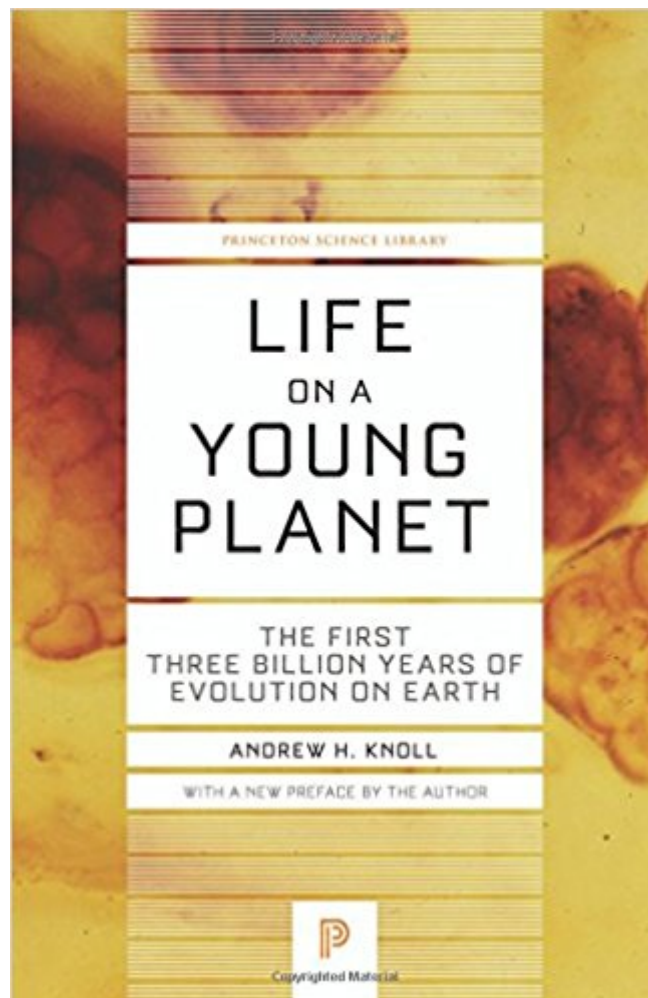




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# **Life On A Young Planet: The First Three Billion Years Of Evolution On Earth (Princeton Science Library)**



## Synopsis

Australopithecines, dinosaurs, trilobites--such fossils conjure up images of lost worlds filled with vanished organisms. But in the full history of life, ancient animals, even the trilobites, form only the half-billion-year tip of a nearly four-billion-year iceberg. Andrew Knoll explores the deep history of life from its origins on a young planet to the incredible Cambrian explosion, presenting a compelling new explanation for the emergence of biological novelty. The very latest discoveries in paleontology--many of them made by the author and his students--are integrated with emerging insights from molecular biology and earth system science to forge a broad understanding of how the biological diversity that surrounds us came to be. Moving from Siberia to Namibia to the Bahamas, Knoll shows how life and environment have evolved together through Earth's history. Innovations in biology have helped shape our air and oceans, and, just as surely, environmental change has influenced the course of evolution, repeatedly closing off opportunities for some species while opening avenues for others. Readers go into the field to confront fossils, enter the lab to discern the inner workings of cells, and alight on Mars to ask how our terrestrial experience can guide exploration for life beyond our planet. Along the way, Knoll brings us up-to-date on some of science's hottest questions, from the oldest fossils and claims of life beyond the Earth to the hypothesis of global glaciation and Knoll's own unifying concept of "permissive ecology." In laying bare Earth's deepest biological roots, *Life on a Young Planet* helps us understand our own place in the universe--and our responsibility as stewards of a world four billion years in the making. In a new preface, Knoll describes how the field has broadened and deepened in the decade since the book's original publication.

## Book Information

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## Customer Reviews

Winner of the 2003 Book Award in Science, Phi Beta Kappa "A fascinating book. . . . The catastrophic surface narrative of this impressive and intriguing book would surely have pleased Stephen Jay Gould; but I think its deterministic subtext would have pleased Charles Darwin still more."--Matt Cartmill, *Times Literary Supplement* "In a book so well written that nonspecialists and specialists alike will find much to savor, [Knoll] captures both the excitement of scientific discovery and the intricacies of scientific interpretation. . . . Readers interested in substance will certainly not be disappointed."--*Publishers Weekly* "Andrew Knoll is an ideal guide through this early phase of life's history on the Earth. . . . [O]ne of the strengths of Knoll's book is that it presents science as the open-ended endeavor that it is.... *Life on a Young Planet* . . . expresses better than most the bumptious vitality and sheer fun of open-minded research."--Stefan Bengtson, *Nature* "Life on a Young Planet stands apart from its predecessors in two fundamental respects. First, Knoll is perhaps the most qualified person to write such an epic: a renaissance man whose text is filled with insightful quotes from authors ranging from Darwin to Dickens to Dyson. . . . Second . . . this book describes the coevolution of life on Earth as an integrated biochemical system that has profoundly and irrevocably changed over time."--Guy M. Narbonne, *Science* "A balanced, excellent account of current theories and discussions of the origin and early evolution of life. . . . Knoll is able to convey difficult scientific issues with a minimum of jargon, using a brisk and witty prose. . . . He is a gifted storyteller with a knack for choosing the right anecdote. . . . A browse through Knoll's book will enlighten both the cognoscenti and those unfamiliar with the complexities of reading a fossil record. . . . Knoll manages to present a multidisciplinary field in an interdisciplinary volume."--Antonio Lazcano, *American Scientist* "Knoll is well placed to tell this amazing story, and he does so with verve."--Douglas Palmer, *New Scientist* "A detective story to match the best crime fiction. It is told with verve."--Paul Nettleton, *The Guardian* "The author weaves a beautifully written, fascinating story of life's origin and development based on his extensive field studies and research in the most remote corners of the globe. . . . This volume . . . is a most valuable asset that should be read by scientists active in the field, by teachers and students who are interested in the most recent thoughts on the subject, and, in fact, by anyone who is interested in how life might have originated and evolved on this planet or on other similar planets in our Universe."--Nathan Dubowsky, *Science*

Books & Films "This is not a textbook but rather a story, giving one person's view of how the jigsaw pieces fit together. It is written in flowing prose with many asides, personal anecdotes and explanations of what evidence there is and how it is used. . . . [F]or ecologists the book has much to offer in putting the early evolution of life into perspective."--Bulletin of the British Ecological Society "[Knoll's] words have a poetic flavor and his deep interest in the study of life on earth flows out of them, carrying readers along while maintaining a rigorous discourse. Knoll's book will appeal to anyone interested in the evolution of life on Earth."--Choice "In this wonderful book . . . Knoll's extensive field experience and eagerness to share data and ideas with colleagues enable him to reconstruct responsibly the broad evolutionary scenario yet to remain close to the evidence."--Lynn Margulis, Times Higher Education Supplement

"Andrew Knoll, one of the world's foremost paleontologists, here presents the origin and early evolution of life the way it should be told: a mystery unfolding as an epic. Resonating with the authority of firsthand stories of discovery, his account will be exceptionally enjoyable for scientists and the educated public alike."--Edward O. Wilson, Harvard University "Here is a firsthand account of one of the most exciting quests in modern science. Knoll writes with the confidence of a distinguished scientist who has devoted his career to unraveling the mysteries of life's origins and the passion of someone who deeply believes in the importance of recent discoveries about life before the Cambrian explosion. From the wilds of Siberia to the ocean floor, from Earth to Mars and beyond, he takes readers on a fascinating personal adventure that may change the way they think about themselves and their place in the world."--Lawrence M. Krauss, author of *The Physics of Star Trek* and *Atom* "In a highly personal, gripping narrative, Knoll takes us on the most incredible journey of all journeys--the history of life on Earth."--Donald E. Canfield, Odense University "This is a truly great book. It is a remarkably readable synthesis of many diverse ideas selected from a breathtaking array of disciplines. The narrative is engaging and entertaining--a travelogue through time that incorporates amusing and informative anecdotes from Knoll's travels to many far-off places."--Sean Carroll, University of Wisconsin, author of *From DNA to Diversity*

Life on a Young Planet by Andrew Knoll: What a brilliant book. Everything you could possibly want to know about the history of the planet and life on it, beautifully, clearly and succinctly explained. No padding. Great writing. I will probably reread this book just to absorb nuances I lost in the first reading. The author explains different opinions on all the divisive topics (like snowball earth) in a fair way and with a kind of organized thinking that's impressive too. And yet he manages to be

completely entertaining. And, the author has no agenda (which ruins a book for me). It's a thoroughly lucid picture of the past and present. I'm impressed almost to speechlessness.

I was fascinated. I am fairly familiar with the Cambrian fauna and probably know more than most about Pre-Cambrian biology. But this book was just over the top. Never appreciated how much paleontology could be done on bacteria. Incredible. If you have any interest in paleontology of the Pre-Cambrian and don't know a lot of bacteriology, this is a great place to start. Obviously I loved it. Bacteriologist friend borrowed it to possibly use it in his intro course. He knows a lot more than I do.

Precambrian evolution? I love it!

This gave a fascinating perspective on early life, doing by a great job of integrating geology, paleontology, and microbiology into a topic that I have immense interest in. Recommended! Citations are replaced with recommended reading at back, I would have preferred more formal citations

Great book explaining the science that goes into the investigation to life's origin. You should have some background in geology, molecular biology, biochemistry and genetics to get the full flavor of what the author presents. I felt I was back in college again.

I have read many books on the history of life on earth. This is my favorite book. Excellent photographs, clear writing, enchantingly told.

Andrew H. Knoll's *Life on a Young Planet: The First Three Billion Years of Evolution on Earth* is one of those rare books that can change your, or at any rate, my, picture of reality. I have posted twice before on this book: *Eu are Irrelevant* and *In the Beginning*, but the present post is my attempt at a review. Dinosaurs and mastodons don't wander through these pages, unless you count a cameo or two. Their time was still far in the future when the characters whose story is told here held center stage. The Cambrian Period, which started about 543 million years ago, or a bit less than ten thousand times as long ago as our own species originated, ushered in the Paleozoic Era and the first easily recognizable fossils. It was the first age of animals - not the very first animals, but the first animals with considerable size and complexity. All the animal phyla we now recognize were onstage in the Cambrian, as well as numerous phyla dead and gone. Before the Cambrian, only sponges,

jellyfish and other very simple animals left any trace. The three billion years of the fossil record preceding the Cambrian are Knoll's subject, and it is unexpectedly fascinating. A couple of chapters feature the Cambrian, but mainly it looms as an offstage presence, foreshadowed more than depicted. Knoll is a graceful and vivid writer, and the story he tells is a detective story, as most good science stories should be (and why does that part always get lost in science textbooks, especially those for kids?). The web of evidence from which the past is constructed is an intricate one, built out of chemistry, physics, and biology, classical and molecular, but above all, out of old rock and the traces left on it by life. Because of that intricacy, the book makes some demands on the reader's attention span and memory for pattern, and enough background in biology to know the difference between Eukaryote and Prokaryote would be useful. The Earth of three and one half billion years ago was different from the one we live in but not quite unrecognizably so. Oceans and continents already existed, and had for 700 million years previously. Those continents have left little of themselves behind though, suggesting, says Knoll, that the great geological engine of plate tectonics might have worked differently in those younger and internally hotter days; able, perhaps, to swallow and digest continents as well as oceanic crust. The earliest, highly suggestive but not quite conclusive, evidence of life dates from then. Of what does that evidence consist? Microscopic impressions in the rock and organic remains of possible life, and context, context, context.

Paleontology is a field science, and paleontologists spend an exciting part of their time clinging to precarious and sometimes icebound cliffs to retrieve their samples, but it is now also a laboratory science. The rocks containing these traces must be sliced in thin transparent sections, scrutinized through powerful microscopes, subjected to isotopic analysis in a mass spectrograph - life, it seems, is picky about the carbon (and other element) isotopes it uses, and that signature is one of the most definitive. Knoll tells of putting the crucial samples under the microscope, scrutinizing them, and in the end concluding that while a circumstantial case existed, it couldn't be considered conclusive. A deep skepticism of both one's own ideas and those of others is indispensable in this most vital kind of science. Knoll is especially good at presenting contrasting ideas and hypotheses - a breath of fresh air after listening to the narrow minded fanaticism of some of the string theory debates. Paleontologists, of course, have a big advantage - they have actual evidence. A few hundred million years later, the evidence becomes more unambiguous. Casts in the rock preserve more detail, both morphological and biogeochemical. Life, too, becomes more elaborate and presents more features for recognition. The cyanobacteria are one of the main heroes of the story. For two and one half billion years they have thrived almost unchanged - they did much of the heavy lifting of producing the oxygen that was previously lacking in our atmosphere, and they were

incorporated in eukaryotic cells to allow plant life to arise. I won't try to summarize this long elaborate story, but let me mention a couple of themes. Geology set the stage for life, but life became a major player in transforming the atmosphere and the oceans. Occasional cataclysms have shaken and transformed evolution. The photosynthetic production of oxygen was certainly one of these. Others likely had extraterrestrial origins - great asteroid impacts, for example. Still others probably originated in the tectonic processes of volcanism and continental drift. Most, like the great ice ages of the late Proterozoic (just before the Cambrian efflorescence) are of uncertain provenance. Those ice ages, incidentally, made the more recent ice ages of the Pleistocene look like midgets. Glaciers advanced even into the tropics, and much, or all, of the ocean surface was frozen to great depths. Cataclysm for one branch of the tree of life may be opportunity for another. Mammals and dinosaurs coexisted for 150 million years, during all of which time the reptiles were clearly dominant. Not until the asteroid wiped out the dinosaurs did the great mammalian expansion happen. Knoll calls this "permissive ecology." When all the good jobs or ecological niches are already taken, it's hard for an evolutionary novelty to get a start. The penultimate chapter is devoted to paleontology beyond the Earth, and especially to LAH-84001, the grapefruit sized meteorite from Mars that NASA in 1996 claimed showed evidence of life. His exceptionally clear prose is put to good use explaining the pros and cons, as well as crucial background material (how do we know it came from Mars, for example - it was found in Antarctica.) The years since of intense study of this meteorite have taught science a lot about how to look for signs of life from other planets, but have not been kind to NASA's claim. The claim has not been disproven, but all the lines of evidence upon which NASA made the claim have been cast into doubt. The final chapter, or epilogue is truly an elegant essay in itself. He touches on many themes, from religion and science to creationism, but concludes with an appeal that we realize the implication of the fact that we, the human race, now play a major role in shaping the future of the planet. If we can acknowledge our unprecedented role as planetary stewards, we may be able to discharge our responsibility with wisdom and with honor. On this issue, at least, faith and science find common ground. I don't know whether God decreed the passenger pigeon, but if He did, it was not for us to exterminate... Through our actions or inaction, we decide the world that our grandchildren and great grandchildren will know. Let us have the grace and humility to choose well. He includes an extensive and lightly annotated list of references and further reading. In case it wasn't obvious, I really liked the book.

A touchStone of authoratative material on a multi discipline descriptive text written in an easy style for all levels of reader

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