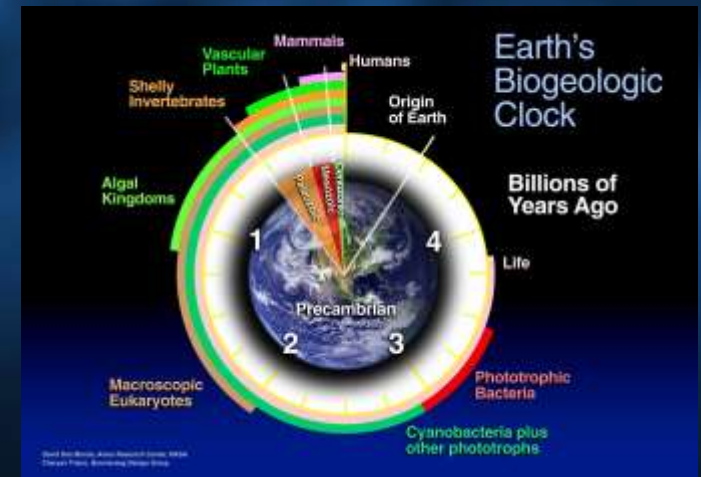
Chemistry of prebiotic environments

Prebiotic evolution and origins of life



**Origins,
Evolution &
Distribution
of Life**

Evolution of biospheres and their biosignatures



Attributes of living systems

NASA Science Mission Directorate

Astrobiology Program





Notional Astrobiology Funding 2017

Program	Funding level
Exobiology and Evolutionary Biology	\$17M
Emerging Worlds	\$2M
Habitable Worlds	\$7.5M
Planetary Science and Technology through Analogue Research (PSTAR)	\$13M
NAI	\$20M (\$1.3M)
NASA Astrobiology Postdoc Program	\$1.5M
NASA Earth and Space Science Fellowships	\$700k
NSF CCE	\$1M
NSF Ideas Lab (OOL)	\$4.3M
Astrobiology Workshops	\$750K
Astrobiology Technology (PSD, STMD)	\$3-20M



What is the Ideas Lab?

Inputs: Grand Challenge Topic, Creative People, Money



Creative Environment: "Ideas Lab"



Outputs: Potentially Transformative, Novel,
Adventurous, Innovative, Interdisciplinary Ideas
"Wow Factor"



Who is Involved?

Mentors

focus on the topic

Facilitators

focus on the process

Participants





NSF-NASA Joint Ideas Lab

Working Title: “The Origin of Translation”
Timeline

Call by June 2016- 130 apps

Participant Selections Sept 2016 -29

In Person “Ideas Lab” Sept 2016

Final Proposals Due Dec 17, 2016

Selections (5) March, 2017



Origins of Life Ideas Lab Selections

NASA-funded:

1. Becoming Biotic: Recapitulating Ancient Cofactor-Mediated Metabolic Pathways on the Early Earth, PI: Laurie Barge (JPL).
2. The emergence of evolvable surface-associated interacting molecular ensembles: A chemical ecosystem selection approach, PI: David Baum (U Wisconsin)
3. Understanding Translation through Experimental Evolution, PI: Michael Travisano (U Minnesota)

NSF-funded:

1. Life Out of Water - Possibility of Evolution in Non-Aqueous Environments, PI: Loren Williams (GA Tech)
2. Biochemical, Genetic, Metabolic and Isotopic Constraints on an Ancient Thiobiosphere, PI: Boswell Wing (U Colorado, Boulder)



Planetary Science in Antarctica



- Future astrobiological research associated with solar system exploration requires science investigations targeting terrestrial extreme environments that may be analogous to those found on other planets, past or present.
- Many Antarctica environments provide a unique extraterrestrial analogs to support studies.
- In the past the Astrobiology Program has supported analog studies in Antarctica that cover a broad range of activities integrating science, instrument testing and technology development.
- PSD is no longer accepting proposals for work in Antarctica. Analog investigations seeking to fundamentally understand the Antarctic environments and/or ecosystems with potential links to planetary environments should be proposed to the United States Antarctic Program (USAP-NSF).
- The USAP manages all U.S. scientific research and related logistics in Antarctica, as well as aboard ships in the Southern Ocean. The USAP, funded by the National Science Foundation's Office of Polar Programs, supports only that research that can be done exclusively in Antarctica or that can be best conducted in Antarctica. The scientific disciplines encompassed by the USAP are astronomy, atmospheric sciences, biology, earth science, environmental science, geology, geophysics, glaciology, marine biology, and oceanography.



Cooperative Agreement Notice (CAN) for the NASA Astrobiology Institute (NAI) Cycle 8

CAN Release Date:	February 27, 2017
Pre-proposal Conference:	March 10, 2017
Step 1 Proposals Due:	April 12, 2017
Questions Due:	Up to 10 days prior to due date
Step 2 Proposals Due:	July 6, 2017, 11:59 pm Eastern
Time	

For this procurement, NASA anticipates making selections during Fall 2017. and making initial awards under this CAN is January 2018.



The theme for AbSciCon 2017 is “Diverse Life and its Detection on Different Worlds.”

April 24–28, 2017 in Mesa, Arizona
at the Mesa Convention Center

Meeting Format:

Plenary sessions on current and controversial topics,

Topical oral and poster sessions

Evening programs, and public programs.

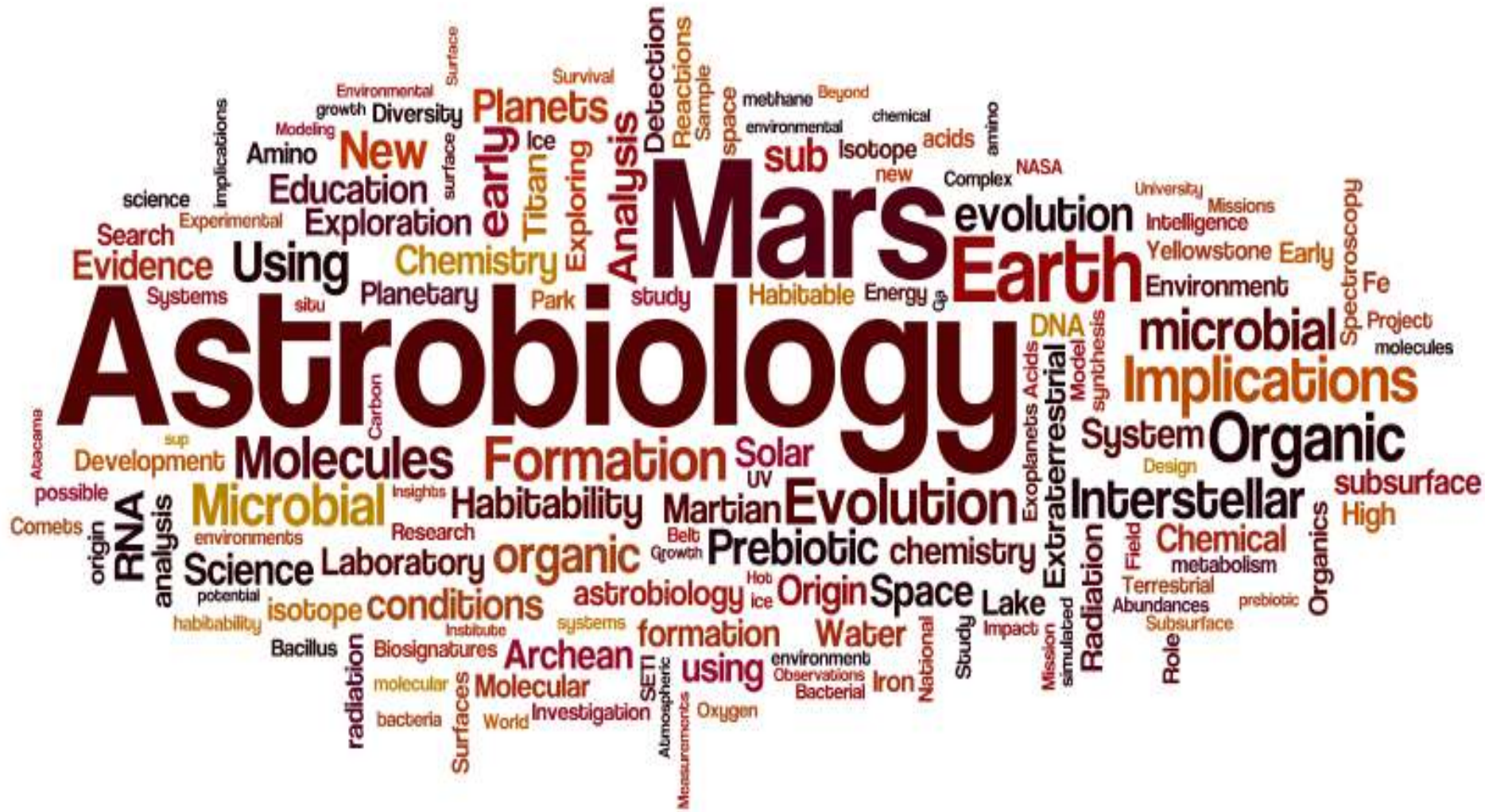
Green Initiatives

Remote Participation



Science Questions

- What interstellar and protoplanetary disk processes determine the chemistry of a planet? What prebiotic chemistry sets the stage for life?
- Is a one-pot approach to prebiotic polymer chemistry possible? What are future applications of origins chemistry?
- Do habitable conditions exist on Europa, Enceladus, or other icy worlds? If so, for how long, and how continuously have they existed?
- Are extreme environments on Earth valid analogs to sites on Mars or icy satellites?
- What are the metabolisms utilized by life in different evolutionary stages, and in extreme environments?
- How can molecular studies and the sequencing revolution help us understand the evolution of the three domains of life, including such evolutionary innovations as multicellularity and photosynthesis?
- What is the evolution of biogeochemical cycles and environment on Earth and other planets?
- Are nominally habitable “water world” exoplanets good places to look for signatures of life?





Europa Lander SDT

- Science Definition Team (SDT) delivered its report with 3 prioritized goals:
 1. Search for Evidence of Life
 2. Assess habitability
 3. Characterize surface and subsurface
- Applying lessons learned from Viking landers
- Used extreme, limited nutrient Earth environments as analogs
- Approach: Multiple line of evidence are needed to detect life
- Presented a decision framework for life detection to assess how results should be interpreted

Town Hall at AbSciCon: Sunday, April 23





NASA Authorization Act of 2017

The SMD-related portion of this bill includes several additional reporting requirements:

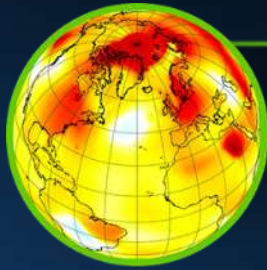
Sec. 508 requires NASA to task **the National Academies to develop a science strategy for the study and exploration of extrasolar planets**; this strategy is due 18 months after enactment (~September 2018).

Sec. 510 requires a report on how NASA **plans to expand public-private partnerships in astrobiology**; this report is due 180 days after enactment (~September 2017)

Sec. 509 requires NASA to task **with the National Academies to develop a science strategy for astrobiology**; this strategy is due 18 months after enactment (~September 2018).



Key NASA/SMD Crosscutting Science Themes



Safeguarding and
Improving Life on Earth



Searching for
Life Elsewhere



Expanding our Knowledge



An NRC Study Would Build on The Astrobiology Science Strategy



- ◆ Community based & semi-decadal
- ◆ Broad participation in creation:
 - ✦ 77 Contributors
 - ✦ 744 members of *astrobiologyfuture.org*
 - ✦ 12 reviewers who made invaluable contributions.
- ◆ Goal was to create an “inspirational and aspirational” document.
- ◆ A PDF version is available on the Web. (Limited Printed Copies)
 - ✦ Will be “wiki-fied” to make it a living document.

(Released Fall 2015)



Six Major Research Areas Covered in the Strategy



1. Identifying abiotic sources of organic compounds
2. Synthesis and function of macromolecules in the origin of life
3. Early life and increasing complexity
4. Co-evolution of life and the physical environment
5. Identifying, exploring, and characterizing environments for habitability and biosignatures*
6. Constructing habitable worlds*

* (Overlap APD)



Additional Foundational Activities and Documents

- ◆ Exoplanet Biosignatures Workshop July 2016- Joint NExSS-NAI-ExEP effort
- ◆ Agnostic Biosignatures: Recognizing life as we don't know it. HQ hosted, September 7-9, 2016
- ◆ Biosignatures of Extant Life on Ocean Worlds Workshop. GSFC hosted, September 12-14, 2016
- ◆ Searching for Life Across Space and Time: A Workshop NRC hosted, December 5-6, 2016 Irvine, CA
- ◆ Europa Lander Study 2016 Report
- ◆ Ocean Worlds Exploration Roadmap OPAG coordinated Input for Mid-Term Decadal (Delivery Date 2017)
- ◆ NExSS

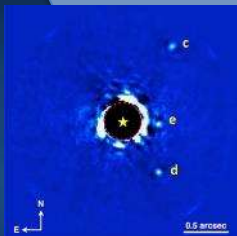


Nexus for Exoplanet Systems Science, NExSS

NASA's cross-divisional studies of Search for Life Elsewhere

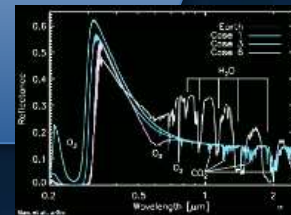
Astrophysics

Exoplanet detection
Star characterization
Mission Data Analysis
Hubble, Kepler,
TESS, JWST,
WFIRST, Etc.



PSD Astrobiology

Comparative planetology
Planetary atmospheres
Exoplanet detection of
Biosignatures
Habitability

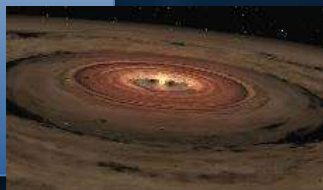


**Earth
Sciences**
How planet
systems works



PSD Exoplanet Research Program (XRP)

Exoplanet characterization
Protoplanetary Disks
Planet formation
Comparative planetology



Heliophysics

Star characterization
Detection of planetary
magnetospheres
Stellar winds





Charge to NRC

In preparation for the upcoming decadal surveys in astronomy and astrophysics and planetary science, the National Academy of Sciences will appoint an ad hoc committee to carry out a study of the state of the science of astrobiology as it relates to the search for life in the solar system and extrasolar planetary systems.



Such a study shall—

- ◆ assess and build on the current Astrobiology Science Strategy 2015;
- ◆ outline key scientific and technology challenges in astrobiology particularly as they pertain to the search for life in the Solar System and **extrasolar planetary systems**;
- ◆ should accommodate the overlap with the Exoplanet Exploration study in the area of assessing habitability and search for signs of life;
- ◆ identify the most promising research goals in the field of life detection in which progress is likely in the next 20 years;
- ◆ consider the role of and how to expand partnerships in furthering the to study life's origin, evolution, distribution, and future in the universe;
- ◆ indicate the extent to which U.S. and international missions and telescopes in operation or in development address the key research goals; and
- ◆ make recommendations on the above as appropriate.



Notional Timeline for Astrobiology Strategy Study

Sec. 509 requires NASA to task with the National Academies to develop a science strategy for astrobiology; this strategy is due 18 months after enactment (~September 2018);

To meet that deadline, NASA envisions the following timeline:

- **April – June 2017** – Engagement with National Academies, negotiation of study terms, establishment of contract (est. 3 mo.).
- **June 2017 – June 2018** – conduct of Astrobiology Strategy Study (est. 12 mo.).
- **June – September 2018** – draft study report, peer review as deemed appropriate, submission of report to NASA.
- **September 2018** – NASA submits report to Congress.



Astrobiology lies at the heart of the NASA Vision

To improve life here,

To extend life there,

To find life beyond,

- *Conduct robotic exploration of Mars to search for evidence of life, to understand the history of the solar system, and to prepare for future human exploration;*
- *Conduct robotic exploration across the solar system for scientific purposes and to support human exploration. In particular, explore Jupiter's moons, asteroids and other bodies to search for evidence of life, to understand the history of the solar system, and to search for resources;*
- *Conduct advanced telescope searches for Earth-like planets and habitable environments around other stars;*



51 U.S. Code § 20102 –

Congressional declaration of policy and purpose [for NASA]

NASA ... “shall be conducted so as to contribute materially to one or more of the following objectives:”

- (1) The expansion of human knowledge of the Earth and of phenomena in the atmosphere and space.
- (2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles.
- (3) The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space.
- (4) The establishment of long-range studies ... for peaceful and scientific purposes.
- (5) The preservation of the role of the United States as a leader in aeronautical and space science and technology...
- (6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency.
- (7) Cooperation by the United States with other nations and groups of nations ...
- (8) The most effective utilization of the scientific and engineering resources of the United States ...
- (9) The preservation of the United States preeminent position in aeronautics and space through research and technology development related to associated manufacturing processes.
- (10) The search for life's origin, evolution, distribution and future in the Universe.**



Questions???

