ASTROBIOLOGY PERSPECTIVE ON LIFE OF THE UNIVERSE

ASTROBIOLOGY
SCIENCE, ETHICS, AND PUBLIC POLICY

EDITED BY

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Astrobiology

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Astrobiology Perspectives on Life of the Universe

Series Editors: Richard Gordon and Joseph Seckbach

In his 1687 book *Principia*, Isaac Newton showed how a body launched atop a tall mountain parallel to the ground would circle the Earth. Many of us are old enough to have witnessed the realization of this dream in the launch of Sputnik in 1957. Since then our ability to enter, view and understand the Universe has increased dramatically. A great race is on to discover real extraterrestrial life, and to understand our origins, whether on Earth or elsewhere. We take part of the title for this new series of books from the pioneering thoughts of Svante Arrhenius, who reviewed this quest in his 1909 book *The Life of the Universe as Conceived by Man from the Earliest Ages to the Present Time*. The volumes in ***Astrobiology Perspectives on Life of the Universe*** will each delve into an aspect of this adventure, with chapters by those who are involved in it, as well as careful observers and assessors of our progress. Guest editors are invited from time to time, and all chapters are peer-reviewed.

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Foreword

The science of astrobiology may be understood as a book with four chapters: the origin, evolution, distribution and destiny of life in the universe. Astrobiology's still unfinished first chapter emerged mainly from the work of Alexander Oparin (1894–1980) and other organic chemists. They gave rise to the subdiscipline of astrobiology that was called chemical evolution, a scientific approach to the origin of life on Earth. NASA was established in 1958. Since then, the young space agency encouraged space exploration of the Solar System: their efforts, together with the space agencies that came after them, could lead to at least a single additional example of life in our cosmic neighborhood. This would be the beginning of a second chapter of astrobiology—the evolution of life in the universe. A preliminary development, a third chapter of astrobiology, was due to the molecular biologist and Nobel Laureate Joshua Lederberg (1925–2008). He raised the question of the origin of life, not as a terrestrial phenomenon, but rather as a cosmic distribution of life. A fourth chapter, the destiny of life in the universe, is a different inspiring topic. For getting off the ground, it will need interdisciplinary interactions at the frontier of astrobiology and humanism.

The eighteen chapters of *Astrobiology: Science, Ethics and Public Policy* attempt to fill a gap in the current literature on the continuing growth of this new science of life in the cosmos. Even though astrobiology has made remarkable progress, the humanistic neighbors across its cultural frontiers are only at the beginning of confronting the problem of other life. A specific neighboring humanistic area is a main concern of the present book. It has been called alternatively *astroethics*, or *astrobioethics*. We will adopt the latter denomination, following the suggestion of the 2016 International Working Group on Astrobioethics.

As suggested by the present book, there are two time-honored philosophic subdisciplines that will be relevant for progress in astrobiology. Firstly, ethics, which goes back to Aristotle's *Nicomachean Ethics* (c. 340 BC). The other one, political philosophy, has its roots in the best known of Plato's dialogues, *Republic* (c. 375 BC). Ethics covers questions such as

culture, religion and human-nonhuman relations. But our main interest regards especially human-nonhuman relations, since they concern not only public policy, but the future of astrobiology itself. To be fair to the society we live in, we need the assistance of government to ensure that justice is implemented, so that our rights, and those of others, are respected. Then, we should return to political philosophy to guide us in enquiries on public policy:

> *What are the right policies for implementing public power in order to respect, preserve, and improve the quality of life on Earth, and elsewhere?*

Governments have the vocation to face difficult decisions concerning the distribution of limited public funds that are available to the State. One aspect of this obligation is the support of big science. The main example goes back to the middle of the last century. It involves physics of high energies with their large accelerators. More recently, astrobiology has been inserted into this restricted group, whose most urgent expenses are due to Solar System exploration. Once again, political philosophy comes to our aid regarding the enormous long-term decisions that our expenses force upon public offices. For instance, if we commit ourselves to terraforming in the Red Planet, this activity presents us with a clear-cut question that begs for a political answer. Even closer to the present, though, governments will face the economic exploitation of the Moon, Mars and the asteroids. For these activities we may profit from an earlier analogous multinational experience that has already been addressed with the exploitation of the Antarctic.

Similarly, we are becoming aware that spacefaring nations, with their corresponding space agencies, will need to take possession of new resources pacifically, according to the UN's Outer Space Treaty. Consequently, political agreement is necessary within the United Nations Organization. All space agencies, which are capable of space exploration, should respect UN agreements: the European Union, the United States of America, Russia, Japan, China and India. More recently, other national agencies have come to the foreground, including Israel and the United Arab Emirates. Clearly, political philosophy may come again to our aid.

In a different line of thinking, philosophical studies of morality serve as a basis for extending ethics into considerations that are forced upon us by the eventual understanding of the distribution of life in the universe. In this case the term "neighbor" takes a new, deeper, inspiring, unexpected and unprecedented philosophical significance. We generally accept the principle of equality as a proper ethical basis for relations with other human beings. But with Peter Singer in *Practical Ethics* (1979), we are aware that

the principle of equality is also a proper ethical basis for the more restricted question of human-nonhuman relations on Earth. A very remarkable example of an animal that we should keep in mind—the dolphin—was singled out by the neuroscientist Lori Marino: she found that the rate of encephalization (variation in relative brain size) in the hominid line may have been matched by this marine mammal's encephalization as recently as only one million years ago. But independent of this special evolutionary factor, all nonhuman animals should be encompassed, without exception, in our ethical codes. But our search for other manifestations of the phenomenon of life ranges from microbial evolution in the Solar System to the evolution of intelligence in worlds elsewhere in our galaxy. Thus, a bigger, inevitable and evident question in morality cannot be avoided:

With nonhuman species, on Earth and elsewhere,
how far should we extend our ethical codes?

In agreement with Edward Osborne Wilson in *Consilience* (1998), the origin of ethics is not a religious debate between believers and nonbelievers, but rather between "transcendentalists," those of us who believe that ethical precepts (such as justice and human rights) are independent of human experience, and "empiricists," who believe that ethical principles are human inventions. In what follows we shall understand how, for astrobioethics, both sides of this debate are fruitfully complementary.

Even though we have already underlined that independent of any theological consideration, the main debate on ethics is between transcendentalists and empiricists, nevertheless we must not exclude, but instead we should pay special attention to some religious aspects both of morality and public policy. Independent of any ethical system, our Judeo-Christian traditions contain writings that are remarkable from an ethical point of view, as they address fundamental questions. An outstanding example is Jesus' *The Sermon on the Mount* (Mathew, **5**,1-14, written c. 85 AD), which is inserted in a long biblical tradition (Psalm 1 and Jeremiah 17,7).

On the other hand, as astrobiologists we are mainly concerned with an empirical approach to ethics. Its insertion in science goes back to Charles Darwin in *The Descent of Man* (1875). This work offers a rationalization of the origin of ethics. Since the second half of the last century, the application of Darwinian theory to social behavior—sociobiology—has taught us how ethical behavior, as well as astrobioethics, can be given solid scientific bases. Consequently, under empiricism, progress in the search for life in the universe is bound to induce us to abandon the idea that ethics is uniquely human.

However, we should keep in mind the other major approach to ethics. In philosophy, from Socrates to Singer, there is a long history of transcendentalism. The following short selection of outstanding contributions clearly illustrates this remark: John Locke's *Second Treatise on Civil Government* (1689), David Hume's *A Treatise of Human Nature* (1739), Immanuel Kant's *The Categorical Imperative* (1785), Georg Wilhelm Friedrich Hegel's *The Philosophy of Right* (1831), George Edward Moore's *Principia Ethica* (1903), and John Rawls' *A Theory of Justice* (1971).

With these major philosophical contributions, we are once again in the satisfactory position that has characterized progress: When empirical bases have been identified, rationalism arises as its inevitable complement. In science, from Democritus to Darwin, the concert between empiricism and rationalism has been the general rule. For example, in classical mechanics, early empirical observations of Galileo were later rationalized by Newton's theory of gravitation. Exceptionally, in the astrobiological context, empiricism arose long after rationalization had preceded it in the form of transcendentalism. Fortunately, both sides of the current debate on ethics, and *a fortiori* on astrobioethics, provide solid bases for a consensus. We are ready to face astrobiology's most pressing objective due to the programs on exploration of the Solar System: our eventual interaction with life beyond our own horizons.

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May 2021

Preface

Science is awesome. Well, actually, it's not the science that's awesome. It's the natural world that science helps uncover, expose, reveal. My friend and Nobel Prize winning physicist, the late Charles Townes, once averred to some students visiting in our home, "science is a form of revelation."

In this sense, astrobiology is awesome. Among the revelations over the last quarter century are exoplanets, more than 4,000 confirmed with thousands more waiting in line for confirmation. Our space spectroscopists are watching and our SETI scientists are listening for biosignatures that could reveal extraterrestrial intelligence. Meanwhile, our solar system spelunkers energetically mine the subsurface of Titan and the atmosphere of Venus, looking for possible microbial neighbors closer to home. Astrobiology offers video game adventure for grown-ups.

Astrobiology provides one component to the more comprehensive matrix of science and technology that comprise space research. Just standing in awe at the numinosity of the cosmos is only part of the picture. Funding launch and orbital technology in the midst of geopolitical competition and tension occupy private entrepreneurs and governmental leaders alike. A competition has arisen between stockholders investing in off-Earth mining, on the one hand, and scientists wishing to maintain pristine off-Earth laboratories for their research, on the other hand.

This competition provides honest work for philosophers who then ask: would critters living in an off-Earth biosphere have intrinsic value? And, if so, would the imputation of intrinsic value protect them from terrestrial profiteering? Regardless of how we respond to these ethical quandaries, the answers should rise to the level of public policy formulation to guide the next generation of space explorers.

We need a book. We need a book that looks at *Astrobiology: Science, Ethics, and Public Policy*. You are now reading this book. Yet, as we delve into the details of reading this book with our eyes focused on the pages, we dare not forget the awesome beauty of the cosmos that can be glimpsed only when we turn to look in the direction of the stars.

Let me alert you to some subtleties of vocabulary. With the term, *astrobiology*, we work with standard definitions summarized as: Astrobiology is the scientific study of the origin and evolution of life on Earth and beyond Earth that draws upon a host of disciplines such as astronomy, physics, planetary science, geology, chemistry, biology.

What about ethics? In general, the term, *ethics*, refers to the theoretical work undergirding standards of value and moral responsibility. Be alert to overlaps and distinctions in various chapters. The panoptic terms, *astroethics* and *space ethics*, are inclusive. They include reflection on the broad scope of ethical concerns arising from concrete procedures in space exploration as well as speculations regarding extraterrestrial life. A more focused term is *astrobioethics*, which concentrates on matters having to do specifically with *bios*, life. Astrobioethics, you will read in Octavio Chon-Torres' chapter, is a branch of philosophy and astrobiology that studies the moral implications of the search for life in space.

The construction of future public policy can be built on a solid foundation laid already in 1958 and 1967. As Jacques Arnould at France's *Centre National d'Etudes Spatiales* (CNES) reminds us, the United Nations Committee on Space Research was established in 1958 on the occasion of the International Geophysical Year. The result is a perduring UN mandate to develop recommendations that form the basis of what is now known as planetary protection.

To this foundational principle of planetary protection was added some superstructure in the 1967 UN Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. This prescient document stipulated:

> "§ 1. The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.
>
> § 2. Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."

In many quarters, this moral foundation for public policy has been forgotten. New debates have broken out over weaponization of space, selling off-Earth real estate, competition for planting national flags, establishing colonies, and property rights for yet-to-be-discovered precious resources.

When we remind ourselves of the foundation laid in 1958 and 1967, we are inspired to see how the awesome magnificence of outer space revealed by the astro-sciences has been bolted to steel moral girders, one of which is to support the notion of a single Earthly society of moral deliberation. When we turn from staring at the stars and look back to Earth, we can perceive a oneness that might have been overlooked in previous centuries. The space sciences reveal something about the cosmos, and something about ourselves as well.

Ted Peters
Berkeley, California, USA
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Astrobioethics: Epistemological, Astrotheological, and Interplanetary Issues

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Abstract
The themes that arise as we enter the philosophical discussion on astrobiology are many and diverse. Of all these, ethics is presented as a rather complex one. Therefore, astrobioethics is the branch of philosophy and astrobiology that is responsible for studying the moral implications of the search for life in space. In this chapter I will analyze three fundamental aspects: epistemological, astrotheological, and interplanetary issues. Each has its own field of discussion and questions that need to be addressed, so that our new small step for mankind does not end up crushing the life we find in the universe.

***Keywords*:** Astrobioethics, astrotheology, interplanetary, teloempathy, transdisciplinary

1.1 Introduction

For a long time, humans have wondered if we are alone in the universe. This has manifested itself in culture, in religion, in philosophy, and in a variety of forms as different as human groups can be on Earth. Although we have not found empirical evidence that we are not alone in the cosmos, eventually this can happen. We do not know exactly when this will happen. However, that is not an impediment to the question of what we should

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morally do about it. Science and technology advance by leaps and bounds in the search for extraterrestrial life.

Every so often we see news about habitable exoplanets being detected. We have the disciplinary nature of Astrobiology, which brings together several disciplines made up of different specialists whose modus operandi is to work in an orchestrated and coordinated way. But what about the humanities, specifically ethics? Can we have a breakthrough that is matched with the Natural Sciences? To make the comparison would not do justice to either of them, since the nature of both respond to forms of knowledge with their own characteristics.

No. Ethics is not a science that gives us answers like mathematical formulas or experiments in a laboratory or astronomical observations. Ethics is a branch of philosophy that studies the moral dimension of human actions and thinking and, as such, since it does not have a unified methodology in which all experts agree and whose proposal is immutable in time, there are no universal moral laws. However, thanks to reflections on morality we can realize and reflect on our actions and thoughts, on their consequences and implications. That is why it is much more difficult to establish a moral system with coherence and adequate sustenance. And if that is so for earthly matters, for matters that go beyond life on Earth this could become a great mental exercise which will take time and the results of which will not be available every few months as if they were the product of the latest technological advances. To be able to engage in the thinking of astrobioethics, one must approach ethics as a branch of philosophy in addition to astrobiology, because astrobioethics was born in conjunction with moral reflection on issues expressly related to extraterrestrial life and, unlike astroethics, it deals with aspects that are more broad and general such as the responsibility of taking care of space junk or the right to property in an interplanetary context [1.6] [1.10] [1.11] [1.24].

The first time the word astrobioethics was used was in 2016 at two international events: the 35th International Geological Congress in Cape Town, South Africa [1.20] and the 12th Rencontres du Vietnam in Quy Nhon [1.21]. The first academic article that directly addressed this issue was published in the *International Journal of Astrobiology* under the title "Astrobioethics." It states that

> "Astrobioethics is an interdisciplinary field of astrobiology and ethics; it studies the ethical implications of astrobiological research. However, astrobioethics must have transdisciplinary practices in order to enrich itself and propose a broader judgement according to the context where it is applied [1.8]."

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