Processes of Life: Essays in the Philosophy of Biology.

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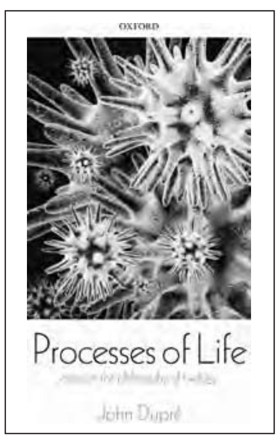
The Hazards of Reductionism

Processes of Life: Essays in the Philosophy of Biology. John Dupré. Oxford University Press, 2012. 320 pp. $55.00 (ISBN 9780199691982 cloth).

Processes of Life: Essays in the Philosophy of Biology collects in one volume 16 essays published between 2004 and 2010 by John Dupré, a prominent philosopher of science and director of Egenis (the Economic and Social Research Council's Centre for Genomics in Society, part of its Genomics Network), at the University of Exeter. Dupré's book is an example of philosophical naturalism, exploring the current state of the sciences as both source and support for philosophical conclusions. Dupré uses the philosophical tools of logical and conceptual analysis to expose hidden assumptions and consequences of long-held views about life and life science and to challenge their acceptability in the light of new discoveries in the biological sciences. Bringing these essays together in one book reveals the interconnectedness of two significant themes in Dupré's work—that biology and the philosophy of biology are transformed by paying close attention to the role of microbes and that the ontology of biological science is better understood in terms of processes rather than static properties.

A variety of topics are explored in this book, inspired by three ideas recently gaining ground in biology: developmental systems theory, epigenetics, and the significance of microbes in understanding the evolution of more complex forms of life. The first part of this collection revisits some of Dupré's earlier ideas in order to clarify and extend them in light of these developments. Here, he establishes his philosophical *grundlage*: disunity instead of reductionism; promiscuous realism tempered by empiricism; and the social character of scientific practice, including the intransigence of some embedded values. These philosophical tenets are defended by his appeal to evidence from contemporary science.

Reductionist attempts to explain the transmission of traits (the target domain of classical genetics) using molecular genetics will fail, Dupré argues, because of the "complex constellations of genetic and environmental factors" (p. 31) that contribute to an individual having a particular trait. There is no simple translation between classical and molecular vocabularies that will permit replacing the former with the latter. The inference that Dupré draws is that the world is made up of a diversity of the kinds of things and properties captured by overlapping but not entirely translatable descriptions and explanations. Indeed, scientific classifications reflect not just diversity in nature but also human goals and interests.



Because, as Dupré suggests, nature underdetermines taxonomy (i.e., there is more than one classification consistent with the results of empirical investigation), which classification we adopt must be chosen for reasons other than empirical ones. Species can be divvied up by a criterion of reproductive isolation or by genealogy, for example. The first will not make sense for asexual organisms, however, and the second ignores the lateral transfer of genes. Which is correct? Neither, if the goal is to have a single, privileged classification of life. Both, if classification strategies are tied to particular, local goals of scientific research. By defending pluralisms of methods, classifications, and natural kinds, Dupré primes his readers to appreciate the scientific and philosophical significance of new developments in biology.

In addition to the philosophical arguments against reductionism, Dupré exposes developments in the contemporary sciences of epigenetics and microbiology that drive the final nail into the reductionist coffin. Why is there no straightforward translation of classical genetics into molecular genetics? The answer partially stems from the kinds of ontologies that each approach encodes. Adopting the view that static genes carry all of the causal information required to make an organism focuses our attention on the presence or absence of genes to explain a trait or a disease. However, there is no easy answer to what physical entity fills that role.

Dupré considers the cystic fibrosis gene to make the case. The disease displays a Mendelian recessive pattern and is associated with the *CFTR* gene, but more than a thousand different defects in the *CFTR* sequence have been identified with the disease phenotype. From a molecular perspective, cystic fibrosis is the result of any one of a large set of variations in the sequence of *CFTR*. There is no exact sequence of base pairs necessary to do the job; rather, a variety of sequences can equally yield a functional protein. This variety is not just a result of alterations in the redundant parts of the sequence; it can also be caused by an alternate splicing of exons or even by an overlapping of sequences from what we initially might define as different genes.

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Aside from sequence and transcription complexities, Dupré refers to external factors and processes that are also implicated in both functional and disease phenotypes. For example, methylation can change a gene, and it can be affected by organism-level behaviors, such as maternal care. The conclusion to Dupré's arguments is that a precondition for insight into the nature of biological systems requires a shift in perspective—from one of viewing the static gene as the only candidate for a cause in a linear, bottom-up model to one of seeing a dynamic "two-way flow of causal influence through a shifting and diverse array of entities" (p. 85). We need both a pluralism of entities and a process ontology.

Microbes are the subject of the third section of the book, the bulk of which is cowritten with Maureen O'Malley. Microorganisms (bacteria, archaea, protists, yeasts, and viruses) are the most populous life forms on the planet, but they have been ignored or marginalized by other disciplines, according to the authors. They suggest a shift from seeing microbes exclusively as unicellular, "primitive" organisms to a focus on the multicellular communities they form, which challenges the long-held assumptions of biological individuality, mechanisms of evolution, and biodiversity. Indeed, Dupré and O'Malley state that life itself should be understood as fundamentally collaborative. This conceptual movement away from an internally directed, discrete organism (i.e., the monogenomic differentiated cell lineage) expands the domain of biology for philosophical reflection in important ways.

The arguments in *Processes of Life* support an expansion of consideration to domains of life that may not have previously been the target of philosophizing about the evolution of eukaryotes such as humans. Developments in metagenomics and in the scientific understanding of microbes, their communities, and the processes by which microbes and macrobes interact within functioning (and malfunctioning) organisms introduce into the philosophy of biology important new examples of the hazards of rigid dichotomies (life versus nonlife) and blind reductionism (genetic determinism versus epigenetics).

In the final section of the book, Dupré tracks the implications of his version of pluralism on our conceptions of ourselves. By investigating evolutionary psychology, racial classifications, and free will, he concludes in his final essay that they have "more to say about what human nature is *not* than what it is" (p. 292). Life consists of not just monogenomic organisms (there are biofilms), evolution is not the result of only selfish competition (there is cooperation), and human nature is not inscribed in our DNA (epigenetics, niche construction, and culture all contribute).

Processes of Life is required reading for biologists and philosophers of biology. It is provocative and original, and the questions that Dupré raises will help shape future reflections on life, its constituents, and its dynamics.

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HOLDING A LEAF UP TO THE LIGHT

The Life of a Leaf. Steven Vogel. University of Chicago Press, 2012. 320 pp., illus. $35.00 (ISBN 9780226859392 cloth).

> Until man duplicates a blade of grass, nature can laugh at his so-called scientific knowledge. (Thomas Edison)

The fascination with plant biology is now spreading rapidly in the general public and in universities. Just as plant-related resources are expanding online, so is a corresponding audience: for example, the upper-level plant physiology class at the University of California, Los Angeles, now attracts more than 400 undergraduates from across the life sciences. Worldwide, there is a growing appreciation of the importance of plant biology to food and ecosystem sustainability under climate change, and with this focus on plants comes a recognition of the power and mystery of leaves, plants' metabolic engines. Leaves evolved multiple times in the history of plant life, and they are a perfect example of sophistication and natural beauty in design. They are the source of food and energy for the biosphere, with an efficiency and capacity for energy conversion that humans dream of duplicating. Leaves are ubiquitous and dazzling in their diversity. The life cycle of a leaf, from flush until fall, presents a microcosm of birth, youth, old age, and death. In *The Life of a Leaf*, author Steven Vogel testifies to all of these points, even as he focuses very specifically on clarifying the design of the leaf using basic concepts in physics.

Vogel finds the leaf to be an ideal subject for his approach to science. Vogel is an emeritus professor at Duke University and the author of several very popular books explaining biological phenomena in terms of physical relationships. He advocates for close examination of an everyday object, such as the leaf, until we can match our thoughts to directly observed forms and processes. He updates this Goethe-like quest for "intuitive reality" by further urging us to unite each observation with physics-based mathematical models. According to Vogel, the leaf is "a 'biological everyman,' an ordinary and ubiquitous living thing that provides the subject of an exploration of our immediate physical world" (p. 2). In the best parts of the book, the author matches thought to form and process to mathematical model perfectly. *The Life of a Leaf* contains the best practical demonstration that I have ever seen of math used as a fluid extension of intuition.

The book focuses on the challenges faced by the "typical" leaf. In successive