

# PLANETS AND LIFE

The Emerging Science of Astrobiology

Edited by **Woodruff T. Sullivan III**  
and  
**John A. Baross**



CAMBRIDGE

# Planets And Life The Emerging Science Of Astrobiology

**Barbara Cavalazzi, Frances Westall**



## **Planets And Life The Emerging Science Of Astrobiology:**

*Planets and Life* Woodruff T. Sullivan, III, John Baross, 2007-09-13 Astrobiology involves the study of the origin and history of life on Earth planets and moons where life may have arisen and the search for extraterrestrial life. It combines the sciences of biology, chemistry, palaeontology, geology, planetary physics, and astronomy. This textbook brings together world experts in each of these disciplines to provide the most comprehensive coverage of the field currently available. Topics cover the origin and evolution of life on Earth, the geological, physical, and chemical conditions in which life might arise, and the detection of extraterrestrial life on other planets and moons. The book also covers the history of our ideas on extraterrestrial life and the origin of life, as well as the ethical, philosophical, and educational issues raised by astrobiology. Written to be accessible to students from diverse backgrounds, this text will be welcomed by advanced undergraduates and graduates who are taking astrobiology courses. **Planets and Life** Woodruff Turner Sullivan, John A. Baross, 2007 **Handbook of Astrobiology**

Vera M. Kolb, 2018-12-07 Choice Recommended Title August 2019 Read an exclusive interview with Professor Vera Kolb [here](#). Astrobiology is the study of the origin, evolution, distribution, and future of life on Earth. This exciting and significant field of research also investigates the potential existence and search for extra-terrestrial life in the Solar System and beyond. This is the first handbook in this burgeoning and interdisciplinary field. Edited by Vera Kolb, a highly respected astrobiologist, this comprehensive resource captures the history and current state of the field. Rich in information and easy to use, it assumes basic knowledge and provides answers to questions from practitioners and specialists in the field, as well as providing key references for further study. Features: Fills an important gap in the market providing a comprehensive overview of the field. Edited by an authority in the subject with chapters written by experts in the many diverse areas that comprise astrobiology. Contains in depth and broad coverage of an exciting field that will only grow in importance in the decades ahead.

**Frontiers of Astrobiology** Chris Impey, Jonathan Lunine, José Funes, 2012-11-15 Astrobiology is an exciting interdisciplinary field that seeks to answer one of the most important and profound questions: are we alone? In this volume, leading international experts explore the frontiers of astrobiology, investigating the latest research questions that will fascinate a wide interdisciplinary audience at all levels. What is the earliest evidence for life on Earth? Where are the most likely sites for life in the Solar System? Could life have evolved elsewhere in the Galaxy? What are the best strategies for detecting intelligent extraterrestrial life? How many habitable or Earth-like exoplanets are there? Progress in astrobiology over the past decade has been rapid, and with evidence accumulating that Mars once hosted standing bodies of liquid water, the discovery of over 500 exoplanets, and new insights into how life began on Earth, the scientific search for our origins and place in the cosmos continues. **Life on Earth and other Planetary Bodies** Arnold Hanslmeier, Stephan Kempe, Joseph Seckbach, 2012-10-29 A trio of editors, Professors from Austria, Germany, and Israel, present *Life on Earth and other Planetary Bodies*. The contributors are from twenty various countries and present their research on life here, as well as the possibility

for extraterrestrial life This volume covers concepts such as life's origin hypothesis of Panspermia and of life possibility in the Cosmos The topic of extraterrestrial life is currently hot and the object of several congresses and conferences While the diversity of normal biota is well known life on the edge of the extremophiles is more limited and less distributed Other subjects discussed are Astrobiology with the frozen worlds of Mars Europa and Titan where extant or extinct microbial life may exist in subsurface oceans conditions on icy Mars with its saline alkaline and liquid water which has been recently discovered chances of habitable Earth like or the terrestrial analogues exoplanets and SETI's search for extraterrestrial Intelligence

**Biosignatures for Astrobiology** Barbara Cavalazzi, Frances Westall, 2018-10-01 This book aims at providing a brief but broad overview of biosignatures The topics addressed range from prebiotic signatures in extraterrestrial materials to the signatures characterising extant life as well as fossilised life biosignatures related to space and space flight instrumentation to detect biosignatures either in situ or from orbit The book ends with philosophical reflections on the implications of life elsewhere In the 15 chapters written by an interdisciplinary team of experts it provides both detailed explanations on the nature of biosignatures as well as useful case studies showing how they are used and identified in ancient rocks for example One case study addresses the controversial finding of traces of fossil life in a meteorite from Mars The book will be of interest not only to astrobiologists but also to terrestrial paleontologists as well as any reader interested in the prospects of finding a second example of life on another planet

**Astrobiology** Akihiko Yamagishi, Takeshi Kakegawa, Tomohiro Usui, 2019-02-27 This book provides concise and cutting edge reviews in astrobiology a young and still emerging multidisciplinary field of science that addresses the fundamental questions of how life originated and diversified on Earth whether life exists beyond Earth and what is the future for life on Earth Readers will find coverage of the latest understanding of a wide range of fascinating topics including for example solar system formation the origins of life the history of Earth as revealed by geology the evolution of intelligence on Earth the implications of genome data insights from extremophile research and the possible existence of life on other planets within and beyond the solar system Each chapter contains a brief summary of the current status of the topic under discussion sufficient references to enable more detailed study and descriptions of recent findings and forthcoming missions or anticipated research Written by leading experts in astronomy planetary science geoscience chemistry biology and physics this insightful and thought provoking book will appeal to all students and scientists who are interested in life and space

**How Molecular Forces and Rotating Planets Create Life** Jan Spitzer, 2021-02-09 A reconceptualization of origins research that exploits a modern understanding of non covalent molecular forces that stabilize living prokaryotic cells Scientific research into the origins of life remains exploratory and speculative Science has no definitive answer to the biggest questions What is life and How did life begin on earth In this book Jan Spitzer reconceptualizes origins research by exploiting a modern understanding of non covalent molecular forces and covalent bond formation a physicochemical approach propounded originally by Linus Pauling and Max Delbrück Spitzer

develops the Pauling Delbrück premise as a physicochemical jigsaw puzzle that identifies key stages in life's emergence from the formation of first oceans tidal sediments and proto biofilms to progenotes proto cells and the first cellular organisms

*Astrobiological Neurosystems* Jerry L. Cranford, 2014-09-27 This book explains why scientists believe that life may be more common in the Universe than previously considered possible It presents the tools and strategies astronomers and astrobiologists are using in their formal search for habitable exoplanets as well as more advanced forms of life in other parts of our galaxy The author then summarizes what is currently known about how and where organic molecules critical to our form of carbon based life are manufactured The core of the book explains and presents educated guesses how nervous systems evolved on Earth how they work and how they might work on other worlds Combining his knowledge of neuroscience computers and astrobiology the author jumps into the discussion whether biological nervous systems are just the first step in the rise of intelligence in the Universe The book ends with a description from both the psychologists and the neuroscientists viewpoints exactly what it is about the fields of astrobiology and astronomy that boggles the minds of many amateur astronomers and interested non scientists This book stands out from other popular science books on astrobiology by making the point that astro neurobiologists need to begin thinking about how alien nervous systems might work

Encountering Life in the Universe Chris Impey, Anna H. Spitz, William Stoeger, 2013-10-25 Are we alone in the universe Are the planets our playground to treat as we will or do we have a responsibility to other creatures who may inhabit or use them Do we have a right to dump trash in space or leave vehicles on Mars or the moon How should we interact with other life forms Encountering Life in the Universe examines the intersection of scientific research and society to further explore the ethics of how to behave in a universe where much is unknown Taking contributions from notable experts in several fields the editors skillfully introduce and develop a broad look at the moral questions facing humans on Earth and beyond Major advances in biology biotechnology and medicine create an urgency to ethical considerations in those fields Astrobiology goes on to debate how we might behave as we explore new worlds or create new life in the laboratory or interact with extraterrestrial life forms Stimulated by new technologies for scientific exploration on and off the Earth astrobiology is establishing itself as a distinct scientific endeavor In what way can established philosophies provide guidance for the new frontiers opened by astrobiology research Can the foundations of ethics and moral philosophy help answer questions about modifying other planets Or about how to conduct experiments to create life in the lab or about How to interact with organisms we might discover on another world While we wait for the first echo that might indicate life beyond Earth astrobiologists along with philosophers theologians artists and the general public are exploring how we might behave even before we know for sure they are there Encountering Life in the Universe is a remarkable resource for such philosophical challenges

*Astrobiology and Cuatro Ciénegas Basin as an Analog of Early Earth* Valeria Souza, Antígona Segura, Jamie S. Foster, 2020-07-14 Astrobiology not only investigates how early life took hold of our planet but also life on other planets both

in our Solar System and beyond and their potential for habitability The book take readers from the scars on planetary surfaces made by space rocks to the history of the Solar System narrated by those space rocks as well as exoplanets in other planetary systems But the true question is how life arose here or elsewhere Modern comparative genomics has revealed that Darwin was correct a set of highly conserved genes and cellular functions indicate that all life is related by common ancestry The Last Universal Common Ancestor or LUCA sits at the base of the Tree of Life However once that life took hold it started to diversify and form complex microbial communities that are known as microbial mats and stromatolites Due to their long evolutionary history and abundance on modern Earth research on the biological chemical and geological processes of stromatolite formation has provided important insights into the field of astrobiology Many of these microbialite containing ecosystems have been used as models for astrobiology and NASA mission analogs including Shark Bay Pavilion and Kelly Lakes Modern microbialites represent natural laboratories to study primordial ecosystems and provide proxies for how life could evolve on other planets However few viral metagenomic studies i e viromes have been conducted in microbialites which are not only an important part of the community but also mirror its biodiversity This book focuses on particularly interesting sites such as Andean lake microbialites a proxy of early life since they are characterized by very high UV light while Alchichica and Bacalar lakes are characterized by high salt and oligotrophic waters that nurture stromatolites However it is only the oasis of Cuatro Ci negas Basin in M xico that stored past life in its marine sediments of the Sierra de San Marcos This particular Sierra has a magmatic pouch that moves the deep aquifer to the surface in a cycle of sun drenched life and back to the depths of the magmatic life in an ancient cycle that now is broken by the overexploitation of the surface water as well as the deep aquifer in order to irrigate alfalfa in the desert The anthropocene the era of human folly is killing this unique time machine and with it the memory of the planet

*Habitability of Other Planets and Satellites* Jean-Pierre de Vera, Joseph Seckbach, 2013-07-30 Is the Earth the right model and the only universal key to understand habitability the origin and maintenance of life Are we able to detect life elsewhere in the universe by the existing techniques and by the upcoming space missions This book tries to give answers by focusing on environmental properties which are playing a major role in influencing planetary surfaces or the interior of planets and satellites The book gives insights into the nature of planets or satellites and their potential to harbor life Different scientific disciplines are searching for the clues to classify planetary bodies as a habitable object and what kind of instruments and what kind of space exploration missions are necessary to detect life Results from model calculations field studies and from laboratory studies in planetary simulation facilities will help to elucidate if some of the planets and satellites in our solar system as well as in extra solar systems are potentially habitable for life

The Limits of Organic Life in Planetary Systems National Research Council, Division on Earth and Life Studies, Board on Life Sciences, Division on Engineering and Physical Sciences, Space Studies Board, Committee on the Origins and Evolution of Life, Committee on the Limits of Organic Life in Planetary Systems, 2007-06-26 The search for life in the solar

system and beyond has to date been governed by a model based on what we know about life on Earth terran life Most of NASA s mission planning is focused on locations where liquid water is possible and emphasizes searches for structures that resemble cells in terran organisms It is possible however that life exists that is based on chemical reactions that do not involve carbon compounds that occurs in solvents other than water or that involves oxidation reduction reactions without oxygen gas To assist NASA incorporate this possibility in its efforts to search for life the NRC was asked to carry out a study to evaluate whether nonstandard biochemistry might support life in solar system and conceivable extrasolar environments and to define areas to guide research in this area This book presents an exploration of a limited set of hypothetical chemistries of life a review of current knowledge concerning key questions or hypotheses about nonterran life and suggestions for future research

**Atmospheric Evolution on Inhabited and Lifeless Worlds** David C. Catling, James F. Kasting, 2017-04-13 As the search for Earth like exoplanets gathers pace in order to understand them we need comprehensive theories for how planetary atmospheres form and evolve Written by two well known planetary scientists this text explains the physical and chemical principles of atmospheric evolution and planetary atmospheres in the context of how atmospheric composition and climate determine a planet s habitability The authors survey our current understanding of the atmospheric evolution and climate on Earth on other rocky planets within our Solar System and on planets far beyond Incorporating a rigorous mathematical treatment they cover the concepts and equations governing a range of topics including atmospheric chemistry thermodynamics radiative transfer and atmospheric dynamics and provide an integrated view of planetary atmospheres and their evolution This interdisciplinary text is an invaluable one stop resource for graduate level students and researchers working across the fields of atmospheric science geochemistry planetary science astrobiology and astronomy

**Fundamental Planetary Science** Jack J. Lissauer, Imke de Pater, 2019-07-04 A quantitative introduction to the Solar System and planetary systems science for advanced undergraduate students this engaging textbook explains the wide variety of physical chemical and geological processes that govern the motions and properties of planets The authors provide an overview of our current knowledge and discuss some of the unanswered questions at the forefront of research in planetary science and astrobiology today This updated edition contains the latest data new references and planetary images and an extensively rewritten chapter on current research on exoplanets The text concludes with an introduction to the fundamental properties of living organisms and the relationship that life has to its host planet With more than 200 exercises to help students learn how to apply the concepts covered this textbook is ideal for a one semester or two quarter course for undergraduate students

**WHERE WHEN AND HOW ANCESTRAL (LUCA) TO ALL LIFE ORIGINATED** Jagjit Singh Rawat, 2021-12-06 The book is all about the living beings All living beings including humans have originated and evolved from the Last Universal Common Ancestor LUCA that was possible as a result of spontaneous step by step chemical origin in about 3 750 billion years ago from the elements consisting of life body such as nitrogen bases adenine thymine cytosine guanine

and uracil which are made up off the elements C H O N and ribose sugar This life originated in the sediments of the palaeo floodplains at the palaeo mouths of fresh water flows rivers on the Hadean surface in the Archaean Eon This was a global phenomenon The life on the rocky planet like our Earth was possible because of existence of fresh water bodies over minerals metals and clay deposits which rested on Hadean surface and active geological processes and active environments The book also makes an attempt to explain as to how do the simple elements like C H O N S and P first change to simple chemistry  $H_2$   $O$   $NH_3$  followed by  $CH_4$   $HCN$  and monomers monosaccharides amino acids glycerol s fatty acids nucleotides and polymers carbohydrates proteins lipids and nucleic acids There was not much development for about 3210 million years from 3750 million years to 540 million years and suddenly changed jumped to complex life forms in about 541 million years ago Here the life originated and evolved without head and heart from 3750 million years ago to 522 million years ago i e for about 3228 million years The head was originated and evolved in about 521million years ago However consciousness emerged along with bonding of carbon with hydrogen and other elements which were finally converted into nucleosides having nitrogenous base and ribose sugar The gravity and gravitational force intertwined with electromagnetic force were the reason there were bonding of carbon and hydrogen and other elements to originate and evolve LUCA which stayed away from thermodynamic equilibrium Nature , *Life* Henry Epps,2012-08-06 Life what is life What is the meaning of life what is death and the afterlife Well this book looks into the diffrent beliefs of life and death *Space, Time, and Aliens* Steven J. Dick,2020-05-11 In this comprehensive and interdisciplinary volume former NASA Chief Historian Steven Dick reflects on the exploration of space astrobiology and its implications cosmic evolution astronomical institutions discovering and classifying the cosmos and the philosophy of astronomy The unifying theme of the book is the connection between cosmos and culture or what Carl Sagan many years ago called the cosmic connection As both an astronomer and historian of science Dr Dick has been both a witness to and a participant in many of the astronomical events of the last half century This collection of papers presents his reflections over the last forty years in a way accessible to historians philosophers and scientists alike From the search for alien life to ongoing space exploration efforts readers will find this volume full of engaging topics relevant to science society and our collective future on planet Earth and beyond **The Nature of Life** Mark A. Bedau,Carol E. Cleland,2018-11-22 Introduces a broad range of scientific and philosophical issues about life through the original historical and contemporary sources

## Decoding **Planets And Life The Emerging Science Of Astrobiology**: Revealing the Captivating Potential of Verbal Expression

In an era characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its ability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Planets And Life The Emerging Science Of Astrobiology**," a mesmerizing literary creation penned by way of a celebrated wordsmith, readers embark on an enlightening odyssey, unraveling the intricate significance of language and its enduring affect our lives. In this appraisal, we shall explore the book is central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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