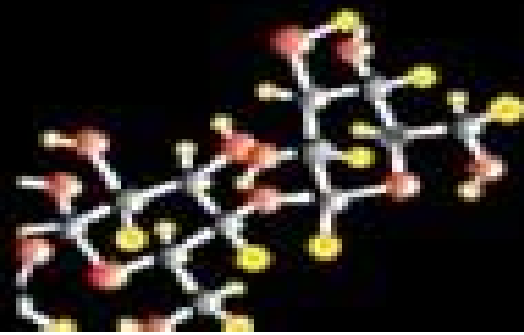




# What is Life?

## How Chemistry Becomes Biology



ADDY

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# What Is Life How Chemistry Becomes Biology

**John Odling-Smee**



## **What Is Life How Chemistry Becomes Biology:**

**What is Life?** Addy Pross, 2012-09-27 Seventy years ago Erwin Schrödinger posed a profound question: What is life and how did it emerge from non-life? This problem has puzzled biologists and physical scientists ever since. Living things are hugely complex and have unique properties such as self-maintenance and apparently purposeful behaviour which we do not see in inert matter. So how does chemistry give rise to biology? What could have led the first replicating molecules up such a path? Now developments in the emerging field of systems chemistry are unlocking the problem. Addy Pross shows how the different kind of stability that operates among replicating molecules results in a tendency for chemical systems to become more complex and acquire the properties of life. Strikingly, he demonstrates that Darwinian evolution is the biological expression of a deeper, well-defined chemical concept: the whole story from replicating molecules to complex life is one continuous process governed by an underlying physical principle. The gulf between biology and the physical sciences is finally becoming bridged. This new edition includes an Epilogue describing developments in the concepts of fundamental forms of stability discussed in the book and their profound implications. Oxford Landmark Science books are must-read classics of modern science writing which have crystallized big ideas and shaped the way we think. **What is Life?** Addy

Pross, 2012-09-27 Pross examines these issues from a chemical perspective, providing a new understanding of how the sciences of chemistry and biology relate to one another. **The Deeper Genome** John Parrington, 2017-10-06 Over a decade ago, as the Human Genome Project completed its mapping of the entire human genome, hopes ran high that we would rapidly be able to use our knowledge of human genes to tackle many inherited diseases and understand what makes us unique among animals. But things didn't turn out that way. For a start, we turned out to have far fewer genes than originally thought: just over 20,000, the same sort of number as a fruit fly or worm. What's more, the proportion of DNA consisting of genes coding for proteins was a mere 2%. So was the rest of the genome accumulated junk. Things have changed since those early heady days of the Human Genome Project. But the emerging picture is, if anything, far more exciting. In this book, John Parrington explains the key features that are coming to light, some such as the results of the international ENCODE programme, still much debated and controversial in their scope. He gives an outline of the deeper genome involving layers of regulatory elements controlling and coordinating the switching on and off of genes; the impact of its 3D geometry; the discovery of a variety of new RNAs playing critical roles; the epigenetic changes influenced by the environment and life experiences that can make identical twins different and be passed on to the next generation; and the clues coming out of comparisons with the genomes of Neanderthals as well as that of chimps about the development of our species. We are learning more about ourselves and about the genetic aspects of many diseases. But in its complexity, flexibility, and ability to respond to environmental cues, the human genome is proving to be far more subtle than we ever imagined. *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

**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

**The Science of Why We Exist** Tim Coulson, 2024-07-02 From the Big Bang and the evolution of the genetic code to the birth of consciousness this is the extraordinary story of the chain of events that led to human life on earth Have you ever wondered why you exist What had to happen for you to be alive and conscious Scientists have come a long way in answering this question and this book describes what they have found out It also examines whether our existence was inevitable at the universe's birth 13.77 billion years ago or whether we are just incredibly lucky The book is aimed at readers who are interested in science but are not experts Written in an entertaining and accessible style the narrative begins by describing how scientists discover facts before taking the reader on a journey from the Big Bang to the creation of the human genome Covering physics astronomy chemistry earth sciences the emergence of life evolution consciousness the rise of humanity and how our personalities are moulded by genes chance and the environment the journey explains how the universe started as point of intense energy that over time in our corner of the universe resulted in our wonderful planet and in you

*Prebiotic Chemistry and Life's Origin* Michele Fiore, 2022-06-29 How life originated from the inanimate mixture of organic and inorganic compounds on the primordial earth remains one of the great unknowns in science This origin of life or abiogenesis continues to be examined in the context of the conditions and materials required for natural life to have begun on Earth both theoretically and experimentally This book provides a broad but in depth analysis of the latest discoveries in prebiotic chemistry from the

microscopic to the macroscopic scale utilising experimental insight to provide a bottom up approach to plausibly explaining how life arose With contributions from global leaders this book is an ideal reference for postgraduate students and a single source of comprehensive information on the latest technical and theoretical advancements for researchers in a variety of fields from astrochemistry and astrophysics to organic chemistry and evolution

**Origins** Jim Baggott, 2018-06-06 What is life Where do we come from and how did we evolve What is the universe and how was it formed What is the nature of the material world How does it work How and why do we think What does it mean to be human How do we know There are many different versions of our creation story This book tells the version according to modern science It is a unique account starting at the Big Bang and travelling right up to the emergence of humans as conscious intelligent beings 13.8 billion years later Chapter by chapter it sets out the current state of scientific knowledge the origins of space and time energy mass and light galaxies stars and our sun the habitable earth and complex life itself Drawing together the physical and biological sciences Baggott recounts what we currently know of our history highlighting the questions science has yet to answer

*Steering Human Evolution* Yehezkel Dror, 2020-05-07 Humanity must steer its evolution As human knowledge moves a step ahead of Darwin's theories this book presents the emergence of human made meta evolution shaping our alternative futures This novel process poses fateful challenges to humanity which require regulation of emerging science and technology which may endanger the future of our species However to do so successfully a novel humanity craft has to be developed main ideologies and institutions need redesign national sovereignty has to be limited a decisive global regime becomes essential some revaluation of widely accepted norms becomes essential and a novel type of political leader based on merit in addition to public support is urgently needed Taking into account the strength of nationalism and vested interests it may well be that only catastrophes will teach humanity to metamorphose into a novel epoch without too high transition costs But initial steps such as United Nation reforms are urgent in order to contain calamities and may soon become feasible Being both interdisciplinary and based on personal experience of the author this book adds up to a novel paradigm on steering human evolution It will be of great interest to scholars and researchers of modern history evolution sciences future studies political science philosophy of action and science and technology It will also be of wide appeal to the general reader anxious about the future of life on Earth Comments on the Corona pandemic add to the book's concrete significance

**The Genesis Quest** Michael Marshall, 2020-11-20 A science journalist focuses on the chemical research into life's origins A fascinating and challenging story leavened with mini biographies Tim Flannery New York Review of Books From the primordial soup to meteorite impact zones the Manhattan Project to the latest research this book is the first full history of the scientists who strive to explain the genesis of life How did life begin Why are we here These are some of the most profound questions we can ask For almost a century a small band of eccentric scientists has struggled to answer these questions and explain one of the greatest mysteries of all how and why life began on Earth There are many different proposals and each idea has attracted

passionate believers who promote it with an almost religious fervor as well as detractors who reject it with equal passion But the quest to unravel life's genesis is not just a story of big ideas It is also a compelling human story rich in personalities conflicts and surprising twists and turns Along the way the journey takes in some of the greatest discoveries in modern biology from evolution and cells to DNA and life's family tree It is also a search whose end may finally be in sight In *The Genesis Quest* Michael Marshall shows how the quest to understand life's beginning is also a journey to discover the true nature of life and by extension our place in the universe As lively in its telling as its subject is thought provoking *The Well read Naturalist* An historical review of the search for the origin of life an approachable introduction and also offers an interesting window on the lives of the scientists involved Recommended Choice

**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

*Insignificant but Special* Bruce Sanford, 2023-01-13 Life is a rarity We know of no other planet where life exists other than on Earth Life started out in a most simple form then proceeded along a labyrinth of evolutionary pathways that resulted in extraordinary and unfathomable designs This is a journey from the beginning of time to this very day guided by circumstances contingencies and chaos that has governed Earth's living assemblage But life's presence was not destined to just happen If it wasn't for our moon which gave Earth orbital and rotational stability life would not be as we know it today If it wasn't for volcanic eruptions Earth would be an ice clad frozen globe If it wasn't for one of the tiniest of living organisms that produced a toxic gas complex life would not have arisen If it wasn't for one particular extinction event Homo sapiens would not be walking this planet and you would not be reading this now If it wasn't for a

million other things life would be much different or not at all Earth made life from the meek to the monstrous from the banal to the bizarre from the humblest to the haughtiest Strap yourself in alongside a window seat and witness the passing of time to view the episodes of change and how the making of life became the greatest story on Earth *A World Beyond Physics* Stuart A. Kauffman, 2019 Explores the possibility and process of evolution beyond the standard and established scientific principles Niche Construction John Odling-Smee, 2024-09-03 How niche construction theory extends evolutionary theory beyond natural selection to a more general theory about the coevolution of organisms with their environments In Niche Construction John Odling Smee the leading authority on niche construction theory extends evolutionary theory from an explanation of how populations of organisms respond to natural selection pressures in their environments to a more general theory about the coevolution of organisms with their environments Organisms he shows cause changes in their local external environments by interacting with them thereby contributing in fundamental ways to their own and one another's evolution This book applies niche construction theory to current problems such as human induced global warming and suggests how humans might contribute positively to the future evolution of life on Earth Odling Smee explains how orthodox evolutionary theory falls short in two ways First it does not describe how organisms contribute to their own and one another's evolution through their environment changing niche constructing activities Second it fails to explain how genetic evolution can give rise to supplementary knowledge gaining processes in many species These include certain developmental processes in individual organisms and socio cultural processes in animals including humans Neo Darwinism the author writes assesses the fitness of individual organisms in populations in terms of their capacity to survive and reproduce but without attributing these capacities to the active purposeful agency of organisms He argues that the purposeful agency of individual organisms plays a central role in evolution He also discusses the relationship of an organism's energy consuming activities and the second law of thermodynamics **The Incomputable** S. Barry Cooper, Mariya I. Soskova, 2017-05-05 This book questions the relevance of computation to the physical universe Our theories deliver computational descriptions but the gaps and discontinuities in our grasp suggest a need for continued discourse between researchers from different disciplines and this book is unique in its focus on the mathematical theory of incomputability and its relevance for the real world The core of the book consists of thirteen chapters in five parts on extended models of computation the search for natural examples of incomputable objects mind matter and computation the nature of information complexity and randomness and the mathematics of emergence and morphogenesis This book will be of interest to researchers in the areas of theoretical computer science mathematical logic and philosophy **The Human Condition** Stefan Wurm, 2020-03-10 Over a very short period only a few hundred years our understanding of the cosmos our planet Earth the evolution of life on it and the beginnings of our very own human endeavor have radically changed These revolutions in science and technology have dramatically altered our societies in many ways For quite some time it seemed as if our planet's resources were unlimited

Today we know that this is not the case Human civilizations are shaping our planets future in ways that have profound consequences for all other life on Earth as well as for us We need to reflect broadly on what defines our human condition if we wish our societies to be successful in navigating a future that cannot be just ours but must include the broad diversity of life on Earth without which humankind will not survive This book tells the story of how we discovered the universe how we learned about our planet and the life evolving on it how humanity emerged from pre history and what some of the future of our civilizations could hold

**On the Riddle of Life** Bohang Chen,2024-09-12 This book presents a historico logical study of vitalism It begins by uncovering previously unknown doctrines of vitalism from the history of science encompassing biological physical and social sciences and then subjects these doctrines to a thorough logical analysis Through this process the book offers a unified conceptual framework to understand the major doctrines of vitalism in the history of science ultimately relating vitalism to the question of life Following the classical methodological approach endorsed by Immanuel Kant nineteenth century philosopher scientists like Ernst Mach and early twentieth century logical analysts including logical empiricists British analysts pragmatists Husserlian phenomenologists and neo Kantians this work provides unconventional and valuable perspectives on vitalism and the riddle of life appealing to a broad audience including scientists historians and philosophers of science particularly those from biological backgrounds

*The Climate of History in a Planetary Age* Dipesh Chakrabarty,2021-03-22 For the past decade historian Dipesh Chakrabarty has been one of the most influential scholars addressing the meaning of climate change Climate change he argues upends long standing ideas of history modernity and globalization The burden of *The Climate of History in a Planetary Age* is to grapple with what this means and to confront humanities scholars with ideas they have been reluctant to reconsider from the changed nature of human agency to a new acceptance of universals Chakrabarty argues that we must see ourselves from two perspectives at once the planetary and the global This distinction is central to Chakrabarty s work the globe is a human centric construction while a planetary perspective intentionally decenters the human Featuring wide ranging excursions into historical and philosophical literatures *The Climate of History in a Planetary Age* boldly considers how to frame the human condition in troubled times As we open ourselves to the implications of the Anthropocene few writers are as likely as Chakrabarty to shape our understanding of the best way forward

**Bioenergetics** Davor Juretic,2021-12-22 Bioenergetics deals with the very first energy transformation steps performed by living cells Increased dissipation is the primary effect of processing external energy packages Enzyme supported charge separation is the minor but essential outcome for maintaining life This book explores the usefulness of dissecting the entropy production of enzymes involved in cellular defenses fermentation respiration and photosynthesis assuming that tightly regulated dissipation is the hallmark of life Researchers educators and students of life sciences can find in this text many examples of how we can use the interdisciplinary approach to study cells virtuoso ability to connect the microscopic to the macroscopic world Each chapter is a self contained unit with a glossary and selected references for



further reading     **Experiences in the Biocontinuum** Richard L. Summers, 2020-08-10 The central question in the biological sciences for the past 100 years has concerned an understanding of how living systems differ from other general physical phenomena and what makes these systems unique With new developments in the fields of nonequilibrium thermodynamics systems theory chaos and information theory over the past few decades there has been growing interest in finally answering the question first posed by Erwin Schrödinger in the 1940s concerning the true scientific nature of living systems Similarly there is also increasing interest within the biologic community for a more holistic and non reductionist methodology The approach followed in this book builds on a foundation of information theory and semiotics while integrating basic thermodynamic considerations and systems theory to form a singular unifying concept that is proposed to be the essential process of living systems However the premise presented is much more than simply the exposition of a new hypothesis This book describes the logical progression of thought incorporating a diverse array of established scientific ideas that were used in the conceptualization of a dynamic mathematical framework that can be employed as a novel analytic means for the study of living systems and their fundamental processes

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