

Talking About Life

Conversations on Astrobiology

With over 450 planets now known to exist beyond the Solar System, spacecraft heading for Mars, and the ongoing search for extraterrestrial intelligence, this timely book explores current ideas about the search for life in the Universe.

It contains candid interviews with dozens of astronomers, geologists, biologists, and writers about the origin and range of terrestrial life and likely sites for life beyond Earth. The interviewees discuss what we've learnt from the missions to Mars and Titan, talk about the search for Earth clones, describe the surprising diversity of life on Earth, speculate about post-biological evolution, and explore what contact with intelligent aliens will mean to us.

Covering topics from astronomy and planetary science to geology and biology, this book will fascinate anyone who has ever wondered, "Are we alone?"

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Chris Impey
Frontmatter
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Preface

Scientists tell stories with the power to inspire. Geologists can tell a story of the titanic forces that have shaped the planet. Chemists can tell the stories of the almost infinite complexity that result from the combinations of fewer than a hundred ingredients. Physicists tell a story where the microworld of forces and interactions is based on a pleasing symmetry and unity. Biologists have their own story of unity, where the diversity of life is based on a single genetic code. The story astronomers tell is perhaps the grandest of all, since it plays out over 13.7 billion years in a universe that utterly dwarfs us.

One vital part of this story has yet to be told: the role of life in the universe. We have a high degree of confidence that the laws of physics and chemistry are universal. The visible universe contains about 10^{22} stars, a number so large that it's hard to grasp intuitively, and theory and observation indicate that many of them will have orbiting planets. Life on Earth is tenacious and pervasive; it's found in a bewildering array of environments, yet Earth is the only place we know of with life. That may be about to change.

Astrobiology is the scientific study of biology in its broadest context. It is a young field. Sixty years ago, we had little idea of how life on Earth started and no idea of the unity of life at a molecular level. Thirty years ago, Earth seemed to be the only plausible site for biology in the Solar System. And just fifteen years ago, we knew of no planets orbiting stars other than the Sun. Currently, a fleet of large telescopes and a small armada of spacecraft are starting to identify and scrutinize plausible sites for life in the Solar System and beyond.

There are excellent textbooks, popular books, and scholarly monographs on astrobiology. Such writing is authoritative, but a third-person narrative can be impersonal and sometimes sterile. *Talking About Life* is different. It's a selection of interviews where scientists tell the story of the search for life in their own words. Taken as a whole, it's a snapshot of the state of the search for life in the universe a decade into the twenty-first century. It has the immediacy of the first-person voice. It describes how science works not in theory but in practice. It conveys the excitement of asking deep questions about nature and the challenge of doing research, which defines the boundary between what we do and don't know.

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The first part of the book sets the scene. Timothy Ferris gives his view as a writer and chronicler of the field for the past thirty years. Iris Fry reveals how modern ideas of the origin of life came about. Steven Dick recounts the history of astrobiology and Ann Druyan explores the excitement of communicating science. Pinky Nelson gives us the view of one of Earth's lucky life-forms who has travelled beyond Earth, and in Neil deGrasse Tyson we hear from the foremost popularizer of astronomy. Then Steven Benner and William Bains remind us that the toolkit of biology in other settings might be quite different than it is on Earth.

In the second part, insights into the history of life on Earth are presented. Roger Buick and Joe Kirschvink talk about the oldest rocks and tell how the changes in the biosphere are intimately coupled to the geological record. Lynn Rothschild and John Baross remind us that the typical organisms on Earth are extremophiles: microbes that can handle physical extremes fatal to us. Next, Andrew Knoll gives the broad sweep of evolution over the past 3 billion years, and Simon Conway Morris discusses the tension between the ideas of contingency and convergence. Even if microbial life proves to be abundant in the universe, some people will likely be disappointed; part of the lure of astrobiology comes from a craving for companionship. As Roger Hanlon and Lori Marino remind us, even as we search for intelligent life out in space, we share a planet with highly functioning creatures; they are the "aliens among us."

The third part turns to the search for life in our backyard, the Solar System. Chris McKay recounts what we can learn from Solar System analogs on Earth, and David Grinspoon talks about what makes a planet habitable. After an overview by Jonathan Lunine, Carolyn Porco takes us with her on the adventure of the Cassini mission to Saturn and its moons. Laurie Leshin and Guy Consolmagno talk about the ingredients for life that are found in primordial material from the formation epoch, and Peter Smith gives us an insider's view of the recent Phoenix mission to Mars.

The biggest revolution in astrobiology is the routine discovery of exoplanets after decades of fruitless searching. Alan Boss presents the theorist's view; he has been struggling to understand the often unusual systems found so far. Geoff Marcy and Debra Fischer give us a sense of the thrill of that chase. Young researchers Sara Seager and David Charbonneau then describe how the discovery phase is giving way to characterization, and how the detection of terrestrial planets is finally within reach. Vicki Meadows closes the fourth part by describing how astronomers hope to find life on distant planets by detecting spectral biomarkers.

The final part of the book gathers perspectives on astrobiology that are more "out of the box," starting with Jill Tarter and Seth Shostak giving an update on the search for extraterrestrial intelligence. Then Ray Kurzweil and Nick Bostrom consider the implications of the fact that humans or species like us elsewhere might pass through a transition to a post-biological stage. Next, Paul Davies and Martin Rees present the cosmic context for life, including the strange alignment

of fundamental physical quantities around values necessary for biology. The last word goes to writers: Ben Bova considers how science fiction has anticipated astrobiology and Jennifer Michael Hecht has a provocative take on the implications of contact with intelligence from afar. Our imaginations may have trouble keeping up with what the universe has conjured up.

I am a novice in many of the subject areas of this book, so I am grateful to my colleagues for their patience and tutelage. The work and words of many of them are contained here, but an equal number who I interviewed are not; their omission is due to the constraints of space and is no reflection on the quality or importance of their research.

The interviews are true to the original digital recordings and so represent a historical record, but a large amount of “invisible” work was required to get them ready for publication. Each interview was transcribed and then edited three or four times to improve clarity and flow. Every attempt was made not to alter the scientific content in this process, but I take responsibility for any mistakes or distortions that remain. Erin Carlson kept track of all the digital files and kept me organized as I juggled this project with many others. I am particularly grateful to Laura Robb, who did the bulk of the transcription and early editing; her talent and attention to detail resulted in material that was already in good shape when I began my work. Katherine Larson did much of the early transcription and editing and served a larger role as the inspiration for this project; I’m indebted to her. Thanks go to my agent Anna Ghosh for encouragement and to Vince Higgs for patiently shepherding this project to completion.