that the authors hew to the information metaphor. Breathlessly, Field and Davies survey the greatest hits and promises of genomics, including *Jurassic Park*-style reanimation of extinct species, the microbiome and environmental engineering. The thin chapters blurt out strings of recent findings, each capped with a crescendo of sensational speculations that mostly rehearse familiar ethical questions. Critical distance is achieved with the time-honoured double negative: "Might a lawyer one day argue that deliberately *not* giving [our children] the best genes available is a form of abuse? It is not inconceivable to imagine a world where natural reproduction would seem primitive and even barbaric." It concludes by exhorting us to set our sights on a global genome project to understand "the software that shapes our living planet". The biocode is Gaia plus DNA. But two clichés do not make a right. *Biocode* simply extends the text metaphor to the macrocosm.

The old metaphor is not wrong; it is incomplete. In the new genome, lines of static code have become a three-dimensional tangle of vital string, constantly folding and rearranging itself, responsive to outside input. The roots of this idea run deep. In her 1983 Nobel lecture, geneticist Barbara McClintock called the genome a "sensitive organ of the cell". McClintock, who discovered mobile genetic elements in the 1940s, had named them controlling elements because she thought they composed the regulatory system that governed gene action. In 1980, Ford Doolittle and Carmen Sapienza proposed that transposons were molecular parasites, jumping into genomes to propagate themselves. Parasitic transposons are now textbook knowledge, but McClintock's larger point holds: the genome is dynamic, full of regulatory elements that respond to environmental cues.

The Deeper Genome is the only book of the three that credits McClintock as a progenitor of the three-dimensional genome. A scientist and journalist, Parrington covered the ENCODE story for *The Times* in 2012; his book enriches those accounts with historical and scientific context. The science is better than the history. He provides a fine discussion of recent support for McClintock's often-overlooked late work on how stress can activate transposition, but he perpetuates the

myth that at first no one thought transposition was real. The contested point was actually McClintock's interpretation of mobile elements as controllers of gene action. Parrington's strongest chapters survey the emerging view of gene regulation, including DNA folding, epigenetics and regulatory RNA. Overall, this is a faithful, engaging portrait of the twenty-first-century genome.

Finally, *Junk DNA*, like the genome, is crammed with repetitious elements and superfluous text. Bite-sized chapters parade gee-whizz moments of genomics. Carey's *The Epigenetics Revolution* (Columbia University Press, 2012) offered lucid science writing and vivid imagery. Here the metaphors have been deregulated: they metastasize through an otherwise knowledgeable survey of non-coding DNA. At one point, the reader must run a gauntlet of baseball bats, iron discs, Velcro and "pretty fabric flowers" to understand "what happens when women make eggs". The genome seems to provoke overheated prose, unbridled speculation and Panglossian optimism. Junk DNA produces a lot of DNA junk.

The idea that the many functions of non-coding DNA make the concept of junk DNA obsolete oversells a body of research that is exciting enough. ENCODE's claim of 80% functionality strikes many in the genome community as better marketing than science.

Still, as with McClintock, the larger point holds: the genome is more than a set of rules and parts descriptions. Finding apt imagery to replace the dead metaphor of the 'instruction book of life' could enable us to break free of the cliché of nature versus nurture. It could usher in a more democratic conception of life, in which all the world's a cell, and all the genes and genomes merely players. ■

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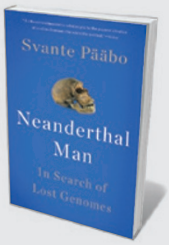
NEW IN PAPERBACK

Highlights of this season's releases



Neanderthal Man: In Search of Lost Genomes
Svante Pääbo BASIC *2015*
Pioneer of ancient-DNA studies Svante Pääbo was inspired in his youth by ancient Egyptian history. Feeling that this field moved too slowly, he decided to study medicine instead, and went on to sequence the first full Neanderthal genome in 2010. Here he details the technicalities of his life's work and the incremental discoveries, such as genetic intimations that modern humans and Neanderthals had mixed, which generated our theories of human evolution. (See Henry Gee's review: *Nature* **506,** 30–31; 2014.)

ORIGINS OF LIFE

An improbable journey

Adrian Woolfson enjoys two studies on microbial life's trek towards complexity.

In 1676, the Dutch merchant and amateur scientist Antoni van Leeuwenhoek submitted an essay to the Royal Society of London detailing a singular discovery. This was the world of unicellular organisms, which he observed using a self-designed microscope. Three hundred years later, Leeuwenhoek's "animalcules" were shown to hold the secret to the evolution of complex life on Earth.

In his imaginative and beautifully written *The Vital Question*, evolutionary biochemist Nick Lane defines a genealogy that links the descendants of the Cambrian explosion — the first appearance of morphologically complex animals in the fossil record, about 540 million years ago — to the simple organisms that preceded them. In so doing, he persuades us that comprehending the structure, function, behaviour, genetics and evolution of microorganisms is necessary for a deep understanding of complex life, and of the processes that undermine it, including diseases and ageing. This visceral insight into the largely uncharted expanses of microbial existence could also form the basis of a predictive science enabling us to speculate about the nature of potential life on other planets.

Biophysicist Paul Falkowski's entertaining, easy-to-read and historically rich *Life's Engines*, meanwhile, uses the work of microbiologist Carl Woese to trace complex life back to its three lines of descent: bacteria, archaea and eukaryotes. By studying the RNA sequences of ribosomes — the cellular machines that make proteins — Woese was able to show that Charles Darwin was correct in suggesting that all life arose from a single, now-extinct, common ancestor.

It remains unclear how and when life first originated on Earth, but we know that the first unicellular organism emerged between 3.6 billion and 2.7 billion years ago, giving rise to bacteria and archaea, which have no nucleus or other sub-cellular organelles. The evolutionary engine of life then seems to have got stuck, idling along at the unicellular level for another 2 billion to 3 billion years. Falkowski explains how unicellular organisms, although morphologically challenged, managed to perfect the basic biochemical 'engines' that would power all forms of life on Earth. According to Lane, the stagnation occurred because the molecular motors that drive the biochemistry of bacteria and archaea were unable to cross the energetic threshold necessary for the evolution of complex form. This energetic constraint on life is the central focus of *The Vital Question*.

THE EVOLUTIONARY ENGINE GOT STUCK, IDLING ALONG AT THE UNICELLULAR LEVEL.

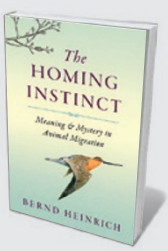
It derives, Lane explains, from two principal design features that all living things use to power themselves. The first is the use of high-energy molecules of ATP, the chemical currency of energy transfer. The second is the idiosyncratic 'chemiosmotic' force, which moves protons and facilitates the continuous generation of ATP. Both Lane and Falkowski describe these molecular processes compellingly. Although adequate to power single bacteria-sized cells, the method constrains the allowable surface-to-volume ratio of a living cell. Lane argues, however, that around 1.5 billion years ago this energetic constraint was overcome by an improbable endosymbiosis event: an ancestral archaean host engulfed a small population of symbiotic bacteria, resulting in the first eukaryotic cell, the forebear of complex life.

The Vital Question: Why is Life the Way it is?
NICK LANE
Profile: 2015.

Life's Engines: How Microbes Made Earth Habitable
PAUL G. FALKOWSKI
Princeton Univ. Press: 2015.

Lane recounts how over time, the engulfed bacteria jettisoned most of their genes that were unrelated to energy production; these were either lost permanently or relocated to the cell nucleus. There they continued to fulfil their original functions, or formed the raw material for the evolution of new genes with unexpected roles, such as transcription factors — proteins that bind to DNA. This allowed embryonic stem cells to be patterned in three-dimensional space. What remained of the imbibed bacteria, with their pared-down genomes and surrounding membranes, became energy-generating mitochondria. The acquisition of these organelles enabled eukaryotic cells to expand their volume by up to 15,000 times that of the average bacterium, and to support a genome around 5,000 times larger. Lane's important realization is that this also gifted eukaryotic cells with about 200,000 times more energy per gene than the average prokaryotic cell. This over-cranking of the evolutionary engine allowed for the development of a baroque diversity in the nature and extent of cellular gene and protein expression.

Although readily accommodated by classic Darwinian evolutionary theory, the horizontal, sudden and co-operative nature of Lane's evolutionary narrative differs from the incremental, vertical and competitive ▶



The Homing Instinct: Meaning and Mystery in Animal Migration
Bernd Heinrich MARINER *2015*
Erudite naturalist Bernd Heinrich attributes the instinct for migration to an affinity for 'home', from beavers' skilful dam-building to the joyful dance of Alaskan cranes returned to their nesting pond. (See Joel Greenberg's review: *Nature* **508,** 317; 2014.)

The Accidental Species: Misunderstandings of Human Evolution
Henry Gee UNIV. CHICAGO UNIVERSITY PRESS *2015*
Nature's palaeontology editor, Henry Gee, condemns the idea that our species is the pinnacle of evolution, arguing that traits prized as uniquely human, such as creativity, are not. (See Tim Radford's review: *Nature* **503,** 34–35; 2013.)

features of the more canonical one. As elegant as the details underpinning the thesis seem, it is occasionally hard to distinguish between fact and speculation. Lane has, nevertheless, made a bold and commendable attempt to sketch out a highly challenging scientific issue for a general audience. In so doing, he has reaffirmed the importance of a largely overlooked area of basic research, and has generated testable hypotheses about the origins of complex life.

Falkowski covers some of the same details of the evolution of microbes and their contribution to complexity, including the historical origins of the concept of endosymbiosis. However, his focus is primarily on how microorganisms have made Earth habitable, perhaps most notably with the development of oxygen-generating photosynthesis by cyanobacteria. This leads him to touch on humanity's potential to undermine Earth's systems.

History has shown how modifications to microbial biochemistry affect global geophysical processes. For example, following 200 million to 300 million years of photosynthesis by ancient microorganisms, oxygen became a significant component of Earth's atmosphere, increasing ozone levels, reducing the greenhouse effects of gases such as methane and leading to one of the most extensive glaciations in the planet's history. Humanity's interference with natural biological processes risks damaging Earth in ways that cannot be predicted.

What is clear is that a deep understanding of how complex life originated will provide insights into human biology and the nature of disease processes. It may also enable the generation of forms of life unconstrained by the contingent processes that locked life into its current trajectory. Life as we know it may eventually be supplanted, perhaps one day even being viewed as a primordial soup that facilitated the emergence of silicon-based existence. ■

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VIROLOGY

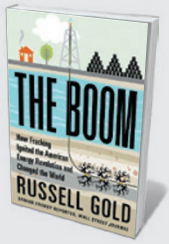
Journal of the plague years

Mark Dybul applauds the latest chapter in an account of a life at the leading edge of HIV research and policy.

Virologist Peter Piot's *AIDS Between Science and Politics* is a terrific follow-up to his highly acclaimed memoir *No Time to Lose* (W. W. Norton, 2012). It demonstrates the deep intellectual lessons of a lifetime at the cutting edge of science and politics. Piot's narrative ranges from his thrilling, on-the-ground experiences in remote regions of Africa as a young scientist and member of the team that identified Ebola, to the high-altitude reflections of his years as executive director of the Joint United Nations Programme on HIV/AIDS (UNAIDS).

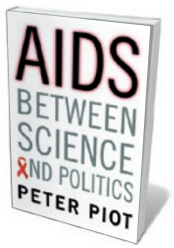
Three messages underpin the book's nine chapters. One is that the HIV epidemic generated an unprecedented local and global response, recast many development and health paradigms, and ultimately triggered treatments that have saved millions of lives. The second is that progress was made only when various scientific disciplines, on-the-ground implementation strategies and politics were aligned. And the third? That AIDS is not over.

This Changes Everything: Capitalism vs the Climate
Naomi Klein ALLEN LANE *2015*
Unafraid to name and shame fossil-fuel junkies hooked on a billion-dollar industry, Naomi Klein investigates capitalism and climate change. She sees the global crisis as a potential spur to positive action, as happened with the women's rights movement. (See Nico Stehr's review: *Nature* **513,** 312; 2014.)



The Boom: How Fracking Ignited the American Energy Revolution and Changed the World
Russell Gold SIMON AND SCHUSTER *2015*
Journalist Russell Gold traces the rise of fracking, a tale of innovation and investment — such as ex-oilman Aubrey McClendon's 260,000 land acquisitions in Texas's Barnett Shale. (See Chris Nelder's review: *Nature* **508,** 185; 2014.)

Piot observes that HIV is one of the most devastating plagues in history, reducing life expectancy in countries such as Botswana by around 30% — and wiping out decades of gains in health and development. Even in places that have not been affected on that national scale, it has devastated groups of the most marginalized and vulnerable people, including men who have sex with men, transgender people, people who inject drugs, sex workers, prisoners and others. Piot also points out the links with historical injustices such as the 1948–94 apartheid in South Africa, where the social fabric was so badly damaged and the mistrust of the authorities grew so deep that it exacerbated the outbreak of the epidemic.



AIDS Between Science and Politics
PETER PIOT
Columbia Univ. Press: 2015.

Piot traces the early days of the response to HIV/AIDS, when governments closed their ears and wallets to the growing epidemic. People with the virus rallied to fight for attention and resources, with increasing energy and sophistication. Remarkable individual and community action effected a breathtaking shift from a paternalistic, government-only approach to development and health, to one in which partnership and inclusivity provided a more effective response.

From such a heady climate were born the Global Fund to Fight HIV, Tuberculosis and Malaria in 2002 and the US President's Emergency Plan for AIDS Relief (PEPFAR) in 2003, both aiming to provide funding for programmes in countries most affected by the diseases. Perhaps of even greater significance was the growth of multisectoral local institutions, including national AIDS councils in dozens of countries, often reporting to the head of state. And there has been an increase of billions of dollars in domestic financing for HIV/AIDS response. As a result, many millions of lives have been saved and lifted up.

The theme of effective partnerships that span disciplines, politics and theologies (religious, scientific and otherwise) permeates the book, and is reflected in its title. The science is complex, as are the politics, and they are intimately linked owing to social elements, and the discrimination and stigma they engender — what Piot calls the challenge of "sex, drugs and rock and roll". Data, modelling and advocacy were essential to move national and global politics, but political leadership also drove a demand for scientific advance, data and results.

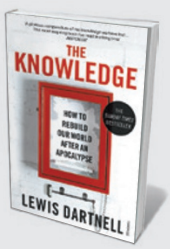
At a national level, Piot praises former president of Botswana Festus Mogae for his personal leadership in declaring, in 2001, that HIV was a threat to his country's existence. Mogae dedicated significant national resources to antiretroviral therapy at a time when much of the global health community scoffed at the viability of such a programme in Africa. These moves were strengthened by an alliance with the Bill & Melinda Gates Foundation and with pharmaceutical giant Merck, creating what Piot deems perhaps the most successful and impactful public–private partnership in history. At the global level, Piot singles out the push by then-UN secretary-general Kofi Annan for the creation of the Global Fund, and George W. Bush's efforts towards the inauguration of PEPFAR.

Piot is honest about failures. He cites an effort he pioneered in the mid-2000s to engage the US and European pharmaceutical industries in expanding access to antiretroviral treatment for people in low-income countries. The opposition came from a diverse group of people and institutions, including academics and political activists, who feared that participation by the pharmaceutical industry would be geared towards increasing profits, not expanding access.

He is also clear about the need to remain focused and vigilant. In his view, the epidemic could be significantly reduced with sufficient resources, channelled to where they would make the most difference. This is the heavy baton that has been picked up by Piot's successor at UNAIDS, Michel Sidibé.

AIDS Between Science and Politics is a must-read for anyone interested in the HIV/AIDS epidemic. More broadly, it offers lessons — and interesting anecdotes — useful in the response to Ebola and indeed to every challenge in global health and development. ■

Mark Dybul *is executive director of the Global Fund to Fight AIDS, Tuberculosis and Malaria in Geneva, Switzerland.*



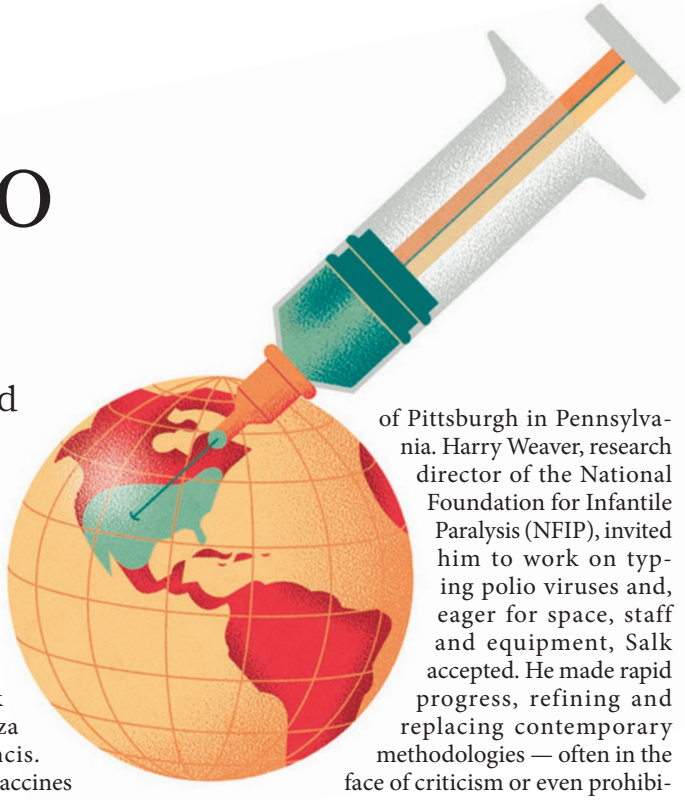
The Knowledge: How to Rebuild Our World After an Apocalypse
Lewis Dartnell VINTAGE *2015*
In a post-apocalyptic world, could we rebuild civilization? Lewis Dartnell condenses millennia of achievement into a handbook on mastering Earth's resources to produce food, energy and medicines using our "greatest invention": science.

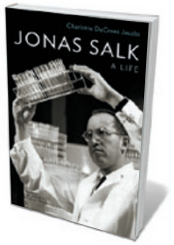
Islands Beyond the Horizon: The Life of Twenty of the World's Most Remote Places
Roger Lovegrove OXFORD UNIV. PRESS *2015*
In his profile of inaccessible islands, Roger Lovegrove's admiration for wildlife shines. But from Russia's ice-locked Wrangel Island, where polar bears banquet on walruses, to the Pacific Tuamotus, few such idylls remain pristine.

MEDICAL HISTORY

Pioneer of polio eradication

Tilli Tansey extols a biography of determined vaccine trailblazer Jonas Salk.





Jonas Salk: A Life
CHARLOTTE DECROES JACOBS
Oxford Univ. Press: 2015.

On 12 April 1955, across the United States, "church bells tolled, horns honked, and sirens rang" in celebration: the largest clinical trial ever undertaken had reported that the first polio vaccine was safe and effective. So writes Charlotte Jacobs in her riveting biography of the vaccine's discoverer, *Jonas Salk*. Two years earlier, poliomyelitis had killed or paralysed almost 36,000 US children. It has been estimated that before the vaccine there were 600,000 cases a year worldwide. Salk's triumph made him a global household name, and the gongs began rolling in.

As Jacobs shows, the tale of Salk's discovery is one of grind, intrigue, rivalry, politics and dirty tricks. Add commercial interests (pharmaceutical giant Eli Lilly made US$30 million from polio vaccine in 1955 alone) and Salk's extramarital entanglements while wedded to artist (and muse to Pablo Picasso) Françoise Gilot, and the mix becomes even headier. Jacobs contextualizes the polio effort with Salk's work on influenza, multiple sclerosis and HIV/AIDS — and with the Salk Institute for Biological Studies in La Jolla, California, which he created and directed, and from which he was ultimately excluded.

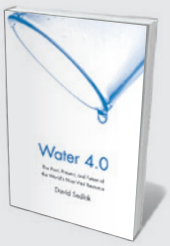
Growing up in the Bronx, New York, in a family of Russian Jewish immigrants, Salk was dominated by his ambitious mother. He came to crave doing things his own way — a tenacity that shaped both his scientific success and his professional difficulties. Early on, at the New York University College of Medicine, Salk worked with influenza expert Thomas Francis. At the time, antiviral vaccines (against smallpox, rabies and yellow fever) used artificially weakened live virus. Salk and Francis developed an experimental technique that used killed virus to stimulate antibody production and confer immunity, suggesting a powerful therapeutic approach.

In 1941, Salk followed Francis to Michigan, pursuing the holy grail — an influenza vaccine. He modified laborious procedures to culture the virus and develop vaccine production, usually with only gloves and a mask as protection. He supervised clinical tests on patients at two psychiatric institutions, deliberately infecting some with influenza — a practice common until the Nuremberg Code of 1947 offered some protection to human research subjects — and in 1945 advised the US surgeon general to vaccinate 8 million soldiers. Without consulting Francis, Salk signed an exclusive contract with pharmaceutical firm Parke, Davis to provide details of production methods that he devised. This departure from academic etiquette did not go unnoticed; nor did his writing for non-professional publications such as *Parents Magazine*. Tensions grew as Francis received honours, while Salk was ignored.

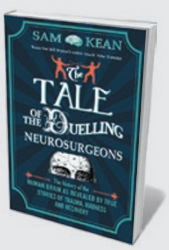
In 1947, Jacobs recounts, Salk left to establish an influenza lab at the University of Pittsburgh in Pennsylvania. Harry Weaver, research director of the National Foundation for Infantile Paralysis (NFIP), invited him to work on typing polio viruses and, eager for space, staff and equipment, Salk accepted. He made rapid progress, refining and replacing contemporary methodologies — often in the face of criticism or even prohibition from the NFIP advisory committee. Weaver supported his protégé, and the foundation came to see Salk as its 'poster scientist', wheeled out for public and media events. Fellow researchers continued to carp.

Undeterred, Salk pioneered a killed-virus vaccine and organized safety testing and field trials. Those leading up to the 1955 announcement involved more than 1.5 million children, tens of thousands of doctors and nurses, and 220,000 volunteers. The clamour attendant on success (a film was mooted, to star Marlon Brando) laid Salk open to charges of self-aggrandisement.

Almost immediately, problems arose. Batches of vaccine became contaminated, and physicians inoculated family and friends while leaving first-grade children, the most vulnerable group, unprotected. Over a few months, 260 individuals contracted polio directly or indirectly from a single substandard preparation. Several states suspended vaccination. Massachusetts halted its programme when children had received only the first of three shots; in July 1955, some 4,000 contracted polio and 1,700 were paralysed. Salk was unfairly associated with these errors and was castigated, especially by scientific colleagues. However, tighter adherence to his



Water 4.0
David Sedlak YALE UNIV. PRESS *2015*
From Roman aqueducts to desalinization plants, David Sedlak's study overflows with facts about water management. Chlorine by-products could be carcinogens, so he argues that water treatment needs another upgrade. (See Margaret Catley-Carlson's review: *Nature* **505,** 288–289; 2014.)



The Tale of the Duelling Neurosurgeons
Sam Kean BLACK SWAN *2015*
Crammed with curious anecdotes from neuroscience's gory past, Sam Kean's book ranges from the crude methods of early brain studies (including the beheading of criminals to use as test subjects) to the prion disease kuru, which spreads through cannibalism.

protocols and resumption of vaccination meant that six years after the vaccine was introduced, polio was almost eradicated in the United States.

Much of the scientific establishment closed ranks against Salk. He was given the prestigious Lasker Award for clinical medical research in 1956, but Swedish virologist Sven Gard dealt his Nobel nomination a fatal blow by sneering that the vaccine was a technical advance, not a discovery. Nor was Salk elected to the US National Academy of Sciences. Virologist Albert Sabin — bombastic, imperious and galled by Salk's success — continued to develop a live, orally delivered poliovirus preparation. By 1961, Sabin's vaccine had performed well in trials and the American Medical Association began to promote it. Salk's vaccine was, for a time, superseded, and his efforts to improve its potency stymied.

Salk moved on, although he remained involved with the polio vaccine. Influenced by chemist C. P. Snow's 1959 book *The Two Cultures and the Scientific Revolution*, he launched a research institute integrating social responsibility and the humanities with the biological sciences. The Salk Institute recruited some of the great biologists of the time, including Jacob Bronowski, Francis Crick and Jacques Monod. But Salk was unable to translate his lofty ideals into practical management. His research from the 1960s onwards, on immune responses in cancer, multiple sclerosis and, later, HIV/AIDS, met with ambivalence. He was increasingly derided by the very scientists whom he had recruited.

In many ways, Salk was ahead of his time, notably in public engagement and in his multidisciplinary agenda. A polio vaccine would have emerged without him, but it was his vision and willpower that produced the first, and a descendant of it is still the basis of many public-health programmes. Yet universal polio eradication remains a dream: cases continue to appear in Pakistan, Afghanistan and Nigeria, and have resurged in recent years in Syria. ■

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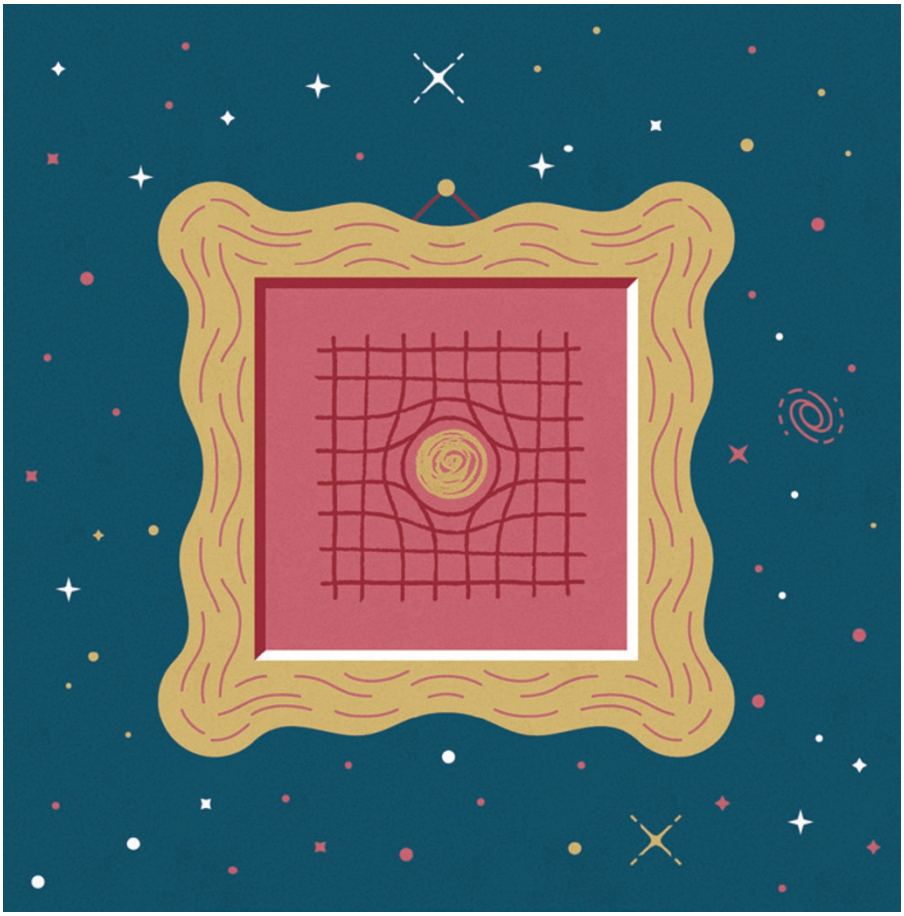


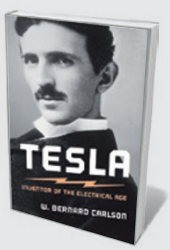
PHYSICS

One hundred years of general relativity

Pedro Ferreira looks back at how Einstein himself and a panoply of other physicists have framed the theory.

Until very recently, relativists were few and often self-taught. General relativity still had the stigma of being esoteric, pointless and, well, hard. In some places you could find specialized graduate courses, but on the whole, if you were at all interested in expanding universes and black holes, you were left to your own devices. That is what happened to me.

I studied engineering and did not enjoy it very much. But during the course on electromagnetism, I discovered Albert Einstein's world of special relativity. ▶



Tesla: Inventor of the Electrical Age
W. Bernard Carlson PRINCETON UNIV. PRESS *2015*
Over-hyped eccentric or electricity wizard? Bernard Carlson's account of Nikola Tesla's life at the turn of the twentieth century recalls the inventor's great creations, such as the alternating-current motor, as well as the unfulfilled promise of wireless power. (See Patrick McCray's review: *Nature* **497,** 562–563; 2013.)

Infinitesimal: How a Dangerous Mathematical Theory Shaped the Modern World
Amir Alexander ONEWORLD *2015*
Through religious and revolutionary figures of the seventeenth century, Amir Alexander tells the history of the struggle for mathematics' place in society. The 'heretical' concept of infinitesimals, the indivisible points of a line, takes centre stage.

The mathematics was seductive, the paradoxes were mind-blowing, and it set me up to try to learn his general theory of relativity. That theory explains how the gravitational force is nothing more than space-time bending and warping as it responds to the presence of energy and mass. To understand this revolutionary viewpoint, I had to look for the right book, something that could lead me through all the intricacies of Riemannian geometry, which overturns the rules of Euclidean geometry that we learn in school. Yet I also needed to understand the physics: the bending of light and the orbit of Mercury.

One book stood out: Einstein's popular *Relativity: The Special and the General Theory*. Published in German in 1916, following Einstein's groundbreaking 1915 paper on the general theory of relativity, it was translated into English in 1920. In 2015, we see the publication of a special anniversary edition, as well as an annotated version of the manuscript of the paper in Hanoch Gutfreund and Jürgen Renn's *The Road to Relativity*.

Einstein's book *Relativity* was supposed to be understandable by all, yet to have enough maths to allow the more educated reader to get into the guts of his ideas. It has very few equations, rendering it less explanatory and more illustrative. But there are definitely a lot of words. Einstein set himself the task of explaining the concepts and ideas behind his theory, using situations from everyday life, such as trains moving on platforms or clocks on walls. His prose is tempered with some philosophical considerations, for example a discussion of the 'a priori' assumption that empty space exists.

Dare I say it, I found the prose inelegant. This caught me by surprise. I had read some of Einstein's 1905 papers, including the one introducing special relativity, and had thought them gems. *Relativity*, by contrast, was not particularly clear and a bit dull. Einstein had declared, in the introduction, that he would repeat himself frequently, "without paying the slightest attention to the elegance of the presentation". In this he might have been following the dictum of physicist Ludwig Boltzmann, who pinned down the concept of entropy and declared that "matters of elegance should be left to the tailor and to the cobbler". Nevertheless, there is something honest about Einstein's attempt at popular writing: he does not gloss over difficulties. His theory was, to some extent, all there in his book. The treatment just did not seem to work, and he knew it. He told a friend, the Swiss–Italian engineer Michele Besso, that it was "quite wooden". In later years, he joked with the Polish physicist Leopold Infeld that the description "generally understandable" on the book's cover should be changed to "generally not understandable".

Relativity: The Special and the General Theory (100th Anniversary edition)
ALBERT EINSTEIN
Princeton Univ. Press: 2015

The Road to Relativity: The History and Meaning of Einstein's "The Foundation of General Relativity" Featuring the Original Manuscript of Einstein's Masterpiece
HANOCH GUTFREUND AND JÜRGEN RENN
Princeton Univ. Press: 2015

BIZARRE PREDICTIONS FROM GENERAL RELATIVITY, PREDICTIONS THAT EINSTEIN WAS WARY OF AT FIRST, HAVE STOLEN HIS THUNDER.

Having given up on Einstein, I looked around and found much to choose from. As soon as Einstein had put his theory out, others took over and made it their own. Arthur Eddington, the UK astronomer who had measured the bending of light in a 1919 eclipse expedition, wrote a beautifully crafted mathematical treatise on the theory of space-time in 1923. Erwin Schrödinger, one of the fathers of quantum physics, came up with his own, more-conceptual rendition, *Space-Time Structure*, published in 1950. Fellow quantum pioneer Paul Dirac's reticent personality comes across in his lecture notes on the theory, numbering just under 70 pages and published as *The General Theory of Relativity* in 1975. Euphoria and creativity pour out of the 1,200-page behemoth *Gravitation* (1973) by John Archibald Wheeler and his disciples Charles Misner and Kip Thorne. I was spoiled for choice.

Although I never used Einstein's book, it kept cropping up in my life. I have a penchant for second-hand bookshops and would keep finding translations, each with its own story. The French version was first translated by Jeanne Rouvière, a protégée of mathematician and politician Emile Borel, and subsequently expanded by Einstein's friend Maurice Solovine. The mathematician Tullio Levi-Civita, whose work had been instrumental in sucking Einstein into Riemannian geometry, recommended an engineer, Giuseppe Luigi Calisse, to do the Italian translation. The Russian version was translated by a Jewish logician-philosopher, Gregorius Itelson, who lived in Berlin and was beaten to death in 1926 by an anti-Semitic crowd.

Today, Einstein's book is a historical curio. I don't think anyone still reads it as he intended. There have been so many attempts at popularizing the theory, from practitioners and journalists, that anyone can find a book to their taste. And we have learnt much in the century since it was published: a popular book on relativity must now talk about the expanding Universe and the Big Bang, black holes and singularities. These bizarre predictions from general relativity, predictions that Einstein was wary of at first, have stolen his thunder.

Yet I can still see some fugitive magic in *Relativity*, despite its "wooden" tone. It conjures Einstein as the oracle presenting a theory to the world — one of the most revolutionary and profound theories of all time. ■

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A Rough Ride to the Future
James Lovelock PENGUIN *2015*
Independent scientist James Lovelock gazes at Earth's past, present and future as the self-regulating system Gaia. Focusing on climate, he foresees humanity in 100 million years merged with artificial intelligence to survive a hotter Earth. (See Tim Lenton's review: *Nature* **508,** 41; 2014.)

Junkyard Planet: Travels in the Billion-Dollar Trash Trade
Adam Minter BLOOMSBURY *2015*
One man's trash is another's treasure in Adam Minter's exploration of the US$500-billion global recycling trade. US waste tops the charts, and China's electronics-manufacturing industry sifts gold from mountains of e-waste. **Emily Banham**