tein pathways) to result in a specific output (break down glycogen). Comparing a cell to a computer, as Dennis Bray does in the book *Wetware: A Computer in Every Living Cell*, yields a fascinating exploration into the complexity of a cell, yet shortchanges the cell and biological systems in general.

The central argument of *Wetware* is that an individual cell contains thousands of enzymes, each performing reiterative, molecular processes. Enzymes act similarly to transistors, in which enzymatic allostery or competitive inhibition alters activity, much like a change in voltage over a transistor. Furthermore, these enzymes, like transistors, can be ordered in pathways, or electronic circuits, to perform logic operations. This design allows cells to sense a variety of environmental stimuli and take action necessary for survival. However, the similarities between the cell and electronics end there. Unlike electronic circuits, there are no wires connecting enzymes in a pathway. Instead, the cell relies on diffusion and compartmentalization in the form of organelles. Additionally, cellular circuitry is noisy due to its analog nature, and the outcome can be difficult to predict, even in the most well-characterized pathways.

Bray acknowledges the difficulties in comparing a cell to electronics. Specifically, his metaphor fails to represent the genetic component of a cell, which is vital and adds to the complexity of cellular function. Cells are not simply the sum of their protein components, or “hardware.” The number and type of enzymes available for molecular processes is the result of gene expression, which is also highly influenced by environmental stimuli and enzymatic pathways. Thus, the molecular circuits, or hardware, of a cell is malleable. Using Bray’s metaphor, this is akin to electronic devices adding and removing transistors depending on the environmental conditions. In this respect, no modern computer can compare to even the most basic of cells. Above all, the genetic material provides all necessary instructions to form another cell, thereby allowing cells to replicate, a unique property of life. Although Bray does touch on the idea of genetic circuits, he only examines them in isolation from all other cellular components.

Throughout the book, Bray expands the idea of a cellular computer by discussing computation in the context of multicellular organisms, the nervous system, and evolution. He often digresses with biological or electrical examples — the idea for first videogame, PacMan, is one — which do not necessarily appear to be connected to the central thread of the chapter. Nevertheless, these winding arguments make an entertaining read for the scientist and non-scientist alike. Bray does an admirable job explaining complex biological phenomena, such as the lac operon in *E. coli* or non-coding RNAs, to non-experts while keeping the attention of people already familiar with these ideas. In this way, *Wetware* is a complex, highly thought-provoking look at how cells are similar to computers. Or, perhaps more correctly, how computers should try to be like living cells.

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**The Art of Ecology, Writings of G. Evelyn Hutchinson.** By David K. Skelly, David M. Post, and Melinda D. Smith, editors. New Haven, Connecticut: Yale University Press; 2010. 356 pp. US $22.00 Paperback. ISBN: 978-0300154498.

G. Evelyn Hutchinson, former Sterling Professor of Zoology at Yale, is often called the “father of modern ecology.” His career spanned much of the 20th century and bore witness to the development of ecology into a rigorous mathematical discipline. *The Art of Ecology* is an eclectic collection of essays, book excerpts, and primary scientific literature by Hutchinson, complete with the original font, figures, and graphs from each excerpt. The selections, which are introduced by historians and scientists, reveal an intellectual breadth unusual in our era of specialization. I came to this book as experimental biologist knowing little of limnol-
ogy or theoretical ecology, but I was fascinated and inspired by this peek into Hutchinson's world.

The editors place Hutchinson's science in its social context through biographical essays by the contributors and generous selections from Hutchinson's autobiography *The Kindly Fruits of the Earth*. Hutchinson's entertaining anecdotes about the curious characters that shaped his intellectual environment at Yale and Cambridge show his deep interest in the history of ideas. This attention to “intellectual phylogeny” also emerges in his scientific writings.

Hutchinson was attracted to limnology because a lake could be considered a microcosm in which biological, chemical, and physical approaches must be integrated to understand the system behavior. In Hutchinson’s words, “many quite disparate things must be done at once.” The theoretical writings that follow show how Hutchinson built on his understanding to transform the field of ecology and create concepts still relevant today. Such deceptively simple questions as “why are there so many kinds of animals?” open the door to deep insights into the ecological niche and why natural biological assemblages deviate from mathematical predictions. This juxtaposition of data and theory allows the reader to follow Hutchinson’s fascinating thought processes.

The basis for the title of the collection becomes explicit in the final section of the book, which features a selection of Hutchinson’s essays that discuss museums and the connection between arts and sciences. As Hutchinson explains in “The Naturalist as Art Critic,” only recently have natural and artistic items been consigned to separate museums, and in many ways the purposes of these museums are the same. Natural collections have both scientific and aesthetic value because they provide the raw materials for generalizations about nature while inviting admiration of natural beauty. Further, natural items frequently perceived as beautiful contain in their structure the theory of their own formation, suggesting a very deep link between aesthetic appreciation and scientific discovery. Such interdisciplinary insights tie together the scientific and humanistic aspects of this volume and make Hutchinson’s writing relevant to a wide audience.

*The Art of Ecology* ultimately feels like the kind of museum collection Hutchinson admired — it is scientifically informative and beautiful in its diversity. The multiple facets of Hutchinson’s life and ideas exemplify what many know but are hesitant to admit: Science is justified. Not by the accumulation or application of knowledge, but rather by the joy derived from understanding aspects of an intriguing universe.

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