approaching a black hole would rapidly vanish and would not, as Rees states, appear to be frozen at a horizon. And using "cycles/cm" as units for frequency is unusual in a book for laics. But such examples are rare and minor. And in almost all cases, Rees's explanations are exactly right—as in his emphasis that the expansion of the universe is due to the creation of space, not due to a primeval explosion.

So would Rutherford show Rees out the door of his laboratory? Perhaps, but I suspect that he would be astonished to see that much of what he had regarded as arrant, unproductive speculation has now been proved. He might also wonder whether some of the current speculations, which form part of the fascination of *Our Cosmic Habitat*, will share that same fate.

BOOKS: BIOMECHANICS

Marvelous Machines Made of Meat

Sharon Swartz

Few scholars have had so profound an impact on a contemporary biological discipline as Steven Vogel has had on biomechanics, particularly that of the basic, organismal variety rather than the applied, biomedical one. Most of my "biomechanician" colleagues have at one time or another worked with or been taught by Vogel, one of his students, or a student of one of his students. I suspect that all of the remaining few have read or, more accurately, studied his work. Happily for us academic practitioners, his influence has spread beyond the narrow confines of university departments through his writings for scientifically curious general audiences. Who could ask for a better ambassador than Vogel? Few among us can explain the often slightly mysterious physical phenomena so central to the biological world with such clarity and exuberance, and fewer yet leave us chuckling as we go.

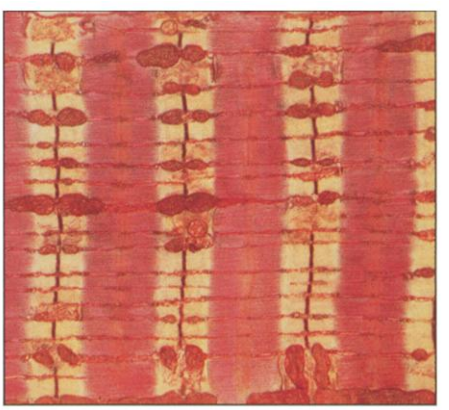
Prime Mover
A Natural History of Muscle
by Steven Vogel
Norton, New York, 2002. 384 pp. $25.95, C$37.99, £19.95. ISBN 0-393-02126-2.

Prime Mover: A Natural History of Muscle is Vogel's newest compendium of biological phenomena packaged for both the diversity of biologists and the far greater diversity of other thoughtful people with at least passing interest in the natural world. Vogel offers to "take a piece of our biological nature, the 'flesh' of our 'flesh and blood' and explore how it works and how we work with it." In the course of this exploration, he manages to educate, enlighten, and entertain. The book begins with a whirlwind tour of muscle mechanics and physiology at a variety of levels—molecular, cellular, organ, and organismal. We are treated to splendidly lucid explanations and discussions of a wide range of topics relevant to understanding muscle. Vogel covers efficiency, thermodynamics, solid mechanics of the materials of muscle and the tissues attached to it (bone, tendon), contractile mechanics, and much more. His signature flair and wit run throughout the text: "No muscle can make ends meet"; "negative work is more negatively efficient than positive work is positively efficient"; "ecology orders, physiology delivers."

But *Prime Mover* is far more than an account of muscle physiology. Vogel argues that human history, culture, and technology can be interpreted from a perspective anchored in the biology of this one peculiar tissue, making his more general point that "biology, physiology, biomechanics...matter in context far beyond their immediate scientific domains." He reminds us that until a few decades ago the work of the world was done by muscle, the engine of zoology for roughly a billion years. Next, he illustrates the remarkable diversity of muscle function in creatures as diverse as flies, clams, and whales, in organs from tongues to timbals. Then we go much farther afield, into the worlds of the history and design of hand tools, the origin and development of human exploitation of animal muscle power, muscle-powered weaponry, and even (to the delight of those among us who would rather cook than fight) muscle as meat. Before *Prime Mover* concludes, we have been treated to explanations of the muscular basis of cursive handwriting, why people of different body sizes should use tools of different sizes, and a bioengineering view of why men rather than women should be the default openers of doors. Along the way, Vogel seamlessly draws history, industrial engineering, and fine art into his discussions. And, in case we are inclined to follow a path to which we've been newly introduced, he points us toward an astonishing variety of references, both printed and electronic.

The book also manages to vividly portray the scientists who have helped unravel the puzzles of muscle biology. We are given a veritable phylogeny of physiologists as Vogel traces the scientific and personal relationships among investigators as well as their classic experimental work. We meet the key architects of our modern understanding of muscle not only as names associated with achievements and awards, but as real people who learned from the natural world and from each other. This, surely, is the paradigm of scientific conduct we should communicate to our students and to the general public. It is also fascinating reading.

My gripes are few and small. This and Vogel's other works clearly demonstrate that he understands and interprets the world through the lenses of language and mathematics. Accordingly, here, as in his earlier books, the quality of the illustrations simply does not match his prose, and some figures are more confusing than enlightening. In places, Vogel explains biological processes by reference to background that he assumes to be much more familiar, such as the workings of automobile engines or phonographic cartridges. This approach is sometimes difficult for those who cartoonist Gary Larsen once designated "the mechanically disinclined." In fairness, however, Vogel's writing offers abundant opportunity for physics and engineering insight to even the least mechanically minded reader. I also miss one of Vogel's distinctive scholarly niceties; the reference sections of some of his earlier books include indications of the pages where particular works are cited in the text, which permit readers browsing the references to re-enter the relevant discussions.



Striated skeletal muscle.

CREDIT: QUEST/PHOTO RESEARCH

Many of us who teach undergraduates perpetually seek ways to go beyond imparting specific scientific knowledge; we believe that scientific inquiry shapes our understanding of our complex present-day world, helps guide our interpretations of human history, and inspires our visions of the future. Vogel's latest success informs and delights, and in the process, exemplifies this approach. He tells us, "Writing the predecessor of this book hooked me on the seductive pleasure of moving out of my scientific box." *Prime Mover* demonstrates how very lucky we are that he has been so seduced.

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