**Proposer Name:** Nathalie A. Cabrol, The SETI Institute Carl Sagan Center/ NASA Ames  
**Session Title:** Environmental Change and the Evolution of Planetary Habitability  
**Summary:** Environmental change can be used as a scientific bridge relating astrobiology to earth, planetary, and space sciences in the study of how life may adapt through abrupt climate crises. Recent discoveries inspire us to re-examine our understanding of how rapidly planetary habitats can be redistributed. Past habitable environments on Mars from the Curiosity rover, possible subsurface lakes and oceans on Europa or Enceladus, methane lakes on Titan, and potentially habitable exoplanets from the Kepler spacecraft continue to expand our definition of the habitable zone. Abstracts on the intertwined aspects of changing habitability, including the complex interactions among astronomical, geological, and climatic forces, on the Earth and beyond, are welcome.

**Proposer Name:** Franck Marchis, SETI Institute  
**Session Title:** Imaging Earth 2.0 - Are We There Yet?  
**Summary:** The recent discovery of Earth-sized exoplanets in stellar habitable zones has legitimized the search for Earth twins—Earth-sized planets with environmental conditions amenable to life. This session will discuss new and future facilities and instruments designed to detect, image and characterize those exoplanets, studying their formation, evolution and also their possible biospheres. The maturation of Adaptive Optics and associated technology could give astronomers the chance to record the first spectrum of an Earth-like planet using one of the Giant Segmented Mirror Telescopes in less than a decade. Space-based projects aimed at understanding the chemical composition of exoplanet atmospheres will also be addressed. This session will also be an opportunity to discuss visionary new projects, such as space-based interferometers or giant telescopes, dedicated to searching not only for an Earth 2.0, but also for signatures of life or even technological civilizations, potentially answering the question “Are we Alone?”

**Proposer Name:** Zsolt Keszthelyi, University Observatory Munich  
**Session Title:** Astrophysical constraints on Habitable Zones  
**Summary:** Different kinds of Habitable Zones (HZs) have been established, however the most commonly referred one is the liquid water HZ (Kasting et al., 1988). Nevertheless, the exact inner and outer parts of the HZ in our Solar System are still under discussion (see e.g. Kasting et al., 1993 or recently Zsom et al., 2013). Furthermore, besides liquid water Habitable Zone, other perspectives may suggest habitability, such as the Continuously HZ (Hart 1979, Gargaud et al., 2005), the Ultraviolet HZ (Buccino et al., 2006), Photosynthesis-sustaining HZ (Franck et al., 2000), Tidal HZ (Barnes et al., 2009) and Galactic HZ (Lineweaver et al., 2004). Therefore one has to deal with the complexity and superposition of different constraints. The integration of these constraints will be considered in order to obtain an overall picture on the astrophysical meaning of habitability.

**Proposer Name:** Greg Fournier, MIT  
**Session Title:** Biological Perspectives on Hadean Impact History  
**Summary:** The impact history of the Early Earth is a major determinant of conditions during the origin of life and early life evolution. Explorations of this impact history have typically included lunar cratering records and computational models. These observations directly relate to hypotheses concerning the timing, nature, and environment of early life evolution, as well as possible genomic signatures inherited from the earliest ancestors of extant life. Conversely, evidence of such signatures within the genome record may reveal likely conditions on the early Earth. This session will explore the relationships between the possible genome and impact records of the Hadean, and if these point towards a consistent narrative for the origin and early diversification of life.

**Proposer Name:** Jason Raymond, School of Earth and Space Exploration, Arizona State University  
**Session Title:** What Tangled Web: Can Life's Early History Be Solved?  
**Summary:** In the four ensuing decades since seminal work advanced molecular methods for resolve a tree of life, Linnean taxonomy and our understanding of the history and diversity of life on have been utterly revolutionized. Recent innovative methods—from targeted multi-gene analyses to phylogenomics to network-based approaches—have been developed to tackle evolutionary reconstructions from massive -omics databases now available. Yet with the number of genomes available set to pass 100,000 in the coming years, no clear consensus has emerged on what approaches might be suitable for classifying this mountain of data, or on whether the roots of the tree of life are even resolvable. This session invites presentations that are pushing the envelope of integrating useful information from massive -omics datasets for unraveling the early history of life on Earth, as well as addressing whether the tree of life might indeed be too tangled to be resolved.
Proposer Name: Michael Hecht, Princeton University  
Session Title: New Life in the Laboratory  
Summary: The field of astrobiology can be divided into three areas: 1) The origins of life on Earth 2) Life in the universe beyond planet Earth 3) The creation of new life in the laboratory. The suggested session will cover this third topic.

Proposer Name: Frank Schmidt, University of Missouri  
Session Title: Systems Biology and Exobiology  
Summary: Living systems at levels from the molecular to the social are organized along the mathematical principles of scale-free networks. This session will examine the basic laws of scale-free networks and specific processes that lead to scale-free systems. Experimental studies of network biology and exobiology will be a key part of the session.

Proposer Name: David Deamer, University of California, Santa Cruz, CA  
Session Title: Nanopore Analysis of Single Molecules: Applications in Astrobiology  
Summary: Nanopore instruments have the unique ability to detect and identify single molecules in solution such as nucleotides, nucleic acids, and proteins. A small, portable device called the MinION is now being tested by early users. The MinION can detect the presence of nucleic acids and also provide base sequences of strands over ten thousand nucleotides in length. A nanopore instrument is now being used to analyze RNA-like polymers produced in simulated prebiotic conditions. Another potential application will be to determine whether samples of martian ice and sediments contain fragments of biomolecules associated with extant or extinct microorganisms.

Proposer Name: Lydia Hallis, University of Glasgow  
Session Title: Extraterrestrial Materials  
Summary: A wealth of information about how life in our solar system developed can be gained through the study of meteorites. Primitive chondritic meteorites are known to contain organic materials, which may have been the source of life’s building blocks on Earth. In addition, organic carbon has recently been discovered in Martian meteorites. This discovery, as well as other recent chemical (e.g., volatile element contents) and mineralogical studies (e.g., to determine ancient weathering conditions) of martian meteorites, highlights the possibility of life on Mars. Only through meticulous chemical analyses of meteorites can the nature and environments of their parent bodies be determined.

Proposer Name: Lahouari Krim, Université Pierre et Marie Curie- Paris VI  
Session Title: Elementary Key Reactions Under the Interstellar Conditions  
Summary: Radical chemistry on the icy interstellar grains is at the origin of the formation of stable molecules in the universe. This dilute and very cold medium is a perfect application field for the study of elementary chemical processes. It is now well established that radical chemistry on the dust grains is at the origin of the formation of exobiologically-relevant molecules, the very first step of complexification towards life. The knowledge of reaction pathways leading to the formation of these complex molecules represents an important step toward the understanding of the origin of life. This session is related to laboratory studies in solid phase at cryogenic temperatures to a better comprehension on the elementary level of the mechanisms implied in interstellar radical reactions.

Proposer Name: Peter H. Schultz, Brown University  
Session Title: Preserving Evidence for Past Life in Impact Materials  
Summary: There is increasing evidence that impact materials can trap (if not host) relicts of past life. Rather than destroying the evidence, impact breccias and melt-matrix breccias on Earth have entrained organics and macroforms through a process of rapid heating and quenching. Questions remain. How widespread and how long such signatures could remain? Are soft sediments a prerequisite target? What are the implications for sampling strategies on Mars? This session would highlight these questions...and more.

Proposer Name: Gustavo Caetano-Anolles, University of Illinois, Urbana-Champaign  
Session Title: Origin and Evolution of Viruses  
Summary: Viruses are infectious biological agents that lack ribosomes, metabolism, homeostasis and other hallmark properties of living cells. They populate our biosphere and impact the genetic makeup of living organisms. The recent discovery of giant viruses now challenges our views of the origin, evolution and role of these agents of genetic change. The session explores the origin and evolution of viruses, their possible role in the emergence of life, and how viruses impinge on biological diversity at molecular cellular, organismic and ecological levels.
Proposer Name: Alian Wang, Washington University in St. Louis
Session Title: Detection of the sign of life – How well we can do?
Summary: As the Blind men and an elephant story told us, the sign of life can have different “face” in the view of different techniques and instrumentations, especially during robotic explorations at the surface of a planetary body. An overall, quantitative evaluation and comparison on the detection sensitivities of available techniques for flight is needed, for the purpose of combining the information revealed by different techniques into a big picture, and for planning future missions.

Proposer Name: Dirk Schulze-Makuch, Washington State University
Session Title: Martian Environments and their Habitability
Summary: Latest mission results indicate that Mars is a planet exhibiting a diverse set of environments, varying greatly with time and location. The focus of this session is on those environments that could be habitable for life, today and in the past.

Proposer Name: Yi-Liang Li, The University of Hong Kong
Session Title: The Astrobiology of Western China
Summary of Session Topic: The western China has three geographic blocks that are attractive for astrobiological explorations: Yunnan-Guizhou plateau of southwestern China, Tibetan plateau, and Xinjiang - Inner Mongolia of northwestern China. The Yunnan-Guizhou plateau is characterized by its large area of Karst topography and massive distribution of sedimentary archives of Ediacaran fauna and Cambrian exploration; Tibetan plateau is well-known for its diverse extreme environments and vast distribution of high-altitude lakes at their different evolutionary stages; while the northwestern area is characterized by its highly arid climate, vast area of Gobi and desert covered by thin cyanobacterial-algal crust. Studies from micro- to planetary scale, from fossil molecule to tectonic physics and from the dawn of animal life to the modern extremophiles may provide panoramic view of the habitability of this area through planetary evolution.

Proposer Name: John F. Cooper, NASA Goddard Space Flight Center
Session Title: The Space Physics of Life on Solar and Extrasolar Worlds
Summary: Origins, evolution, and detection of life on solar and extrasolar worlds can be enabled by interactions with space environments. Water content of surface regolith and subsurface environments is detectable by photolytic and plasma interactions, atmospheric analysis, neutrons, and by natural magnetic sounding. Surface irradiation of icy bodies can provide oxygen and other chemical nutrients to subsurface life, but it also destroys organic molecular signatures of life. Chemical energy input into subsurface habitable environments by irradiation can also drive cryovolcanism by oxidation of primordial materials, thereby bringing up molecular biosignatures into the sensible atmospheres and surfaces. Space weathering ages exposed surfaces and its signatures can be used to identify regions of freshly emergent material more likely to contain biomolecular signatures. Electromagnetic emissions can reveal the presence of planetary magnetic fields potentially important to survival of surface life. Presentations are invited on astrobiologically relevant processes, observational methods, and space missions.

Proposer Name: T. Marshall Eubanks, Asteroid Initiatives LLC
Session Title: Nomadic Planets : The Closest Habitable Worlds?
Summary: Gravitational microlensing surveys reveal a substantial population of nomadic planets, bodies not in orbit around any star, with published population estimates predicting literally dozens of Earth-mass nomadic planets closer to the Solar System than the nearest star. Such planets could have sufficient internal heat and insulation to support biospheres for billions of years, and thus could have active biospheres. This session seeks papers dealing with all the astrobiological implications of a population of nomadic planets, including the potential formation of biospheres on nomadic planets, remote signatures of such biospheres in astronomical observations, the implications of biologically-active nomadic planets for panspermia, both between nomadic planets and between them and stellar system planets, and the potential of nomadic planets as locations for advanced civilizations and as targets for SETI. Also sought are papers dealing with the initial exploration of remote dark biospheres by high-speed spacecraft flybys and impactors.

Proposer Name: John R. Spear, Colorado School of Mines
Session Title: The Astrobiological Implications of Geobiology
Summary: The now maturing field of Geobiology seeks to better understand the biologic:geologic interface across the entirety of the rock record. Many systems have been studied that point us toward a better understanding for the role of biology in Earth’s history as revealed by unlocking the secrets of biology’s past from the rock record. Biosignatures, trace fossils and growth of stromatolites are but a few examples. Geologic, geochemical,
biochemical, stable isotope and molecular microbial community characterization are a few of the tools that can be employed. What we have learned is a greater understanding for how Earth formed and records life's presence. This in turn has significance for all things astrobiologic.

**Proposer Name:** Ramses Ramirez, Institute for Pale Blue Dots, Cornell University  
**Session Title:** What is the True Size of the Habitable Zone?  
**Summary:** The habitable zone (HZ) is the region around a star in which liquid water could exist on the surface of a rocky planet. Traditionally, the HZ assumes that habitable planets have: a) ocean inventories similar to that of the Earth, b) dense atmospheres, and c) CO2 and H2O are the core absorbers as per our planet. However, some have questioned these premises, arguing that relaxing any or all of the above significantly increases the size of the HZ. The goal of this session is to determine the most practical HZ definition that space missions can utilize to find potentially habitable exoplanets. Solar system and exoplanet talks that shed light on this intriguing puzzle, including theory, observations, and comparative planetology between Earth and other planets are invited. Contributions that analyze the interplay between the atmosphere and other planetary subsystems (e.g. carbonate-silicate cycle, tectonics) are welcome, including both atmospheric and geologic arguments.

**Proposer Name:** Tyler Robinson, NASA Ames Research Center  
**Session Title:** Comparative Planetology in the Era of Exoplanets  
**Summary:** Studying similarities and differences in the rules that govern the atmospheres and interiors of Solar System worlds offers the chance to understand how planets, as systems, work. Generalizations drawn from such studies can be applied to other worlds, and are the foundation for models of planetary habitability. However, holes exist in our understanding of many key atmospheric and geophysical processes relevant to the origin and maintenance of life on a planet. In the near future, remote observations of worlds inside and outside the Solar System will offer important opportunities to apply and/or test models of planetary habitability. This session will feature recent results related to observations and models of the general physical processes that influence planetary habitability and its evolution through time, as well as studies of how exoplanet observations may, one day, use or constrain these models.

**Proposer Name:** Vlada Stamenkovic, Massachusetts Institute of Technology  
**Session Title:** Life and Planet Interiors  
**Summary:** Processes within planetary interiors, from plate tectonics to magnetic field generation, have shaped the origins and evolution of life on Earth and impact the habitability of planets and moons in our solar system and beyond. On the other hand, life itself might have shaped interior dynamics by mediating crustal properties and cycles. However, the co-evolution of life and planetary interiors is still a poorly explored field of science and is often based on unverified assumptions rather than on scientific fact or data. This session invites contributions that critically address: 1) to what degree and how geodynamically-driven processes (e.g., tectonic mode of a planet, hydrothermal vents, magnetic fields, etc.) influence the origins of life and planetary habitability, and also 2) whether life itself affects those interior processes. We especially welcome scientists with a keen interest in interdisciplinary dialogue and who try to connect models to experimental or observational evidence.

**Proposer Name:** William Ratcliff, Georgia Institute of Technology  
**Session Title:** Complexity in a Test Tube: Experimenting with Major Transitions in Evolution  
**Summary:** How and why complex organisms evolve remain fundamental questions in astrobiology. On Earth, complex life has evolved through a series of ‘major transitions’, in which formerly autonomous individuals become parts of new, higher-level individuals. For example, chromosomes are thought to have evolved from autonomous genetic replicators, eukaryotes from multiple prokaryotic ancestors, multicellular organisms from unicellular ancestors, and eusocial ‘superorganisms’ from solitary multicellular ancestors. Despite this clear historical signature, the evolutionary dynamics underlying major transitions remains poorly understood. In this session, we will focus on newly-developed experimental approaches that use microbes and digital organisms to examine the early steps in major evolutionary transitions with unprecedented precision. Matthew Herron at the University of Montana will co-organize.

**Proposer Name:** Kennda Lynch, Colorado School of Mines  
**Session Title:** Targeting Habitable Environments for the Mars2020 and ExoMars Missions  
**Summary:** The past decade of Mars exploration has revealed diverse habitable aqueous environments that exhibit varying likelihood for preservation of biosignatures. The Mars2020 and ExoMars rovers will explicitly focus on searching for these biosignatures of past life and, as such, the selection of the landing site for each of these missions is of critical importance. This session will focus on evaluating the habitability and preservation potential of candidate landing sites, from an astrobiological perspective. This will be a continuation of habitability issues raised...
at the first Mars2020 landing site meeting and discussed at the 2014 AGU fall meeting. The synthesis of this session will be carried forward to future site selection meetings. Abstracts that focus on evaluating habitability and preservation potential of aqueous environments relevant to ancient Mars are welcome. Those that address ExoMars and Mars2020 candidate sites are highly encouraged. Possible Mars2020 landing sites: 

Proposer Name: Magnus Ivarsson, Swedish Museum of Natural History
Session Title: Detection of Life Signatures in Geological Material
Summary: The search for and characterization of life signatures in geologic material is a prioritized theme in upcoming space missions, especially to Mars. Studying Earth’s fossil and geological record tells us how to find and identify such signals both in deep time but also on other rocky, planetary bodies. Such investigations are usually performed on a micro- or nano-scale, and call for instruments capable of high resolution analysis. It also constantly demands refining of current techniques and protocols, and triggers innovative solutions. This session invites presentations that discuss molecular fossils, biomarkers, isotopes and microfossils as well as development of new techniques and methods to detect traces of life, both in situ by future missions but also in laboratories.

Proposer Name: Betul Kacar, Georgia Institute of Technology and Rika Anderson, University of Illinois at Urbana-Champaign
Session Title: Life’s Molecular Solutions: Evolutionary Insights into Life’s Origin, Early Evolution, and Radiation across the Planet
Summary: In this session we seek to understand, from a molecular standpoint, how the restless nature of evolution led to life’s origins and radiation across every conceivable niche on Earth. We aim to bring together scientists from diverse disciplines to provide insights into the molecular mechanisms of evolution that have shaped the diversity of life on Earth, from the scale of the single gene, to the organism, to the ecosystem. To achieve this we invite studies that draw on a range of expertise, including RNA or protein evolution, bioinformatics, molecular and synthetic biology, and culture-based analyses, with the common goal of elucidating the evolutionary mechanisms of life and how they have led to the diversity of life on the planet. By exploring the molecular mechanisms of life as we know it, we ultimately hope to arrive at a better understanding of why is life the way it is.

Proposer Name: David J. Smith, NASA John F. Kennedy Space Center
Session Title: Life in the Clouds - Recent Advances in Upper Atmosphere Exploration
Summary: Maybe the sky is not the limit, after all. Microbial taxa from every major biological lineage have been detected in Earth’s upper atmosphere and a vast region of the sky is awaiting further biological exploration. This session invites research aerobiology research relevant to the astrobiology community. The upper altitude biosphere boundary, airborne microbial activity in clouds, habitable atmospheres (solar system and exoplanets), extremophiles, contamination control, and planetary protection are just some of the broader astrobiology topics that can be examined in this session.

Proposer Name: William Ratcliff, Georgia Institute of Technology
Session Title: Evolving Multicellularity: Catalysts and Constraints
Summary: Multicellularity has evolved repeatedly in diverse lineages on Earth (including archaea, bacteria, and eukaryotes). These natural experiments reveal much about the potential for multicellularity to arise in various forms within starkly different ancestors. The first steps in these transitions, however, may also place severe constraints on the future evolutionary potential of resulting lineages. Understanding how multicellularity arises is thus a key step in determining which environmental conditions on extrasolar planets might support the evolution of complex life. In this session, we will take an interdisciplinary approach to answering the question: What factors promote or hinder the evolution of multicellular complexity? Specifically, we will focus on the evolution of cooperation and conflict, how the spatial dynamics of group formation affect evolutionary feedbacks, how multicellular development originates, and how multicellularity may be inferred or detected in the future. Speakers will include theorists and experimentalists studying naturally-occurring (e.g., volvocine algae) and laboratory-evolved multicellular organisms (e.g., snowflake yeast), developmental biologists working near the origin and paleobiologists studying the evolutionary history of multicellularity. Zach Adam at Harvard University will co-convene.

Proposer Name: Paula Welander, Stanford University
Session Title: What Can Modern Microbes Tell Us about Ancient Earth Ecosystems?
Summary: The history of life on Earth has been dominated by microbial organisms whose metabolic inventions have had, and continue to have, a significant impact on the Earth’s environment. As a result, studies of extant bacteria and archaea have the potential to impact our understanding of the co-evolution of life and Earth. Microbial
Over geological timescales, multiple large bursts of ionizing radiation are expected on habitable planets. In addition, new microbes with novel (and potentially ancient) metabolisms continue to be discovered. However, linking these modern studies to our interpretation of ancient environments remains a challenge. This session will explore how molecular and environmental studies of modern microbes can inform our interpretation of ancient Earth ecosystems.

**Proposer Name:** Nicholas V. Hud, Georgia Institute of Technology  
**Session Title:** Prebiotic Chemistry and the Origins of Functional Biopolymers  
**Summary:** A key challenge to understanding the origin and early chemical evolution of life is to determine how small molecules were selected from complex starting mixtures and joined together to create the first functional biopolymers. We propose a session of chemists that are exploring mechanisms for the selection and coupling of molecules that could provide insights into the earliest stages of biopolymer chemical evolution. We are interested in having speakers that are exploring the hypothesis that alternative amino acids, nucleobases and sugars were used in the earliest biopolymers and, if this proves to be possible, why nature settled on the molecules found in life today.

**Proposer Name:** Rafal Wieczorek, Harvard University  
**Session Title:** Protocellular Designs  
**Summary:** "What I cannot create, I do not understand", a famous quote from Richard Feynman best summarizes our knowledge of Life. Therefore, the construction of new artificial forms of life is a major challenge and a next stepping stone in our understanding of the phenomenon of Life at the most basic level. In many laboratories around the world energetic research towards creating life from scratch is being pursued. This session will explore various theoretical designs and experimental work aiming at real world realization of synthetic living organisms; creating their subsystems and challenges encountered with those subsystems' integration.

**Proposer Name:** Trinity Hamilton, Penn State Astrobiology Research Center  
**Session Title:** Phototrophic Life and Earth's Redox Evolution  
**Summary:** Understanding the role of biology in planetary evolution remains an outstanding challenge to geobiologists. In this session, we aim to highlight the current understanding of the role of phototrophs in Earth's redox evolution and provide a platform for new hypotheses and future challenges. Important topics include (but are not limited to): isotopic and geochemical biosignatures in modern and ancient environments, characterization of the biochemistry, physiology, or ecology of phototrophs and their ecological niches, and the genetics and evolution of phototrophic metabolisms. Jenn Macalady at Penn State will co-convene.

**Proposer Name:** Brett A. McGuire, NRAO/California Institute of Technology  
**Session Title:** Interstellar Chemical Evolution: Astrochemistry From Atoms to Amino Acids  
**Summary:** The seeding of nascent worlds by (pre-)biotic molecules as the genesis of life-essential biopolymers has been an exciting line of inquiry for decades. The detection of the simplest amino acid, glycine, by the STARDUST mission has only intensified this interest in recent years. Yet, the chemical-evolutionary routes leading to the formation of glycine, and other (pre-)biotic molecules in the interstellar medium, remain an open question. This session invites contributions from observational, laboratory, and theoretical astrochemistry examining all aspects of complex chemical evolution in the interstellar medium. A special emphasis is placed on the roles of physical environment, and the interplay between gas-phase and condensed-phase reaction chemistry, in driving molecular inventories toward increased complexity.

**Proposer Name:** Julie Castillo-Rogez, JPL/Caltech  
**Session Title:** Habitability of Dwarf Planets - State of the Landscape (Right) Before Dawn and New Horizons  
**Summary:** Icy dwarf planets have been identified early on as targets of major astrobiological significance. 2015 celebrates these objects with two missions, Dawn and New Horizons that will reach Ceres (April) and Pluto and Charon (July), respectively. This conjunction of missions offers the prospect for exciting comparative planetology between the warm icy body Ceres and the frigid Pluto and Charon. All display evidence for recent or ongoing activity and are suspected to have hosted extensive hydrothermal activity. This session will review our state of understanding of that class objects in the anticipation of imminent new observations of Ceres and Pluto/Charon, but more generally in the context of the many observations of dwarf planets returned over the past decade.

**Proposer Name:** Adrian L. Melott, University of Kansas  
**Session Title:** Intermittent Radiation as a Modifier of Habitability and Evolution of Advanced Life  
**Summary:** Over geological timescales, multiple large bursts of ionizing radiation are expected on habitable planets. Sources include nearby supernovae, gamma-ray bursts, and according to recent research, stars of Solar type. Effects include damaging the UVB shield of ozone in oxygen atmospheres, and may also alter the climate or
irradiate organisms on the ground and in the upper ocean. Studies are underway to determine parameters of an indicated moderately nearby supernova around the beginning of the Pleistocene, determining whether an isotopic signal of $^{60}$Fe could have come from any other source. Presenters study survival and damage of biomolecules and microorganisms, including marine primary producers, under relevant electromagnetic and particulate radiation.

**Proposer Name:** Patricia M. Beauchamp, JPL-Caltech  
**Session Title:** The Habitability of Icy Worlds  
**Summary:** This session will be a follow-on to the workshop by the same name, held in Pasadena in February 2014. The primary objective is similar and will focus on the astrobiological potential of icy worlds in the outer solar system — including Europa, Ganymede, Enceladus, Titan, and beyond — with discussion on future research directions and spacecraft missions that can best assess that potential given the unique planetary environments of the outer solar system. Comparative planetology presentations are encouraged as well as research involving terrestrial analogs. Topics covered include (but not necessarily limited to): - Water and exotic solvents - Chemical energy for life - Organics and their detection - Ocean physics and chemistry - Icy world activity and habitability over time - Continuing and future outer solar system exploration.

**Proposer Name:** George E. Fox, University of Houston  
**Session Title:** Origin and Evolution of the Ribosome  
**Summary:** Comparative genomics has revealed that the ribosome is already largely in its modern form at the time of LUCA. Thus, its evolutionary history provides a unique window into the pre-LUCA world. As an RNA machine, the origins of the ribosome relate in a yet to be determined way with the prebiotic synthesis of peptides and the hypothetical RNA World. Recent progress that provides substantial insight to the order and manner in which various ribosomal subsystems arose will be discussed.

**Proposer Name:** Raghav R. Poudyal, University of Missouri  
**Session Title:** Origins and Evolution of Biomolecular Catalysts: Molecules at Work  
**Summary of Session Topic:** The origin of functional biomolecules and macromolecular catalysts is considered one of the key steps for the origins of life and modern biology. This session will encompass topics such as biomolecular catalysts, their origins and evolution and the implications for origins of life. Talks and posters in this session will include topics such as origins and evolution of functional nucleic acids (RNA, DNA and TNA etc.) and peptides (Protein enzymes). Other topics include covalent synthesis and non-covalent assemblies of biopolymers, catalysis and evolution of heterobiopolymers with mixed monomer types, and mapping of structure and fitness landscapes onto biopolymers sequence space.

**Proposer Name:** Christos Kotakis, Biological Research Center, Hungarian Academy of Sciences  
**Session Title:** RNA-mediated Cell Evolution  
**Summary:** Orchestration of genetic inter-communication between organellar and nucleic genomes is a complex mechanism in nature. Gene transfer phenomena are generally accepted as DNA-directed but experimental evidence is provided for RNA modularity in such a control, too. In this session, we will try to unravel functional aspects of the RNA autonomy relatively to the bio-geochemical landscape of the primordial life, from the molecular eco-evolutionary perspective, described above. Contributions concerning non-coding RNAs studies in photosynthetic extremophiles; archean species from geothermal vents and Antarctic ones as well as regarding possible RNA involvement in the redox organismal fitness and cell bioenergetics will be discussed, under the endosymbiotic umbrella.

**Proposer Name:** Wesley Swingley, Northern Illinois University  
**Session Title:** Extreme Informatics: Linking Omics and Geochemistry in Extreme Environments  
**Summary:** Modern advances have quickly broadened the spectrum of information researchers can extract from the environment. Traditional geophysical and geochemistry characterizations have expanded to include nearly every chemical species, with an increasing wealth of field-measurable parameters. Microbial analysis has exploded beyond 16S ribosomal clone libraries to allow sequencing of near-complete environmental genomes, transcriptomes, and proteomes as well as the embodiment of reductionism: the single-cell genome. However, all of this information comes at the cost of overwhelming analysis paralysis. This session will cover promising new directions in all aspects of environmental omics, with particular focus on integrating data sets from extreme environments in order to understand how life may adapt and evolve to similar conditions on extraterrestrial bodies and early Earth.
Proposer Name: Alexander A. Pavlov, NASA Goddard Space Flight Center  
Session Title: Past vs. Extant Life Search Strategies for Mars Exploration. How Should we Proceed?  
Summary: Searching for “past” vs. “extant” life on Mars requires different and sometimes mutually exclusive approaches in landing site selection and the choice of instruments for the future Martian rovers. Current and near future missions to Mars focus on the search for the evidence of past life in the surface rocks. However, recent experimental results on the bacterial growth under Martian conditions and evidence of atmospheric methane variability indicate that the search for “extant life” on Mars should not be discarded. The “past” life search strategy must respond to observations from recent and current surface missions (e.g. MSL) and experimental studies of organic preservation under Martian conditions. This session invites scientists to present new experimental studies, observations or modeling results, which would enhance “past” or “extant” life search strategies in future missions to Mars. We seek to initiate a comprehensive discussion among proponents of both life search strategies.

Proposer Name: Armando Azua-Bustos, Blue Marble Space Institute of Science  
Session Title: What We Know about Water and Life on Earth: Implications for Potential Life Forms Elsewhere in the Solar System and the Universe  
Summary: Although Earth is known as the “water planet”, this molecule is present only as a thin film covering 70% of its surface. In addition, one third of Earth’s exposed surface falls in the desert category, and water present as ice or as salty solutions is unavailable or difficult to be used by life. Nevertheless, life has been able to adapt and evolve in these habitats using physiological and molecular mechanisms that, once understood, could guide us on where to search for similar life forms elsewhere in the Solar System and other planets in the Universe. In this session, abstracts focused on the relation between water and life on Earth from the ecological, physiological and molecular point of view are welcome, in particular those focused in terrestrial analog environments. Works on how “life as we do not know it” could have evolved using water analogs elsewhere are also welcome.

Proposer Name: Aaron Engelhart, Massachusetts General Hospital/Harvard Medical School  
Session Title: Chemical Systems Enabling the Emergence of Cellular Life  
Summary: Contemporary life employs lipid bilayer cell membranes, which separate cellular components from the extracellular environment. Thus, a critical event in early life was the emergence of compartments capable of growth, division, and retention of their contents. Considerable progress has been made towards the development of simple chemical systems that recapitulate cell-like behaviors. Perhaps the most-studied prebiotic analogue of modern cell membranes is their close relative: vesicles formed from single-chain fatty acids. Recently, numerous non-lipid systems have also attracted interest as potential precursors to cellular life, including electrostatically-formed coacervate droplets, aqueous two-phase systems, and scenarios involving limited diffusion on surfaces. In this session, presenters will examine these and other chemical systems that could have given rise to compartmentalization. Topics of interest include the growth, division, and selective permeability of these systems; primitive metabolic and homeostatic processes in these systems; and pathways for the evolution of these systems into contemporary cell membranes.

Proposer Name: Jennifer Glass, Georgia Institute of Technology  
Session Title: Metals in Astrobiology: From Minerals to Molecules to Microbes  
Summary: Metals played a key role in the evolution of microbial metabolisms and macromolecules on Earth and likely would be essential the rise of life elsewhere in the universe. This session invites presentations on any aspect of metallic elements in an astrobiological context, with particular focus on interdisciplinary studies linking geochemistry, microbiology, inorganic/organic biochemistry, molecular evolution, planetary science and other fields. Examples of relevant research include microbial metabolisms that respire metals, macromolecules that bind metals for their catalytic function, metals as geochemical proxies for the rise of atmospheric oxygen, and novel findings on metallic minerals in our solar system and others.

Proposer Name: Jamie S. Foster and Giorgio Casaburi, University of Florida  
Session Title: Gravity and its Impact on Life  
Summary: Gravity is one of the few constant environmental factors on Earth yet little is known on how this force has impacted the evolution of life. Through experimentation using simulated microgravity and spaceflight new
insights have been gained to understand how microbes, plants and animals have responded to changes in gravity across the g-spectrum. This session will examine what happens to life when gravity changes and whether by removing gravity we can learn new processes by which life responds to changes in its environment that may otherwise go undetected in normal terrestrial conditions.

**Proposer Name:** Betul Kacar, Harvard University  
**Session Title:** Chance and Necessity in Biological Evolution  
**Summary:** Monod asserted unpredictability as the main determinant of life in the cosmos, referring to the origins of life as a “freak accident”. Scientists have limited means with which to infer the exact cosmic evolutionary events that transpired to produce the biosphere. A question arising from this limitation is whether the evolutionary paths of systems are predominantly constrained by internally or externally controlled processes, or by inherently random processes that would generate completely different outcomes. What aspects of life would emerge as convergent features in the Universe and which features are likely unique “frozen accidents,” the outcomes of chance or different starting conditions? In this session we will attempt to discern aspects of Earth life that are primarily the result of deterministic causes and those which are attributed to stochasticity, focusing on how this understanding will help our attempts to search for life in the Universe. Jim Cleaves (ELSI) will co-convene.

**Proposer Name:** José C. Aponte, NASA Goddard Space Flight Center/ Catholic University of America and Zita Martins, Imperial College London (UK)  
**Session Title:** The Organic Ingredients for Life in Comets, Asteroids, and Meteorites  
**Summary:** The early Earth was heavily bombarded by comets, asteroids and meteorites, which may have brought the organic ingredients for life to our planet. Laboratory analyses of meteorites show they preserve some of the most primitive materials in the solar system. The majority of the meteoritic organic material is locked as an insoluble kerogen-like polymer, while the remaining consists of a rich inventory of soluble organic compounds, some of which have shown enantiomeric and isotopic enrichments. Present and future space missions (Rosetta, Osiris-Rex, Hayabusa-2, etc.) will also enable the study of the organic ingredients for life in comets and asteroids. In this session we will discuss the chemical diversity and distribution, and the enantiomeric and isotopic composition of soluble and insoluble organic compounds present in meteorites, asteroids and comets. Method development as well as laboratory studies relevant to present and future space missions to those planetary bodies will also be considered.

**Proposer Name:** Kelly Smith, Clemson University  
**Session Title:** The Moral Value of ETL  
**Summary:** This session will address a series of related questions from a number of different perspectives: 1) What is it that accounts for the moral value of different types of ETL?, 2) How does this value compare with the moral value of human beings?, and 3) how do these theoretical questions inform the kinds of practical decisions we need to make in astrobiological contexts?

**Proposer Name:** Abel Méndez, Planetary Habitability Laboratory, UPR Arecibo  
**Session Title:** The Diversity of Biospheres: From Desert to Super-Habitable Worlds  
**Summary:** Near-future telescopes will observe the atmospheres of Earth-like planets in search for global biospheres. The evolution of the telluric atmosphere and comparative planetology indicate that an Earth-sized planet's spectral signature can be quite different from Earth's modern spectral fingerprint, depending on the biosphere's habitability and habitation status. Efficient detection and proper characterization of potentially habitable worlds therefore require an understanding of various global biosphere stages, that is, the transition from desert planets devoid of life to superhabitable worlds. The latter might host biospheres that are larger, longer lasting, or more diverse than Earth's. We invite presentations on possible prototypes of global biospheres with a particular interest in extrasolar habitability and habitation scenarios producing spectral or photometric signatures that can be detected by the next generation of telescopes.

**Proposer Name:** Stefanie Milam, NASA Goddard Space Flight Center  
**Session Title:** Determining the Origin and Nature of Prebiotic Species in Comets
Summary: Sublimated molecular ice, silicate dust, and solid-state carbonaceous materials are the major components of cometary comae that can be studied by space- and ground-based observations, as well as by rendezvous missions. Multiple organic molecules are now routinely detected, including ethylene glycol and formamide, as well as a number of unidentified lines in bright comets which suggests that other organic/prebiotic molecules may be present and detectable in comets. New facilities, such as ALMA, with improved sensitivity using state-of-the-art detectors, will facilitate the detection of additional new species in comets and will dramatically increase the number of possible comets in which to conduct searches. This session invites contributions from comet observations at all wavelengths, investigating the inventory and origin of cometary organics. A special emphasis is placed on the roles of new facilities, instruments, and techniques to decipher the molecular origin and distribution of prebiotic species in cometary comae.

Proposer Name: Vlada Stamenkovic, Massachusetts Institute of Technology
Session Title: Artificial Biospheres and Habitable Worlds
Summary: The first Biosphere 2 mission was an experiment in the early nineties to create a closed artificial biosphere for humans. The mission failed in its goal to be self-sustaining for two years, but it successfully demonstrated how difficult it is to create an isolated and self-sufficient artificial biosphere for humans. However, we are at a verge of human planetary exploration where artificial biospheres must be explored. Adding to this urgency is the chance of artificial biospheres being ideal test beds for understanding and experimenting with complex environmental and biogeochemical feedbacks – exploring the processes needed to build habitable worlds. This session invites contributions that explore: 1) the science and technology needed for creating a functioning artificial Biosphere, and 2) how artificial biospheres can be used as tools for understanding the formation of habitable niches on Earth and beyond.

Proposer Name: Samantha Marie Waters, Georgia Institute of Technology
Session Title: Extreme Earth: Understanding Terrestrial Environments through Omics and What This Reveals of Possible Life-supporting Environments in the Solar System
Summary: Earth life is found in a number of environments considered to be extreme. Understanding how life on Earth adapts to and contributes to the chemistry of these environments may aid in our understanding of how life has shaped the planet; ultimately widening what we think of as being habitable and the search for extraterrestrial life. Due to the limited culturability of microorganisms, shotgun omic and meta-omic investigations have revolutionized the ability to describe members of communities (metagenomics), how these communities respond to environmental changes (metatranscriptomics), what functional role these organisms contribute to biogeochemical cycles (metaproteomics and metabolomics), and how select organisms have evolved to thrive (adaptive mutation). This session welcomes presenters to share their extremeomics research and how it informs on (i) the search for extraterrestrial life, (ii) how Earth life has evolved to extreme environments, and (iii) how microorganisms have ultimately shaped our planet and possibly more distant environments.

Proposer Name: Magdalena Osburn, Northwestern University and Jan Amend, USC
Session Title: Life Underground -- Habitats and Inhabitants
Summary of Session Topic: The search for deep subsurface life is a key focus of the astrobiological community that has profound implications for extraterrestrial exploration. Recent studies have shown subsurface environments to be physically and geochemically diverse, providing both a range of energy sources and unique challenges for in situ populations. Diverse microbial communities have been documented from deep subsurface sites on Earth that encompass broad phylogenetic ranges. Combined, these studies suggest ever more potential for habitable space beneath rock, ice or water in extraterrestrial settings. We invite contributions that use laboratory experimentation, theoretical approaches, remote sensing, and/or field work to the study of marine, continental, or extraterrestrial subsurface environments.

Proposer Name: William Brazelton, University of Utah
Session Title: Interdisciplinary Integrations of 'omics' Data with Environmental Data
Summary: Astrobiology can be described as the study of life over very large spans of space and time. Next-generation sequencing technologies have radically improved the spatial and temporal resolutions at which we can
measure the distributions and activities of life on Earth, and these developments are likely to enable a more general understanding of how life interacts with its environmental settings. Making sense of these huge datasets, however, will require statistically meaningful integrations of biological, chemical, and geological data. Interdisciplinary syntheses are a strength of astrobiology, so astrobiologists can play a leadership role in these efforts. Therefore, this session will highlight examples of interdisciplinary integrations of ‘-omics’ data with environmental data, chemical measurements, geological information, and laboratory experimental data. Environmental studies that yield interdisciplinary insights through effective sampling strategies and multidisciplinary collaborations are particularly encouraged, especially those that are designed to test specific hypotheses and go beyond initial data exploration.

**Proposer Name:** Martin Cordiner, NASA GSFC / Catholic University of America  
**Session Title:** The Formation and Evolution of Organic Molecules in Titan's Atmosphere  
**Summary:** Titan's thick, carbon and nitrogen-rich atmosphere contains abundant organic molecules and is considered as a possible analog for the atmosphere of the young Earth. Remote and in-situ observations continue to provide a wealth of information on the distributions of Titan's hydrocarbons, nitriles and oxygen-bearing species. Subject to intensive theoretical investigation, these studies are working towards a fuller understanding of Titan's atmospheric chemistry, and are expected to provide insights into the likely (perhaps pre-biotic) conditions prevalent in the atmospheres of young planets in our own Solar System and beyond. The scope of this session is to include new work on observations and modeling of Titan's atmosphere, including multi-wavelength ground-based observations, in-situ (Cassini) measurements, and photochemical and dynamical modeling. An emphasis will be placed on topics relating to the formation and evolution of molecules that could be relevant to the chemistry of life.

**Proposer Name:** José C. Aponte and Jamie E. Cook, NASA Goddard Space Flight Center  
**Session Title:** Mechanisms for the Prebiotic Emergence of Homochirality  
**Summary:** Although homochirality is essential to life on Earth, the mechanism behind its emergence remains an unanswered question in astrobiology and origins of life research. The left-handed enantiomeric excess found for a few chiral meteoritic amino acids may trace a link between these extraterrestrial molecules and all living systems on Earth. In this session we will discuss the various processes that may have influenced the emergence of homochirality in life on Earth. These include processes that occurred before the formation of our solar system, during parent body accretion/alterations, or on the prebiotic Earth, as well as the influence of chirality on the emergence of early life.

**Proposer Name:** Russell S. Shapiro, California State University, Chico  
**Session Title:** Detection of Life Signatures in Geological Material II: The Macroscale  
**Summary:** The search for an extraterrestrial fossil record on both Mars and other planetary bodies targeted for astrobiological exploration requires investigation across a wide range of spatial scales and includes chemical tracers and morphological structures. Macroscale features produced by microorganisms on the early Earth and in microbially-dominated extreme environments provide a rich data set of potential macroscale features that may provide evidence of biogenicity if microbial communities ever thrived on the surface of Mars. Astrobiology explorations on Mars require increasingly sophisticated sets of morphological and chemical criteria for recognizing an exobiological fossil record. This session invites presentations that discuss the challenges and strategies employed in searching for evidence of an extraterrestrial fossil record through macroscale features such as mineral assemblages, biofabrics, microfossils, microbial trace fossils, and anomalous deposits in both field and laboratory studies. Sherry Cady (PNNL) will co-convene.

**Proposer Name:** Alexis Templeton, University of Colorado  
**Session Title:** The Habitability of Water-Rock-Supported Ecosystems  
**Summary:** Rocky planets can power living systems through chemical energy released through the interaction of rocks with water. Astrobiological investigations commonly use a thermodynamic framework to predict the habitability of planetary environments based upon the disequilibrium between rocks, minerals, aqueous species, and gases. Rock-hosted chemosynthetic ecosystems play a key role in sustaining contemporary life in near surface environments and are likely to have done so since early in Earth history. This session invites papers that focus on recent investigations of water-rock systems that explore mechanisms of energy transduction supporting resident
microbial populations. Of particular interest are studies that combine theoretical, experimental, and observational approaches to extend the habitability boundaries or limits for life in contemporary water-rock supported ecosystems, with application towards processes which fueled early life or which can guide the search for signatures of life on other planets. This session will be co-convened with Eric Boyd and Eric Roden.

**Proposer Name:** Rakesh Mogul, California State Polytechnic University, Pomona  
**Session Title:** Issues in Planetary Protection: Preserving Astrobiology Opportunities and the Earth  
**Summary:** In solar system exploration, the ability to conduct astrobiological investigations without biological or organic contamination is intrinsically connected to the objectives and practices of planetary protection. Likewise, planetary protection provisions provide for the possibility that other worlds might harbor life of their own. With developments ongoing for ExoMars 2018 and Mars 2020, and planning underway for Europa and Enceladus missions, Mars sample return, and future human missions beyond Earth orbit, the need for robust planetary protection policies, procedures, and designs are of increasing importance. This session will focus on issues in planetary protection including research on the microbiota that may be taken to other worlds by robotic and human spacecraft, plans for the implementation of planetary protection provisions for future missions, the identification of Special Regions on Mars, and holistic studies aimed at minimizing the contamination of explored extraterrestrial environments including icy satellites of the outer solar system.

**Proposer Name:** Meghan Rouillard, 21st Century Science and Technology Magazine  
**Session Title:** On Non-Chemical Theories of the Origin of Life  
**Summary:** With much of the work of astrobiology focusing on how life could originate in an “abiotic” environment, a concept pioneered by Russian scientist Alexander Ivanovich Oparin in his 1924 “Origin of Life,” it is important to also direct attention to past experiments, theories, and well as current work which point toward the idea that life might only originate from life. This idea has been elaborated by scientists such as 15th century Italian scientist Francesco Redi, the namesake of “Redi’s Principle,” or “omne vivum viv”, Louis Pasteur and Pierre Curie in the 19th century, and Vladimir Vernadsky in the 20th century, among others. Attempts to recreate Oparin’s primordial soup may also point in this direction, when considerations such as symmetry are taken into account. This session seeks to review any historical contributions to this argument, as well as any current work and prospects for future work and experimentation along these lines.

**Proposer Name:** Morgan Cable, NASA Jet Propulsion Laboratory, California Institute of Technology  
**Session Title:** Titan: Challenging Our Definition of Habitability  
**Summary:** Determining the ubiquity of life in the universe requires understanding of the range of environments in which chemical self-organization and assembly can occur. On Earth, liquid water is the solvent, but is water exclusively suited for habitability? Discovering that self-assembly of chemical systems can occur in liquid solvents other than water would argue that life is an intrinsic property of chemical reactivity. The best example we have in our solar system of nonaqueous environments is on Titan. The primary objective of this session will be to explore the nonaqueous chemistry of Titan and how this challenges our current definitions of habitability. Presentations are encouraged in astrobiology, organic chemistry, geochemistry, and atmospheric chemistry, and can include both experimental data (from the lab or mission science) and modeling results.

**Proposer Name:** Jill Tarter, SETI Institute and Victoria Meadows, UW Astronomy Dept. & Astrobiology Program  
**Session Title:** Biosignatures and Technosignatures: The Search for Inhabited Planets  
**Summary:** The co-evolution of life with its planetary host can modify the planetary environment in many complex ways that can potentially be sensed remotely at great distance. Biosignatures are life’s global footprint on the environment. Their detection relies on being able to identify phenomena that are “out of place” in a sufficiently well-characterized environment. We must also be able to discriminate these life-mediated characteristics from the results of abiotic planetary and atmospheric processes that may act as false positives. Technosignatures are deliberate or inadvertent modifications of the planetary environment as the result of technology, and involve their own set of false positives. This session encourages the broadest possible discussion of how it may be possible to tell which potentially habitable worlds are actually inhabited.
Proposer Name: Charles Cockell, University of Edinburgh  
Session Title: The Microbiology of Analog Environments  
Summary: To assess the habitability of extraterrestrial environments we need to understand the microbial ecology and limits of life in similar environments on Earth. In this session we will explore what we know about the habitability of analog environments with a special focus on microbiology - the limits and physiology of organisms that inhabit these environments.

Proposer Name: Ronald Breslow, Columbia University  
Session Title: Important Molecules in the Prebiotic World to Make Life Possible.  
Summary: For life to start some primitive forms of RNA and catalysts and structural components such as early sugars and amino acids and especially selective chirality need to arise spontaneously. Breslow and Pizzarello and Blackmond and others are working in this area.

Proposer Name: R. Thane Papke, University of Connecticut  
Session Title: Halophilic Archaea: Insight into a World before Eukaryotes  
Summary: The diversity and characteristics important to the emergence of eukaryotes remain a mystery. However, modern bacteria and archaea have features analogous to those of eukaryotes (e.g., multiple chromosomes, cell fusion, heterozygosity, cell-cell communication, cell differentiation, multicellularity, homologous recombination), suggesting they were widespread throughout the Precambrian Eon, and were available for modification at the origin of Eukaryotes. Members of the archaean order Halobacteria are obligate inhabitants of, and are the numerically dominant organisms living in extreme saline habitats, an exclusive microbe only niche. Furthermore, halobacteria contain most of the above eukaryote-like traits. Together, the habitat and the organisms represent an excellent model system for insightful comprehension of the biological world before eukaryotes: indeed halobacteria were recently noted as failed experiments at eukaryogenesis. This session will advance the latest exciting developments in the evolution of this archaean order as observed through the intersections of genetics, physiology, biochemistry, genomics and metagenomics.

Proposer Name: Maitrayee Bose and Sandra Pizzarello, Arizona State University  
Session Title: Extraterrestrial Materials, Isotopic Anomalies and the Emergence of Life  
Summary: This session will explore isotopic anomalies exhibited by organic matter in extraterrestrial materials and their possible relationship with the biomolecules that are relevant for emergence of life. The extraterrestrial samples analyzed may include meteorites, interplanetary dust particles, Antarctic micrometeorites, and samples from return missions.

Proposer Name: Sara Waller, Montana State University  
Session Title: Perception, Cognition,and Neural Architecture and Astrobiological Theorizing  
Summary: Evolutionary forces necessarily direct the ways in which human beings develop and refine scientific knowledge. Astrobiology, as an emerging science, provides an excellent case study in the ways in which we create new hypotheses and methods, decide on important questions, and set parameters for satisfactory answers. In this session we will explore the self-reflexive nature of astrobiology – intelligent life, shaped by selective forces, perceives, cognizes, and understands itself, its origins and its possible distribution, through specific perceptual-cognitive-neural constraints, drives, predispositions, and abilities. How can we overcome the worries of anthropic evolution as a biasing force in science? Should we?

Proposer Name: Lewis R. Dartnell, University of Leicester, UK  
Session Title: Effects of Ultraviolet and Cosmic Ionising Radiation on Life and Habitability  
Summary: The present-day surface of the Earth is well protected from solar ultraviolet and the ionising radiation of cosmic rays by the planetary magnetic field and thick atmosphere (including stratospheric ozone shield). But this has not always been true throughout terrestrial history, and is not the case for other potentially habitable bodies such as Mars. In what ways can unfiltered UV or bombardment by cosmic rays limit the survival of exposed life, or affect the continued detectability of biosignatures indicating its present or past existence, for bodies within our solar system and exoplanets? Or, indeed, in what ways might UV flux or cosmic rays aid in the origin or survival of
microorganisms? Topics for this session may include, but by no means by limited to: Earth past and present, radiation effects on Mars, radiolytic generation of oxidants at Europan, habitability of exoplanets and detectability of atmospheric biosignatures.

**Proposer Name:** Manish R. Patel, Open University, UK  
**Session Title:** Current and Future Instrumentation for Assessing Habitability and Detecting Biosignatures  
**Summary:** Planetary exploration and astrobiology with robotic orbiters, landers and rovers necessitate highly sophisticated science payload instruments to assess the present or past habitability of extraterrestrial environments or detect unambiguous signs of life. Each successful mission advances our understanding and also generates new questions, informing the selection of subsequent instrumentation packages and driving the implementation of novel approaches. What are the design features and capabilities of instruments deployed on current missions, and what insights have they provided? How are these capabilities and sensitivities expected to improve over coming years? And more importantly, what promising novel techniques - perhaps by adaptation from terrestrial applications - are there that can offer whole new capabilities for assessing habitability or detecting biosignatures in the near future? This session will explore current instruments and opportunities offered by novel techniques for upcoming and proposed missions.

**Proposer Name:** Carol Oliver, Australian Centre for Astrobiology, University of New South Wales, Sydney  
**Session Title:** Transforming Astrobiology Education and Outreach in the 21st Century  
**Summary:** Increasing innovations in educational technology that offer students and the public information and visually rich experiences are also transforming the way we create and deliver astrobiology education and outreach to Generation Z (today's high school and early year university students). This session explores local, national and international astrobiology education and outreach offerings, especially those that demonstrate the effectiveness of these programs. Hands-on and live experiences are particularly welcomed -- bring your own Internet-connected device to participate. This session is designed to be a dynamic and enriching exchange of information and aims to prompt food for thought on future directions for engaging students and the public with astrobiology.

**Proposer Name:** Nigel Goldenfeld, University of Illinois at Urbana-Champaign  
**Session Title:** Laws of Life: Exploring Universal Biology through Computer Simulation  
**Summary:** Universal Biology is the science of the fundamental laws that underlie the phenomenon of life. It aims to understand why life can occur as a phenomenon, one distinct from self-organization that is now well-studied in physical systems. In addition, it asks what are the generic phenomena characteristic of living systems, independent of the particular substrate from which they are constructed: in other words, carbon-based life is thought to embody higher principles of information flow and non-equilibrium statistical thermodynamics, none of which depend on the precise molecules that make up earthly living systems. This quest for universal laws of life means that computer simulation of digital organisms ---computer viruses are but one well-known example --- plays a unique role, providing minimal models that can caricature living processes and make quantitative predictions of evolutionary and ecosystem behavior that would otherwise be intractable mathematically.

**Proposer Name:** Louisa Preston, The Open University  
**Session Title:** Spectroscopic Techniques for Assessing Planetary Habitability and Detecting Biosignatures  
**Summary:** Spectroscopy is a valuable tool in planetary exploration. It is crucial to the search for extraterrestrial habitable environments due to its sensitivity to both organic and inorganic molecules, and its ability to distinguish spectral signatures of life from geological and atmospheric backgrounds. Optical spectroscopy techniques such as FTIR, UV-Vis, Raman, Fluorescence, and Laser-Induced Breakdown Spectroscopy (LIBS), as well as hyperspectral imaging instruments, have been/or will soon be included on mission payloads due to the range of potential biosignatures they can detect, and their capacity for miniaturisation. Spectrometers are therefore an important asset to any life-detection mission. The aim of this session is to bring together researchers using spectroscopic techniques to identify biosignatures within terrestrial analogue environments, in situ on planetary surfaces, and remotely within atmospheres; in order to explore the range of signatures being detected, and new and developing strategies for their discovery.
Proposer Name: Mario Livio, Space Telescope Science Institute  
Session Title: What Should We Look For to Find an Advanced Civilization?  
Summary: The solar system is only about 5 billion years old. This implies, that if advanced civilizations exist in our Galaxy, some of them may be much more advanced than ours. In this session we will explore what GENERIC features may characterize such evolved civilizations, and what might be the detectable signatures of such characteristics.

Proposer Name: Elbert Branscomb, UIUC IGB/IU  
Session Title: Prospects for Putting the Alkaline Vent Model for the Emergence of Life to Experimental and Theoretical Test  
Summary: It has been proposed that alkaline vents resulting from serpentinization acting in the floor of the Hadean ocean generated a suite of essential preconditions for the initial events in the emergence of life, preconditions that necessarily entail specific structural, geochemical, and (non-equilibrium) thermodynamic components. What are the opportunities in principle for putting these proposals to dispositive tests, what are the promising approaches in practice for carrying out such tests, and where do such efforts now stand?

Proposer Name: Melissa Kirven-Brooks, NASA Astrobiology Institute  
Session Title: Astrobiology Research and Education at Minority Serving Institutions  
Summary: This session highlights the contributions of Minority-Serving Institutions (MSIs) to the larger astrobiology community. Presentations from faculty at Hispanic-Serving Institutions (HSI), Historically Black Colleges and Universities (HBCU) and Native American Serving Institutions (NASI) will illustrate the diversity of current astrobiology research at MSIs. Contributions to the scientific and the larger outreach effort will be presented. This session invites researchers to share their research progress, astrobiology experiences, and to explore topics such as institutional support, student interest, and models for sustaining or expanding opportunities for diversity in astrobiology.

Proposer Name: Gal Sarid, University of Central Florida, Florida Space Institute  
Session Title: Panspermia in A Minor (Body)  
Summary: Minor bodies in the solar system (and other planetary systems) may play a significant role in the promotion, proliferation, dissemination and perhaps the cessation of life and its related building blocks. The potential of such populations (i.e., comets and asteroids) has been demonstrated to: (i) dynamically distribute prebiotic material across different regions; (ii) affect the volatile and isotopic composition of planetary atmospheres and surfaces; (iii) support aspects of Litho-pansperrmia; (iv) support “in-situ” conditions for sustaining life’s pre-requisites; (v) promote prebiotic compound creation on planetary surfaces via impacts; We propose here to hold a session that will combine recent insights from observational, numerical and experimental work about the revised idea that minor bodies may play the major role of couriers and emissaries for life's building blocks across the solar system.

Proposer Name: Jacob Haqq-Misra, Blue Marble Space Institute of Science  
Session Title: Life in the Anthropocene: The Future of Earth's Biosphere  
Summary: The distant future of Earth’s biosphere will be shaped by the balance between factors such as orbital variations in solar insolation, cycles in glacial coverage, the carbonate-silicate cycle, and the resonating effects of anthropogenic climate change. Even longer geologic timescales will force the climate to adapt to a steadily brightening sun by drawing down atmospheric carbon dioxide until habitable conditions no longer remain. This session invites any contributions that consider potential threats or challenges to the future of civilization, life, and climate from factors that will affect the Earth system over the next 100,000 to million years or longer.

Proposer Name: Randall W. Smith, Portland State University, Dept. of Physics  
Session Title: Surface Morphology and the Bacterial Footprint: Habitats and Organisms  
Summary: The presence of water in the past, and the detection of ancient living forms resolves some questions of organisms, habitat and habitability. From the ALH84001 meteorite to the Yamato000593, microscopical evidence of early aquatic environments, water and organisms suggests that casts, fossils and imprints are key features and
evidence for establishing environmental models in astrobiology. Metallic surface films that occur in natural waters and wetlands are a model for temperate aquatic environments in that bacterial and algal 'footprints', casts and impressions document habitats, organisms, density and other important morphological features of living organisms, and define both habitat and nutrient conditions for life. This session further develops microscopy as an analytical tool to document microbiological diversity and morphology through imaging and analysis.

**Proposer Name:** Olga Prieto-Ballesteros, Centro de Astrobiología-INTA-CSIC  
**Session Title:** Experimental Astrobiology  
**Summary:** Planetary habitability, early Earth environments, or geochemical processes in extreme conditions are some of the many areas that, by the inaccessibility and cost of space missions, the impossibility to find remnants in the terrestrial geological record, or exploring unknown phenomena, require experimentation and, in many cases, unique and dedicated facilities. Specific simulation chambers have been already developed by the astrobiology/planetology community, which are providing plenty relevant information so far. The goal of this session is to discuss the results of their experiments, recent technical progress, and the future challenges.

**Proposer Name:** Steve Desch, Arizona State University  
**Session Title:** Exploring Life's Detectability on Chemically Diverse Exoplanets  
**Summary:** In the not-so-distant future, transiting Earth-like planets in their stars' habitable zones will be discovered and infrared absorption features by the putative biosignature gases O2, O3 or CH4 will be sought. Prioritization of exoplanet targets will be necessary. Stellar compositions vary significantly, and exoplanet compositions are likely at least as diverse. It will be important to identify those exoplanets whose chemical compositions are most likely to yield "detectable" life, with ecosystems that potentially can produce these gases faster than their planet's abiotic geochemical cycles. We invite presentations on the production rates of O2 and CH4 by terrestrial ecosystems that might be analogs to exoplanet ecosystems, especially considering the chemical limiting factors on their productivity. We also invite presentations on the geochemical cycles of exoplanets that are Earth-like but chemically different. We especially invite papers that compare abiotic and biological rates of production of O2 and CH4 on chemically distinct but otherwise Earth-like exoplanets.

**Proposer Name:** Erik Persson, Lund University  
**Session Title:** What is Life?  
**Summary:** Understanding life can be seen as the ultimate aim of astrobiology. Having a definition of life that reflects how we understand life and is practically useful is also important for our ability to choose the right strategy and instruments when looking for life, to know whether the phenomena we find are instances of life or not, and to identify when life started. Understanding life and defining life are closely connected. We need a preliminary definition to know what it is we try to understand but as our understanding progresses it will affect our definition.

**Proposer Name:** Robert Blankenship, Washington University in St. Louis  
**Session Title:** The Origin and Early Evolution of Photosynthesis  
**Summary:** Photosynthesis is the only significant solar energy storage process on Earth, and this type of metabolism dominates modern as well as ancient surface environments. The origin and early evolution of photosynthesis is one of the key unresolved issues in the history of life on Earth, and the potential exists for this light-harvesting metabolism to occur on other planetary bodies within and beyond our solar system. This session invites submissions that utilize biochemical, -omics, and physiological approaches in understanding key events in the development of photosynthetic machinery and the transition from anoxygenic to oxygenic photosynthesis. Submissions that seek evidence of these events in the rock record are also welcome.

**Proposer Name:** Rory Barnes, University of Washington  
**Session Title:** Formation and Orbital Evolution of Habitable Planets  
**Summary:** Planets form and evolve in complex systems that influence their composition, climate, and internal energy. The planet formation process mixes molecules and results in major collisions that provide the refractory, volatile and radiogenic material that creates a potentially habitable world. Planet formation can be affected by galactic processes, such as close encounters with other stars. After formation, other planets in the system force
oscillations in orbital properties, like eccentricity, that can significantly alter a habitable planet's climate. For low-luminosity hosts, tidal interactions with the host star can lead to long-term changes in orbital properties. This session invites contributions that explore the roles planet formation and/or orbital evolution on habitable planets and moons.

Proposer Name: Michael Tice, Texas A&M University and Abigail Allwood, NASA Jet Propulsion Laboratory
Session Title: Spatial Proxies: Mapping Chemical Variability in Astrobiological Materials
Summary: Organisms set up chemical gradients over a wide range of spatial scales. Correlations between physical structures and elemental, molecular, and isotopic compositional variations can thus carry information about past environments and processes, including the presence and activity of organisms. This information is accessible to an array of modern instruments currently being applied to geologic materials, including micro-x-ray fluorescence spectrometers, secondary ion mass spectrometers, Raman microspectrometers, etc. This session invites submissions exploring chemical mapping (elements, minerals, organics, isotopes) as a tool for paleoenvironmental and paleobiological interpretation, particularly with application to defining or refining biosignatures.

Proposer Name: Bruce Fouke, University of Illinois at Urbana-Champaign, Susan Rosenberg, Baylor College of Medicine, Philip Hastings, Baylor College of Medicine, Charles Werth, University of Texas at Austin
Session Title: Survival: Exploring the Effects of Stress on Microbial Evolution Rates and Survival Strategies
Summary: There is considerable debate regarding how life evolved (and subsequently survived) from the last common ancestor of the three domains of life in the severe and fast-changing environment on early Earth. The well-developed genetic code and the countless permutations and combinations of nucleotides plays a key role in microbial evolution in the presence of environmental stress, and suggests that a similar evolutionary processes may be occurring on other planets with environments similar to those on early Earth. It has been proposed that genetic mutations of microorganisms in response to environmental stress is either spontaneous or induced, and which of these controls mutations affects the corresponding rate. The survival of the genotypes relies on mutation rates: faster mutation provides a higher probability of both advantageous and deleterious mutations, and stress selects the advantageous mutations. Gradients of stress also stimulate taxes of organisms and can affect evolution and survival.

Proposer Name: Victoria Meadows, University of Washington and Avi Mandell, Goddard Space Flight Center
Session Title: The Future of Habitable Exoplanet Detection and Characterization
Summary: This session will focus on the science and technology requirements for the next generation of observatories that will study the habitability of extrasolar planets and undertake the search for life beyond the Solar System. Topics to be covered in this session include 1) the foundational astrobiological science for these observatories, including current knowledge of exoplanet habitability, markers for habitability, key biosignatures, and strategies for target selection 2) the architecture, instrument requirements and technologies to detect these markers, and 3) the impacts of astrophysics, telescope design and instrumentation properties on the yield of potentially inhabited exoplanets. We encourage abstracts on spacecraft and ground-based facilities and concepts that can find potentially-habitable worlds around other stars – such as MEarth, Kepler, TESS, and PLATO, and characterize them—such as ground-based ELTs, JWST, WFIRST, Exo-C, Exo-S, and ATLAST. Discussions of the complementarity of these facilities are also encouraged.

Proposer Name: Clark Johnson, University of Wisconsin-Madison and Sherry Cady, Pacific Northwest National Laboratory
Session Title: Celebrating Fifteen Years of the Journal "Astrobiology"
Summary: AbSciCon 2015 coincides with the fifteenth anniversary of the journal "Astrobiology," and this session is intended to highlight some of the landmark research that has been published in the journal, and to look to the future. The session presenters, organized by the senior editorial board of the journal, will summarize the impact of key findings published in "Astrobiology," summarize progress since their publication, and discuss future directions and challenges in the respective topics of the field. These later components, progress and future directions, are viewed as critical for creating a stimulating and popular session. We envision this session to have one- to two-
dozen talks of 15- or 30-minute length. Presentation at the session would be by invitation only. The session is likely to attract a wide range of AbSciCon attendees, from students to senior researchers, interested in a summary of various subjects in the field of astrobiology.

**Proposer Name:** Reggie L. Hudson, NASA Goddard Space Flight Center  
**Session Title:** Radiation and Astrobiology – Friends or Foes?  
**Summary:** Ionizing radiation provides challenges and opportunities for astrobiologists. On one hand, radiolytic and photolytic formation and destruction of molecules are important to the evolution of biologically-important molecules from the Solar System to the interstellar medium. Radiation also can provide the chemical disequilibrium for biospheres. Conversely, radiation-rich environments can only be habitable if molecules vital to a bio-system can be protected. These considerations suggest that knowledge of relevant photo- and radiation chemistries is crucial to observational astronomy, laboratory studies of life’s origin and evolution, theoretical models, and exploratory space missions. This AbSciCon session will bring together a diverse group of contributors linked by an interest in the interplay of radiation and astrobiology. Particularly welcome are studies related to the icy Galilean moons, molecular survival at Mars, Titan chemistry, current and planned space missions, radiation protection, interstellar molecules, and life’s origin. Observational and laboratory studies as well as theoretical results are invited.

**Proposer Name:** Lev Horodyskyj, Arizona State University  
**Session Title:** Astrobiology Education and Public Outreach (E/PO) ... and its Impact: Fresh Ideas and Experienced Perspectives  
**Summary:** New to E/PO? Or are you a seasoned professional? Are your efforts having an impact? How do you know? Present your projects in this section, where the focus will be on measuring the impact of our efforts on our audiences. We encourage submissions across the spectrum from tried-and-true, battle-tested programs to innovative, next-generation initiatives. A companion workshop later in the conference will bring together best practices and fresh ideas in evaluation techniques to take your projects further.

**Proposer Name:** Penelope Boston, New Mexico Tech & Nat Cave Karst Res Inst  
**Session Title:** The Pattern of the Beast: Biopatterns as Biosignatures  
**Summary:** Many biosignatures have been suggested, both chemical and physical. Physical structures as biosignatures at both macroscopic and microscopic scales benefits from the potential to be decoupled from the precise biogeochemistry that produces them. Two and three dimensional structure can be created in response to basic ecological necessities like nutrient or fluid availability, and in response to the basic physics of the system. Are there distinguishable patterns produced by life that could be universal? Can we identify and characterize these in both living and fossil materials?

**Proposer Name:** Pablo Sobron, SETI Institute, Carl Sagan Center and Laurie Barge, Jet Propulsion Laboratory  
**Session Title:** Pushing the Limits of Astrobiology Technology  
**Summary:** Recent advances in robotics, optics, and electronics have spurred the development of new instruments and mission concepts for the astrobiological exploration of the Solar System. This session will review state-of-the-art technological approaches to detecting and characterizing biosignatures in upcoming planetary exploration missions, and will showcase innovative technologies and concepts for orbital, airborne, landed, and subsurface/underwater astrobiological investigations moving forward.

**Proposer Name:** Sanjoy Som, Blue Marble Space Institute of Science  
**Session Title:** Early Earth as an Extrasolar Planet  
**Summary:** The quantity and range of planets detected by ongoing planet searches suggests that Earth-sized terrestrial planets within the habitable zone of their host star are within detection capabilities. Work is underway to constrain the spectral signatures of how modern Earth would appear at a distance. Yet, the spectral signature of early Earth would have been significantly altered from present-day Earth because of the impact of different biogeochemical processes on atmospheric properties. This session invites contributions that seek to characterize early Earth’s environment through theoretical, experimental, and field investigations, with particular emphasis toward research that will better constrain the past spectral signature of the early Earth. This includes, but is not
limited to, research on past “strange” epochs in Earth history (e.g. Snowball Earth, pre rise of oxygen), work on the differences in active metabolisms at different points in Earth history, and work on the global properties of a prebiotic Earth.

**Proposer Name:** Sanjoy Som, Blue Marble Space Institute of Science  
**Session Title:** Advances in Astrobiological Instrumentation Development  
**Summary:** Astrobiology science goals are important in defining the science requirements for many future planetary and astronomical missions. These goals include not only the direct search for evidence of life, but also the characterization of planetary environments to assess past or present habitability. This session aims to bring together astrobiology scientists and engineers to address these requirements and to aid their translation into instruments and instrumentation suites. We invite original contributions that discuss instrument design, development and testing for astробiologically-relevant space missions, whether they involve remote or in situ analyses. We also welcome presentations that propose new approaches or analytical methods of astrobiological interest from currently deployed instruments or that could be the basis of future instruments, as well as reviews of the current state of instrumentation.

**Proposer Name:** Andrew Pohorille, NASA Ames Research Center  
**Session Title:** Co-evolution of Metabolism, Information Molecules and Membranes  
**Summary:** Considerable efforts have been expended to explain the origins of metabolism, information molecules and membrane-bound compartments. Only recently attention has shifted towards understanding how these essential components of primordial life co-evolved and how evolutionary processes impacted each of these components. Specifically, information molecules and metabolism must have been coupled to produce more progeny at the expense of other protocells. Also, protocellular boundaries were inextricably connected to the metabolism they encapsulated: to be inheritable, metabolism must have led to faster growth and division of protocells and, similarly, transport through protocellular boundaries must have supported the evolution of metabolism. In recent, high profile studies, it has been demonstrated how chemical reactions and peptides catalyzed by primitive catalysts could stimulate competitive growth of vesicles in which they are encapsulated, and how membrane permeability might couple to information polymers. This session will be devoted to reviewing experimental and theoretical progress in this area.

**Proposer Name:** Margaret S. Race, SETI Institute  
**Session Title:** Anticipating Real-World Policy Issues: Astrobiology, Habitability and Life  
**Summary:** Astrobiology has significantly changed our understanding of habitability, extremophiles and life. Soon, decision makers and planners must integrate these new perspectives into revisions of space policies developed decades ago. This session will explore real-world challenges in a deliberately interactive way—using a lightning-style workshop format combining structured tutorials, case studies, sub-group deliberations, and plenary discussions. Participants will experience first-hand the complications arising at the intersection of scientific, technological, legal, policy, cultural, and ethical domains. Workshop topics will focus on two hypothetical exercises related to astrobiology and searches for ET life in the solar system. The first will explore whether and how the discovery of life on celestial bodies may affect future mission plans and activities—on Earth and beyond. The second will examine how information (scientific and otherwise) will be integrated into deliberations about future management and use of celestial bodies in ways that minimize irreparable environmental disturbances.

**Proposer Name:** Rohit Bhartia, JPL/NASA  
**Session Title:** Correlative Imaging: Characterizing Microorganisms, Biosignatures and Minerals in their Spatial Context  
**Summary:** This session highlights current research efforts using a fusion of spectroscopy, microscopy, and other analytical imaging methods to understand the tie between the signatures of life and the distribution and composition of organics, minerals, and key elements. In situ and laboratory instrumentation offer a wide range analytical and spectroscopic techniques to detect and/or characterize microbial cells, macromolecules, aliphatic and aromatic compounds, minerals, elements and isotopic composition, and physical textures. Though traditionally these techniques are applied to spot or bulk analysis, methods that preserve the spatial distribution and the spatial
relationship between target materials are necessary for correlations with biotic signatures. This session focuses on new research strategies which employ combinations of imaging methods to study planetary analogs, environmental samples, or lab based model systems as a means to provide unique insights to how life adapted to or uniquely altered the environment and/or how these signatures persist through time.

Proposer Name: Frances Westall, CBM, CNRS, Orléans, France
Session Title: Analogues
Summary: Analogues are used in astrobiology to prepare future missions and to understand extraterrestrial phenomena and observations. A very large range of scientific domains is concerned: - Geology, with analogue sites and rocks containing traces of a past or extant microbial activity and their associated biosignatures, - Interstellar and prebiotic chemistry, with the study of the physico-chemical processes taking place in the solar system in dust, meteorites, comets or natural satellites, using simulation chambers and sample materials from specific terrestrial environments, - Biology, with the study of organisms living in extreme environmental conditions similar to those existing on some bodies of the solar system, their preservation and fossilization, and with laboratory experiments designed to understand the limits of life. The aim of this session is to bring together researchers coming from various domains in order to explore the concept of analogues in its entirety.

Proposer Name: Rachel Whitaker, University of Illinois at Urbana-Champaign
Session Title: Crossing the Darwinian Threshold
Summary: The Darwinian threshold describes the change in evolutionary mode from one of communal evolution to one of individuality. Different lineages crossed this threshold at different times in the evolutionary history of life of Earth and to different extents. What cellular features delineate this threshold? Although horizontal gene transfer and the sharing of innovations remain powerful factors to the present-day, what characterizes the point of no return, where Darwinian individualized evolution predominates the evolutionary mode? What evolutionary innovations were responsible for the initial bifurcations in the domains of life? This session will examine the common cellular features that hold individual species together, and keep them apart. In addition, we will identify cellular features that are shared between Archaea and Eukaryotes uniquely that differentiated their common ancestor from the Bacteria in the first bifurcation on the Tree of Life.

Proposer Name: Nader Haghighipour, Institute for Astronomy, University of Hawaii
Session Title: Water in Solar System and Extrasolar Habitable Planets
Summary: Water is the medium in which the chemistry of all Earth life takes place. It has modified Earth's geology and climate to a degree that has allowed life to persist to the present epoch. However, how water appeared on Earth is still an unresolved issue. With the discovery of many super-Earth planets in the Habitable Zone, this issue has now extended to other planetary systems as well. Whether any of these planets is suitable for life depends critically on the availability of water. We propose a topical session to present and discuss the results of current research on the origin of Earth’s water and its implications for other habitable planets. We plan to bring experts from key areas related to this topic, and will also accept abstracts from the members of the community. By bringing together diverse experts, our session will facilitate progress in this area.

Proposer Name: Richard Leveille, McGill University
Session Title: Scratching the Subsurface
Summary: Due to the harsh conditions at planetary surfaces, subsurface environments may offer a greater chance of being habitable, and they may favor the preservation of biosignatures and organic molecules. NASA’s Curiosity rover has successfully drilled rocks on Mars. These samples have revealed the true composition of the rocks, and they are helping to understand the fate of organics on Mars. The ExoMars and Mars 2020 rovers will also use drills to access the subsurface. Natural processes, such as impact cratering, cryovolcanism and cryotectonics may bring deeper subsurface materials to the surface on Europa and Enceladus. In addition, natural subsurface environments, such as lava tubes on Mars, may be directly accessible to future robotic and human explorers. This session focuses on results and the scientific rationale for accessing subsurface environments and materials on planetary bodies. In addition, strategies for accessing these environments and acquiring subsurface materials are welcome.
Proposer Name: Sonny Harman, Pennsylvania State University  
Session Title: The Downsides of Detection: False Positives in the Search for Life  
Summary: The search for life in the Universe often discovers previously unknown processes that mimic the signals for life. The purpose of this session is to discuss under what circumstances the standard metrics for life detection (spectral, geological, chemical, or even technological bioindicators) might be compromised by non-biological processes. If these metrics have been compromised, the open discussion of such false positives ultimately leads to more discerning techniques or enhanced metrics. Whether we're looking for the red edge of chlorophyll in the spectra of another world, or preserved biomarkers of Earth's earliest life, it is critical to eliminate the physical processes that would generate such signals in the absence of life. Only then can we be sure of the result - that life is out there. Abstracts from any discipline of Astrobiology working to understand or separate true from false positives are welcome.

Proposer Name: Linda B. McGown, New York Center for Astrobiology, Rensselaer Polytechnic Institute  
Session Title: The Emergence of Life at the Intersection of Prebiotic Chemistry and Early Earth Environments  
Summary: The interplay between prebiotic chemistry and the environment(s) in which life emerged is a complex yet essential consideration in understanding origins of life. The dynamic geological landscapes of early Earth undoubtedly played an active role in the chemical transformations leading to the first biomolecules and their appropriation into the earliest “cells”. Environments such as deep crustal domains, deep-sea hydrothermal systems, and shallow surface pools offered diverse conditions with wide ranges in temperature, pressure, pH, redox potential, mineralogy, and hydration state, often with gradients or cyclical changes. These parameters could not only constrain the synthesis and stability of molecular precursors to life, but also affect sequence and chiral selectivity. We will bring together researchers from both sides of the problem – experts in early Earth environments and experts in prebiotic chemistry, in this highly interdisciplinary approach to origins of terrestrial life. Karyn Rogers, also of the NYCA at RPI, will co-convene.

Proposer Name: Andrew D. Czaja, University of Cincinnati  
Session Title: Earth’s Early Biosphere: Life On An “Alien” Planet  
Summary: Unraveling the early history and evolution of life on Earth is fundamental for understanding our origins. But studying Earth’s early biosphere, which evolved under environmental conditions very different than today’s, also expands our frame of reference for understanding life elsewhere in the universe. Our main lines of evidence for early life are fossilized microorganisms, fossilized microbial structures, and geochemical proxies of microbial metabolisms. Work in this field has accelerated recently due in part to advancements in microscopy, spectroscopy, and mass spectrometry. This work includes the discovery of previously unknown and unique types of microfossils, as well as the development of organic and inorganic geochemical and isotopic proxies that have expanded our understanding of the metabolic diversity and evolutionary history of early life. This session will explore the evolution and diversity of early life as revealed by such morphological and geochemical evidence. Studies combining multiple and/or novel techniques are particularly encouraged.

Proposer Name: Dale P. Winebrenner, University of Washington  
Session Title: Ice-Covered Seas on Earth and Icy Moons as Biogeochemical Systems  
Summary: It now appears that ice-covered lakes and seas may be numerous in the outer solar system, notably including those on Europa and Enceladus, as well as on Earth. Whether such seas are inhabited, however, remains completely unknown, even for most Antarctic subglacial lakes (with the exceptions of the Dry Valley lakes, Lake Whillans and perhaps Lake Vostok). The question hinges not on the presence of water, but rather on the energy required for life, i.e., quantitative habitability. Investigation of actual and possible biogeochemistry in ice-covered seas is thus important for understanding whether ice-covered seas on Earth analogous to outer solar system seas, and for clarifying what chemical analyses of icy moon surfaces and plumes should be pursued. This session seeks to bring together work pertaining to a variety of ice-covered seas to better understand biochemical scenarios that may be common, or distinct, among seas on various planetary bodies.

Proposer Name: Yuri Gorby, Rensselaer Polytechnic Institute  
Session Title: Following the Electrons: Unusual Strategies for Microbial Energy Acquisition
Summary: Electron transfer is central to all of life’s energy conversion pathways. Microorganisms, in particular, have evolved into formidable energy scavengers by diversifying the range of potential electron donors and acceptors during their approximately 3.8 billion years on Earth. It is now clear that microbes wield clever strategies to tap into the redox active elements of the planet, while mediating long-distance electron transport to couple redox half-reactions that are more spatially separated than previously thought. During the last decade alone, observations of microbial electron transport distances have jumped 7 orders of magnitude, from nanometer to centimeter length scales. This session provides a cross-disciplinary forum to discuss established and novel electron transport systems in microbes with special emphasis on systems that operate under low energy conditions and that may leave ‘fingerprints’ of life here on Earth and throughout the Universe. Moh El-Naggar will co-convene.

Proposer Name: Henry Sun, Desert Research Institute
Session Title: Sunlight and Radiation as a Cost to Life
Summary: Solar radiation is a double-edged sword. While photons in the visible range can support photosynthetic production of biochemicals, those in the UV band destroy life-sustaining organics, either by direct photolysis or by interacting with minerals and generating oxidants. Decreases in water availability curtail the biological production without affecting the photochemical destruction. At some point life no longer exists but light-stimulated chemical reactions continue to take place, which can mimic life. The positive, but controversial result of the Viking labeled release experiment shows that we cannot adequately understand planetary surface processes and habitability without taking photochemical oxidation into consideration. This session invites papers that address photochemical oxidation of organics on planetary surfaces, the role of light in mineral formation and transformation, radiation resistance in microorganisms, cold and dry limits of life, and life detection methods that distinguish chemical and biological reactivity.

Proposer Name: Rory Barnes, University of Washington
Session Title: Exotic Habitability
Summary: Most investigations into habitable surfaces have focused on planets orbiting main sequence stars which burn hydrogen at a steady rate for billions of years. But other astrophysical bodies could also host objects with clement surface conditions, such as evolved stars, multiple star systems, brown dwarfs, white dwarfs, and planets (e.g. exomoons). Many of these potentially habitable worlds could be more common and easier to detect than those around main sequence stars. These environments can be very different from that of the Earth, so their habitability requires surmounting different obstacles than the Earth. This session examines the formation, habitability and detectability of these exotic worlds.

Proposer Name: Fred A. Rainey, University of Alaska Anchorage
Session Title: Getting it Right the First Time Around: Expert advice on Characterizing and Describing Novel Species of Bacteria and Archaea.
Summary: Studies of extreme and analog environments routinely yield novel microorganisms with interesting properties. Many scientists working in diverse fields of astrobiology are interested in describing and naming these organisms. There is a large body of literature on how to do this but it is not always applicable to all organisms and taxonomic groups. This session will bring together a number of experts in the field, including members of Bergey’s Manual Trust and Editorial Boards of the taxonomic journals. They will present an overview of the current classification of bacteria and archaea, discuss the approaches that should be taken to successfully describe a new genus species and answer question on the process.

Proposer Name: Vaughn Cooper, University of New Hampshire
Session Title: The Role of Mutators in the Origins of Life
Summary: The origins of life were almost certainly accompanied by an explosion of diversity caused both by inaccurate replication and selection for different strategies in varied conditions. When these new lineages reestablished contact, their interactions likely ranged from synergistic to antagonistic, with some genotypes changing growth conditions that facilitate the growth of neighbors and other genotypes competing to their mutual detriment. The forces that govern this mutation-selection balance remain uncertain, represent an active area of research enabled by contemporary genomics, and are central to understanding the evolution of biocomplexity. The
evolution of lineages with high mutation rates – mutators – is commonly seen in clonally reproducing microbes and tumor cells and is associated with varied long-term outcomes. This session will feature theoretical and experimental-evolutionary approaches to understand why adaptation is often accompanied with heritable variation in mutation rate and how these dynamics influence the fate of populations and nascent communities.

Proposer Name: Alexander A. Pavlov, NASA Goddard Space Flight Center
Session Title: Cosmic Rays – Important but often Unrecognized Factor in Astrobiology
Summary: Unlike UV radiation, cosmic rays and ionizing radiation have been mostly overlooked as important factors in Astrobiology studies. Even though the total energy flux of UV radiation exceeds the total energy flux of cosmic rays by orders of magnitude in the solar and most stellar systems, cosmic rays have the unique ability to penetrate deep within planetary atmospheres and surface rocks causing numerous chemical reactions relevant to life. This session will focus on the broad range of effects which occur in planetary atmospheres and surface rocks due exposure to cosmic rays, gamma rays and energetic electrons. Possible topics for this session may include but are not limited to: the radiolytic transformation of the organic molecules in planetary surface rocks, destruction of the atmospheric ozone by cosmic rays, survival and mutations of microorganisms under ionizing radiation, modeling of the evolution of the cosmic ray fluxes in the solar and exoplanet systems.

Proposer Name: Margaret Turnbull, Global Science Institute
Session Title: Where Could We Be in Ten Years? Finding Habitable Worlds and Life with the Next Round of Planetary and Astronomical Missions
Summary: What could the near future hold for detecting habitable worlds and life? This session will focus on (1) the newly published results of two NASA “probe” studies for direct detection of planets and biosignatures using small coronagraph and starshade space observatories, (2) the life-relevant capabilities of proposed missions to Europa, Mars, Titan, Enceladus, and other bodies in the Solar System, and (3) the prospects for finding and characterizing habitable worlds with JWST and WFIRST-AFTA. Let's hear about the current thinking on these fronts, consider some even bolder ideas, and imagine where we could be in one, two, or three decades.

Proposer Name: Creighton Jones, 21st Century Science and Technology
Session Title: What is Life's Relationship to the Different Frequencies of the Electromagnetic Spectrum, and What Does this Mean for Life Outside of the Earth Environment; Both for Life Originating on Earth and Life Originating Outside of Earth's Environment?
Summary: Life has existed and evolved in a very particular electromagnetic environment, dominated by the spectral emission from the Sun. Earth has also evolved structures, such as the ozone, that regulate what radiation reaches Earth's surface. So, life outside of Earth's environment will be in a different dynamic relationship to the electromagnetic spectrum. Life that originates on Earth, namely human life, will have to accommodate to a different EM condition as we venture out into the cosmos. Conversely, life that originates outside of Earth will have different qualities and characteristics as a function of its particular location in the cosmos. How do we better understand this, and what do we look for?

Proposer Name: Lucianne Walkowicz, Adler Planetarium and Maggie Turnbull, Global Science Institute
Session Title: Understanding Your Parents: The Challenges of Host Star Characterization for Exoplanet Science
Summary: The study of exoplanets is intimately enmeshed with our understanding of exoplanetary host stars. As exoplanet detection techniques have become more refined and have pressed discoveries into new regimes (e.g. smaller, more potential Earth-like planets, as well as outwards to true Jupiter-like analogues), the field has come to find that in many cases, our limit on what is knowable about the exoplanets discovered is driven by limits on the host star characterization. We invite talks describing what we do and do not know about exoplanet host stars, and which specific new observations or studies could help us the most in characterizing exoplanets. We anticipate that several reports on forthcoming and proposed missions will have been freshly released near to AbSciCon, making this a particularly timely topic.

Proposer Name: Haritina Mogosanu and Jen Blank, BMSIS
Session Title: Teaching and Communicating Astrobiology via Collaborative Technologies in a Web 2.0 era
Summary: Collaborative technologies, remote learning and citizen science, Twitter and blogs are the latest trends to communicate science (for instance astronauts tweeting from the ISS), just to give a few examples. This topic explores what could be the most effective ways to communicate astrobiology and engage the audience in a Web 2.0 environment - a space that allows community and collaboration on a scale never seen before. This session could include descriptions of lessons learned (what works best with remote collaboration and social networking, social media and/or teaching; what doesn't work and how to avoid it) and examples from astrobiology, benefits of bringing the field or laboratory into the classroom. The session could also look at what will the future bring in terms of education and science communication and how can this future be harnessed to engage and enthuse the audience.

Proposer Name: Helen Matsos, NASA
Session Title: Astrobiology Magazine-The Best of Year in Review
Summary: Astrobiology Magazine presents a gallery display of the most-read articles of 2014 on astrobio.net. Articles are presented as poster-sized info graphics to highlight astrobiology research that has made a high impact with readers over the previous year. Relevant researchers from the field will also be on hand to discuss the topics.

Proposer Name: Dr. Debajyoti Bose, Yobe State University
Session Title: Inter Planetary Habitation of Agriculturally Important Microorganisms
Summary: Human survival is dependent on the products obtained from agriculture. So, development of agriculture on other planets are very important to make it habitable. Development of soil fertility is the primary step towards development in agriculture which is highly governed by microorganisms. Therefore, session topics should cover experiments related to habitation of agriculturally important microorganisms of Earth to the soil of other planets, especially Mars and Europa.

Proposer Name: Abigail Allwood, Jet Propulsion Laboratory
Session Title: Mars 2020 Rover Mission: Astrobiology In Situ and with Returned Samples
Summary: The Mars 2020 rover mission will use a suite of science instruments to assess past habitability and the potential for preservation of biosignatures, and seek potential signs of past life on Mars. Samples will also be carefully selected and cached for possible future return to Earth, for detailed analysis in terrestrial laboratories. Together, the in situ and returned sample analyses will bring unprecedented scientific capability to focus on the search for evidence of life on Mars. In preparation for this important opportunity, this session seeks diverse contributions relevant to Mars in-situ and returned sample astrobiology, including: field or laboratory analyses of terrestrial analogues, studies using relevant instruments or analytical methods, research on biosignature detection, biosignature preservation, habitability assessment and landing site selection, and papers on sample integrity, contamination and receiving/handling.

Proposer Name: Sherry L. Cady, Pacific Northwest National Laboratory
Session Title: Challenges for the Next Generation of Biosignature Detection Strategies
Summary: The next generation of organic biosignature detection strategies for Mars faces two major and persistent challenges: reactive oxidants (e.g., perchlorates) in the martian regolith make it difficult to detect organics using pyrolysis techniques, and high doses of UV and cosmic radiation alter the chemical fidelity of organic compounds. The potential exists to find organic compounds that provide multiple biosignatures indicative of life on Mars. Hence, this session invites contributions that address technically, experimentally, and theoretically such challenges for detecting and deciphering preserved organics in the presence of primary and secondary reactive oxidants in rock within the shallow martian regolith. Strategies with which to improve the ability to detect carbonaceous remains on Mars today in the presence of reactive oxidants are particularly encouraged.

Proposer Name: Haley Sapers and Alexandra Pontefract, The University of Western Ontario
Session Title: Beyond the Catastrophe: Impact Generated Environments and the Search for Life
Summary: Meteorite impact events create unique microbial niches that may have served as significant habitats on early Earth and are important astrobiological targets on other rocky bodies such as Mars. Impact generated lithologies represent understudied microbial habitats both for microbial colonization as well for the potential to preserve evidence of biological activity. During the Late Heavy Bombardment, a period affecting the early inner Solar System, impact flux on the early Earth was significantly higher. Intriguingly, the earliest evidence for life on Earth coincides with the end of LHB suggesting that impact events profoundly influenced the early evolution, if not origin, of life. Considering the ubiquity of impact events in the Solar System, understanding biological potential of such environments has implications for current and future life detection missions. This session will explore the potential for preservation of biosignatures, and seek potential signs of past life on Mars. In preparation for this important opportunity, this session seeks diverse contributions relevant to Mars in-situ and returned sample astrobiology, including: field or laboratory analyses of terrestrial analogues, studies using relevant instruments or analytical methods, research on biosignature detection, biosignature preservation, habitability assessment and landing site selection, and papers on sample integrity, contamination and receiving/handling.
habitability of ancient and modern impact-generated environments and the potential of such systems to preserve biosignatures.

**Proposer Name:** Afshin Khan, Washington State University  
**Session Title:** Ethical Implications of Not Being Alone  
**Summary:** As humans advance to explore deeper space, invest efforts into SETI and METI, mine asteroids for natural resources and inhabit Mars, the scientific implications need to be derived with thorough examination of the ethics and sociological impact of these explorations. Our panel will focus on emerging bioethical issues related to space exploration and astrobiology. We have seen an exponential growth in emerging technologies many of which will assist us in our journey into deeper space. Beyond health risks, we need to focus on new areas of concern, such as: informed risk, especially with citizen-astronauts and risk assessment under conditions of great uncertainty. Address questions about protocols in the event we discover alien life, including how or whether we bring it back to Earth and questions about what ethical or moral obligations apply to protect life from technological or natural risks and other issues related to ethics, policy, and law.

**Proposer Name:** Harold Bernhardt, University of Otago  
**Session Title:** Chemical Evolution of RNA  
**Summary:** Nicholas Hud argues that the various attributes of RNA suggest it has undergone a process of optimization. This session includes experimental and theoretical investigations into how RNA may have arisen on the prebiotic Earth through a process of chemical evolution prior to replication.

**Proposer Name:** Sara Walker, Arizona State University  
**Session Title:** Chemistry, Information and Life: Is there a Dividing Line?  
**Summary:** “Information” is often cited as the dividing line between chemistry and life. But, how should we define it? And, how does information operate in chemical systems? This session seeks to build a constructive dialog centered on chemical systems that are “life-like” with regard to how they store, process and/or propagate information and narrow down what it is that we mean in making such a distinction. We invite contributions from researchers working in both experiment and theory that bridges the chemical/biological interface including as might apply to alternative chemistries for life. (This session is co-convened with David Lynn, Emory University)

**Proposer Name:** Ariel Anbar, Arizona State University  
**Session Title:** Planetary Protection in the Age of Exploration  
**Summary:** Life detection and other missions to astrobiologically relevant Solar System bodies are constrained both by treaty and by good practice to exert great care in ensuring minimal contamination potential of microbial passengers and biological materials on spacecraft, and to minimize the risk from returning extraterrestrial organisms on Earth-bound samples. These considerations are driven by the goals of astrobiology research and ethical considerations. What is the state of the art today, and where must we go to develop new or improved methodologies of accomplishing our Planetary Protection goals while still producing nimble and capable missions? How do we deal with the eventual conundrum of human exploration while still protecting potentially biologically sensitive sites?