

## MEDICAL RESEARCH

# Riding the global tide of blood

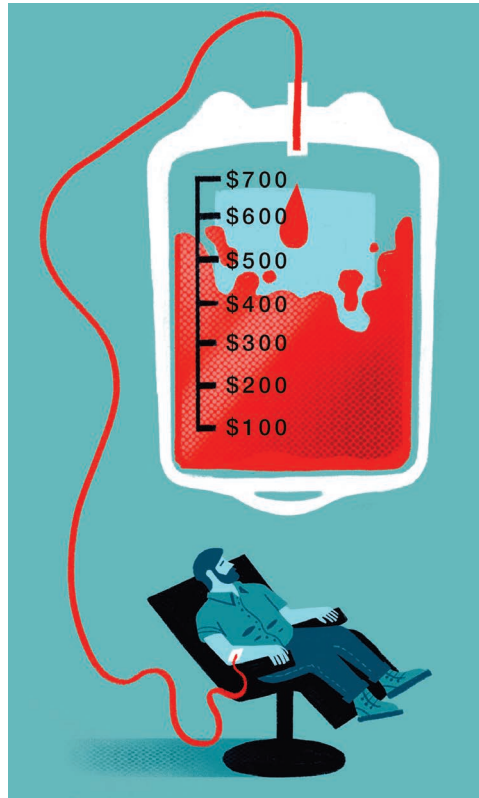
Tilli Tansey enjoys a compelling exploration of the dynamic biological fluid.

**B**lood is life. Blood is death. Writer Rose George's book ranges extensively and often disturbingly between these contradictory extremes. George examines blood as a life-saving medicine, an infective agent, an easily accessible indicator of disease and injury, a taboo, a weapon and, in all contexts, a commodity to be bought, sold, used, misused or controlled.

George (whose previous books examined shipping and human waste) develops each theme in a series of engaging personal stories and journeys. The "vein to vein" account of blood transfusion starts at St George's Hospital in South London, where George donates 470 millilitres of blood. She then 'follows' it to a National Health Service Blood and Transplant (NHSBT) processing facility in south-west England. There, a single donation can provide a range of products. These include red blood cells, platelets and cryoprecipitate for clotting disorders, as well as whole blood depleted of white blood cells to transfuse into infants with less-developed immune systems, and fresh frozen plasma for transfusion to replace lost blood. We learn that, since 2003, a "male donor preference" has operated in Britain: women's plasma, laden with excess hormones, mainly from contraceptive pills and hormone-replacement therapy, requires considerably more screening and treatment, and is routinely discarded.

George shares some sobering statistics. Every three seconds, someone in the world receives a blood transfusion (this translates to 2.5 million units of blood transfused per year in Britain, and 16 million in the United States). But many nations, including all those in Africa, fail to reach the World Health Organization's target of 1–3% of the population donating. In Sweden, a modest initiative begun in 2012 has increased contributions by simply texting donors to let them know when their blood has been used; Britain has followed suit.

But these life-saving donations can also carry death and disease. The disturbing

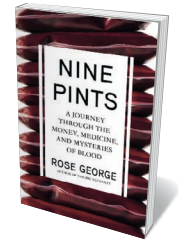


stories of contamination from around the world, especially by HIV and hepatitis C, are now well known. For instance, many people with haemophilia, surgical patients and new mothers who received blood products in the 1970s and early 1980s in Britain also unknowingly received infections, mainly HIV and hepatitis C. Many are still seeking recognition and compensation. The introduction of more-stringent criteria for donors has removed these problems from Britain's blood supply. There are effective measures. One is the rejection of blood donations from people who have recently visited areas where blood-borne diseases such as malaria, West Nile fever or Zika are rife. Another is testing for a wide range of viruses, including hepatitis B

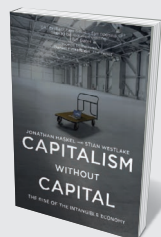
and C, HIV and syphilis. (Ironically, British blood is considered a risk for contamination with the prions causing the neurodegenerative condition Creutzfeldt–Jakob disease, and is not accepted outside the country.) Elsewhere, larger risks remain. HIV infection from a transfusion is 3,000 times more likely in India than in the United States. And, worldwide, as many as 10% of HIV infections have been calculated to come from blood products.

There are further disturbing tales. We sense the terror of 16-year-old Radha in western Nepal: while she is menstruating, she must make her lonely way each evening to a remote hovel to sleep. This practice, *chaupadi*, makes Radha, like thousands of other teenagers, vulnerable to sexual assault by local men. George also recounts stories of poverty-stricken "plassers" in the United States, who legally sell their plasma twice a week (European limits are 24 donations a year) to earn US\$2–3 per day. And there are the rural communities in India where blood is now a kind of cash crop. As George reports, this has led to horrific abuse of migrants, imprisoned as "blood slaves" and bled for cash.

Heroes and heroines, too, abound in *Nine Pints*. Janet Vaughan, considered "too stupid to be educated" by her headmistress, qualified in medicine in the mid-1920s and specialized in blood disorders at the London Hospital. She made crude liver extracts for the treatment of pernicious anaemia, using mincing machines borrowed from friends, including Virginia Woolf (a distant relative). By the late 1930s, war was looming, heralding a need for blood. Knowing of



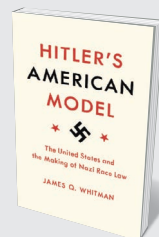
**Nine Pints: A Journey through the Money, Medicine, and Mysteries of Blood**  
ROSE GEORGE  
Metropolitan (2018)



### Capitalism Without Capital

Jonathan Haskel and Stian Westlake  
PRINCETON UNIV. PRESS (2018)

In our new industrial era, business assets are mostly intangible, from software to research. Jonathan Haskel and Stian Westlake offer insight into this mass economic shift, and how to exploit the move towards immaterial capital.



### Hitler's American Model

James Q. Whitman PRINCETON UNIV. PRESS (2018)

Early US eugenics policies famously helped to inspire Nazi atrocities. Here, legal historian James Whitman examines how US Jim Crow laws, which enforced racial segregation from the 1880s to the 1960s, became a model for the Reich's egregious anti-Semitic Nuremberg Laws.

advances made in collection and storage during the Spanish Civil War, Vaughan established several effective blood depots — one in a bar in Slough, which always attracted donors. She initiated a mobile service, using ice-cream vans to collect and deliver blood around the country. One contemporary commentator, Major General W. H. Ogilvie, considered the greatest medical advance of the Second World War to be not penicillin, but the blood-transfusion service.

For me, the outstanding hero is Arunachalam Muruganatham, an innovator in sanitary products from southern India. It is an area where menstruation is considered shameful and dirty, many women cannot afford commercially produced pads, and public toilets and running water are rare. The lack of basic hygiene and the use and reuse of inadequate washable rags can lead to girls and women missing out on education and employment, and contracting gynaecological infections.

Muruga, as he is known, noticed his wife using newspapers and cloth during menstruation, and decided to experiment with alternatives. He carried a football filled with goat blood under his clothes so that he could release the liquid as he moved, and gain some sense of the practical difficulties. Ridiculed even by his family, he persevered, and designed machines to manufacture affordable pads, encouraging local communes and factories to produce and sell them. Muruganatham's story has featured in a 2013 documentary by Amit Virmani, *Menstrual Man*, and a 2018 Bollywood feature film by R. Balki, *Pad Man* (see S. Priyadarshini *Nature* 555, 27–28; 2018).

*Nine Pints* is highly readable and informative, but the chatty style grates at times, and there are a few irritating duplications. And the title — a nod to the volume of blood in a human body, which is variable and related to body size — seems strangely static for a dynamic biological fluid with many vibrant contexts. ■

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## PHYSICS

# Black-hole fever

Richard Panek on two books tackling the counter-intuitive weirdness of these gravitational beasts.

In the late nineteenth century, physicist Ernst Mach wrote that when Isaac Newton published his theory of gravity in his book *Principia* (1687), it disturbed his fellow natural philosophers. The reason? It “was founded on an uncommon unintelligibility”: two objects interacting without physical contact. Mach was trying to show how an affront to common sense gains respectability through familiarity. By his own era, gravity had become “common unintelligibility”.

Black holes — gravitational beasts that warp space and devour light — have undergone a similar trajectory. In the 1980s, they still seemed like science fiction. Since then, advances in technology and theory have transformed them into scientific (near) certainties. Now, two books — *Einstein's Monsters* by astronomer Chris Impey, and science journalist Seth Fletcher's *Einstein's Shadow* — trace that transition without losing sight of how weird their subject is.

In *Einstein's Monsters*, Impey provides a history of black holes and an overview of investigations into their supremely counter-intuitive behaviour. The possibility of their existence arose from the idea that gravitation is a force of attraction between bodies of matter. If light were matter, as British philosopher John Michell and French mathematician Pierre-Simon Laplace argued in the eighteenth century, it would be subject to Newton's laws. And if Newton's laws were correct, an object with sufficient mass could overwhelm light's mass, creating a “dark star”. Laplace even provided a mathematical foundation for such a thing, in 1799. That year, however, polymath Thomas Young demonstrated that light acts as a wave. Laplace dropped his idea.

Albert Einstein's 1905 paper on the photoelectric effect, suggesting that light travels as both waves and packets of matter (photons), might have revived the dark star — had he not, ten years later, rendered obsolete the idea

## Einstein's Monsters: The Life and Times of Black Holes

CHRIS IMPEY  
W. W. Norton (2018)

## Einstein's Shadow: A Black Hole, a Band of Astronomers, and the Quest to See the Unseeable

SETH FLETCHER  
Ecco (2018)

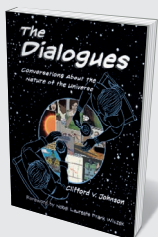
of gravitation as a force mysteriously operating without physical contact. In Einstein's universe, light follows curves in space-time created by the presence of objects with mass. Within months of Einstein's 1915 presentation of his general theory of relativity, astrophysicist Karl Schwarzschild found a solution for Einstein's equations: an object needn't be huge to trap light, as Michell and Laplace had assumed; it just needs to be sufficiently dense.

Impossibly so, thought many physicists, including Einstein. Such an object could result only from mass collapsing into a state of infinite density — a singularity. And infinities don't lend themselves to enthusiastic scientific endorsements. Just because a “monster” is mathematically feasible doesn't mean it exists.

However absurd, the possibility lurked, and some theorists love lurking absurdities. From the 1920s, they had the benefit of quantum mechanics, an understanding of the subatomic Universe in which previously unimaginable density makes sense. Theorists in the 1930s calculated that the mass of a star determines its eventual fate — and that those fates include a neutron star or a dark star.

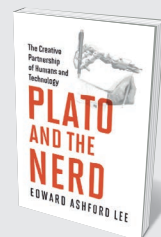
A neutron star was fine: quantum mechanics could account for a creature wherein a few cubic centimetres of matter weighs one billion tonnes, and the nuclei of adjoining atoms abut one another. A dark star was different. The ugly, infinity-dependent singularity at its heart defeated both general relativity and quantum mechanics.

For black holes to become commonly ▶



### The Dialogues

Clifford V. Johnson MIT PRESS (2018)  
Physicist Clifford Johnson aims to spark curiosity about science through discourse. In this thought-provoking graphic novel, he optimizes the rule of ‘show, don't tell’, encouraging engagement with concepts from the multiverse to immortality in everyday social scenarios.



### Plato and The Nerd

Edward Ashford Lee MIT PRESS (2018)  
Technology and creativity are irrefutably intertwined. Computer scientist Edward Ashford Lee explores both the potential impact of the digital revolution on human evolution and how technology's “real power comes from partnership with humans”.