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Astrobiology as Science

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Definition

"Astrobiology as science" refers to how astrobiology is characterized and discussed in the philosophy of science.

Overview

The name "astrobiology" could be interpreted to imply that astrobiological research is limited to the search for, and eventual study of, extraterrestrial life (as was the case with astrobiology's predecessor, exobiology). This interpretation of the term "astrobiology" would be misleading, however. "Astrobiology" is commonly defined as "the study of the origin, evolution, distribution, and future of life in the universe" (e.g., Blumberg 2011; Dunér et al. 2018). In the latest edition of the Astrobiology Primer (Domagal-Goldman and Katherine 2016), "astrobiology" is defined as "the science that seeks to understand the story of life in our universe." Both these definitions, as well as a look at the research published in journals and presented at conferences dedicated to astrobiology, tells us that the focus of astrobiology is rather on the universal aspects of biology. If biology primarily studies living organisms, relations between living organisms, and relations between living organisms and their environments, it can be said that the focus of astrobiology is on the phenomenon of life as such, including eventual universal properties of life, its boundaries, and its boundary conditions. This means, for instance, that though many astrobiologists do study organisms in the form of extremophiles and the relation between these organisms and their environments, astrobiologists are not (in their role as astrobiologists) focused on the particular organism they study, but on properties that can inform our understanding of life as a phenomenon, general properties of life and life's boundaries and boundary conditions.

Taxonomy

Whether astrobiology should count as a discipline, a research field, or something else entirely, is a matter of ongoing discussion (Dick 2020; Michaud 2007). Astrobiology does fulfill some commonly accepted criteria for being a discipline, such as having its own questions and its own

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journals, conferences, and professional societies. A number of universities have centers that focus entirely or partly on astrobiology, though it is still uncommon for universities to have astrobiology departments. An increasing number of universities also offer courses and programs in astrobiology. On the other hand, there is no particular astrobiological method. Instead, astrobiology uses a multitude of methods borrowed from (other) disciplines. It has therefore been suggested that astrobiology is best characterized as an interdisciplinary (e.g., Grinspoon 2003; International Journal of Astrobiology 2002; Michaud 2007) or multidisciplinary (e.g., Dick and Strick 2004) science. It has also been referred to as a metadiscipline by Grinspoon (2003) and Michaud (2007).

Czyzewska (2013) uses both "multidisciplinary" and "interdisciplinary" when talking about astrobiology, which may in fact be the most correct way to characterize astrobiology. Many studies in astrobiology are performed strictly within the borders of a traditional discipline, but it takes many such studies from different disciplines to answer some of the questions of astrobiology. In this sense, astrobiology is multidisciplinary. On the other hand, some of astrobiology's questions call for genuinely interdisciplinary studies. It is also often insufficient to just add together results from different disciplines to answer the bigger questions of astrobiology. Instead, the work of synthesizing results from different intra- and interdisciplinary studies into answers to astrobiological questions needs to be interdisciplinary in itself. So, astrobiology is also interdisciplinary.

The term "metadiscipline" used by Grinspoon (2003) and Michaud (2007) is less well established and defined than the terms "multidisciplinary" and "interdisciplinary." Michaud (2007) uses the term to emphasize astrobiology's ambition to formulate universal laws and a universal theory of biology. This ambition is echoed by Blumberg (2011), though without using the term "metadiscipline." Grinspoon (2003) uses the term in connection with describing astrobiology as being "potentially revolutionary in its attempt to reverse the slide toward increasing scientific specialization and isolation," adding a will to "blur the borders and tear down the walls that modern academia has erected." Lynn Rothschild reasoned along the same lines by declaring that astrobiology "liberates us from disciplinary boundaries" (Dick and Strick 2004).

If it is correct to say that astrobiology, in addition to its explicit research goals, also has the ambition to transform (another) discipline and/or to transcend or abolish the borders of (other) disciplines, it may make sense to describe astrobiology as metadisciplinary, in addition to being multi- and interdisciplinary.

Is Astrobiology a Science Without a Subject?

In 1964, biologist George Gaylord Simpson criticized exobiology for being a science that has yet to show that its subject matter exists (Simpson 1964). From a philosophy of science perspective, Simpson's critique was misinformed since the aim of exobiology was not merely to study extraterrestrial life but also, and primarily, to find it – an aim that is perfectly consistent with extraterrestrial life not yet having been found or shown to exist. Looking for something that is not yet known for sure to exist is in fact, not an unusual scientific aim. It is an aim that exobiology has in common with, for instance, the search for the Higgs Boson, the search for exoplanets (Dick 2020), the search for black holes, and the search for Neptune and Pluto, all of which have now succeeded. Simpson's words are sometimes also used about astrobiology where they are misguided for the same reason, but also because the scope of astrobiology is different from that of exobiology through astrobiology's focus on life as a phenomenon, where finding and studying extraterrestrial life would be important milestones but not the only or the ultimate goals.

Astrobiology as an Empirical Science

Even though the characterization of astrobiology as a science without a subject is incorrect, the fact

that we so far only have one example of life (namely Earth life), means the empirical basis for astrobiology is still relatively weak. This is presently handled in two ways. One is to continue to collect data about the life we know on Earth, as well as about its living conditions on Earth and the physical and chemical conditions on other worlds. The other is to continue searching for a second data point (that is, extraterrestrial life).

Given, however, that we will (presumably) never be able to find every life-form in the universe or travel in time, the main aim of astrobiology cannot be to find the ultimate truth about how life actually started on Earth or in the universe, exactly how life is distributed in the universe, or be absolutely certain that the laws and theories we formulate about life are truly universal. On the other hand, this does not mean in any way that the field is completely open for speculation. The space for speculation is circumscribed by logic and mathematics, but also by existing data. As an empirical science, astrobiology also moves forward by continuing to formulate explanations that are possible given the current state of knowledge, while at the same time keep narrowing down the number of possible explanations by formulating testable hypotheses and figuring out new and better ways of testing these hypotheses. Through this general method, the room for speculation will successively shrink.

SETI

Another controversy regards whether the search for extraterrestrial intelligence (SETI) is a proper part of astrobiology (Almár and Race 2011). This controversy is not in a strict sense a matter of philosophy of science, however, but rather a matter of the politics and sociology of science (Dick and Strick 2004; Michaud 2007). From a strictly scientific and philosophy of science perspective, neither the scientific status of SETI, nor its fit within the broader area of astrobiology can be considered controversial.

Cross-References

- ▶ Astrobiology by Discipline
- ▶ Astrobiology, Definition of
- ▶ Evidence in Astrobiology
- ▶ Exobiology
- ▶ Life, Definition of
- ▶ SETI
- ▶ Sociology of Astrobiology

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