Jersey; and the University of Geneva in Switzerland. In 1958, he began a 35-year career at the IBM Research Center in Yorktown Heights, New York.

His work on market fluctuations in the 1960s could have revolutionized financial economics if the field's equilibrium-focused ideology hadn't pushed it aside for 30 years. Perceiving parallels in everything from fractured surfaces to stock-market movements, Mandelbrot coined the term fractals and did more than anyone to make it possible to talk about natural roughness and disorder in a precise, scientific way.

In 1979, he returned to Szolem's suggestion of quadratic dynamics. Within a year, his explorations of functional iterations led him to discover the Mandelbrot set — an astonishing pattern of infinite richness produced by simple rules. This launched a whole branch of mathematics.

Much of what makes *The Fractalist* fun to read is Mandelbrot's scattered recollection of encounters with luminaries. At MIT he discussed linguistics with the young Noam Chomsky and argued with anthropologist Margaret Mead. Robert Oppenheimer liked his ideas, and Mandelbrot worked with the famed psychologist Jean Piaget in Geneva and computing pioneer John von Neumann at Princeton.

Mandelbrot recalls how after one of his lectures, a famous mathematician objected, saying he had made "absolutely no sense at all". Oppenheimer and von Neumann sprang into action, explaining points that even Mandelbrot hadn't noticed. The meeting, he remembers, "went from abysmally low to unforgettably high". His appreciation of friends, music and quirky mathematics colours every page of *The Fractalist*. Mandelbrot's odd habits explain why he was so original: he avoided work involving direct competition with others, and naturally worked in the gaps between fields, in blind spots.

"A youthful decision set me on a maverick's lonely ride," he writes. "Its consequences took a long time to develop." ■

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MEDICAL HISTORY

Stemming the red tide

Lab luminaries jostle with consumptive cultural icons in a vivid history of tuberculosis, finds **Stefan H. E. Kaufmann**.

Tuberculosis has killed more people than all wars combined, and was a leading cause of death in many Western megacities as recently as the 1950s. Historically, tuberculosis (TB) was hotheaded in overcrowded European and US cities: at the start of the twentieth century in New York and Berlin, it killed 40% of people aged 25–40. Yet TB was in decline until the late twentieth century, when the HIV/AIDS epidemic in sub-Saharan Africa triggered a resurgence. Now, it is the number one cause of death among people with HIV, and the incidence of multi-drug-resistant strains is rising.

But the story goes beyond the medical. TB's long history, wide spread and lethality irrevocably link it to social and cultural history, as Helen Bynum reveals in her gripping history of the disease and its impacts, *Spitting Blood*.

Bynum kicks off with the case of George Orwell, which encapsulates the progression of TB and its impact on culture. In 1949, when Orwell published *Nineteen Eighty-Four*, he was in the late stages of the disease, which arguably influenced his novel's dystopian tone; he died a year later. Bynum goes on to expertly turn the many facets of TB to the light, from biology to medicine and socio-economics. She ends with a brief account of why it has not been eradicated.

TB is caused by *Mycobacterium tuberculosis*, a bacterium that probably evolved from an environmental microbe to a human pathogen. The signs of 'consumption' or phthisis — pulmonary TB, triggered by aerosol infection of the lung — are coughing and spitting of blood. Before the nineteenth century, another common form was scrofulosis, in which the lymph nodes became pus-filled and ulcerated. It usually arises from ingesting bacteria, so the increasing eradication of bovine TB and the sterilization of milk have radically reduced its incidence. Pott's disease, a third, rare form, affects the bones.

Phthisis and scrofulosis were known in antiquity. But it was not until the late Renaissance that anatomists came to recognize TB lesions, and spotted similarities between the manifestations of the disease.

TB began to gain cultural cachet as artists succumbed. The death at 25 of English Romantic poet John Keats (a trained surgeon) did much to glamorize the disease. In Rome in 1820, Keats "vomited near two cupfuls of blood"; he died a few months later. Anne Brontë and, possibly, her sister Emily succumbed at 29 and 30. Consumption became linked to the punishment and redemption of a bohemian life, as with the courtesan Violetta in Giuseppe Verdi's 1853 opera *La Traviata*.

Meanwhile, as Bynum shows, the medical disease began to emerge, and "consumption became tuberculosis". Louis Pasteur provided the first evidence that microbes caused certain diseases. Robert Koch showed that TB was infectious, and demonstrated that a single pathogen was responsible for its different forms. At the time, clinicians tried to treat the disease using the 'pneumothorax' method, collapsing the lung by inserting needles into the pleural cavity, in the hope that pressure on the lung would lead to a cure. But

the unveiling of TB as a bacteriological disease paved the way for effective drugs, diagnostics and a vaccine.

In the second half of the nineteenth century, efforts to control public spitting began. Dispensaries were set up, then sanatoriums for the rich, the first in Germany in the 1860s. Working-class sanatoriums emerged courtesy ▶

Spitting Blood: The History of Tuberculosis
HELEN BYNUM
Oxford Univ. Press:
2012. 352 pp. £16.99,
\$34.95

Knocking on Heaven's Door

Lisa Randall (Ecco, 2012; \$16.99)

What can CERN's Large Hadron Collider (LHC) reveal about the make-up of the Universe? Particle physicist Lisa Randall explains, alternating details of the LHC's inner workings with more general musings on the philosophy of science. (See Joseph Silk's review: *Nature* **477**, 30–31; 2011.)

Survivors: The Animals and Plants that Time Has Left Behind

Richard Fortey (Harper, 2012; £9.99)

Palaeontologist Richard Fortey narrates the history of life by looking not to the long-extinct, but to organisms that have survived, almost unchanged, for millions of years. These survivors, he says, speak to us of pivotal evolutionary events.

► of national-insurance programmes and philanthropy. People with joint and bone TB, often children, underwent orthopaedic treatments, such as wearing shells and jackets that left just face and ears exposed.

In 1921, as Bynum reveals, Albert Calmette and Camille Guérin devised the first breakthrough: the vaccine bacille Calmette–Guérin (BCG). Twenty years later, Albert Schatz and Selman Waksman discovered the second: the TB drug streptomycin. Intensive research spawned others, and the 1950s saw the first broad-scale fight against TB, with mass X-ray screening and drug therapy. But although national TB-control programmes sprang up, interrupted treatments and poor patient compliance led to drug resistance, notably in regions of conflict and asylum camps. From the beginning, resistance against single drugs was noted, and clinical trials spearheaded by the UK Medical Research Council revealed that multi-drug therapy was essential for preventing the development of drug-resistant strains.

A rigorous multi-drug treatment programme led by the World Health Organization (WHO) effectively defeated non-resistant TB, but about 50 million people currently harbour multi-drug-resistant tubercle bacilli. Of these, nearly half a million develop the disease each year. With around 15 million people co-infected with HIV and tubercle bacilli, and nearly 1 million active TB cases a year among people with HIV, we are seeing a perfect storm. If Bynum's book has a weakness, it is that it lacks an outlook on how the WHO's goal to eliminate TB by 2050 could be achieved.

Spitting Blood provides impressive insight into TB as a medical and social disease. Meanwhile, photographer James Nachtwey's gallery of people with drug-resistant TB (www.xdrtb.org) complements this work on a disease that is still very much with us. In 2009, London alone harboured nearly 3,500 TB cases: an almost 50% increase over the preceding decade. ■

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A More Perfect Heaven: How Copernicus Revolutionised the Cosmos

Dava Sobel (Bloomsbury, 2012; £8.99)

Mixing drama with history, Dava Sobel offers a biography of Copernicus with a twist, working in a two-act play in which a student convinces him to publish his revolutionary work. (See Owen Gingerich's review: *Nature* **477**, 276–277; 2011.)

Margaret Sanger: A Life of Passion

Jean H. Baker (Hill and Wang, 2012; \$17.00)

Margaret Sanger emerges as a daring and determined character in historian Jean Baker's vivid life. Sanger's fervent belief that women should be able to limit the size of their families led to the development of the contraceptive pill. (See W. F. Bynum's review: *Nature* **478**, 318; 2011.)