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Design by Nature

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O'Brien refers to countless experiments nature has "composed and performed" and implies that through comparative genomics, people will gain a greater understanding of how living organisms evolve and how they are connected. The implications for humanity are emphasized in the opening and closing chapters of the book. The Human Genome Project and human gene therapy are presented to reveal their potential, still in its infancy, for curing disease. It is impossible to read one of the stories and put the book down without wondering how lessons learned from the evolution of other species might be relevant to us. The potential to point the way for a cure to some human diseases, including AIDS, seems inevitable.

Each of the stories in *Tears of the Cheetah* contributes to an understanding of how science works in the real world, at least in part by showing how graduate students, researchers, and technicians work to solve problems. These are familiar stories to O'Brien, who was directly involved in each one. In fact, they are largely a chronology of his career, starting as a self-proclaimed "naïve" fruitfly geneticist and developing into an internationally renowned conservation biologist. O'Brien also touches on the difficulties involved in translating scientific knowledge into political action, portraying international scandal and courtroom intrigue as he systematically introduces familiar concepts reported in the news—polymerase chain reaction, DNA fingerprinting, and microsatellite markers, to name a few. A brief glossary explains the less familiar terminology.

Tears of the Cheetah is an excellent introduction to its subject, accessible to people without a background in genetics. It quickly reveals the potential of molecular biology for understanding mammalian evolution, assisting conservation efforts, aiding forensic science, and curing human disease. *Tears of the Cheetah* is also an enormously inspiring and entertaining read. As I mused on the book, I was struck by the relevance of the stories to many current issues involving conservation, disease, and forensics—issues that are relevant to the lives of undergraduates at the university where I teach, and doubtless at other campuses as well. *Tears of the Cheetah* will provoke discussion among nonmajor students and other readers who are searching for a way to connect science to their lives. It is a unique contribution to the literature and a superb introduction to the vast potential of molecular biology as a tool to help us understand how the natural world works. Finally, it is a reminder of human mortality and of our place among the other mammals that are so much like us.

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Organisms and Artifacts: Design in Nature and Elsewhere. Tim Lewens. MIT Press, Cambridge, MA, 2004. 183 pp., illus. $32.00 (ISBN 0262122618 cloth).

Biologists routinely deploy the language of intentional design in describing and explaining the characteristics of the entities they study. For example: The eyespots on the wings of some moths function to misdirect the pecks of avian predators, increasing the moths' chances of escape. Upon emerging from their long subterreanean sojourn, male 17-year cicadas have just one purpose: to find a mate and pass on their genes, thereby completing the bizarre life cycle that defines their existence. The exquisitely sensitive infrared heat sensors of pit vipers are superbly designed for detecting warm-blooded prey, even in total darkness.

The characteristics of organisms have functions, have purposes, are well or poorly designed, are *for* something. This is in striking contrast to the physical sciences. Physicists are not concerned with explaining the function of electrons; chemists do not struggle to identify the purpose of benzene molecules; geologists do not marvel at how well designed geodes are. Teleological language dropped out of the physical sciences in the 17th century when, for example, talk of the "purpose" of the celestial bodies signaled to the leading natural philosophers of the day a sterile and retrograde understanding of the natural world. By contrast, teleological language has been going strong in biology for the last two and a half millennia. Odd.

A popular philosophical pastime is to try to show that teleological language is not really essential to biology, that all talk of functions, purposes, design, and related concepts can be translated into nonteleological language of the sort that characterizes the physical sciences. Perhaps it can. But biologists continue to use teleological language nonetheless. They continue to think of living things as akin to human artifacts, that is, to objects intentionally created in order to serve some function, to have a purpose, and about which it makes sense to ask whether, or to what extent, they are well designed. None of this would be in the least bit puzzling if it could be assumed that living things reflect in their structure and behavior the will of a designer whose intentions they embody. But most biologists assume nothing of the sort, and when pressed on the issue will patiently explain that all of these teleological terms can be replaced by nonteleological terms through a suitable (albeit tedious) process of translation. Still, the language of "design" persists. How are we to make sense of such intentional language without positing an "intender" doing the intending?

In *Organisms and Artifacts: Design in Nature and Elsewhere,* Tim Lewens tackles this and related questions. Although Lewens is University Lecturer in History and Philosophy of Science at Cambridge University, historical analysis plays no significant role in his treatment. The

book focuses instead on philosophical issues connected with what he calls "the artifact model" in biology: the approach that treats the organic world as though it were designed. Throughout the book it is evident that Lewens's concern is to acknowledge what is right about artifact thinking in biology, to point out its limitations, and to find the *via media* (middle way) between wholesale adoption and wholesale rejection of this approach. Such balance makes Lewens's insightful book rewarding to read but difficult to summarize in a short review.

Begin with the fact that despite its pervasiveness in biology, the artifact model—which includes talk of species facing "problems" that they "solve" using various "strategies"—is also controversial. For example, Richard Lewontin has argued that the very concept of an adaptive problem, upon which so much of the artifact model (and adaptationism more generally) is built, is bankrupt because in fixed environments, species do not encounter preexisting adaptive problems that they then solve. Rather, organisms actively construct their environments according to their needs. Lewens concedes that organisms frequently manipulate, rather than merely conform to, their environments, yet notes that organisms do face specific selective pressures; evolving in response to them is a way in which species solve adaptive problems. Thus a concept of an environmental problem can be constructed that preserves the problem-solving element of the artifact model.

This does not, however, mean that the artifact model is in the clear. Lewens points out a number of additional shortcomings, among them that the model tends to lead its devotees to ignore drift, it exaggerates the independence of organismic traits while encouraging biologists to ignore developmental relations between traits, and it overlooks the fact that selection is—necessarily—a population-level process rather than a force that acts on individual entities. But these are merely qualifications, not vanquishers, of the artifact model. His conclusion, restated throughout the book, is that artifact thinking in biology is often useful but "needs to proceed with caution."

This much will, I suspect, seem familar to most biologists. On the other hand, the heart of the book is an in-depth analysis of "function talk" in biology, which is likely to test the resolve of even the most interested reader. Puzzles about the meaning and proper ascription of functions have generated a large technical literature in the philosophy of biology, along with a number of competing accounts of how functions are to be understood. Lewens carefully sorts through these accounts, pointing out the strengths and weaknesses of each, finally noting somewhat anticlimatically that the results of their applications to real-world examples rarely diverge. Still, readers stand to learn something worthwhile along the way from Lewens's penetrating discussions of fundamental issues in evolutionary biology, including the sense in which selection explains (and fails to explain) adaptations, the differing meanings of *adaptationism,* the promise and pitfalls

of evolutionary reverse engineering, and the role of development in evolution.

Readers expecting a wide-ranging discussion of "design in nature and elsewhere," however, of the sort one might get from a work in popular science, are likely to be disappointed. The book is not so much about design in nature in some inclusive sense as it is about design talk in biology. Moreover, the discussion of design elsewhere is for the most part confined to the last chapter, which addresses similarities and differences between biological evolution and technological change. There Lewens applies the results of the previous chapters to the question of technological change and to the claims of "intelligent design creationism," showing first that enthusiasts for evolutionary models of technological change need to be cautious in using concepts from biological evolution to explain the intentional creation of artifacts and, second, that, viewed in light of the foregoing discussions, the central claims of intelligent design creationism are quite simply eviscerated. This important take-home message is perhaps the chief value of the book for the general reader. While creationists are busy trying to convince anyone who will listen that we live in a world of nature by design, Lewens shows how biologists (and philosophers) are engaged in the much more interesting enterprise of describing, explaining, pondering, and debating the myriad forms of design by nature. What could be more inspiring than that?

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