Contemporary Debates in Philosophy of Biology

Edited by

Francisco J. Ayala and Robert Arp
Contemporary Debates in Philosophy of Biology
Contemporary Debates in Philosophy

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General Introduction

Who Is This Book For?
This book features current research by scholars doing work in the central areas of philosophy of biology. Further, the papers are presented in a debate style with yes and no responses—often qualified—to basic questions posed in this continually developing sub-discipline of philosophy. This being the case, this book is ideal as (1) a stimulus for students in philosophy of biology and biology classrooms, as well as (2) a reference work for scholars who are working in this exciting field.

What Is the Philosophy of Biology?
The word “philosophy” comes from two Greek words: philos, meaning “love,” and sophos, meaning “wisdom.” Love here means something like an intense desire for something, while wisdom is arguably a kind of knowledge gained from experience, whether this be practical experience (gained from living life with all of its ups and downs) or theoretical experience (gained from understanding, evaluating, critiquing, and synthesizing ideas, positions, and concepts). Ever the theoretician, the philosopher has always been the person who not only desires to look deeper into some claim, idea, argument, event, or state of affairs by questioning assumptions and challenging status quo thinking, but also attempts to broadly explain and systematize aspects of reality (also see Craig, 2002; Pojman, 2007). In Bertrand Russell’s (1912/1999) words, which are appropriate given the nature of this book: “Philosophy, like all other studies, aims primarily at knowledge. The knowledge it aims at is the kind of knowledge which gives unity and system to the body of the sciences, and the kind which results from a critical examination of the grounds of our convictions, prejudices, and beliefs” (p. 9).

The word “biology” comes from two Greek words as well: bios, meaning “life,” and logos, meaning “word,” “rational account,” or “science.” Thus, biology is the kind or type of science that studies life, which most of us already know. Whereas biology
can be characterized as a set of sub-disciplines (the biological or life sciences) under science, the concern of which includes the description, classification, analysis, explanation, prediction, and ultimately control of living things (Audesirk, Audesirk, & Byers, 2008; Campbell & Reece, 2007), *philosophy of biology* can be characterized as a sub-discipline of philosophy—complete with topical subject-matter to be discussed momentarily—the concern of which is the meta-leveled attempt on the part of philosophers, biologists, and other thinkers to understand, evaluate, and critique the methods, foundations, history, and logical structure of biology in relation to other sciences, disciplines, and life endeavors so as to better clarify the nature and purpose of biological science and its practices (see Hull & Ruse, 2007; Rosenberg & Arp, 2009; Rosenberg & McShea, 2007; Ruse, 2008; Sarkar & Plutynski, 2008).

### The Classification of Biology and Philosophy of Biology

Concerning the classification of biology within the general discipline of science, it is usually envisioned as a natural, empirical, pure science, as we illustrate in Figure 0.1 (also see Sadava, Heller, Orians, Purvis, & Hillis, 2008; Silberberg, 2008; Tippens, 2007). We are aware that what is represented in the figure is a partial taxonomy, and that there may be other ways to classify the sciences.

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**Figure 0.1:** A basic classification of biology as a science

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**General Introduction**
Concerning the classification of philosophy of biology within the general discipline of philosophy, it is usually envisioned as a sub-discipline of philosophy of science, along with others like philosophy of physics, philosophy of chemistry, and philosophy of medicine. Because it concerns not only what kinds of things exist (metaphysical parts, processes, principles) as well as how we can know these things (epistemological perceptions, models, beliefs, justifications), the classification of philosophy of science itself can be considered a hybrid under metaphysics and epistemology; although, of course, this is debatable (Godfrey-Smith, 2003; Newton-Smith, 2001). Figure 0.2 represents a partial taxonomic classification of philosophy of biology, and we are aware that there are many other philosophical disciplines and sub-disciplines not shown, as well as that it is possible to classify the discipline of philosophy by historical time-periods or major movements (Copleston, 1994; Jones, 1997; Solomon, 2005).

The Relationship between the Biologist and the Philosopher

There are many biologists who think philosophically, and there are many philosophers who think like biologists, and this has always been the case in Western history since these two disciplines began coexisting with one another. In fact, researchers in these two disciplines have been able to assist one another in advancing ideas, putting issues to rest once and for all, and overthrowing faulty paradigms, as well as furthering technological comforts, establishing moral codes, and alleviating pain and disease (National Research Council, 1996, 2000; Watson & Arp, 2008).

A universally known example of this relationship between biology and philosophy is Charles Darwin (1809–1882), the field biologist and scientific naturalist, thinking like a philosopher of biology by mounting his self-proclaimed “one long argument” for natural selection in his famous work titled *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (1859/1999). In line with our descriptions of philosophy and philosophy of biology put forward above, Darwin definitely challenged status quo thinking with natural selection and offered a meta-level analysis, explanation, and systematization of the biosphere. Darwin’s contemporaries even referred to him as a philosopher (Schad,
2004, p. 9). There is a famous paper by Theodosius Dobzhansky (1900–1975) titled “Nothing in Biology Makes Sense Except in the Light of Evolution” (1973) and it is obvious that, were it not for Darwin’s philosophy of biology-like thinking and theorizing concerning natural selection and evolution, the biological sciences would be foundationless today.

Just as many biological conundrums have been aided by philosophical thinking, so, too, many philosophical problems have been either solved or enlightened with the help of the biological sciences. Let us focus on one example. In philosophy of mind, *substance dualism* is the belief that a person is made up of two fundamental things—a material or physical body and an immaterial or non-physical mind/soul/spirit—that can exist apart from one another. Those who believe in the immortality (or reincarnation) of the soul are substance dualists because they think that the death of the body does not mean the death of the soul (for example, *Catechism of the Catholic Church*, 1994; also Baker & Morris, 1996). The soul lives on as a separate substantial thing after the death of the body, which is another, distinct, separate substantial thing. A lot of people on the planet are substance dualists of one sort or another, probably because of their religious upbringing (Morgan & Laungani, 2005). Think of the cartoons where a character gets killed and the body stays flat on the ground while the soul/mind/spirit/immaterial substantial part leaves the body and ascends into a heavenly world—this is straight-forward mind–body substance dualism.

Contemporary discussions of religious and non-religious forms of substance dualism in Western history usually trace their roots back to the famous Modern philosopher, René Descartes (1596–1650) (Descartes, 1998; see also Baker & Morris, 1996), but forms of substance dualism can be found in the history of Western philosophy in the twentieth century and back through Aquinas (1225–1274) to Augustine (354–430), Plotinus (ca. 204–270), Aristotle (384–322 BCE), and Plato (ca. 428–348 BCE) (Foster, 1991; Aquinas, 1949; Augustine, 1991; Plotinus, 1992; Aristotle, 1995; Plato, 1997). In fact, the cartoon character rendition of the soul leaving the body is very close to what people actually believed in most Western societies throughout the history of Western civilization. The histories of Eastern and Middle Eastern philosophy are also peppered with beliefs in various forms of substance dualism (Abramson & Kilpatrick, 1995; Hook, 1963; Knapp, 1992).

Now, here is where *neurobiology* has made important contributions to the philosophy of mind, and our thinking concerning substance dualism. First, it seems that the mind is, at best, an emergent or supervenient *property* that is the result of brain states; it may not be reducible to brain states, but it is certainly dependent upon brain state processes (Baars & Newman, 2001; Bisiach, 1999; Gold & Roskies, 2008; Hardcastle, 2007; Kim, 2000, 1999, 1995). If there is any doubt about this, one need only peruse any textbook or journal devoted to the human brain’s workings and read about the effects of brain damage upon the psychology of a person (see Bear, Connors, & Paradiso, 2006; Kandel, Schwartz, & Jessell, 2000). For example, without the normal functioning of the prefrontal cortex, individuals are not able to make plans, nor are they able to carry out the behavior necessary to fulfill those plans (Fuster, 1997; Passingham, 1993). Also, as Finke (1980) demonstrated many years ago, damage to the prefrontal cortex causes a person to be unable to store short-term memories. Further, damage to the limbic system can cause certain autisms and other emotional dysfunctions (Bauman & Kemper, 1994).
Given the influence and preponderance of neurobiological data, and the fact that no one has ever witnessed a soul leaving a body or existing in some other “state”—both indicating the fact that, no brain, no mind—many philosophers and other thinkers who still think that there is something special about the mind and mental capacities have opted for forms of property dualism in place of substance dualism. According to property dualism, a person is one substance that is made up of two wholly distinct features, characteristics, or properties: an immaterial mental property (the mind and mental states) and a material bodily property (the brain and neurobiological states). On this view, the mind and brain are distinct properties of some one person, similar to the way roundness and blackness are distinct properties found in the one period at the end of this sentence. Just as we can distinguish the property of roundness from the property of blackness in some one period, so, too, we can distinguish an immaterial mental property from a material bodily property in some one person.

However, just as the roundness and blackness of that particular period can exist only while that particular period exists, so, too, according to property dualists, the mental and bodily properties of a person can exist only while that person is alive. So when we delete the period, the properties of roundness and blackness in that particular period cease to exist along with the period. Likewise, when a person dies, both that person’s body and mind cease to exist (no brain, no mind). Such a view of mind in relation to body seems to be consistent with neurobiological and other scientific data, and is appealing to those who do not believe in the immortality or reincarnation of the soul.

There is another possibility, namely, that the mind and mental states are completely illusory notions and all that really takes place when one thinks, decides, calculates, feels, believes, and the like, consists solely of neurobiological parts, processes, and principles. Thus, there is neither mental substance nor mental property, just brain and various brain functions. Given the influence and success of neurobiology—as well as the influence and success of physics, cognitive science, and artificial intelligence—many famous living philosophers, such as Paul Churchland (1989), Daniel Dennett (1990), and Jerry Fodor (2001), hold to this materialistic or physicalistic view of mind/brain. There are other positions concerning the nature and existence of mind that have come about as a result of the interaction of philosophy with the various life and behavioral sciences (see Heil, 1998; Lowe, 2000).

There are countless other ways in which the biologist and the philosopher have been helpful to one another, and this will become all the more evident to the reader after having gone through this book. Also, the reader is encouraged to investigate the material in the philosophy of biology, philosophy of science, and the history of biology and science that is referenced at the end of this introduction. It is through the fruitful interactions of the biologist and the philosopher that the subject-matter of philosophy of biology has come to be the way that it is in its present state today.

The Subject-Matter of Philosophy of Biology

Every body of knowledge—science, discipline, study, domain—has a subject-matter and specific questions that give a limit, form, and function to that body. So, for example, biology studies parts, processes, and principles associated with living things primarily as its subject-matter, and not stamp-collecting, business ethics, or World War II.
Philosophy of biology, too, has a subject-matter and specific questions which it has developed near the end of the twentieth century, and we have included material in this book that reflects much of the current discipline. Figure 0.3 offers some of the central topics that comprise the subject-matter of philosophy of biology (there are others). We have included most of these topics in this book, and describe and explain the basics of the topics in the introductions to each section, complete with further reading material.

There are other topics that, depending upon whom you talk to, can be considered either central or peripheral to philosophy of biology. For example, the philosopher of biology and the ethicist converge (along with other thinkers) in bioethics, a sub-discipline of ethics or moral philosophy that deals with issues such as abortion, personhood, contraception, euthanasia, advance directives, informed consent, human and animal experimentation, cloning, prenatal screening, gene therapy, and others (Beauchamp & Childress, 2001; Kuhse & Singer, 2001). The philosopher of biology, the epistemologist, the neurobiologist, and other thinkers converge in evolutionary epistemology, a sub-discipline of epistemology that investigates (among other things) the extent to which human perception, cognition, and theorizing are reliable because of natural selection and other evolutionary factors (Harms, 2004; Radnitzky & Bartley, 1993). Philosophers of biology, metaphysical ontologists, biologists, practitioners of medicine, bioinformaticians, and others converge in the burgeoning field of biomedical ontology, an area concerned with building domain and formal ontologies (here, understood as standardized, structured, taxonomic classification systems) so as to assist biomedical researchers in classifying, categorizing, and coding their data and information so that it may become optimally interoperable, re-usable, and shareable with the assistance of computational systems and the World Wide Web (Arp, 2007; Arp, Romagnoli, Chhem, & Overton, 2008; Smith, 2003, 2004).

Several of the topics in philosophy of biology exist because of Charles Darwin’s ideas concerning evolutionary biology, many of which can be found in the *The Origin*
of Species. Also, every topic in philosophy of biology touches upon Darwin’s principles in some way, and vice versa. In the Introduction to the Origin, Darwin (1859/1999) notes:

In considering the Origin of Species, it is quite conceivable that a naturalist, reflecting on the mutual affinities of organic beings, on their embryological relations, their geographical distribution, geological succession, and other such facts, might come to the conclusion that each species had not been independently created, but had descended, like varieties, from other species. Nevertheless, such a conclusion, even if well founded, would be unsatisfactory, until it could be shown how the innumerable species inhabiting this world have been modified so as to acquire that perfection of structure and co-adaptation which most justly excites our admiration... It is, therefore, of the highest importance to gain a clear insight into the means [italics added] of modification and coadaptation. (pp. 4–5)

Chapters 3 and 4 of the Origin describe Darwin’s principle of natural selection, his means or explanatory mechanism for the modification and coadaptation of species. Based upon observations of the biosphere, thinkers in the past had hypothesized that evolution took place, but it was Darwin who explained how evolution occurred with the principle of natural selection, complete with several arguments, numerous pieces of evidence, and other principles that provided a coherent picture of the so-called “Tree of Life” (also see Ayala, 1985; Gould, 2002; Stebbins & Ayala, 1987; Strickberger, 2000; Mayr, 2001). We encourage you to read all of the Origin, as this is a classic and foundational piece of writing for anyone doing research in biology or philosophy of biology.

The reader can consult various other resources in philosophy of biology to get a sense of the scope and breadth of this discipline (e.g., Grene & Depew, 2004; Rosenberg & Arp, 2007; Sarkar & Plutynski, 2008; Garvey, 2007; Hull & Ruse, 1998, 2007; Sober, 2000; Sterelny & Griffiths, 1999). The philosophy of biology has a long, varied, and complex history that would take several lifetimes to ingest completely. Besides references to research in the philosophy of biology, we have also included further reading material related to philosophy of science and the history of biology and science below. We hope that students and scholars of philosophy of biology alike will benefit from the material in this book.

References and Further Reading


General Introduction


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**General Introduction**


General Introduction


**Further Reading in Philosophy of Science**


**Further Reading in the History of Science and Biology**

Humans seek both unity and simplicity when classifying and explaining reality, and this is especially true in the sciences. This way, we can understand, control, and—in the words of the famous Modern philosopher, René Descartes (1596–1650)—“thus render ourselves, as it were, masters and possessors of nature” and other aspects of reality (Descartes, 1637/1998, p. 35). Consider the law of gravity, the kinetic theory of gas, or the principle of natural selection and how they form unified, simple, powerful bases for our explanations of many of the events that occur in the universe. This being the case, there is a tendency for researchers to reduce diverse and complex parts, processes, and principles to their most basic constituents, or “lowest common denominator” (as Evelyn Fox Keller calls it in the first paper included in this part), if this is possible.

Now reductionism is a complicated term that has many meanings, distinctions, and uses, and one can look at the material in the further reading section at the end
of this introduction for further insights and clarifications. It is arguable that wholes can be reduced to parts, higher levels can be reduced to lower ones, the complex can be reduced to the simple, the older theory can be reduced to the newer one—and there are other forms of reduction. For our purposes here, following the excellent work of Michael Silberstein (2002), we can distinguish (broadly) between a metaphysical form of reductionism and an epistemological form of reductionism, bearing in mind that there are multiple versions and subversions of each form.

Metaphysics concerns what exists in reality. According to metaphysical reductionists, there are really no entities, properties, or substances that arise out of more fundamental chemical or physical ones since, once the more fundamental ones have been described, that is all there is to the reality of an entity, property, or substance. Thus, for example, when people speak about water, they may take it to be a substance in its own right. However, according to the metaphysical reductionist, water just is hydrogen and oxygen—nothing new emerges when two hydrogen molecules combine with one oxygen molecule. The same goes for biological phenomena as, for example, a cell just is the basic chemico-physical parts, process, and principles of which it is composed. In the first paper of this part, Evelyn Fox Keller seems to be expressing this position when she claims: “I am committed to the position that all biological phenomena, including evolution, require nothing more than the workings of physics and chemistry.”

Conversely, according to a metaphysical non-reductionist, there is something about water—for example, its liquidity or liquid property—that emerges from (or supervenes on) the hydrogen and oxygen molecules, making it such that this liquidity exists on a separate metaphysical plane from the molecules on which it depends. In the case of the cell, this emergence or supervenience is true even more so, since a cell is a complexly organized hierarchical system of interactions. After all, reasons the metaphysical anti-reductionist, liquidity and the cellular system itself appear to be something distinct from hydrogen, oxygen, and DNA molecules, chemical bonds, and other chemico-physical parts, processes, and principles.

In many researchers’ minds, the possible reduction of biological phenomena to chemical and physical phenomena became all the more probable starting with James Watson and Francis Crick’s elucidation of the molecular structure of DNA that occurred in a Nature paper from 1953. In that paper (1953a) and a quick follow-up paper (1953b), Watson and Crick got scientists and philosophers of science to think about what parts, processes, and principles were really at work in heritability. Could Mendelian genetics be reduced to molecular genetics in the same way that heat was reduced to kinetic motion or lightning to electrical discharge? Given that chemistry and physics were making incredible strides at revealing the real workings of other parts of the universe—and, thereby, reducing things to chemical phenomena, then physical phenomena—it would only seem to make sense that living things could be revealed as chemical and/or physical phenomena too. Thus, the possibility of biology being reduced to chemistry and/or physics became solidified as a topic in philosophy of biology with papers such as J.J.C. Smart’s “Can Biology Be an Exact Science?” (1959), Kenneth Schaffner’s “Approaches to Reduction” (1967), Francisco Ayala’s “Biology as an Autonomous Science” (1968; also see Ayala & Dobzhansky, 1974), Alexander Rosenberg’s “The Supervenience of Biological Concepts” (1978), Philip Kitcher’s “1953 and All That: A Tale of Two Sciences” (1984), Ernst Mayr’s “The
Autonomy of Biology: The Position of Biology among the Sciences” (1996), and Elliot Sober’s “The Multiple Realizability Argument against Reductionism” (1999), among others.

Whereas metaphysics concerns what exist in reality, epistemology is concerned with how we can know, describe, model, and explain reality, as well as our justification for doing so. According to a standard epistemological form of reductionism—often called theoretical reduction—it is possible to replace one theory A by another more explanatorily powerful theory B; thus, in effect, intertheoretically reducing A to B. For example, the phlogiston theory of combustion (which stated that an undetected substance called phlogiston was released during combustion) was replaced by the oxygen theory of combustion, while the caloric theory of heat (which stated that a fluid substance called caloric was responsible for a thing’s temperature) was replaced by the kinetic theory of heat. In Kitcher’s above-mentioned “1953 and All That,” he responds to the typical epistemological reductionist’s claim that classical genetics can now be intertheoretically reduced to—and, hence, replaced by—molecular biology, especially now that we know “what’s really going on” with heredity at the molecular level. By using the general line of reasoning that the biological sciences are subfields corresponding to multiple levels of complex organization in nature, Kitcher (1984) wants to show that, “despite the immense value of the molecular biology that Watson and Crick launched in 1953, molecular studies cannot cannibalize the rest of biology” (p. 373).

In his paper included in this part, John Dupré mounts a primarily epistemological argument for non-reductionism in biology—and would likely agree with Kitcher—since he argues that “properties of constituents cannot themselves be fully understood without a characterization of the larger system of which they are part” and, hence, the “notion that complex systems, such as those found in biology, can be fully understood from a sufficiently detailed knowledge of their constituents, is mistaken.” In her paper included in this part, it would seem that Evelyn Fox Keller is advocating a kind of promissory note that chemistry and physics will be able to explain biology completely. She offers two examples—(1) bacterial chemotaxis and (2) regulating the levels of oxygen and CO₂ in the termite nest—that she believes “provide evidence of partial successes in the effort to ‘reduce biological explanations to explanations in chemistry and/or physics.’” Whatever the case may be, the best strategy for researchers in biology is probably to pursue a general form of methodological reduction until parts, processes, or principles in reality are encountered that cannot be reduced. If such non-reducibility is encountered in the metaphysical or epistemological senses, then, following Keller, it may be that what is required is “fundamental transformations in the conventional approaches of both physics and chemistry.”

References and Further Reading


Is It Possible to Reduce Biological Explanations?