

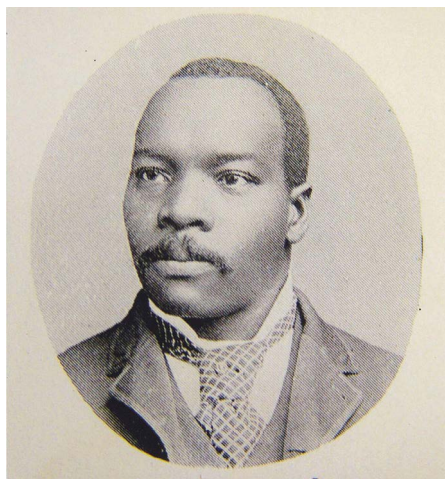
emphasize that the idea was so central to the founding of the country that it appears in Article I, Section 8 of the Constitution: “To promote the Progress of Science and useful Arts, by securing for limited Times for Authors and Inventors the exclusive Right to their respective Writings and Discoveries”. They also often observe that the US system was intentionally more democratic than its European predecessors, with low barriers to participation.

They rarely mention that this access was limited to free persons. Enslaved people created inventions, often in agricultural technology, but could not receive intellectual-property protection through patents. After the abolition of slavery, many Black Americans held patents – including Lewis Latimer and Granville Woods, who worked on electricity and telegraphic communications. Yet, well into the twentieth century, racists used low rates of patenting to argue that people of colour lacked ingenuity and could not fully participate in the US project of technological progress.

The problem is not just one of systematic exclusion. Vats argues that it is one of fundamental orientation. The rules and procedures of the patent system embody approaches to knowledge production that promote a “vision of inventorship as a process that unfolds in a laboratory, at the hands of expert scientists”. It has little truck with the creative fruits of the kitchen, forest, farm or workshop.

She cites a landmark case at the beginning of modern biotechnology. In 1980, *Diamond v. Chakrabarty* focused on the patentability of a genetically engineered bacterium capable of breaking down crude oil. Ultimately, the Supreme Court decided that the micro-organism was patentable, along with “anything under the sun made by man”. In Vats’s view, the case validated Western ideas of both genius and human dominion over nature.

Ironically, it was an Indian immigrant – microbiologist Ananda Chakrabarty – who played the game and reaped the benefits, she points out. Meanwhile, traditional knowledge systems that have cultivated nature for centuries – from seedbanking to controlled burning – have gone unrecognized and unrewarded. Perhaps most perversely, the medicinal potential of plants such as neem (*Azadirachta indica*) or turmeric (*Curcuma longa*), or systems such as yoga or meditation, are seen as valuable and protectable only when they are made legible to the white gaze. This involves crediting a single individual rather than a community and its history; certification by Western experts; and characterization in terms of papers produced rather than, say, lives changed.



Granville Woods held numerous patents.

There is growing resistance, which Vats discusses. This includes the transnational dispute over the patentability of leukaemia drug Glivec (imatinib). In 2013, the Indian Supreme Court ruled that the drug was neither innovative nor more effective than a previously patented form of its active ingredient, and so did not deserve a patent. This ensured greater access to the drug for India’s population.

Vats says that the United States characterized the decision as “patent insolence”. Rather than understanding it as arising from different values or understandings about the relationship between patents and public health, the US

government admonished the country as primitive and childlike, lacking knowledge about the benefits of patents for technological progress and a civilized and democratic society.

Vats suggests that to become anti-racist, intellectual-property systems must make space for multiple forms of knowledge. I agree. But this requires more than rules that recognize epistemological diversity. We must rethink how intellectual property shapes high-tech industries and markets. After all, our ‘modern’ system privileges individual reward and recognition, private property and a nature–culture binary.

Reading Vats’s book is an important step. So are efforts to empower Black and brown communities to protect their knowledge systems from Western commodification – for example, in the United Nations protocol for sharing access to and benefits of plant and animal material, which is up for reform next year. Scientists must approach experts from other knowledge systems humbly and as equals to learn about their innovations, rules, practices and values. Only then can we co-create a new generation of intellectual-property rights that can be truly respectful across communities and cultures.

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Timely book tells the CRISPR story so far

A gene-editing primer maps the solid ground better than the quagmires. **By Natalie Kofler**

As the world was reminded by their Nobel win last month, Jennifer Doudna and Emmanuelle Charpentier discovered in 2012 that an ancient bacterial immune system could be rejigged to edit the genetic sequences of living things. Today, CRISPR technology is used to engineer thousands of organisms. In theory, it could cure heritable diseases, increase food security and counter the impacts of climate

change. Already, infamously, twin girls have been born in China with CRISPR-edited genomes.

As the founding director of Editing Nature, a platform to support responsible decisions about genetic engineering, I’ve watched CRISPR technologies expand and transform at dizzying speeds. At times it feels like we are on a roller-coaster ride that no one remembers buying a ticket for. And many societal



Germans protest in Berlin in 2015 against genetic engineering.

questions remain unanswered — such as who should have a voice in deciding how CRISPR is used, and who gets to access its benefits.

In *Editing Humanity*, Kevin Davies attempts to illuminate the twists and turns of the CRISPR journey. As executive editor of *The CRISPR Journal* and founding editor of *Nature Genetics*, he is intimately acquainted with the events and the people concerned. The result is both a historical record and a map, inviting readers to learn from the past to navigate the present. It is, however, only part of the CRISPR story: Davies leaves many thorny ethical issues uncharted.

His is an all-star cast: as well as Doudna and Charpentier, there are appearances by bioengineer Feng Zhang and synthetic biologist George Church, who were the first to use CRISPR gene editing in eukaryotic cells, including those of humans, resulting in an ongoing patent dispute since 2016. And Davies highlights hundreds of other researchers who helped to enable genome editing and its many applications in microorganisms, plants and animals. While studying salt-loving archaea in Spain in the 1990s, for example, microbiologist Francisco Mojica noticed the unusual genetic repeats that are now a telltale sign of an ancient acquired immune system. There followed a decade-long journey to understand

“Most non-consenting participants in rogue gene-therapy trials were young women and girls.”

the role of those repeats, leading eventually to the coining of the term CRISPR.

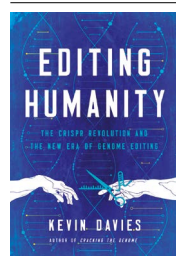
Davies weaves in the histories of genetic engineering and gene therapies that predated CRISPR, for interest and as a point of caution. In the 1970s, US physician Stanfield Rogers and haematologist Martin Cline administered untested gene therapies for rare inherited diseases: Rogers treated girls in Germany, two of whom had a developmental disability, for argininaemia, and Kline treated young women with β -thalassaemia in Israel and Italy. Both researchers went abroad to

sidestep US institutional approval.

In the past few years, international experts have pushed for more ethical oversight of gene editing, and in 2015 they reached a consensus that human sperm, eggs or embryos should not be gene-edited. But in 2018, in front of an astonished assembly of scientists, ethicists and journalists in Hong Kong, He Jiankui described how his team (which included Chinese and US scientists) had CRISPR-gene-edited human embryos in an attempt to provide protection against HIV infection. Twin girls, known only by the pseudonyms Lulu and Nana, were thereby born with every cell genetically altered, including the reproductive cells that could pass the change to future generations.

Davies's telling of this disturbing saga is gripping, even for someone like me who followed it as it happened. Davies points fingers at He's circle of US confidants for not halting such an ethically dubious experiment (*Nature* 566, 427; 2019). His unearthing of government and institutional involvement in these experiments left me with an eerie feeling of history on repeat: most non-consenting participants in rogue gene-therapy trials today and in the past were young women and girls.

Despite this misuse of power, CRISPR continues to propel advances in the clinic, in the field and in the environment. Davies offers



Editing Humanity: The Crispr Revolution and the New Era of Genome Editing

Kevin Davies
Pegasus (2020)

adroit descriptions of its potential to cure conditions from sickle-cell disease to cystic fibrosis. He delves into how CRISPR could be used to create tastier tomatoes, hardier oranges and hornless cattle, although he could have more deeply explored how it might transform world food-supply chains. China, for example, has invested billions of dollars in CRISPR gene-editing technology in the hope of feeding the nation and increasing exports.

Davies makes a complicated technology clear, succinct and engaging. Yet he fails to give equal attention to its ecological, social, political and ethical ramifications. The chapter on pushing genetic edits into the environment, for example in mosquitoes designed to suppress those that carry malaria, does not mention whose value systems will shape decisions about deploying such CRISPR-based 'gene drives' in the wild.

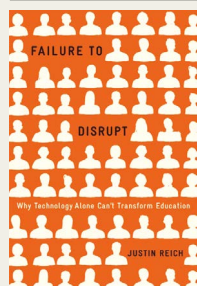
Davies also doesn't fully address the inadequacies of regulatory agencies or inter-governmental bodies. Most do not effectively engage interdisciplinary expertise and affected communities to inform decision-making about CRISPR. Not a single member of the World Health Organization's human-gene-editing advisory committee identifies as having a physical disability. Yet one focus of that group is to develop global-governance standards for CRISPR-based therapies that could one day eliminate certain disabilities such as deafness and dwarfism.

Narratives shape perceptions, and can be used to maintain the status quo or to envision new kinds of futures. I was relieved to see that the book gives contemporary female scientists the leading roles they deserve. But I was troubled by an insensitive remark suggesting that Chinese scientists tend not to be affable, and (given continuing protests over racialized police brutality) by a page-long metaphor likening bacterial immune defences to police surveillance. CRISPR's ability to transform the collective human experience demands social context defined by diverse perspectives, such as can be found in Angela Saini's *Superior*, Françoise Baylis's *Altered Inheritance*, Kim TallBear's *Native American DNA*, Charles Mann's *The Wizard and the Prophet* and Alondra Nelson's *The Social Life of DNA*.

Editing Humanity, one of several popular books on CRISPR just published or in the pipeline, clearly charts the terrain of this new world. But like any map, it can't tell us how to get from A to B. To arrive at a healthy and just future requires an ethical compass, guided by a rich chorus of lived experiences. History is being written and everyone deserves to have a voice.

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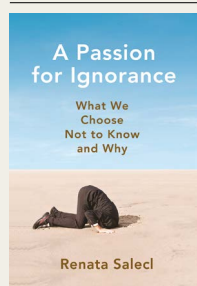
Books in brief



Failure to Disrupt

Justin Reich *Harvard Univ. Press* (2020)

In 1913, Thomas Edison said books would soon become obsolete in schools, as teaching embraced the motion picture. Similar claims for MOOCs (massive open online courses) in the early 2010s already seem dated. Yet as educational researcher Justin Reich observes, video now dominates informal learning, and Wikipedia enchants many educators. His account of digital technology, neither utopian nor dystopian, offers "a tinkerer's guide to learning at scale", to fit — not disrupt — the complex system of school and university education.



A Passion for Ignorance

Renata Salecl *Princeton Univ. Press* (2020)

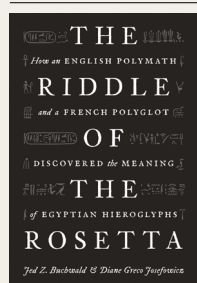
Philosopher and sociologist Renata Salecl begins her study of ignorance with US President Donald Trump's handling of the coronavirus pandemic. In early 2020, he misunderstood the danger to his country. Yet as it became obvious, he claimed: "I felt it was a pandemic long before it was called a pandemic." This attitude, shared by many leaders, revealed both "not knowing (ignorance)" and "not acknowledging (ignoring)" — the intimately related subjects of this compellingly topical book, which ranges from genetics to fake news.



Cubed

Ernő Rubik *Flatiron* (2020)

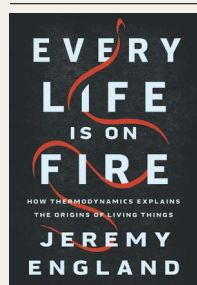
Rubik's Cube needs no introduction, unlike Ernő Rubik. An architect and son of an aircraft designer, born in Second World War Budapest, he had a childhood passion for puzzles. But in his rewarding, idiosyncratic autobiography — his first book; he "hates to write" — he calls himself a lifelong amateur, lacking professional experience of toys or industrial design when he created the cube in 1974. Perhaps his inner feeling explains why both children and adults still contemplate the toy with "a rare moment of peaceful coexistence between order and chaos".



The Riddle of the Rosetta

Jed Z. Buchwald & Diane Greco Josefowicz *Princeton Univ. Press* (2020)

The Rosetta Stone and the deciphering of Egyptian hieroglyphs continue to fascinate. This valuable analysis by historian of science Jed Buchwald and writer Diane Josefowicz combines exhaustive excavation of archives with eclectic biographical elements on the decoders, English polymath Thomas Young and French polyglot Jean-François Champollion. They clarify in unique detail, as far as evidence allows, how much credit should go to Young, to whom the "intemperate" Champollion undoubtedly showed "lack of generosity".



Every Life is on Fire

Jeremy England *Basic* (2020)

Jeremy England trained as a biochemist, gained a physics PhD, is ordained as a rabbi and has been a university physicist and a director in artificial intelligence at drug firm GlaxoSmithKline. These interests feed his book about life's origins, which explores his unproven thermodynamic hypothesis of "dissipative adaptation": that random groups of molecules can self-organize to absorb and dissipate heat from the environment more efficiently. Original, intriguing and theological, the book will probably be scientifically controversial. **Andrew Robinson**