

Preface

Astrobiology is a relatively new research area that addresses questions that have intrigued humans for a long time: “How did life originate?” “Are we alone in the Universe?” “What is the future of life on Earth and in the Universe?” These questions are jointly tackled by scientists converging from widely different fields, reaching from astrophysics to molecular biology and from planetology to ecology, among others.

Whereas classical biological research has concentrated on the only example of “life” so far known – life on Earth – astrobiology extends the boundaries of biological investigations beyond the Earth to other planets, comets, meteorites, and space at large. Focal points are the different steps of the evolutionary pathways through cosmic history that may be related to the origin, evolution, and distribution of life. In the interstellar medium, as well as in comets and meteorites, complex organics are detected in huge reservoirs that eventually may provide the chemical ingredients for life. More and more data on the existence of planetary systems in our Galaxy are being acquired that support the assumption that habitable zones are frequent and are not restricted to our own Solar System. From the extraordinary ability of life to adapt to environmental extremes, the boundary conditions for the habitability of other bodies within our Solar System and beyond can be assessed. The final goal of astrobiology is to reveal the origin, evolution, and distribution of life on Earth and throughout the Universe in the context of cosmic evolution, and thereby to build the foundations for the construction and testing of meaningful axioms to support a theory of life.

The multidisciplinary character of astrobiology is a challenge on the one hand because it complies with modern science approaches; on the other hand, the full expertise in astrobiology is not always available at a single university. To overcome this problem, experts from seven different European universities or research centers, specialized in leading fields of astrobiology, gathered in an astrobiology lecture course network with live tele-teaching and an interactive question-and-answer period. This book is based mainly on this multidisciplinary lecture series in astrobiology, and each chapter corresponds to a 90-minute lecture. The main fields of astrobiology are covered in a very competent and instructive manner.

The book starts with a general introduction to the fascinating world of astrobiology. The next chapters provide insights into the different steps of cosmic evolution, from the Big Bang through the formation of galaxies and stellar systems, with emphasis on the evolution of matter required for life: the elements and molecules of life. The history of life on Earth is covered in the next chapters, including the latest results about the RNA world and concepts of a “window for life” as inferred from life’s strategies to adapt to factually every location on Earth. This leads to a definition of habitability that is applied to the planets and moons of our Solar System, especially our neighbor planets Venus and Mars and the satellites of the giant planets, Titan and Europa. With the advent of space exploration, space and the bodies of our Solar System are now within our reach; therefore, the technology required for astrobiology missions is also covered, exemplified by astrobiology experiments in low Earth orbit and astrobiology missions to Mars. The book concludes with a chapter on the legal and scientific issues of planetary protection required for each space mission within our Solar System.

This book is intended as a textbook in astrobiology for students and teachers from various fields of science that are interested in astrobiology. In each chapter, a list of questions for students is included. The CD is based on the original lectures that were given at the astrobiology lecture course network. The lectures can be followed on the Web streaming network of the European Space Agency (ESA) (streamiss.spaceflight.esa.int) under “Astrobiology Lecture Course Network (a.y. 2005–2006).”

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