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Review of *The Earth's Biosphere: Evolution, Dynamics, and Change* by Vaclav Smil (MIT Press, 2002)

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THE EARTH'S BIOSPHERE: EVOLUTION, DYNAMICS, AND CHANGE.

By Vaclav Smil. Cambridge (Massachusetts): MIT Press. $32.95. ix + 346 p; ill.; scientific name, name, and subject indexes. ISBN: 0-262-19472-4. 2002.

What do the end of the Cold War, NASA, and the molecular biology revolution have in common? Humankind's relentless delving into the molecular basis of life and the burgeoning search for extraterrestrial life are blurring the distinctions among physics, chemistry, and biology. Biological concerns are setting much of the agenda for physics and chemistry, including the search for the origins of life, here and elsewhere in the universe, and the harnessing of life's efficient information storage and transmission capabilities in the service of humankind. Biological concerns also include the effort to save the biosphere and its constituents, a job of enormous proportions given the complexity of the biosphere. If the next generation of biologists is to be capable of maintaining this leadership role in the development of science, we need to teach them differently, beginning with introduc-

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tory courses for first-year university students. That new way of teaching will be interdisciplinary and holistic; in short, it will be based on the intellectual traditions developed most highly in Eastern Europe and the former Soviet Union during the Cold War.

This magnificent book represents an excellent starting point for all biological educators; if I were planning a new introductory biology course, this would be one of two essential textbooks. The author presents an introductory account of the origins, development, and future of the biosphere, based mostly on physicochemical themes. If there is any shortcoming in this account, it is that scientists approaching biology primarily from a physicochemical background have not yet fully internalized the implications of the autonomy and historical nature of biological systems. The origins of life, which Smil refers to as "evolution," may be explained largely, if not wholly, by basic physicochemical processes operating in a defined set of surroundings, but the subsequent evolution of life appears to have been the result of a complex historical mosaic of events involving changes in the living systems themselves and changes in their surroundings. Biological systems, however, produce variation with little regard for the surrounding conditions of life. Most variation has little net influence on the structure and function of the biosphere, comprising what Smil calls the "dynamics" of the biosphere. Some of that variation, however, produces changes in the biosphere, even if the surrounding conditions have not changed. Furthermore, biological information is transmitted by highly conservative replication through time, making biological systems conservative with respect to changes in the surrounding conditions. The autonomous production of variation is the basic stuff of natural selection, while the historically conservative nature of biological information leads to differences among lineages with respect to the ways in which, and the extent to which, those systems adapt to their surroundings. Darwinian evolution embodies this duality, denoted by Darwin as the outcome of changes in "the nature of the organism" and in "the nature of the conditions." These self-generated elements of what Smil calls "change" in the biosphere are not fully integrated into his account, certainly not to the extent that they are in what I consider the second essential introductory textbook for the new biology, *The Origins of Life: From the Birth of Life to the Origin of Language* (J Maynard Smith and E Szathmáry. 1999. Oxford: Oxford University Press).

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