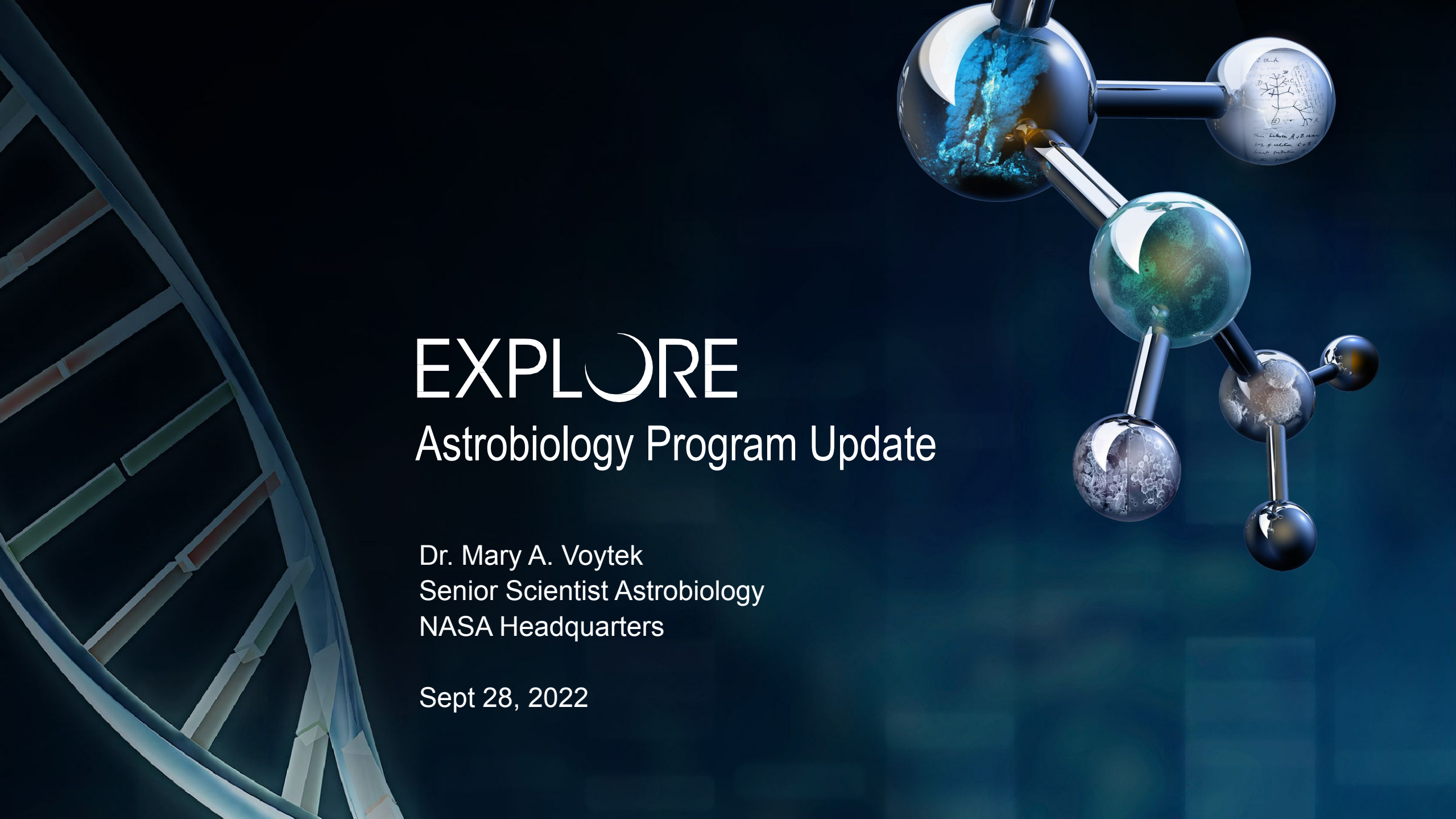


EXPLORE

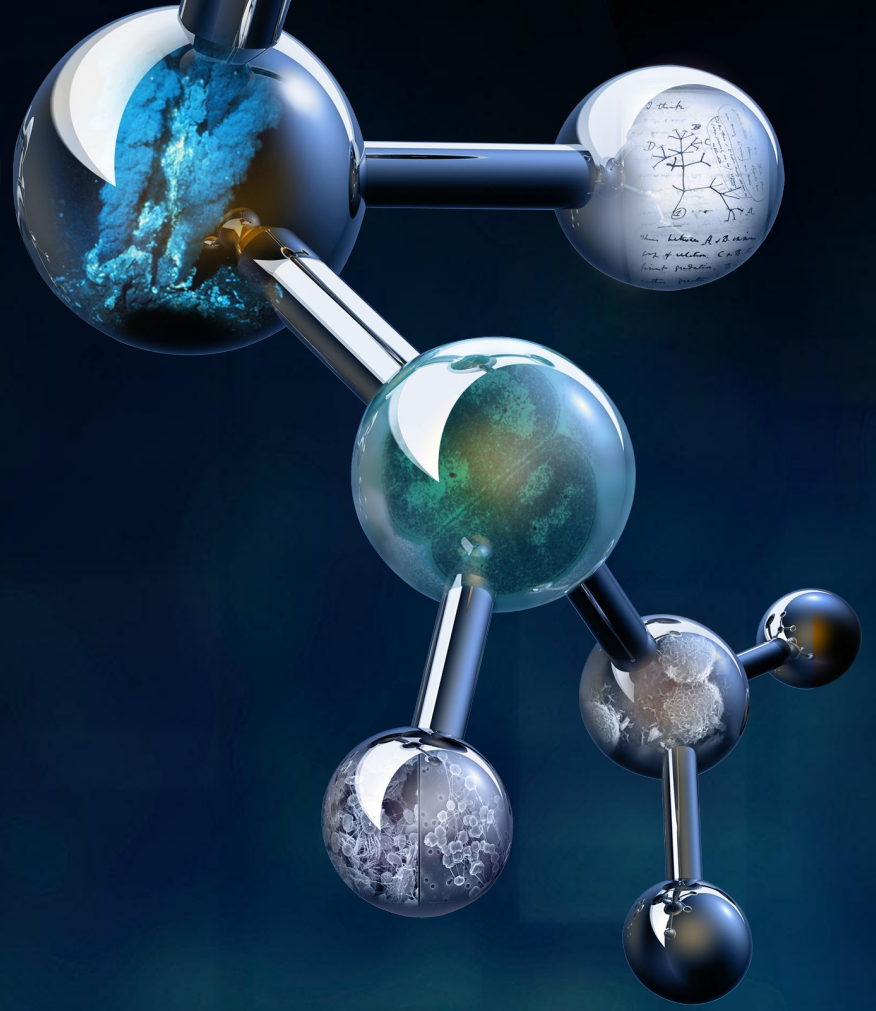
Astrobiology Program Update

Dr. Mary A. Voytek
Senior Scientist Astrobiology
NASA Headquarters

Sept 28, 2022

Astrobiology Funding Programs

- New requirements
- Exobiology
- Habitable Worlds
- ICAR



New Requirements

- **New requirements-Always read C.1**

  Fieldwork

  - Proposers conducting field research must include a description of their use of field site(s) that demonstrates:
    - Respect for the values of other users of the site by considering the impact that their work will have on the environment (e.g., sensitive ecosystems or historic properties of religious, cultural, or scientific significance).
    - A research plan that reduces impact to the site (if any).
    - The intention to obtain relevant permits and follow their guidelines.
    - Moreover, to help create an environment that is free of harassment and discrimination, proposers must cite a specific policy, code of conduct, or ground rules provided to participants in advance of the fieldwork. This information will be provided by proposers in response to an NSPIRES cover page question.

Exobiology Program

- Starting in ROSES-21 – No Due Dates
  - Overlap between ROSES years
  - Regular reviews (like a bus schedule)
  - Regular selections and managed funding (like a household budget)
- Response times – slightly better on average
- One-year prohibition on resubmission
- External Reviews – more important than before!

Habitable Worlds

- Starting with ROSES-2020, HW uses the dual-anonymous peer review process (DAPR)
- To submit a compliant proposal, it must be written using the anonymized format. Very important for proposers to REALLY pay attention to rules!
  - Out of 71 proposals submitted in HW20, 16 proposals were flagged for non-compliance. Ranged from no issue (e.g. improperly blacked out text) to minor infractions (e.g. improper citation format), to egregious (e.g. identification of proposal team/institution throughout).

Check out https://science.nasa.gov/researchers/dual-anonymous-peer-review

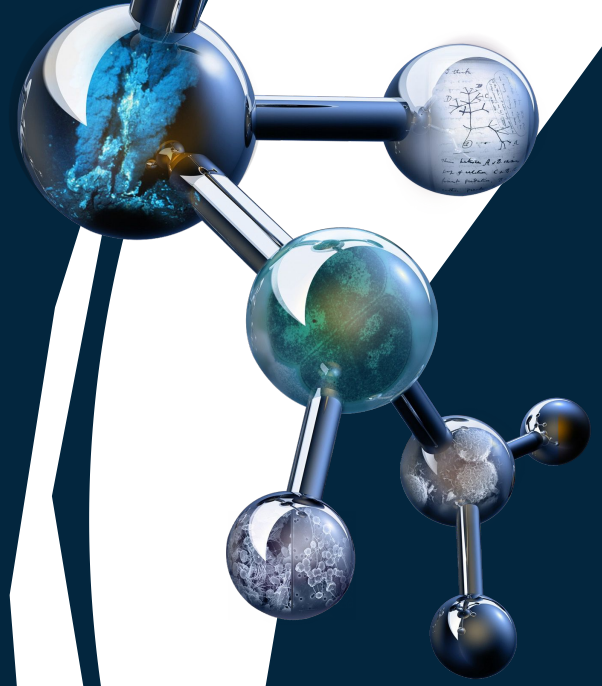
ICAR (Interdisciplinary Consortia for Astrobiology Research)

DATES:

- Step-1s were due Sept 15, 2022 (31 proposals received)
- Step-2s due Jan 10, 2023

Areas of Research Solicited:

- Biosignatures and Life Detection (RCN-NfoLD)
- Habitability and Detection of Life on Ocean Worlds (RCN-NOW)
- Habitability and Detection of Life on Exoplanets (RCN-NExSS)
- Prebiotic Chemistry in Early Earth Environments (RCN-PCE3)
- Primitive Cells to Multicellularity (RCN-LIFE)



AbSciCon 2022

Attendees: 1044 (a 12% increase over 2019 registration)

Onsite Attendees
260 students
384 professionals
8 retired

Online Attendees
137 students
241 professionals
14 retired

35 countries represented (29 were represented in 2019)

KEYNOTES & PLENARIES

DR. REVA KAY WILLIAMS
Sunday, 15 May 2022
6:30 PM ET
Lecture
LEARN MORE

NICOLE KING
Monday, 16 May 2022
8:30 AM ET
Lecture
LEARN MORE

KATHRYN STACK MORGAN
Tuesday, 17 May 2022
8:30 AM ET
Lecture
LEARN MORE

MEENAKSHI WADHWA
Tuesday, 17 May 2022
8:30 AM ET
Lecture
LEARN MORE

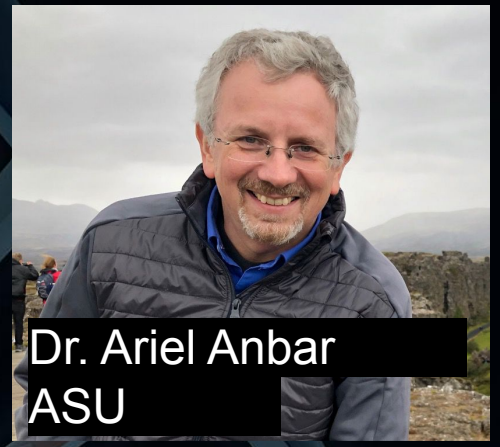
DR. BETÜL KAÇAR
Wednesday, 18 May 2022
8:30 AM ET
Lecture
LEARN MORE

DR. AOMAWA SHIELDS
Thursday, 19 May 2022
8:30 AM ET
Lecture
LEARN MORE

TRACY DRAIN
Thursday, 19 May 2022
6:30 PM ET

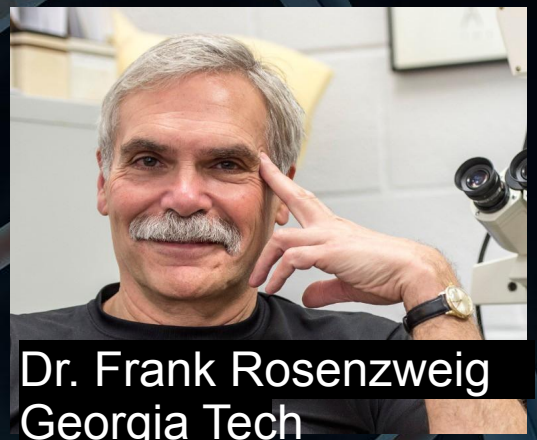
THE VENUS DIALOGUES: GETTING TO KNOW OUR NEIGHBOR: PROGRESS AND PROSPECTS IN A NEW GENERATION OF VENUS RESEARCH
Friday, 20 May 2022
8:30 AM ET

RCN Update



Dr. Ariel Anbar
ASU

Dr. Betül Kaçar
UW – Madison



Dr. Frank Rosenzweig
Georgia Tech

Dr. Mary Droser
UC – Riverside

LIFE

FROM EARLY CELLS TO MULTICELLULARITY

Earth is the only planet known to harbor life.

If we can't understand it here, how can we look for it elsewhere?

LIFE will discern rules of co-evolution that will enable us to predict how life could evolve on worlds other than our own, and how we might search for it.

Topics include environmental pressures and evolutionary opportunities behind:

- *Establishment of the first cells*
- *Rise of LUCA and LECA*
- *Life's expansion to planetary scale*
- *Compartmentalization of function within and among cells*
- *Rise of multicellularity and cellular differentiation*

Upcoming workshops:

"Reconstruction of Ancient Metabolisms" in Madison, WI

The search for life's ORIGIN, EVOLUTION, DISTRIBUTION, and FUTURE in the Universe.

Prebiotic Chemistry and Early Earth Environments
PCE3

LIFE: Early Cells to Multicellularity
ECM

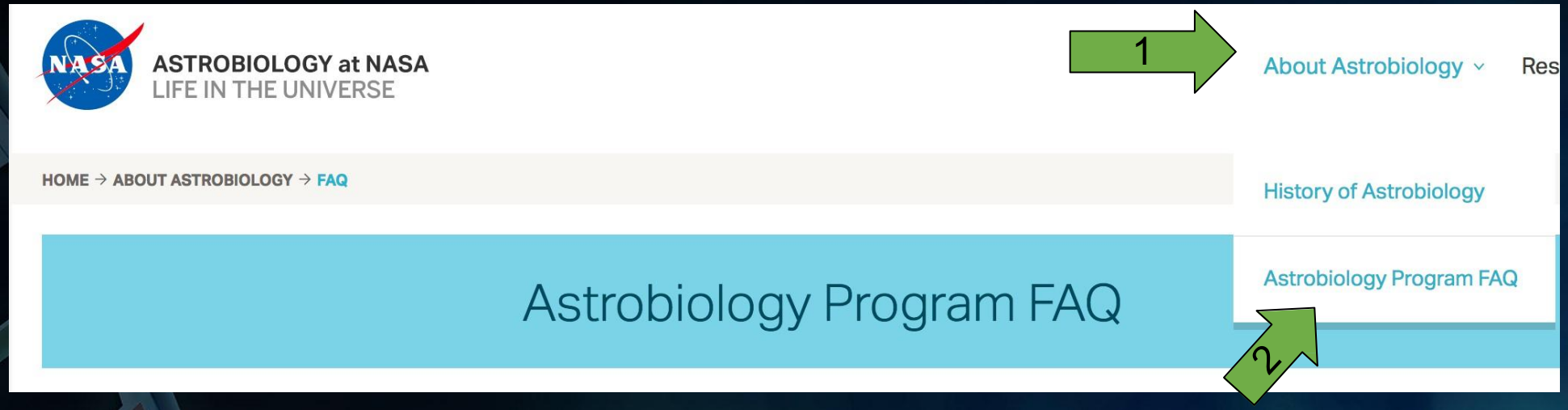
Network for Life Detection
NfOLD

The Nexus for Exoplanet System Science
NExSS

Network for Ocean Worlds
NOW

NASA Earth Sciences Division
NASA ESD

NASA Astrobiology Program - FAQs



This document contains answers to Frequently Asked Questions about the Astrobiology Program organized by topical areas:

- NASA Astrobiology Program (goals, 2015 Strategy, history, contact)
- Funding Astrobiology Research (ICAR, Workshops, Early Career, topic-specific programs)
- Coordinating Astrobiology Research (RCNs: what, who, how)

Network for Ocean Worlds

Primary Research Themes

- Physical Processes on Ocean Worlds
- Biogeochemical Cycles on Ocean Worlds
- Investigating Earth Analogs (Sites & Processes)
- Technology Development (Platforms & Sensors)

Upcoming Workshop

- Ocean World Analogs
  - -October 13-15th, 2022
  - -Denver, CO (*Museum of Nature & Science*)

Oceans Across the Solar System

- Workshop in 2019
- OCB session June 2021
- OASS white paper posted summer 2021 - different sections outline some of the priority areas for ocean research across the solar system, identify existing gaps, and provide ideas for developing testable ideas based on the Earth System
- Oceans Across the Solar System special issue of Oceanography – to be published summer 2022
- Interdisciplinary ROSES element (ESD):Ocean Worlds: Research at the Interface (NOIs due 10/14/2022; proposals due 11/16/2022)

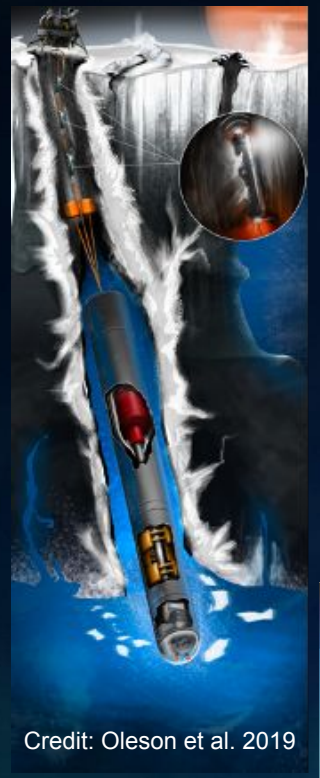
Oceanography

NASA

NOW Network FOR Ocean Worlds

Oceans Across the Solar System

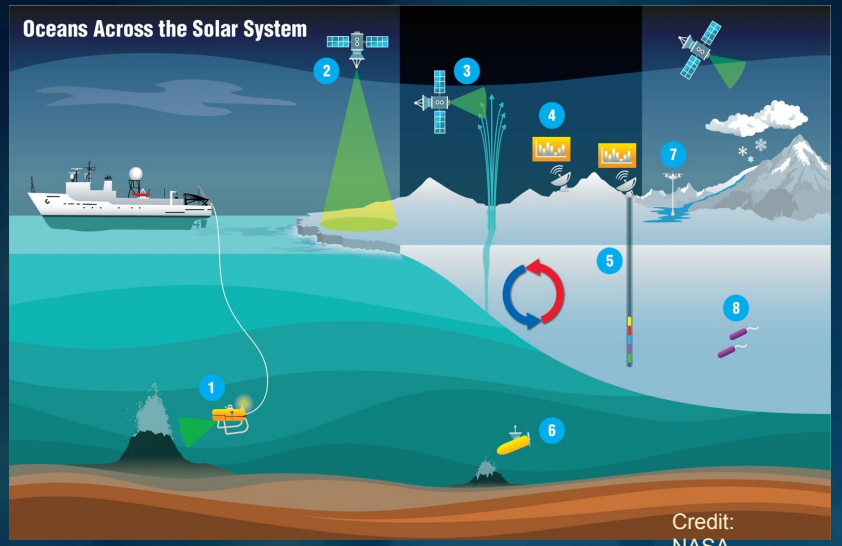
- Ocean system science to inform the exploration of ocean worlds – German et al.
- Defining and characterizing habitable environments in ocean world systems – Glass et al.
- Understanding the properties of environmental change in ocean worlds – Grebmeier et al.
- Research in analog environments to enable studies of ocean worlds - Arrigo
- Leveraging Earth hydrosphere science in the search for life on ocean worlds – Hoehler et al.
- Technologies for in situ and remote sensing exploration of ocean worlds – Chirayath et al.



Credit: Oleson et al. 2019

Fig 2. Artist concept for a cryobot probe

Credit: NASA



Credit: NASA

Network for Life Detection (NfoLD)

Advancing the science and technology required to search for evidence of life beyond Earth

Heather Graham,
co-lead

Brook Nunn,
co-lead

Alfonso Davilla,
co-lead

“Future of the Search for Life”

Life detection science and technology workshop, Spring 2022

FUt

Future of the Search for Life (FoSL)

March 21-25 and April 11-15, 2022

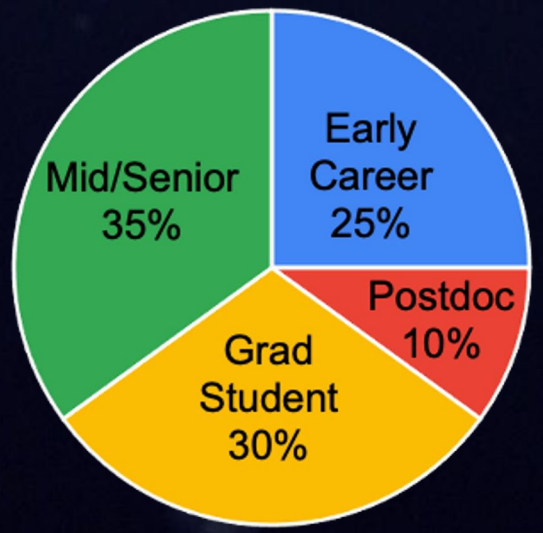
Future of the Search for Life: Science and Engineering Workshop

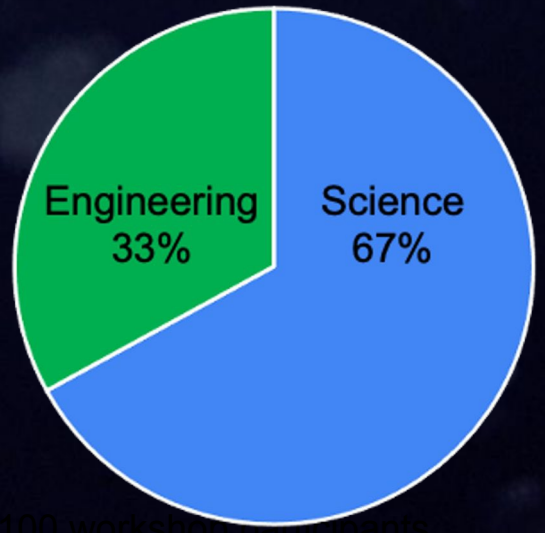
Purpose:

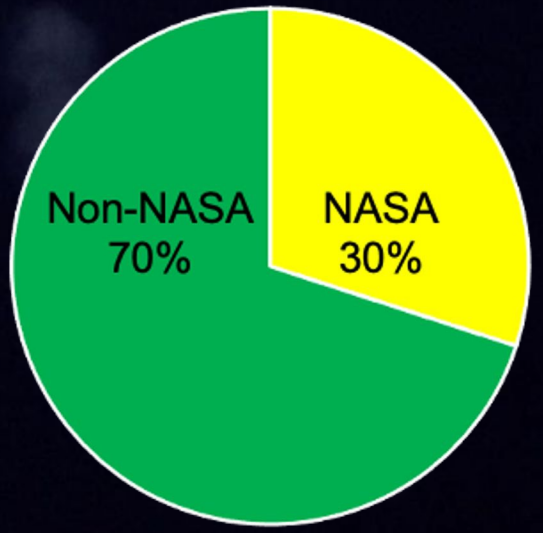
- Develop new and creative approaches to in-situ searches for life in our solar system
- Foster new science and engineering partnerships
- 2 Weeks , half-days, virtual, small breakouts

Think Beyond the State of the Art!

- **20+ years** from now (2040's)
- What **signs of life** should we look for, beyond Europa Lander / Enceladus Orbilander-type objectives? Broaden the set.
- What **levels of detection** are needed?
- Engage those from **outside usual NASA backgrounds**
- Engage **engineers** in science measurement development
- Workshop Report to help guide research and technology development

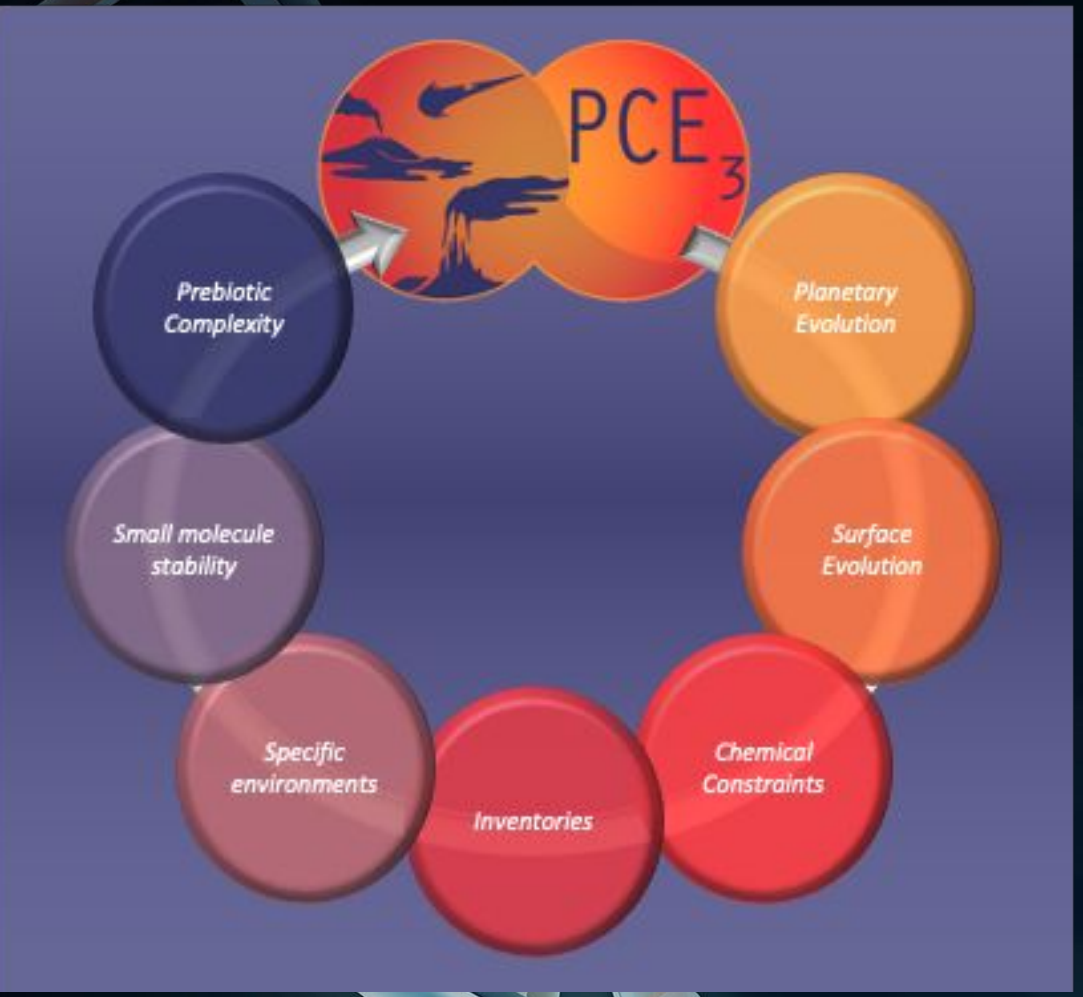






100 workshop participants

Prebiotic Chemistry & Early Earth Environments



PCE_3 Community Workshops

I: Building a New Foundation

Workshop Organizers: D. Trail, U. Muller, J. Elsila-Cook

1. Earliest Planetary Formation
2. Evolution of the Near Surface
3. Inventories, Geological Settings, & Building Blocks
4. Prebiotic Complexity
5. Peering into the Past with Today's biochemistry

Over 16,000 views of these lectures on our YouTube channel

II: Nano-to-Cosmic Studies of Complex System

The Nexus for Exoplanet Systems Science (NExSS)

NExSS covers the study of exoplanets, their habitability, and their potential biosignatures from a multi-disciplinary, cross-divisional perspective.

NExSS

- Running multiple virtual seminars, including on quantifying habitability, and inter-model comparisons for exoplanet climate models.
- Review

https://nexss.info
@nexssinfo


Dawn Gelino


Daniel Apai


Vikki Meadows


Shawn Domagal-Goldman

Expected outcomes for the Astrobiology Program RCNs:

- Investigators carry out and propose interdisciplinary research that addresses new topics through new collaborations.
- Produces a plan for utilization of current mission data (if applicable).
- Spawns ideas for new and exciting missions, and encourages participation in and contributions to missions from planning through operations (if applicable).
- Identifies new targeted technologies or instrumentation needed, but not yet reported elsewhere.
- Influences Decadal Surveys for all NASA Science Mission Directorate (SMD) Divisions
- Enhances international engagement.
- Supports continued development of the astrobiology community.

Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023 – 2032

22-16: NASA and other relevant agencies should catalyze research focused on emerging systems-level thinking about dynamic habitability and the coevolution of planets and life, with a focus on problems and not disciplines—that is, using and expanding successful programmatic mechanisms that foster interdisciplinary and cross-divisional collaboration.

Response: NASA concurs with this recommendation and shares the committee's acknowledgment of the importance of systems-level thinking about many topics in Astrobiology (e.g., dynamic habitability and understanding biosignatures — a measurement result interpreted as indicative of the presence of past or present life) and continues to initiate strategies that promote cross-discipline collaboration.

Since receiving this recommendation in the *2019 NASEM Astrobiology Strategy for the Search for Life in the Universe*, the NASA Astrobiology Program has established three new Research Coordination Networks (RCNs) that are interdisciplinary, cross-divisional and facilitate systems-level thinking about dynamic habitability and the coevolution of planets and life, with a focus on problems and not disciplines. The three new RCNs are the Network for Ocean Worlds, Pre-biotic Chemistry in Early Earth Environments, and Early Cells to Multicellularity (LIFE).

In the coming decade, the NASA Astrobiology Program will work with the research community via the RCNs and relevant AGs for ideas and connections to other agency activities designed to enhance systems-level approaches to answering the fundamental questions in Astrobiology. We will also use the framework established by the existing NASA/NSF Interagency Act Agreement and continue to engage with relevant directorates at NSF (e.g., Biological Sciences (BIO), Geosciences (GEO), and Mathematical and Physical Sciences (CHE Division)) to develop new partnerships to advance system science through co-sponsored workshops and coordinated research announcements of opportunity. Partnerships with other federal agencies, academic institutes and non-profits (e.g., Simons Foundations, Kavli Foundation, Templeton Foundation) will be explored.

Collaboration with NSF (with NIH)

Division of Chemistry
Directorate for Mathematical and Physical Sciences

Molecular Foundations for Biotechnology (MFB)

- Detecting, quantifying, and sequencing noncanonical nucleic acids
- Understanding structure, stability, function, and dynamics of artificial and natural uncommon nucleic acid bases
- Advancing synthesis of modified nucleic acids
- Understanding the nature, breadth and role(s) of RNA glycosylation
- Predicting RNA binding sites and mutable sites, classes of RNA structures and viral infectivity/fatality
- Increasing diversity of small molecules that bind to RNA
- Understanding unusual structure/function found in less well studies nucleic acids, e.g. archaeal RNAs
- Understanding circular RNA (bio)synthesis, context, properties and function
- Improving the enzyme toolbox (ligases; reverse transcriptases; enzymes that recognize, install and remove RNA modifications)

NASA POC Lindsay Hays

22-17: NASA's programs and missions should reflect a dedicated focus on research and exploration of subsurface habitability in light of recent advances demonstrating the breadth and diversity of life in Earth's subsurface, the history and nature of subsurface fluids on Mars, and potential habitats for life on ocean worlds.

Response: NASA concurs with this recommendation and acknowledges the importance of expanding its efforts in applicable astrobiology research and exploration on subsurface habitability.

Since receiving this recommendation in the *2019 NASEM Astrobiology Strategy for the Search for Life in the Universe*, the NASA Astrobiology Program has shifted its funding focus to prioritized support for investigations involving targets (e.g., subglacial/sub-ice environments, caves, aquifers, deep sea), technologies (e.g., drilling and AUV), and research enabling subsurface exploration.

In the coming decade, the NASA Astrobiology Program will continue to prioritize subsurface research and technology. In addition, program leadership will take advantage of advisory board service (e.g., Sanford Underground Research Facility (SURF), International Ocean Drilling Program, Ocean Exploration Advisory Board) to expand opportunities for NASA researchers to engage in subsurface exploration.

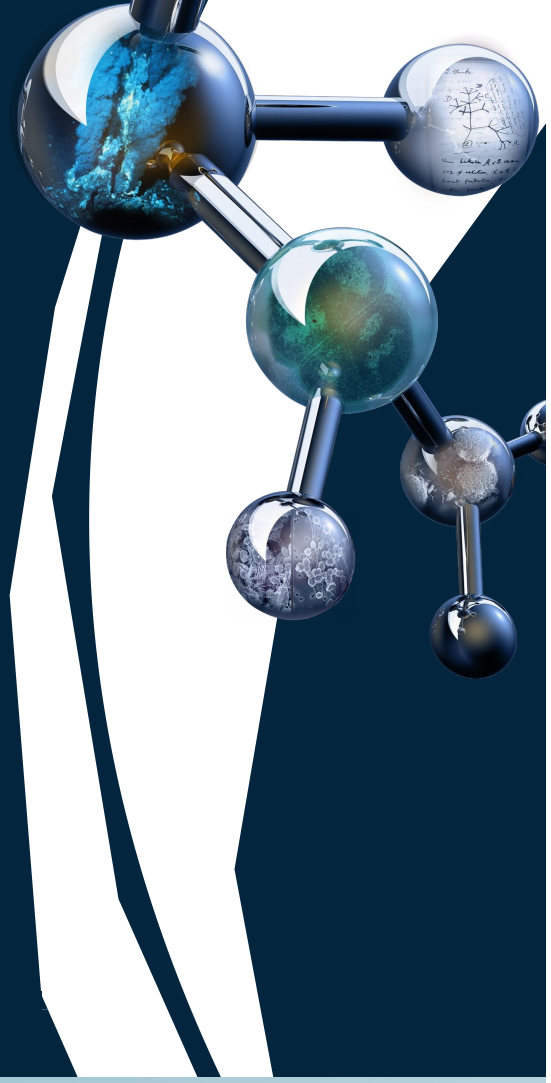
22-18: To advance the search for life in the universe, NASA should accelerate the development and validation, in relevant environments, of mission-ready, life detection technologies. In addition, it should integrate astrobiological expertise in all mission stages—from inception and conceptualization to planning, development, and operations.

Response: NASA concurs with this recommendation and is committed to, and actively supports, the acceleration, development, and validation of life-detection technologies through the Planetary Sciences Division's PICASSO and MatISSE instrument development programs, targeted technology development programs for Ocean Worlds, and Planetary Science and Technology through Analog Research (PSTAR).

Since receiving this recommendation in the *2019 NASEM Astrobiology Strategy for the Search for Life in the Universe*, the NASA Astrobiology Program has worked with the Planetary Exploration Science and Technology Office (PESTO) and Space Technology Mission Directorate (STMD) to develop solicitations for instruments and sample handling technology related to life detection. Additionally, the program and PESTO co-sponsored a two-week Future of the Search for Life (FoSL) workshop, run by the Network for Life Detection (NfoLD) RCN, bringing together scientists and engineers to develop specific life detection technology requirements necessary to strengthen our solicitations.

In the coming decade, the NASA Astrobiology Program will directly engage with PESTO and STMD to look for additional opportunities to accelerate the development of technologies necessary for future life detection missions. NASA may, for example, consider incentivizing life detection technologies in AOs.


QUESTIONS?

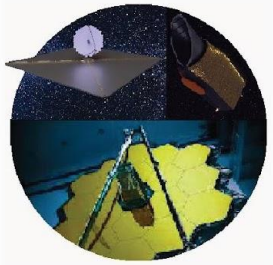


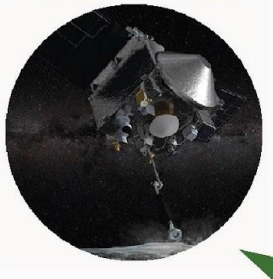
OSIRIS REx

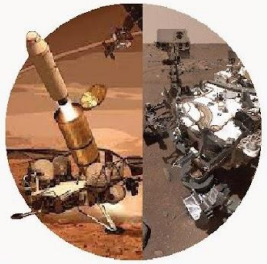
JWST
Luvoir/HabEx

Perseverance
Mars Sample Return

Europa Clipper
Europa Lander





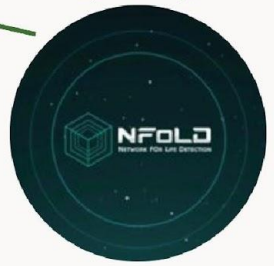


The Nexus for Exoplanet System Science

NExSS

Prebiotic Chemistry and Early Earth Environments

PCE3



Network for Life Detection

NfOLD

Network for Ocean Worlds

NOW

LIFE: Early Cells to Multicellularity

ECM

The themes of the RCNs map to ongoing and future missions planned and being considered with Astrobiological significance.