

result is a highly readable, scholarly narrative, supported by an extensive bibliography and detailed explanatory notes that occupy about a third of the book.

A significant portion of the book is devoted to the considerable literature on hormones and their effects on brain and behavioral development. This technical material has been well researched and is presented so as to give nonspecialists a good sense of the current state of the field. Some of the findings cast such a surprising new light on biological sex differences that old formulations of the social-biological dichotomy may disappear into the shadows. We are led to wonder, for example, whether brain differences that arise from social stimulation are biological or social in nature. The chapter on sex hormones makes it clear that testosterone and estrogen are found in both sexes and have many functions that have nothing to do with sex. This observation at the level of cells and molecules brings us back to the central questions of this provocative book: Can the body be sexed? Should it?—*Celia L. Moore, Psychology, University of Massachusetts, Boston*

MATHEMATICS

A Mind for Math

The Math Gene: How Mathematical Thinking Evolved and Why Numbers Are Like Gossip. Keith Devlin. xvii + 328. Basic Books/Perseus, 2000. \$25.

Why is mathematics like a soap opera? Answer: Both deal with imaginary relationships. Armed with this dubious insight, and fortified by the rapidly growing literature on evolution of the mind, mathematician Keith Devlin proposes here an answer to one of the most difficult questions of human biology: How did our ancestors acquire a mind for mathematics?

Every month or so a new book appears seeking to explain some human characteristic in terms of the selective advantage it supposedly provided our distant ancestors. Although the benefits for genetic survival of some behaviors are reasonably clear, others—such as altruism—seem puzzling.

One of the more mysterious is mathematics. What possible genetic advantage

might be conveyed to a hunter-gatherer who was prone to daydream about abstract ideas? Most likely, any budding prehistoric mathematician would have met a fate similar to that of Archimedes, who it is said was killed by a Roman centurion because, being preoccupied with a mathematical problem, he failed to take appropriate notice of the soldier.

According to *The Math Gene*, an important clue to resolving this puzzle can be found in that bad joke about mathematics, soap operas and imaginary relationships. People clearly have

an extraordinary interest in human relationships. Indeed, most of the world's literature and a great deal of media attention are devoted to this subject: History and the news report on real relationships, and fiction and soap operas portray imaginary ones. Thinking about relationships—what Devlin calls "gossip"—is one of the most common preoccupations of the human mind.

In this clear and engaging analysis, Devlin sets forth a thesis quite contrary to common experience: that reasoning about relationships between

Science and Art

PERMISSIBLE DOSE

A History of Radiation Protection in the Twentieth Century

J. Samuel Walker

"This concise and readable guide to the historical development of radiation protection standards by the federal government is exceptionally even-handed in discussing often controversial issues."

—Barton C. Hacker, author of *Elements of Controversy*

\$35.00 cloth

COLOR AND MEANING

Art, Science, and Symbolism

John Gage

New in Paperback—"Gage's *Color and Meaning* is full of ideas.... He is one of the best writers on art now alive."

—A. S. Byatt, Booker Prize winner

"Everything Gage writes is essential reading for the serious student of color in art."—*Nature*

\$35.00 paper

WHAT IS LIFE?

Lynn Margulis and Dorion Sagan

Foreword by Niles Eldredge

New in Paperback—"A masterpiece of science writing.... You will cherish *What Is Life?* because it is so rich in poetry and science, in the service of profound philosophical questions."

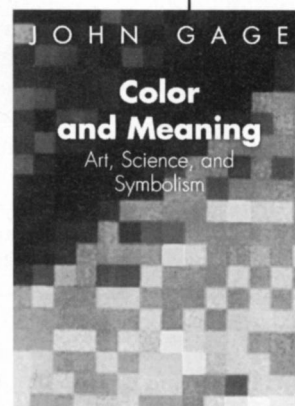
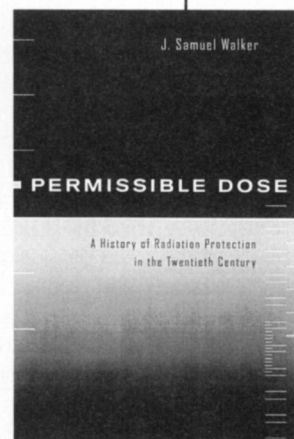
—Mitchell Thomashow, *Orion*

\$24.95 paper

At bookstores or order (800) 822-6657

University of California Press www.ucpress.edu

Circle 60 on Reader Service Card



mathematical objects is no different from reasoning about human relationships between people, and that this similarity in reasoning explains the origin of mathematics.

Devlin's argument develops along several parallel tracks. One concerns the nature of mathematics as an enterprise very different from arithmetic. Mathematics requires nuanced understanding of relations among abstract patterns. Complex mathematical structures are built, like nested Russian dolls, by encapsulating into new patterns specific relationships among simpler patterns.

Another line of reasoning concerns the nature of language. Devlin argues that the syntactic structure of all human languages can be represented with tree diagrams built from a single simple pattern—a Lego block of language—that he calls the “fundamental language tree.” The many different grammars in the world all use the same phrase structure built by repeated nesting of this simple pattern.

A third source of evidence is the fossil record of hominoid evolution, which shows significant growth in brain size for several million years without a corresponding increase in the use of either language or tools. Then suddenly (in evolutionary time), the distinctively human traits of language, symbols and tools appeared.

Devlin argues that our ancestors' increase in brain size was driven not by acquisition of language (as most standard theories assert) but by the selective advantage conferred by a richer understanding of relationships among objects in the physical environment and in an increasingly complex social world. Once the brain reached sufficient size and complexity, it rather quickly developed the capacity for what Devlin calls “off-line” or “what-if” thinking—the capacity to reason hypothetically about relationships and abstractions that undergirds both language and mathematics.

Thus, according to this argument, when the human brain acquired the ability to use language, it automatically acquired the ability to do mathematics. It follows, contrary to popular wisdom, that everyone has a metaphorical “math gene.” It is not genetics but interest that makes the difference between those who are hooked on mathematics and those who prefer soap operas.—Lynn Arthur Steen, *Mathematics*, St. Olaf College, Northfield, Minnesota

PALEONTOLOGY

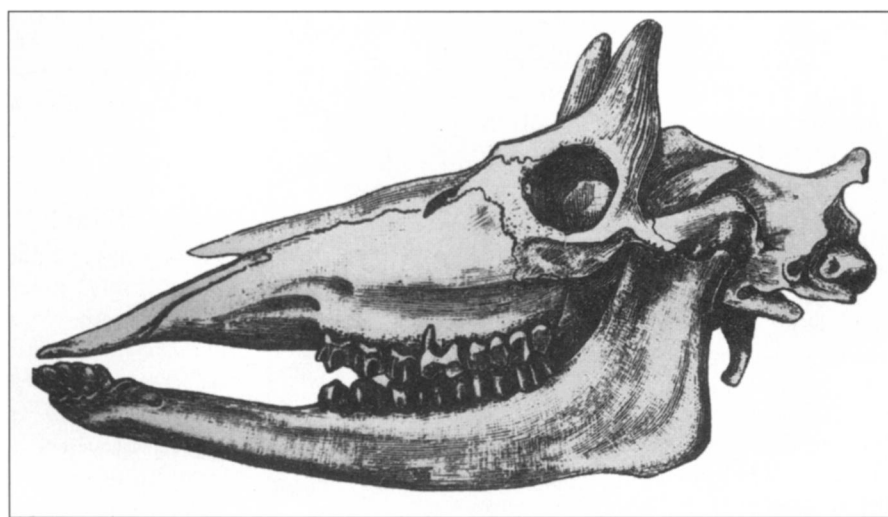
Explaining Giant Bones

The First Fossil Hunters: Paleontology in Greek and Roman Times. Adrienne Mayor. xx + 361 pp. Princeton University Press, 2000. \$35.00.

Most paleontologists vividly recall their reaction to their first fossil discovery: the feel, the texture of the bone or shell, the color, the weight—all wrapped in the realization that this may be the first time this object has been recognized for what it is, the remains of something long extinct. For curious minds today, the answers to questions about a fossil's age or its ap-

pearance in life are only a teacher or computer link away. But how did people address these questions thousands of years ago? People who unearthed odd bones and stones often relied on religious and cultural stories to explain what they had uncovered. How much did they understand about what are now called fossils? This is the question that Adrienne Mayor seeks to answer in *The First Fossil Hunters: Paleontology in Greek and Roman Times*.

Mayor examines surviving stories and myths of the early Mediterranean cultures and the work of contemporaneous historians for clues. For example, Pausanias, a 2nd-century historian, documented the discovery of a large skeleton 11 cubits (about 5 meters) in length that was found in a dry Syrian riverbed. The oracle of Apollo at Claros confirmed



On the late Corinthian (560–540 B.C.) vase shown above, Heracles and Hesione face the Monster of Troy, which is depicted as a skull on an outcrop. Note the similarities between the monster and the fossil skull of a giant Miocene giraffe of Samos shown underneath. From *The First Fossil Hunters*.