

precipitated the collapse of Simón Bolívar's republic by his own reckoning. This ultimately led to Bolívar freeing Colombia, Ecuador, Peru and Bolivia from Spanish rule.

In Japan, the Great Kanto earthquake of 1923, which reduced two-thirds of Tokyo to ashes, spawned political and racial turmoil that contributed to the rise of militarism and, ultimately, to the Pacific war. If the Tokyo area experiences another such earthquake in decades ahead as seismologists expect, its repercussions will surely make the global financial system tremble. Were it to strike at a time of economic depression, its effects might be globally catastrophic.

*Apocalypse* focuses mostly on the ancient world, with a distinct emphasis on biblical archaeology. It discusses earthquake evidence from the Middle East, including Jericho, Megiddo (Armageddon), Jerusalem and Qumran, the location of the 2,000-year-old Dead Sea Scrolls.

In the caves at Qumran, Nur has considerable field experience, which he deploys to illuminating effect. He was part of an expedition from Jerusalem's Hebrew University that excavated the rubble in the Cave of Letters, in the hope of finding a previously glimpsed skeleton and other evidence of habitation buried by the collapse of the roof in an ancient earthquake. Nur is convinced — a little like Howard Carter in the Valley of the Kings — that there remain sealed caves that were not looted by the Bedouin who first reported the scrolls' existence in 1947. "These places, undisturbed since their destruction by earthquakes, may provide the means to unravel the complicated and emotionally charged story of the Dead Sea Scrolls."

*Apocalypse* is a winning combination of cautious interdisciplinary investigation and interpretation, writing suitable for a general readership, and excellent illustrations (including a striking photograph of Nur's own crushed office chair). Although it will deliberately irritate many archaeologists, it should also provoke a serious reconsideration of the archaeological record. As with the evidence for human activity in climate change, the evidence for earthquakes in pre-historical change may be staring archaeologists in the face. ■

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## Brave new bioethics

**Life As It Is: Biology for the Public Sphere**  
by William F. Loomis

University of California Press: 2008.  
272 pp. \$24.95

**Eugenie Scott**

Science's task is to explain the natural world: what it is, how it works and why it is the way it is. Ethics is about the oughts and the shoulds. Most ethicists — religious and secular — agree that knowledge of the natural world helps us make better, or at least better-informed, ethical decisions. But, as David Hume, Thomas Henry Huxley and G. E. Moore have noted, a particular understanding of nature does not dictate a unique moral stance. For every Alexander Pope declaring "Whatever is, is right," there is a Rose Sayer (from the film *The African Queen*) retorting, "Nature ... is what we are put in this world to rise above!"

It is the complicated interplay of moral decisions and biological sciences that motivates cell biologist William F. Loomis. His brief book, *Life As It Is*, is a tour of the brave new biology relevant to such social issues as abortion, euthanasia, the use of embryonic stem cells, cloning, overpopulation and global warming. Loomis holds that scientific evidence should be taken into account when making socially important decisions. He provides a fascinating, if occasionally disjointed, survey of topics that bear on these decisions: the nature and evolution of life, and current scientific thought regarding consciousness, psychology and social behaviour.

Sometimes it is questionable whether the scientific aspects of a situation are most relevant to the ethical decision. Is it ethically permissible to destroy the surplus human embryos created for *in vitro* fertilization (IVF), for example? Loomis believes the answer should be shaped by a better understanding of the nature of cells.

Loomis emphasizes that at the cellular level life is cheap: at any given moment, billions of bacteria in our body are dying. A human zygote is merely a single cell, so shouldn't we think of it as such rather than the multicellular, functioning, conscious and precious baby into which it might develop? If a zygote is just a cell, and cells die regularly,

then the answer to whether it is ethically permissible to destroy it is yes. But this argument comes after the ethical question of whether a zygote is just a cell, which is one that science cannot answer.

The ethical status of a human zygote or early-stage embryo turns on the issue of personhood. For those who believe in a soul, the moral standing of the zygote is largely unaffected by the nature of life at the cellular level. Belief in souls is a first principle, unlikely to be either proved or disproved by science.

By contrast, as Loomis correctly notes, science may provoke a rethinking of religious dogma. Catholic theology holds that a soul is infused into a fertilized egg. So if an eight-celled embryo can be made to produce eight separate human beings, do they share a soul, or are seven new souls somehow generated?

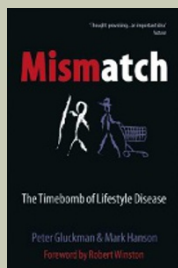
This conundrum has led some Catholic theologians to contend that the soul is infused not at fertilization, but only when cells of the dividing organism lose their plasticity. Other theologians try to accommodate scientific facts about cells in other ways. Although scientific facts about the nature of a developing embryo may have profound consequences for Christian (or at least Catholic) thinking about souls — as a first principle, the concept of a soul is unlikely to be abandoned, and will be a factor in ethical decisions about many issues that biology touches on.

Policy-makers deciding between contending positions are ultimately forced to make political decisions, not scientific ones. Science — ideally, and in most cases — influences the thought of the proponents of the contending positions, and they in turn influence the policy-makers. But science is rarely the deciding factor. In many cases, such as the example of the human embryos in IVF, the contenders on both sides can agree on the science and disagree on the policy, owing to a disagreement about whether (and which) religious concerns are most relevant. And such disagreements are beyond the competence of science to adjudicate.

Refreshingly, Loomis's discussion of ethical issues roams beyond the comparatively narrow issues of abortion and euthanasia and the

**Mismatch: The Timebomb of Lifestyle Disease**  
by Peter Gluckman and Mark Hanson (Oxford Univ. Press, £8.99)

The bodies we have now are the product of evolution. Peter Gluckman and Mark Hanson argue that they are mismatched to our needs in society today, and that this divide has increased the rate of lifestyle diseases such as diabetes and obesity.



**Vaccine: The Controversial Story of Medicine's Greatest Lifesaver**

by Arthur Allen (W. W. Norton, \$17.95)

Journalist Arthur Allen investigates the history of vaccination, covering three centuries' worth of controversies. Reviewing the hardback edition, Michael Oldstone wrote that, "What becomes clear ... is that, when facts tangle with culture, culture often wins" (*Nature* 448, 137; 2007).





like. He devotes a final important chapter to sustainability. In the face of pollution, global warming and population increase, how will it be possible to ensure an adequate supply of food, water and energy for all of Earth's people while maintaining respect for the well-being of other creatures? Loomis recommends a programme of voluntary population reduction, requiring both political leadership

and a radical change of public opinion.

Loomis identifies the source of his title *Life As It Is* — his wife apparently — but not its significance. The idea that a realistic understanding of biology will usher in a paradise of ethical correctness is naive: the panoply of extra-scientific considerations that influence ethical decision-makings cannot be ignored or minimized. A weakness of Loomis's book is

his comparative neglect of such considerations. But if his intention is less ambitious, namely that a realistic appreciation of biology ought to inform ethical decision-making, then that is incontrovertible. ■

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## Engines of life

### Energy in Nature and Society

by Vaclav Smil

MIT Press: 2008. 512 pp. \$70, £45.95

#### Tim Lenton

The explosion of myriad life-forms throughout Earth's history has been fuelled by their ability to collect and process increasing amounts of energy. Thus organisms have become ever more complex, culminating in humans and our technology. In *Energy in Nature and Society*, Vaclav Smil describes in quantitative detail the evolutionary and technical innovations responsible, from photosynthesis and respiration to solar cells and steam turbines.

The first living things probably accessed chemical energy by breaking down large molecules into smaller ones. By 3.7 billion years ago, the first photosynthesizers evolved. These organisms could capture energy from sunlight and use it to split simple molecules and liberate electrons, which they used to make sugars

from carbon dioxide. Their ingredients probably included electron donors — hydrogen ( $H_2$ , then  $H_2S$ ) and later iron ( $Fe^{2+}$ ) — that were in limited geological supply. This restricted global productivity to at most a tenth that of the modern marine biosphere.

Next came the greatest energetic innovation in the history of the planet: oxygenic photosynthesis, the ability to capture enough energy from sunlight to split water, thus liberating oxygen gas. This evolved in cyanobacteria more than 2.7 billion years ago. Initially, oxygen production was confined to microbial mats and sunlit surface waters; 2.4 billion years ago it rose in the 'great oxidation' of the atmosphere.

When oxygen reacts with organic matter during aerobic respiration, an order of magnitude more energy is liberated than was available for earlier anaerobic respiratory pathways. Ultimately, this source of power allowed the evolution of larger and more mobile

organisms, including humans.

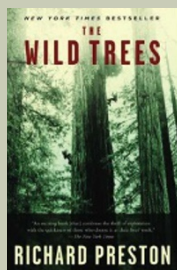
Smil is brief on the history of the biosphere. He gives a fascinating assessment of its present energetic state, quantifying global energy capture in photosynthesis and the uses that all organisms, including humans, put it to. Then he shifts the focus to human technological innovations that have progressively increased the capture and conversion of energy into forms that are useful to us. *Energy in Nature and Society* tells this story wonderfully, from hunter-gathering to traditional agriculture, the shift from human to animal power, the invention and refinement of water wheels and windmills, improvements in roads and ship design, and to charcoal production and its use in metallurgy. The fossil-fuel age takes off with exponential global increases in coal, then oil, then gas extraction and consumption.

In a feat unprecedented for a single animal species, humanity's total energy use has now exceeded that of the entire ancient biosphere before oxygenic photosynthesis, reaching about a tenth of the energy processed by today's biosphere. Almost half of the world's total primary energy supply is consumed by the rich

### The Wild Trees

by Richard Preston (Random House, \$16)

A dramatization of the lives of Californian botanists, Richard Preston reveals the hidden world of the coastal redwood trees, the tallest organisms the planet has sustained. Science, adventure and a passion for trees are combined.



### Demons in Eden: The Paradox of Plant Diversity

by Jonathan Silvertown (Univ. Chicago Press, \$16)

How is plant biodiversity maintained and why is the world not overgrown by aggressive weeds? Jonathan Silvertown explores the dynamics of the plant world and suggests that "tasting the fruit of evolutionary knowledge may provide us with a ticket for readmission to the Garden of Eden", according to Peter Moore's review (*Nature* 438, 27; 2005).

