should a physicist rethink "his" commitment to quarks just because a philosopher alleges that the small scientific elite responsible for their discovery systematically overlooked other explanations as a result of its social standing? (Though recent social studies of science *do* claim to have located cultural processes, rather than unmediated natural ones, at the heart of what the "hard" sciences study; see for example Sharon Traweek, *Beamtimes and Lifetimes* [Harvard University Press, 1988] and Karin Knorr-Cetina and Michael Mulkay, Eds., *Science Observed* [Sage, 1983].) Though Harding provides a logical argument against distinctions between applied and pure, natural and social, and "softer" and "harder" sciences as themselves hierarchical social constructions, only those of us already committed to this position are likely to take her word for it. A deeper engagement with these tough cases would have made the book more useful to audiences beyond those already well read in feminist epistemology.

Still, what is most compelling about *Whose Science? Whose Knowledge?* is its belief in the power of democratizing scientific personnel, subjects, and objects. In the late 20th century, "we" are all inside science: women, racial and sexual minorities, inhabitants of the most underprivileged (as well as what Harding labels the "overprivileged") parts of the globe. People whose standpoints develop out of these diverse experiences must be recruited into setting and carrying out scientific agendas not only for reasons of justice, but for what they can contribute to scientific practice. That's a large and utopian agenda whose fulfillment should benefit everyone.

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An Enthusiasm in Cosmology

Quantum Cosmology and Baby Universes. S. COLEMAN, J. B. HARTLE, T. PIRAN, and S. WEINBERG, Eds. World Scientific, River Edge, NJ, 1991. xiv, 353 pp., illus. $54; paper, $32. Jerusalem Winter School for Theoretical Physics, vol. 7 (Dec. 1989).

Quantum cosmology (quantum mechanics applied to the entire universe, and in particular to its space-time structure) essentially began with a small number of foundational papers by Bryce DeWitt, Charles Misner, and John Wheeler in the 1960s. However, the subject did not really explode until the early 1980s, when James Hartle, Stephen Hawking, Andrei Linde, and Alexander Vilenkin made proposals regarding the quantum state of the universe, thereby fundamentally going beyond the dynamical laws that are the focus of those seeking a "theory of everything." The subject was further inflamed by Sidney Coleman's 1988 proposal of a mechanism by which baby universes (other regions of space-time connected to our large region only by tiny wormholes) might force the cosmological constant to zero, thereby explaining why we don't see empty space gravitate or antigravitate. A blaze of activity resulted, which culminated in a Jerusalem Winter School for Theoretical Physics held over New Year's 1990. The present book is the archival record.

The Jerusalem Winter School occurred when the flames of enthusiasm for baby universes were dwindling as the fuel of basic information known in quantum gravity and applicable to baby universes became largely depleted. Even at the school, one of the invited lecturers, Leonard Susskind, remarked that the subject was dying. He only bothered to write up a seven-page summary of his lectures.

The man most responsible for the blaze, Sidney Coleman, codirector of the school, notes in the preface to this book that "the more responsible lecturers submitted lecture notes to be published." A quick check reveals that every lecturer contributed at least some notes, except Coleman himself. Coleman and Susskind's responses seem to indicate that they had little new to write on the subject or that they had turned their attention to other areas where it is less difficult to avoid sinking into "a trackless swamp," in Coleman's earlier characterization of the subject.

The problem is not that baby-universe theory has been shown to be wrong but rather that quantum gravity is simply not understood well enough to be applied to baby universes or wormholes with any confidence. Not only are there formidable technical issues (on which some important progress has been made in superstring theory), also there are obstinate conceptual problems (which are largely still unresolved even in superstring theory). Stephen Hawking and Andrew Strominger present stimulating lecture notes on certain approaches to these problems, but their basic assumptions are certainly not beyond controversy.

Perhaps for these reasons it is well to step back from baby universes and look at the foundations of quantum gravity and quantum cosmology. This is what the lectures of Claudio Teitelboim, James Hartle, and Jonathan Halliwell do, taking up over two-thirds of the book. After giving beautiful review lectures of Hamiltonian gravity, Teitelboim focuses his notes on BRST theory and generally covariant systems, which are not so well known as the rest of his subject. Hartle goes most deeply into the fundamental conceptual issues and proposes a generalized quantum mechanics for cosmology. Halliwell gives introductory lectures on quantum cosmology, proposals regarding the quantum state of the universe,

Vignettes: Ontogenetic Viewpoints

Developmental biology is a strange science because it denies the hegemony of the adult . . . . To a developmental biologist, the expression, "Mayflies live but for a day," is completely fallacious . . . . the embryonic and larval states of this organism last the remaining 364.

—*Scott F. Gilbert*, in *Organism and the Origins of Self*
(Alfred I. Tauber, Ed.; Kluwer Academic Publishers)

About twenty years ago a French embryologist named Raynaud took fertile eggs out of a reticulated python at various intervals and examined them closely. He was interested in that most snakey of qualities, limblessness. One of the things he discovered was that his unborn pythons weren't naked below the waist throughout their development. At one point tiny mounds of tissue known as limb buds appeared on either side of their cloacal regions, much like the ones that in most higher vertebrates eventually become legs. But his snakes were not freaks; almost immediately the epithelial cells covering these buds began to die. It was as if a message had been received: *Upon thy belly thou shalt go.*

—*Thomas Palmer*, in *Landscape with Reptile: Rattlesnakes in an Urban World*
(Ticknor and Fields)

and the implications of certain toy models for basic properties of our observed world. These subjects did not blaze up so much as baby universes did, but neither have they dwindled so much. Like baby universes, quantum cosmology rests on highly uncertain foundations, but it is somewhat simpler to apply to our world and get quasi-explanations for certain observed features that otherwise seem quite mysterious.

For a good introduction to some of these topics, as well as a glimpse of how the subject appeared just past the peak of interest in baby universes, this conference proceedings is to be recommended.

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Biological Restoration

A History of Regeneration Research. Milestones in the Evolution of a Science. CHARLES E. DINSMORE, Ed. Cambridge University Press, New York, 1992. x, 228 pp., illus. $54.95. Based on a symposium, San Francisco, Dec. 1988.

With the recent specialization and reduction of much biological science to the cellular and molecular level, it becomes important that the studies and insights of the past that have inspired the foundation of this research be recorded and reviewed. This collection of essays dedicated to embryologist Oscar Emile Schotté presents a selected tour through the origins and milestones of regeneration research. Although the editor acknowledges that his own interests have "influenced" the contents of this collection of essays and that it does not attempt to be conclusive, it does present a rich blending of both the history and the science of this old and new field.

Regeneration research led the way for the field of experimental biology, and this book attempts to provide a perspective from which to appreciate that pioneering work. It is a humbling work to read, in that it appears that remarkably little has been accomplished toward our understanding of what T. H. Morgan called "vital factors" of regeneration since the experiments and insights of Réaumur, Trembley, Bonnet, and Spallanzani in the 18th century. For example, Dorothy Skinner and John S. Cook illustrate that the principles underlying our current understanding of crustacean limb regeneration were well reflected in the careful observations of René-Antoine Réaumur, in whose words "Nature gives back to the animal precisely and only that which it has lost, and she gives back to it all it has lost." Similarly, Abraham Trembley's precise and systematic experiments on Hydra regeneration, as reviewed by Howard and Sylvia Lenhoff, still serve not only as our basis for understanding this phenomenon but as a standard "to all researchers in the natural sciences as the best paradigm of method, out of which they must learn the still too little known art of how to investigate the truths of nature." The essay on Trembley as well as others in this collection is enriched by material from the notes and correspondence of the scientists themselves. Trembley's serendipitous discovery that Hydra regenerate is brought to life through his words, "It is to such a happy chance that I owe this discovery which I made, not only without forethought, but without my ever having in my entire life any idea slightly related to it."

Two other themes recurring in these chapters are the role of regeneration research in the establishment of experimental biology and in the debate surrounding preformation and epigenesis. This controversy comes to life through Dinsmore's presentation of correspondence between Spallanzani, Bonnet, and others, which reflects ideas of that period concerning preformationism, emboîtement, and the "infinity of germs" that were presumed by many to exist within regenerative tissues. This background provides an antidote to what Frederick Churchill refers to as "Gipfelsammler's myopia," a syndrome that "afflicts historians of science, philosophy and art and other areas of high culture," resulting in "a single-minded attention to dramatic mountain peaks accompanied by total neglect of the surrounding hills and valleys."

There are several chapters that do indeed reflect the interests of the editor in amphibian limb regeneration. The history of studies of the role of innervation, bioelectricity, and the origin of the blastemal cells in regenerating amphibian limbs in particular is well reviewed by Marcus Singer and Jacqueline Géraudie, by Joseph Vanable, and by Richard Liversage, respectively.

Oscar Schotté was known to say (jokingly) that he would give his right arm to discover the "secret" of mammalian limb regeneration. With the advent of molecular biology and its new arsenal of probes to "key" proteins associated with pattern, differentiation, and cell-cell interactions it should now be possible to discover the secrets governing regeneration. Trembley commented, "It is even good to repeat successful experiments a number of times. All that it is possible to see is not discovered, and often cannot be discovered, the first time." It is safe to say that we are still repeating these "successful experiments." It seems fitting that the regenerating systems that first inspired experimentation in biology may, coming full circle, be those through which the molecular cues and cellular interactions now being characterized may be understood.

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