

An abstract illustration of various microorganisms, including bacteria and viruses, rendered in a light gray, semi-transparent style. The organisms are scattered across the page, with a higher concentration in the upper right quadrant. The background is a dark gray gradient.

# SIZE LIMITS OF VERY SMALL MICROORGANISMS

*Proceedings of a Workshop*

SPACE STUDIES BOARD  
NATIONAL RESEARCH COUNCIL

# Size Limits Of Very Small Microorganisms Proceedings Of A Workshop

**Richard Gordon**



## **Size Limits Of Very Small Microorganisms Proceedings Of A Workshop:**

**Size Limits of Very Small Microorganisms** National Research Council, Division on Engineering and Physical Sciences, Space Studies Board, Commission on Physical Sciences, Mathematics, and Applications, Steering Group for the Workshop on Size Limits of Very Small Microorganisms, 1999-10-13 How small can a free living organism be On the surface this question is straightforward in principle the smallest cells can be identified and measured But understanding what factors determine this lower limit and addressing the host of other questions that follow on from this knowledge require a fundamental understanding of the chemistry and ecology of cellular life The recent report of evidence for life in a martian meteorite and the prospect of searching for biological signatures in intelligently chosen samples from Mars and elsewhere bring a new immediacy to such questions How do we recognize the morphological or chemical remnants of life in rocks deposited 4 billion years ago on another planet Are the empirical limits on cell size identified by observation on Earth applicable to life wherever it may occur or is minimum size a function of the particular chemistry of an individual planetary surface These questions formed the focus of a workshop on the size limits of very small organisms organized by the Steering Group for the Workshop on Size Limits of Very Small Microorganisms and held on October 22 and 23 1998 Eighteen invited panelists representing fields ranging from cell biology and molecular genetics to paleontology and mineralogy joined with an almost equal number of other participants in a wide ranging exploration of minimum cell size and the challenge of interpreting micro and nano scale features of sedimentary rocks found on Earth or elsewhere in the solar system This document contains the proceedings of that workshop It includes position papers presented by the individual panelists arranged by panel along with a summary for each of the four sessions of extensive roundtable discussions that involved the panelists as well as other workshop participants

*Size Limits of Very Small Microorganisms* National Research Council, Division on Engineering and Physical Sciences, Space Studies Board, Commission on Physical Sciences, Mathematics, and Applications, Steering Group for the Workshop on Size Limits of Very Small Microorganisms, 1999-09-13 How small can a free living organism be On the surface this question is straightforward in principle the smallest cells can be identified and measured But understanding what factors determine this lower limit and addressing the host of other questions that follow on from this knowledge require a fundamental understanding of the chemistry and ecology of cellular life The recent report of evidence for life in a martian meteorite and the prospect of searching for biological signatures in intelligently chosen samples from Mars and elsewhere bring a new immediacy to such questions How do we recognize the morphological or chemical remnants of life in rocks deposited 4 billion years ago on another planet Are the empirical limits on cell size identified by observation on Earth applicable to life wherever it may occur or is minimum size a function of the particular chemistry of an individual planetary surface These questions formed the focus of a workshop on the size limits of very small organisms organized by the Steering Group for the Workshop on Size Limits of Very Small Microorganisms and held on

October 22 and 23 1998 Eighteen invited panelists representing fields ranging from cell biology and molecular genetics to paleontology and mineralogy joined with an almost equal number of other participants in a wide ranging exploration of minimum cell size and the challenge of interpreting micro and nano scale features of sedimentary rocks found on Earth or elsewhere in the solar system This document contains the proceedings of that workshop It includes position papers presented by the individual panelists arranged by panel along with a summary for each of the four sessions of extensive roundtable discussions that involved the panelists as well as other workshop participants *Origin of Life via Archaea* Richard Gordon, 2024-08-26 This book surveys the models for the origin of life and presents a new model starting with shaped droplets and ending with life as polygonal Archaea it collects the most published micrographs of Archaea discovered only in 1977 which support this conclusion and thus provides the first visual survey of Archaea *Origin of Life via Archaea* s purpose is to add a new hypothesis on what are called shaped droplets as the starting point for flat polygonal Archaea supporting the Vesicles First hypothesis The book contains over 6000 distinct references and micrographs of 440 extant species of Archaea 41% of which exhibit polygonal phenotypes It surveys the intellectual battleground of the many ideas of the origin of life on earth chemical equilibrium autocatalysis and biotic polymers This book contains 17 chapters some coauthored on a wide range of topics on the origin of life including Archaea s origin patterns and species It shows how various aspects of the origin of life may have occurred at chemical equilibrium not requiring an energy source contrary to the general assumption For the reader s value its compendium of Archaea micrographs might also serve many other interesting questions about Archaea One chapter presents a theory for the shape of flat polygonal Archaea in terms of the energetics at the surface edges and corners of the S layer Another shows how membrane peptides may have originated The book also includes a large table of most extant Archaea that is searchable in the electronic version It ends with a chapter on problems needing further research Audience This book will be used by astrobiologists origin of life biologists physicists of small systems geologists biochemists theoretical and vesicle chemists **Maelstrom** Peter Watts, 2009-01-06 Second in the Rifiers Trilogy Hugo Award winning author Peter Watts *Maelstrom* is a terrifying explosion of cyberpunk noir This is the way the world ends A nuclear strike on a deep sea vent The target was an ancient microbe voracious enough to drive the whole biosphere to extinction and a handful of amphibious humans called rifiers who d inadvertently released it from three billion years of solitary confinement The resulting tsunami killed millions It s not as though there was a choice saving the world excuses almost any degree of collateral damage Unless of course you miss the target Now North America s west coast lies in ruins Millions of refugees rally around a mythical figure mysteriously risen from the deep sea A world already wobbling towards collapse barely notices the spread of one more blight along its shores And buried in the seething fast forward jungle that use to be called Internet something vast and inhuman reaches out to a woman with empty white eyes and machinery in her chest A woman driven by rage and incubating Armageddon Her name is Lenie Clarke She s a rifier She s not nearly as dead as everyone thinks And

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*Space Studies Board Annual Report 2009* National Research Council, Division on Engineering and Physical Sciences, Space Studies Board, 2010-01-01 The Space Studies Board SSB was established in 1958 to serve as the focus of the interests and responsibilities in space research for the National Academies The SSB provides an independent authoritative forum for information and advice on all aspects of space science and applications and it serves as the focal point within the National Academies for activities on space research It oversees advisory studies and program assessments facilitates international research coordination and promotes communications on space science and science policy between the research community the federal government and the interested public The SSB also serves as the U S National Committee for the International Council for Science Committee on Space Research COSPAR The present volume reviews the organization activities and reports of the SSB for the year 2009

Astrobiology Charles S. Cockell, 2020-04-09 A guide to understanding the formation of life in the Universe The revised and updated second edition of *Astrobiology* offers an introductory text that explores the structure of living things the formation of the elements required for life in the Universe the biological and geological history of the Earth and the habitability of other planets Written by a noted expert on the topic the book examines many of the major conceptual foundations in astrobiology which cover a diversity of traditional fields including chemistry biology geosciences physics and astronomy The book explores many profound questions such as How did life originate on Earth How has life persisted on Earth for over three billion years Is there life elsewhere in the Universe What is the future of life on Earth *Astrobiology* is centered on investigating the past and future of life on Earth by looking beyond Earth to get the answers *Astrobiology* links the diverse scientific fields needed to understand life on our own planet and potentially life beyond This new second edition Expands on information about the nature of astrobiology and why it is useful Contains a new chapter What is Life that explores the history of attempts to understand life Contains 20% more material on the astrobiology of Mars icy moons the structure of life and the habitability of planets New Discussion Boxes to stimulate debate and thought about key questions in astrobiology New review and reflection questions for each chapter to aid learning New boxes describing the careers of astrobiologists and how they got into the subject Offers revised and updated information throughout to reflect the latest advances in the field Written for students of life sciences physics astronomy and related disciplines the updated edition of *Astrobiology* is an essential introductory text that includes recent advances to this dynamic field

*Space Studies Board Annual Report 2010* National Research Council, Division on Engineering and Physical Sciences, Space Studies Board, 2011-01-01 The Space Studies Board SSB was established in 1958 to serve as the focus of the interests and responsibilities in space research for the National Academies The SSB provides an independent authoritative forum for information and advice on all aspects of space science and applications and it serves as the focal point within the National Academies for activities on space research It oversees advisory studies and program

assessments facilitates international research coordination and promotes communications on space science and science policy between the research community the federal government and the interested public The SSB also serves as the U S National Committee for the International Council for Science Committee on Space Research COSPAR This volume reviews the organization activities and reports of the SSB for the year 2010

**The Biophysics of Cell Membranes** Richard M. Epand, Jean-Marie Ruysschaert, 2017-09-25 This volume focuses on the modulation of biological membranes by specific biophysical properties The readers are introduced to emerging biophysical approaches that mimic specific states like membrane lipid asymmetry membrane curvature lipid flip flop lipid phase separation that are relevant to the functioning of biological membranes The first chapter describes innovative methods to mimic the prevailing asymmetry in biological membranes by forming asymmetrical membranes made of monolayers with different compositions One of the chapters illustrates how physical parameters like curvature and elasticity can affect and modulate the interactions between lipids and proteins This volume also describes the sensitivity of certain ion channels to mechanical forces and it presents an analysis of how cell shape is determined by both the cytoskeleton and the lipid domains in the membrane The last chapter provides evidence that liposomes can be used as a minimal cellular model to reconstitute processes related to the origin of life Each topic covered in this volume is presented by leading experts in the field who are able to present clear authoritative and up to date reviews The novelty of the methods proposed and their potential for a deeper molecular description of membrane functioning are particularly relevant experts in the areas of biochemistry biophysics and cell biology while also presenting clear and thorough introductions making the material suitable for students in these fields as well

**How Life Began** Alexandre Meinesz, 2024-05-31 The origin of life is a hotly debated topic The Christian Bible states that God created the heavens and the Earth all in about seven days roughly six thousand years ago This episode in Genesis departs markedly from scientific theories developed over the last two centuries which hold that life appeared on Earth about 3.5 billion years ago in the form of bacteria followed by unicellular organisms half a millennia later It is this version of genesis that Alexandre Meinesz explores in this engaging tale of life's origins and evolution How Life Began elucidates three origins or geneses of life bacteria nucleated cells and multicellular organisms and shows how evolution has sculpted life to its current biodiversity through four main events mutation recombination natural selection and geologic cataclysm As an ecologist who specializes in algae the first organisms to colonize Earth Meinesz brings a refreshingly novel voice to the history of biodiversity and emphasizes here the role of unions in organizing life For example the ingestion of some bacteria by other bacteria led to mitochondria that characterize animal and plant cells and the chloroplasts of plant cells As Meinesz charmingly recounts life's grandeur is a result of an evolutionary tendency toward sociality and solidarity He suggests that it is our cohesion and collaboration that allows us to solve the environmental problems arising in the decades and centuries to come Rooted in the science of evolution but enlivened with many illustrations from other disciplines and the arts How Life Began intertwines the

rise of bacteria and multicellular life with Vermeer's portrait of Antoni van Leeuwenhoek the story of Genesis and Noah Meinesz's son's early experiences with Legos and his own encounters with other scientists All of this brings a very human and humanistic tone to Meinesz's charismatic narrative of the three origins of life

Space Studies Board Annual Report 2017 National Academies of Sciences, Engineering, and Medicine, Division on Engineering and Physical Sciences, Space Studies Board, 2018-12-19 The original charter of the Space Science Board was established in June 1958 three months before the National Aeronautics and Space Administration NASA opened its doors The Space Science Board and its successor the Space Studies Board SSB have provided expert external and independent scientific and programmatic advice to NASA on a continuous basis from NASA's inception until the present The SSB has also provided such advice to other executive branch agencies including the National Oceanic and Atmospheric Administration NOAA the National Science Foundation NSF the U S Geological Survey USGS the Department of Defense as well as to Congress

Space Studies Board Annual Report 2017 covers a message from the chair of the SSB David N Spergel This report also explains the origins of the Space Science Board how the Space Studies Board functions today the SSB's collaboration with other National Academies of Sciences Engineering and Medicine units assures the quality of the SSB reports acknowledges the audience and sponsors and expresses the necessity to enhance the outreach and improve dissemination of SSB reports This report will be relevant to a full range of government audiences in civilian space research including NASA NSF NOAA USGS and the Department of Energy as well members of the SSB policy makers and researchers

Review and Assessment of Planetary Protection Policy Development Processes National Academies of Sciences, Engineering, and Medicine, Division on Engineering and Physical Sciences, Space Studies Board, Committee on the Review of Planetary Protection Policy Development Processes, 2018-10-17 Protecting Earth's environment and other solar system bodies from harmful contamination has been an important principle throughout the history of space exploration For decades the scientific political and economic conditions of space exploration converged in ways that contributed to effective development and implementation of planetary protection policies at national and international levels However the future of space exploration faces serious challenges to the development and implementation of planetary protection policy The most disruptive changes are associated with 1 sample return from and human missions to Mars and 2 missions to those bodies in the outer solar system possessing water oceans beneath their icy surfaces

Review and Assessment of Planetary Protection Policy Development Processes addresses the implications of changes in the complexion of solar system exploration as they apply to the process of developing planetary protection policy Specifically this report examines the history of planetary protection policy assesses the current policy development process and recommends actions to improve the policy development process in the future

**Environmental Microbiology and Microbial Ecology** Larry L. Barton, Robert J. C. McLean, 2019-03-26 An authoritative overview of the ecological activities of microbes in the biosphere

Environmental Microbiology and Microbial Ecology presents a broad overview of microbial activity and microbes interactions

with their environments and communities Adopting an integrative approach this text covers both conventional ecological issues as well as cross disciplinary investigations that combine facets of microbiology ecology environmental science and engineering molecular biology and biochemistry Focusing primarily on single cell forms of prokaryotes and cellular forms of algae fungi and protozoans this book enables readers to gain insight into the fundamental methodologies for the characterization of microorganisms in the biosphere The authors draw from decades of experience to examine the environmental processes mediated by microorganisms and explore the interactions between microorganisms and higher life forms Highly relevant to modern readers this book examines topics including the ecology of microorganisms in engineered environments microbial phylogeny and interactions microbial processes in relation to environmental pollution and many more Now in its second edition this book features updated references and major revisions to chapters on assessing microbial communities community relationships and their global impact New content such as effective public communication of research findings and advice on scientific article review equips readers with practical real world skills Explores the activities of microorganisms in specific environments with case studies and actual research data Highlights how prominent microbial biologists address significant microbial ecology issues Offers guidance on scientific communication including scientific presentations and grant preparation Includes plentiful illustrations and examples of microbial interactions community structures and human bacterial connections Provides chapter summaries review questions selected reading lists a complete glossary and critical thinking exercises Environmental Microbiology and Microbial Ecology is an ideal textbook for graduate and advanced undergraduate courses in biology microbiology ecology and environmental science while also serving as a current and informative reference for microbiologists cell and molecular biologists ecologists and environmental professionals

**Signs of Life** 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, 2002-11-07 A workshop to assess the science and technology of life detection techniques was organized by the Committee on the Origins and Evolution of Life COEL of the Board on Life Sciences BLS and the Space Studies Board SSB Topics discussed in the workshop included the search for extraterrestrial life in situ and in the laboratory extant life and the signature of extinct life and determination of the point of origin terrestrial or not of detected organisms

**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 **NASA Conference Publication**,2000 *The Quarantine and Certification of Martian Samples* National Research Council,Division on Engineering and Physical Sciences,Space Studies Board,Committee on Planetary and Lunar Exploration,2002-05-16 One of the highest priority activities in the planetary sciences identified in published reports of the Space Studies Board s Committee on Planetary and Lunar Exploration COMPLEX and in reports of other advisory groups is the collection and return of extraterrestrial samples to Earth for study in terrestrial laboratories In response to recommendations made in such studies NASA has initiated a vigorous program that will within the next decade collect samples from a variety of solar system environments In particular the Mars Exploration Program is expected to launch spacecraft that are designed to collect samples of martian soil rocks and atmosphere and return them to Earth perhaps as early as 2015 International treaty obligations mandate that NASA conduct such a program in a manner that avoids the cross contamination of both Earth and Mars The Space Studies Board s 1997 report Mars Sample Return Issues and Recommendations examined many of the planetary protection issues concerning the back contamination of Earth and concluded that although the probability that martian samples will contain dangerous biota is small it is not zero 1 Steps must be taken to protect Earth against the remote possibility of contamination by life forms that may have evolved on Mars Similarly the samples collected at great expense must be protected against contamination by terrestrial biota and other matter Almost certainly meeting these requirements will entail opening the sample return container in an appropriate facility on Earth presumably a BSL 4 laboratory where testing biosafety certification and quarantine of the samples will be carried out before aliquots are released to the scientific community for study in existing laboratory facilities The nature of the required quarantine facility and the decisions required for disposition of samples once they are in it were regarded as issues of sufficient importance and complexity to warrant a study by the Committee on Planetary and Lunar Exploration COMPLEX in isolation from other topics Previous studies have been much broader including also consideration of the mission that collects samples on Mars and brings them to Earth atmospheric entry sample recovery and transport to the quarantine facility The charge to COMPLEX stated that the central question to be addressed in this study is the following What are the criteria that must be satisfied before martian samples can be released from a quarantine facility Aquatic Geomicrobiology Don Canfield,Erik Kristensen,Bo Thamdrup,2005-02-22 Microbes catalyze countless chemical reactions in nature which control the chemistry of the environment Aquatic Geomicrobiology looks at these reactions and their effect on the aquatic environments from the perspective of the microbes involved The volume begins with three introductory chapters outlining the basic principles of microbial systematics microbial ecology and chemical thermodynamics These provide a framework for exploring the microbial control of elemental cycling in the remaining chapters Readers will learn how microbes control the cycling of elements the structure of the microbial ecosystems involved

and what environmental factors influence the activities of microbial populations Also available in paperback Written by international experts in the microbial ecology and biogeochemistry of aquatic systems Includes introductory chapters on microbial systematics principles of microbial ecology and chemical thermodynamics Contains over 1500 references *Space Studies Board Annual Report 2013* National Research Council, Division on Engineering and Physical Sciences, Space Studies Board, 2014-04-09 The original charter of the Space Science Board was established in June 1958 3 months before the National Aeronautics and Space Administration NASA opened its doors The Space Science Board and its successor the Space Studies Board SSB have provided expert external and independent scientific and programmatic advice to NASA on a continuous basis from NASA's inception until the present The SSB has also provided such advice to other executive branch agencies including the National Oceanic and Atmospheric Administration NOAA the National Science Foundation NSF the U S Geological Survey USGS the Department of Defense as well as to Congress *Space Studies Board Annual Report 2013* covers a message from the chair of the SSB Charles F Kennel This report also explains the origins of the Space Science Board how the Space Studies Board functions today the SSB's collaboration with other National Research Council units assures the quality of the SSB reports acknowledges the audience and sponsors and expresses the necessity to enhance the outreach and improve dissemination of SSB reports This report will be relevant to a full range of government audiences in civilian space research including NASA NSF NOAA USGS and the Department of Energy as well members of the SSB policy makers and researchers *Space Studies Board Annual Report 2014* National Research Council, Division on Engineering and Physical Sciences, Space Studies Board, 2015-04-10 The original charter of the Space Science Board was established in June 1958 3 months before the National Aeronautics and Space Administration NASA opened its doors The Space Science Board and its successor the Space Studies Board SSB have provided expert external and independent scientific and programmatic advice to NASA on a continuous basis from NASA's inception until the present The SSB has also provided such advice to other executive branch agencies including the National Oceanic and Atmospheric Administration NOAA the National Science Foundation NSF the U S Geological Survey USGS the Department of Defense as well as to Congress *Space Studies Board Annual Report 2014* covers a message from the chair of the SSB David N Spergel This report also explains the origins of the Space Science Board how the Space Studies Board functions today the SSB's collaboration with other National Research Council units assures the quality of the SSB reports acknowledges the audience and sponsors and expresses the necessity to enhance the outreach and improve dissemination of SSB reports This report will be relevant to a full range of government audiences in civilian space research including NASA NSF NOAA USGS and the Department of Energy as well members of the SSB policy makers and researchers *Advances in Applied Microbiology* , 2003-12-18 *Advances in Applied Microbiology* offers intensive reviews of the latest techniques and discoveries in this rapidly moving field The editors are recognized experts and the format is comprehensive and instructive

## Unveiling the Energy of Verbal Artistry: An Mental Sojourn through **Size Limits Of Very Small Microorganisms Proceedings Of A Workshop**

In a world inundated with displays and the cacophony of instantaneous interaction, the profound energy and emotional resonance of verbal artistry usually diminish into obscurity, eclipsed by the regular assault of noise and distractions. Yet, situated within the musical pages of **Size Limits Of Very Small Microorganisms Proceedings Of A Workshop**, a interesting perform of literary splendor that impulses with organic thoughts, lies an wonderful journey waiting to be embarked upon. Published by way of a virtuoso wordsmith, this magical opus books visitors on a mental odyssey, gently revealing the latent potential and profound influence stuck within the complicated web of language. Within the heart-wrenching expanse of this evocative examination, we can embark upon an introspective exploration of the book is main styles, dissect its interesting writing type, and immerse ourselves in the indelible impact it leaves upon the depths of readers souls.

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