The workshop activities have culminated in five review papers on the science and technology of remote searches for signs of life on exoplanets. Broad participation was solicited for these papers, which will serve as an interdisciplinary, educational, state of the art reference for use across a wide community. Community comments are invited in May 2017 at: nexss.info.

Exoplanet Biosignatures: A Review of Remotely Detectable Signs of Life in the Context of Its Environment
Contact: Victoria S. Meadows, vmeadows@uw.edu

O₂ remains our most robust biosignature. However, possibilities for false negatives exist, as on the early Earth when accumulation of biogenic O₂ in the atmosphere was delayed by at least a billion years. Possibilities for false positives also have been uncovered through computer modeling of mechanisms for abundant O₂ in the absence of a biosphere. We review past and current biosignature research to detail the story of O₂ as a specific example of how life is a function of and modifies its planetary environment, and how we would use remote-sensing observations to search for biosignatures in the near term. In addition, we describe current knowledge of specific photometric, spectrscopic and time-dependent observations of environmental context that could be made by future observatories to identify O₂ as a biosignature, and discriminate it from potential false positives.

Exoplanet Biosignatures: A Framework for Their Assessment
Contact: David Catling, dc@uw.edu

We present a general scheme for observing potential exoplanet biosignatures and grouping and expressing confidence levels for positive detection of signs of life. An appropriate framework uses models with data (in the form of exoplanetary system properties and spectral or photometric data) to find the Bayesian likelihoods of those data occurring if the exoplanet has or does not have life. The latter includes the case of false positives, i.e., where abiotic sources mimic biosignatures. Prior knowledge (including all factors that influence habitability and previous exoplanet observations) would be combined with the likelihood to arrive at the probability of life existing on a given exoplanet given the observations.

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The search for life beyond our Solar System motivates future exoplanet missions to observe for biosignatures with global, potentially detectable, impacts on a planet. Biosignatures occur in an environmental context in which geological, atmospheric, stellar processes and interactions, and evolutionary history may work to enhance, suppress or mimic these biosignatures. Thus biosignature science is inherently a systems science, and our ability to inform the design of the next flagship missions that will obtain spectra of habitable extrasolar planets.

NASA's Nexus for Exoplanet System Science and the NASA Astrobiology Institute held a joint Exoplanet Biosignatures Workshop Without-Walls in June-July 2016, which brought together the astrobiology, exoplanet, and mission concept communities to review, discuss, debate, and advance the science of biosignatures. A broad range of experts were engaged, merging the interdisciplinary reaches of NExSS, the NAI, NASA's Exoplanet Exploration Program (ExEP), and international partners, such as the European Astrobiology Network Association (EANA) and Japan's Earth Life Science Institute (Elsi).

The workshop focused around three goals:
1. Enhancing the current understanding of biosignatures: How can we develop a more comprehensive conceptual framework for identifying additional biosignatures and their possible abiotic mimics?
2. Advancing the science of biosignatures: How can we develop the methodologies to assess the possibility of biospheres as the methodologies these projects will employ. We distinguish between the methodologies these projects will employ. We distinguish between the broad range of experts were engaged, merging the interdisciplinary reaches of NExSS, the NAI, NASA's Exoplanet Exploration Program (ExEP), and international partners, such as the European Astrobiology Network Association (EANA) and Japan's Earth Life Science Institute (Elsi).

The latter includes the case of false positives, i.e., where abiotic sources mimic biosignatures. Prior knowledge (including all factors that influence habitability and previous exoplanet observations) would be combined with the likelihood to arrive at the probability of life existing on a given exoplanet given the observations.