

LIFE

FROM EARLY CELLS TO MULTICELLULARITY



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FROM EARLY CELLS TO MULTICELLULARITY

Who are we?

What are our goals?

A community dedicated to understanding life-planet co-evolution recorded in the rock record, in biodiversity, in genome databases, and modeled *in silico* or by lab proxy studies.

A community that will develop a science of living worlds by viewing life-planet co-evolution through one lens asking: *What environmental pressures, biological mechanisms, and evolutionary opportunities:*

- 1) *gave rise to cellular life?*
- 2) *caused life to expand to planetary scale?*
- 3) *led to the emergence of eukaryotes?*
- 4) *avored the transition from single cells to multicellularity?*

To understand how major biological innovations shaped the evolutionary path of our integrated life-planet system.

To discern the rules of co-evolution so as to predict how life could evolve on worlds other than our own and inform how we search for it.



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Who are we?

co-Leads:

Ariel Anbar, Arizona State
Mary Droser, UC-Riverside
Betül Kaçar, UW-Madison
Frank Rosenzweig, Georgia Tech

Steering committee

Don Burke-Aguero, U Missouri
Shelley Copley, CU Boulder
Mark Ditzler, NASA Ames
Ben Gill, Virginia Polytechnic
Trinity Hamilton, U Minnesota
Tim Lyons, UC Riverside
Niki Parenteau, NASA Ames
Cynthia Silveira, Univ Miami
Daniel Stolper, UC Berkeley
Steve Vance, JPL

NASA Point of contact:

Becky McCauley-Rench

Early career investigator committee, 2023

Christina Buffo, Gatech
Jaime Cordova, UW-Madison
Bruno Cuevas, UW-Madison
Ethan Edmans, ASU
Brandon Hasty, ASU
Adam Hoffman, UCR
Charles Ross Lindsey, Gatech
Kathryn Rico, ASU
Rachel Surprenant, UCR



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What are we doing to reach our goals?

From our Charter

LIFE will bring together paleontologists and geobiologists, geochemists and biochemists, molecular biologists, and evolutionary biologists in an intellectual environment that is collegial and scientifically rigorous.

We welcome theoreticians and experimentalists investigating evolution of catalysts, pathways, networks, and compartments across scales from macromolecules to ecosystems in ways that inform the search for past and presently inhabited worlds and their biosignatures.

Outreach

- Presence at AbGradCon 2023
- 6 Session Proposals to AbSciCon 2024
- Seminar series



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What are we doing to reach our goals?

LIFE RCN Speaker series

Led by Early Career Committee

Showcases research by leaders and emerging leaders in Astrobiology.

1st Monday of the month, 1-2 pm EST, live-streamed 30-40 min talks followed by moderated Q&A.

Open to all who share an interest in Earth-life co-evolution from early cells to multicellularity.

Date	Speaker	Field
5 June	Maria Rebolleda Gomez, UC Irvine	Microbial Communities
10 July	Paula Welander, Stanford	Archaea
18 Sept.	Steve Vance, JPL	Ocean Worlds
2 Oct.	Patricia Sanchez-Baracaldo, University of Bristol	Origins of Photosynthesis
6 Nov.	Galen Halverson, McGill	Geochemistry
4 Dec.	Chinmayee Govinda Raj, NASA Ames	Instr. Dev. & Space Biol.



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Outreach

- LIFE member leadership at GRC, SMBE, AGU et al.
- Presence at AbGradCon 2023
- 6 Session Proposals to AbSciCon 2024
- LIFE member leadership of local symposia, e.g.,
Spring 24 Suddath Symposium at Georgia Tech
Evolution of Multicellularity & Cellular Differentiation

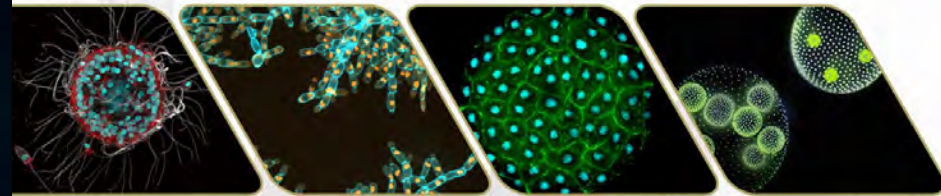


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Georgia Tech
Parker H. Petit Institute for
Bioengineering and Bioscience



32nd Annual Suddath Symposium

The Evolution of Multicellularity and Cellular Differentiation

March 15-16, 2023

Georgia Tech

Petit Biotech Building

Suddath Seminar Room 1128

research.gatech.edu/bio/suddath-symposium

2024 Featured Speakers



**Magdalena
Bezanilla, Ph.D.**



**Omayya Dudin,
Ph.D.**



Nicole King, Ph.D.
"Mating and
Multicellularity in the
Closest Living Relatives
of Animals"



**Andrew Knoll,
Ph.D.**
"The Evolution of
Complex
Multicellularity: An
Earth System
Framework"



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What are we doing to reach our goals?



Ancient Life on Earth as a Guide for Alien Earths

Prof. Betül Kaçar, UWisconsin-Madison

24 October 2023

Beckman Center, Irvine, CA

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Evolution of Multicellularity & Cellular Differentiation
- LIFE member leadership at NAS CAPS



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What are we doing to reach our goals?

Fall 2023 Virtual Workshop

Nitrogen Cycling Across Planetary Scales

October 18 and 20, 2023

Lead Organizers: Ben Johnson (Iowa State),
Eva Stueeken (St. Andrews Univ)

Synopsis: Life as we know it requires nitrogen, but how does our understanding of the N cycle inform our search for life in the universe? The goal of this workshop was to define key questions that should focus research in anticipation of the next generation of astrobiology exploration.

Presentations covered planetary origins and formation, terrestrial planets, icy worlds, and evolution

Attendees: 100 (day 1); 70 (day 2)
Manuscript in preparation





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MUSE

METAL UTILIZATION AND
SELECTION ACROSS EONS

What are we doing to reach our goals?

Research

ICAR 2021, PI: Betül Kaçar, UW-Madison
Metal Utilization across Eons (MUSE)

<https://museastrobiology.org/>

Ariel Anbar¹ (DPI), Anne Dekas², Betsy Swanner³,
Amanda Garcia⁴, Lance Seefeldt⁵, Bill Seyfried⁶, Kurt
Konhauser⁷

¹ Arizona State University, ² Stanford University, ³ Iowa
State University, ⁴ UW-Madison, ⁵ Utah State University,
⁶ University of Minnesota, ⁷ University of Alberta



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METAL UTILIZATION AND
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MUSE focuses on the evolution of metal use on Earth - specifically, the biochemistry of carbon and nitrogen acquisition throughout time. MUSE conducts geochemical and biological investigations that involve ancient materials, modern experiments, and exploration of past and present natural systems.



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Research

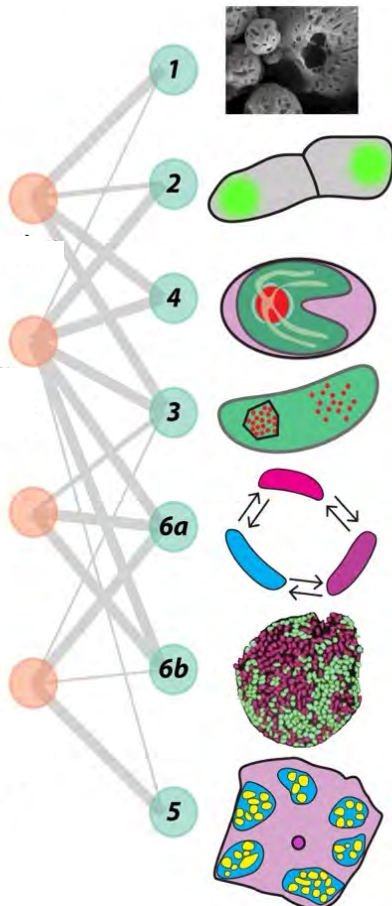
ICAR 2023

Engine of Innovation:

How compartmentalization drives evolution of novelty and efficiency across scales

Jeff Cameron¹, Shelley Copley¹, Joshua Goldford^{2,5}, Chris Kempes³, John McCutcheon⁴, Victoria Orphan⁵, Frank Rosenzweig⁶ (PI), Alexis Templeton¹, Boz Wing¹

¹CU-Boulder, ²Blue Marble SSI, ³Santa Fe Institute, ⁴Arizona State Univ, ⁵Caltech, ⁶Georgia Tech



We define a compartment as a structure in which exchange of components with the surrounding milieu is restricted, often but not always, by a membrane or a protein shell. We hypothesize that compartmentalization increases flexibility and/or efficiency in acquiring, processing and conserving resources across scales from the molecular to the ecological. To test this hypothesis we will use theory and experiment to study an increasingly complex hierarchy of compartmentalized structures:

1. **prebiotic aggregates,**
2. **problematic metabolites,**
3. **bacterial micro-compartments,**
4. **nested metabolic compartments**
5. **serial endo-symbioses,**
6. **microbial consortia.**

Online community seminars and workshops!



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LIFE is a network of astrobiologists focused on the coevolution of Earth and life. Together, we explore ways to advance this science, and its implications for the search for life on other worlds.



lifercn.org

 [@LIFE_RCN](https://twitter.com/@LIFE_RCN)

 youtube.com/@LIFE-RCN

A connected network of networks – supporting current NASA Mission Science

