

First, when Earth is operating near a tipping point, small changes in the driving factors can tip it rapidly from one state to another. We do not know how much the radiation balance of the atmosphere, or the ecological richness of ecosystems, or the chemical state of the oceans can be altered before cascades of effects are set off. Human activity could trigger a switch in important Earth-system processes even though the underlying change is gradual.

Their second observation is that former revolutions left life using more energy, with increased flows of materials from the environment, recycling of essential elements through life and increased networking of biological information. The authors extrapolate that for human societies to remain viable while using large amounts of energy to process large volumes of matter and maintain densely populated landscapes — as we do today using fossil fuels — we will have to boost the rate of recycling. The consciousness revolution must be followed by a recycling revolution.

Lenton and Watson's thought-provoking book is the latest in a distinguished line of works that have altered our perception of the planet. Russian-Ukrainian geochemist Vladimir Vernadsky first discussed the deep involvement of life in planetary chemistry in his 1926 book *Biosfera* (Biosphere). In *Gaia* (Oxford University Press, 1979), James Lovelock brought the self-stabilizing mechanisms of life into view by seeing the planet as a partially self-regulating, living whole. And Hans Joachim Schellnhuber's book-length chapter in *Earth System Analysis* (Springer, 1998) laid out a blueprint for a scientific discipline concerned with the interplay of social and environmental dynamics.

The inventor R. Buckminster Fuller proposed in the 1950s to construct a giant globe of light bulbs to display data sets of global phenomena. His idea was that an external, physical realization of world mechanisms would engage our minds and change our ecological perspective. He was convinced that if we did not become an active, consciously reflective part of planetary evolution, we would become an unwitting, passive part of it.

Lenton and Watson's *Earth* — shaped by life, an escapee of close calls and again on a perilous course in the wake of biological innovation — is a similarly novel depiction. The Copernican revolution had no direct effect on people's everyday lives, but it ushered in a new era of self-consciousness. Perceiving Earth as a complex system of co-evolution similarly alters our outlook. ■

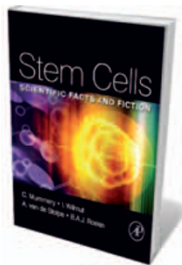
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Books in brief



The Dance of Air and Sea: How Oceans, Weather, and Life Link Together

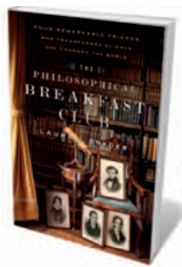
Arnold H. Taylor OXFORD UNIVERSITY PRESS 288 pp. £16.99 (2011)
Recurring weather patterns such as El Niño and the North Atlantic Oscillation underlie many changes in biological systems. Marine scientist Arnold Taylor explains how great global circulations come about through ties between air and sea, and how they impinge on life. He describes how they were discovered, through tracking drifting wrecks, plastic toys and other flotsam. And he cautions that, despite the cycles' regularity, their complex and nonlinear origins make predictions of their future behaviour difficult.



Stem Cells: Scientific Facts and Fiction

Christine Mummery, Ian Wilmut, Anja Van De Stolpe & Bernard Roelen ACADEMIC PRESS 324 pp. \$79.95 (2011)

Stem-cell research holds great promise but is mired in controversy. Although our understanding of regenerative tissues has increased in recent decades, clinical applications of stem cells for treating chronic diseases such as diabetes and Parkinson's have proved hard to develop. Ethical issues also surround the use of embryonic stem cells. Translated into English from Dutch, this balanced book aims to set out all sides of the debates for both scientist and non-scientist readers, from researchers to patient advocates.



The Philosophical Breakfast Club: Four Remarkable Friends Who Transformed Science and Changed the World

Laura Snyder BROADWAY 448 pp. \$27 (2011)

Cambridge University has schooled many great scientists. Historian Laura Snyder explores the friendships between four men who met there in the 1810s: Charles Babbage, inventor of the computer, astronomer John Herschel, crystallographer William Whewell and economist Richard Jones. Inspired by their seventeenth-century forebears, including Francis Bacon, they founded a breakfast club, where they plotted to revolutionize science. Drawing on their correspondence, Snyder describes how they did just that.



An Optimist's Tour of the Future: One Curious Man Sets Out to Answer "What's Next?"

Mark Stevenson PENGUIN 384 pp. \$26 (2011)

Science communicator and stand-up comedian Mark Stevenson travels the globe to interview top thinkers about what the future holds. From Harvard University geneticist George Church to the President of the Maldives, Mohamed Nasheed, he examines trends in personal medicine, robotics, nanotechnology and climate-change mitigation. He concludes that the future will be humane despite the growth of technology. People will adapt to change, as they always have done, and networks will replace hierarchies.



The Book of Universes

John D. Barrow BODLEY HEAD 368 pp. £20 (2011)

Mathematician John Barrow ponders the myriad types of universe — expanding, spinning, with and without life — that fall out of Albert Einstein's equations of general relativity. From Aristotle's spherical cosmos to the latest ideas about parallel universes, Barrow eruditely describes the many possibilities that astronomers are rushing to test through observations. Yet he admits that ultimately, even though our knowledge has come a long way, the Universe is still baffling.