concerns" (236). In this sobering analysis, the authors successfully integrate a number of perspectives to demonstrate that even potential solutions to the challenges posed by infectious disease, such as implementation of more stringent health regulations, are not themselves without complications.

While Price-Smith and the contributors to *Plagues and Politics* focus on different aspects of the political economy and ecology of infectious disease, there are some points of consensus, particularly in the realm of policy suggestions for constraining the further expansion of ERIDs. Themes that are echoed throughout the texts include the need for improved surveillance and monitoring of infectious disease patterns, increased funding to improve research efforts and the public health infrastructure, and improved efforts to curb the over-prescription of antibiotics.

These two books increase our awareness of the effects that the interaction of global environmental and socioeconomic change have on the prevalence of disease, and of the consequences of infectious disease for the welfare of people and the capabilities of states. The next step is to identify and assess courses of action to deal with these disease threats, and to muster up the courage to implement policies to reduce the burden of disease. In the meantime, *The Health of Nations* and *Plagues and Politics* serve as engaging, innovative, and informative introductions to these problems.

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Making Sense of Life: Explaining Biological Development with Models, Metaphors, and Machines.
By Evelyn Fox Keller. Cambridge, MA: Harvard University Press, 2002. Pp. xii + 388. $29.95.

Silly Putty® without the word *silly* was just mundane putty until 1949, when an unemployed ad man named Peter Hodgson added bright colors to the substance and packaged it in plastic eggs. Silly Putty® became one of the most successful novelty toys of the 20th century, grossing hundreds of millions of

dollars in sales and achieving name recognition in more than 95% of American households. Evocative metaphors in science are quite like Silly Putty®: colorful, alluring, simply packaged, widely recognized, enduring, and highly moldable. However, they also have a more serious side.

As models, scientific metaphors can be visual, conceptual, linguistic, digital, mechanical, or mathematical interpretations that encapsulate complex phenomena in oft-brilliant images intended to evoke an enhanced sense of cognition or understanding by the finite human mind. But what constitutes understanding? What counts as knowledge? As explanation? As progress in science? What are the ways of knowing? What do scientists want, and how well do metaphors, models, and machines help to meet those desires? Indeed, what is reality as compared to facsimile, analogy, correspondence, or similitude, and to what extent do the lines blur as metaphorical models improve? Such are the provocative intellectual and epistemological topics that Evelyn Fox Keller eloquently addresses in this insightful book.

The theatrical stage for Keller's treatment is the historical study of animal embryogenesis. Trained as a theoretical physicist, Keller had been indoctrinated in the notion that mathematics and logic provide determining arguments, and that experiential evidence, by contrast, is fallible. Later in life, when she moved into molecular biology, she was aghast to discover that most developmental biologists view experiments and observations as far surer paths to truth. Several sources underlie the differing outlooks in these fields, but an early revelation for Keller was that many biologists interpret the supposed benefactions of mathematical models—their economy of explanation, focus on idealized settings, simplifying assumptions, and pursuit of the theoretically imaginable—as weaknesses rather than strengths. Whereas physicists had canonized these attributes as cardinal virtues, developmental biologists often interpreted mathematical descriptions as pointless window-dressing—perhaps elegant in construct, but ultimately sterile for yielding genuine insights into the nature of complex living beings.

Making Sense of Life is an effort to understand what qualifies as scientific knowledge, using the field of embryogenesis as the touchstone. Divided into three parts, the book traces major empirical and conceptual episodes in the history of developmental biology during the 20th century, and explores the changing landscape of what has and what has not counted as scientific enlightenment in that discipline.

Part 1 summarizes the non-genetic orientation of the first several decades by comparing three scientists' extended metaphors of cellular operations and organismal development. Stéphane Leduc's physical models entailed manipulations of inorganic chemicals (e.g., potassium nitrate on glass slides) and material processes (e.g., osmosis and diffusion) to mirror, as artificial fabrications, biological phenomena such as cell division or the emergence of lifelike morphological structures. D'Arcy Thompson's graphical models and Alan Turing's

mathematical representations likewise were developed with the broad intent of illuminating developmental processes. Each of these scientists believed his approach to be of great significance in interpreting the ontogeny of form in the real biological world. Indeed, some of the representations were so mimetic of living operations as to be deemed essentially equatable with them. Keller closely examines these metaphorical constructs in the context of their own times and from the perspective of today. She critically asks, for example, why history made an icon of Thompson and an embarrassment of Leduc, when both developed provocative new ways of looking at the problem of individual development.

Part 2 turns to more familiar models of development that emerged from molecular biology and genetics during the latter half of the century. Terms like *gene action*, *genetic program*, *positional information*, *genetic code*, *DNA blueprint*, *developmental switches*, *gene batteries*, *networks*, *steering mechanisms*, *metabolic feedback*, *pattern formation*, and others are lexical devices that paint metaphorical concepts of cellular workings and ontogeny. Keller asks "What's in a name?" and answers that a serviceable language metaphor summarizes existing ideas in simple recognizable terms, stimulates further scientific inquiry, and even becomes, in a deeper sense, our actual understanding of reality.

Keller also notes that some of the best metaphoric constructs are little more than surrogates for ignorance, giving an illusion of truth yet remaining necessarily ambiguous in the lack of actual understanding. Being initially amorphous, like putty, they can change shapes (meanings) with time to accommodate new scientific discoveries. Indeed, the most successful metaphors become immortalized by death, incorporated so fully into conventional wisdom as to avoid the radar of consciousness. Camouflaged by their own banality, we no longer notice such metaphors for what they are, and think them the actual truth.

Part 3 discusses turn-of the-century developments in recombinant DNA and computing technologies that bear on the notion of what counts as useful explanation in developmental biology. One of Keller's themes is that the manipulative capabilities of physical genetic engineering and the new powers of computer modeling have some epistemological parallels with last-century approaches in developmental biology and theoretical physics. The new initiatives, Keller suggests, some day may even facilitate a greater rapport between these two seemingly different kinds of scientific culture.

In the end, however, Keller concludes that the human mind, being itself a part of the natural world and having evolved for reasons largely unrelated to making scientific sense of things, may never be able to grasp in rational terms all that we encounter. This will be especially true, she argues, when real phenomena are as complex as embryonic development would seem to be. She endorses instead an "explanatory pluralism" that not only accepts differences in epistemological cultures but is itself a virtue, representing our best chance to come to grips with the natural world. Keller contends that "A description of a phenomenon counts as an explanation . . . if and only if it meets the needs

of an individual or community" (5), and that "The question of what qualifies as a scientific explanation may not be answerable in absolute terms, but perhaps . . . in terms of the particular human needs that are, after all, the *raison d'être* of the entire pursuit" (302).

Personally, I don't fully share these relativistic notions about science, nor their rather gloomy postmodernistic ramifications about the limits to genuine understanding in biology. Nonetheless, Keller's work is intelligent and I recommend it highly. The book provides an informative history of developmental biology, and an even more penetrating look at the epistemology of science. Not least, the book should serve as a powerful antidote to any egoistic scientist or self-congratulatory biological discipline that takes its metaphors too seriously. Life is, after all, nothing more nor less than evolution's silly putty.

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Possessing Genius: The Bizarre Odyssey of Einstein's Brain.
By Carolyn Abraham. New York: St. Martin's Press, 2002.
Pp. xi + 388. $24.95.

Sometime in the mid-1970s, what at the time seemed like two noteworthy specimens arrived on the surgical pathology bench during the same week, a week I had been assigned to put up such specimens as part of my pathology residency. In those days, the professional hockey team in the town where I was training was fresh off of a Stanley Cup Championship, so there was more than the usual interest in the two sets of "bone chips" that came to me. Indeed, these "joint mice" had been removed from the elbows of two star hockey players on that team. The thought occurred to a resident making around $15,000 per year that bone chips from two local sports heroes might fetch a handsome price as relics—but I can comfortably report that I suppressed that brief entrepreneurial flash and handled the specimens just like any of the others that had to be processed that week. But I do wonder what those specimens were worth then in a post–Stanley Cup market . . . or what comparable relics would be worth now when the same hockey team makes headlines only for firing its coach each year. Value is relative.

It is, quite aptly, onto a panorama of cultural relativism that Carolyn Abraham crafts her account of the journey taken by an even more notable anatomic relic, the brain of a 20th-century icon, Albert Einstein. Although it may be the literal movement of the famous physicist's organ through the time and space of contemporary America that occupies Abraham's absorbing nar-