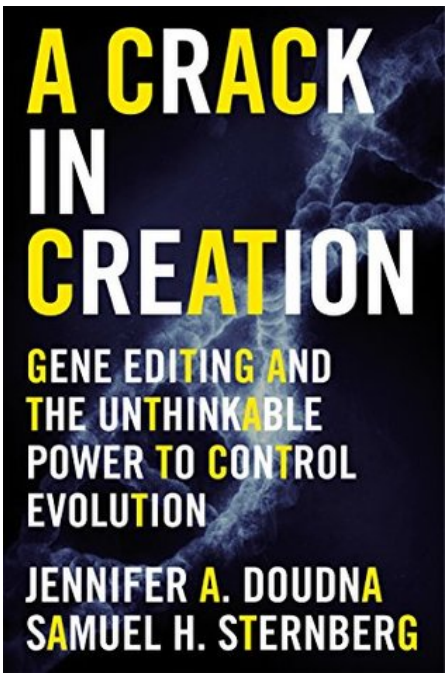

A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution

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A trailblazing biologist grapples with her role in the biggest scientific discovery of our era: a cheap, easy way of rewriting genetic code, with nearly limitless promise and peril.

Not since the atomic bomb has a technology so alarmed its inventors that they warned the world about its use. Not, that is, until the spring of 2015, when biologist Jennifer Doudna called for a worldwide moratorium on the use of the new gene-editing tool CRISPR—a revolutionary new technology that she helped create—to make heritable changes in human embryos. The cheapest, simplest, most effective way of manipulating DNA ever known, CRISPR may well give us the cure to HIV, genetic diseases, and some cancers, and will help address the world's hunger crisis. Yet even the tiniest changes to DNA could have myriad, unforeseeable consequences—to say nothing of the ethical and societal repercussions of intentionally mutating embryos to create "better" humans.

Writing with fellow researcher Samuel Sternberg, Doudna shares the thrilling story of her discovery, and passionately argues that enormous responsibility comes with the ability to rewrite the code of life. With CRISPR, she shows, we have effectively taken control of evolution. What will we do with this unfathomable power?

A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution Details

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From Reader Review A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution for online ebook

Adeyemi Ajao says

Last time a book gave me this feeling of awe and amazement was reading Stephen Hawkin's "Brief history of time" 20 years ago. It speaks volumes to Jennifer's ability to distilled the essential on this complex topic that I left feeling I had a good grasp on the subject (albeit with my mind racing over a million questions). A must read.

Will Simpson says

From studying how bacteria fight off viral infections to development of the Life (not personal but humanity) changing technologies of CRISPR/Cas9. This book a great, mostly understandable primer on the development and technologies used. Understandable even for a 61 year old who has no microbiology background at all. My experience of this book comes in 3 parts.

1. In the first part, I learned some about microbiology. Exciting to see advances, I found myself caught up in the excitement. Who knew that bacteria were plagued by viruses and that they have coevolved in a ongoing battle of attacks and defense. Learned how this process can be used for gene-editing. Learned about somatic cell editing and germline cell editing and the implications of this lead to the second phase of the book.

2. The authors painted a scary picture of the whole gene editing field. I almost gave up as it seemed as though they were so focused on what could go wrong. Seemed to promote scare tactics to try and put CRISPR back in the proverbial box.

3. Redemption! The third part of the book is a reasoned and measured dialogue of pros and cons of the ethics of germ line and somatic gene editing. I zoomed through this section in a single session. So excited. This section confirmed my biases. I'm biased towards the moral imperative to alleviate the suffering of those with genetic diseases when possible. This technology helps make this a possibility.

Random notions with roots in the reading.
* I hope that CRISPR/Cas9 technologies and separate themselves form the false and misleading current public perception of GMO's.
* If I was to have a genetic disease like ALS, of course I'd opt for any potential. Why wouldn't I want the same for everyone else in the same position?
* This is another issue which Frances Collins, Director of the NIH, is on the wrong side.
* This can be used to up regulate and down regulate various proteins much like a "gene-expression controller" or like a dimmer switch adjusting lighting levels.
* "Someday we may consider it unethical not to use germline editing to alleviate human suffering."
* Thank you Jennifer and Samuel for coming out of the lab and coming into the fire of public policy and education. Thanks for being the adults in the room.

Personal aside.
Science, is polarizing. There are those that understand and those that don't. Sure scientists alone can't make decisions in a vacuum. They need the support of people with other backgrounds and experiences *who*

understand the science. Those that don't understand don't have a vote. This is not condemnation but is a exhortation to become knowledgable. Unfortunately our current societal makeup is such that "everyone is their own expert". This is holding us back.

Tony says

A CRACK IN CREATION: Gene Editing and the Unthinkable Power to Control Evolution. (2017). Doudna & Sternberg. ***.
This work is a short history of CRISPR, a term that refers to a region of bacterial DNA. The acronym stands for “clustered regularly interspaced short palindromic repeats.” The author attempts to show what these repeats are by the use of simple drawings and a further definition of the use of the term palindrome. Although I had worked in AgBiotech towards the end of my career, the term was new to me. (I left the field in 2000). The author does her best to explain the term and its use to describe areas of DNA that contain these repeating units. Using the possibilities that CRISPER opens up, DNA can be successfully divvied up into precise segments on a repeatable basis. It seems that the CRISPER sequences in DNA came from Bacterial DNA insertions that occurred over the course of evolution. Unfortunately, however, the book left me in a state where I came from not knowing about CRISPER to ultimately not understanding it. The author did her best to open up discussions about the current technology using CRISPER and projecting the potential applications yet in the near future. The science of genetics is moving so quickly that one can hardly keep up with it. Bottom line, however, is that the author is appealing to a more considered use of this new technology – its power is so strong that it might just be too tempting for rogue scientists to abuse. The book reads a lot like the verbiage put out by atomic scientists after the development of the atomic bomb. It’s good that someone is keeping an eye on the use of new technology, but it is difficult to get the average guy to understand it.

Charlene says

I found this book equally informative and annoying. So much GREAT information. Crispr is nothing short of miraculous. Have you ever studied viruses or plasmids and been amazed at how a virus knows how to cut into a gene sequence and take over a cell and eventually tons of cells inside an entire organisms? This is that on a much more intense scale. Absolutely love this technology!

The writing not was as great as I had hoped. I liked to be wowed without having to sift through bragging or what seem to be very unimpressive philosophical discussions. Even with those limitations, this book is a solid 5 star book.

Rachel (Kalanadi) says

A great explanation of CRISPR Cas9 that recounts the research that uncovered it and makes a case for determining how we will responsibly control and wield this powerful tool in future gene editing. The ethical and moral questions are very difficult, and Doudna/Sternberg don't pretend to have solid answers, and instead encourage more discussion and, above all, communication because governments and society as a whole will have to drive policy (and they should do so in an informed way).

This was riveting all the way through. Incredibly timely and the sheer speed of this breakthrough is amazing and terrifying - adoption of CRISPR worldwide has pretty much outpaced discussions and policy-making. It's also very heartening to hear about scientists who deeply care about the repercussions of their work and will step out of their comfort zones (and labs) into the arena of policy and politics to get the conversation started.

I think this a must-read for people following genetics, but also for anyone interested in how science is truly global... and this is one real technology that in its implications and far-reaching consequences feels like science fiction.

Andrew says

Pretty dry and hyper-technical (or at least poorly explained) re: the details surrounding the CRISPR discovery and how CRISPR works: I learned much, much more from Siddhartha Mukherjee's "The Gene" re: genetics in general and what all this DNA/RNA stuff does (which then makes understanding CRISPR relatively straightforward). The rest of this book, concerning all the ways CRISPR is (or will be) being used, was much more interesting and worth reading.

If you're interested in CRISPR but don't want to get bogged down in the technical details, I would recommend just doing some googling for stories on CRISPR by "The Atlantic" and then skipping to section two of this book after you understand the CRISPR mechanism.

Also, the lawsuit concerning the proper patent holder for CRISPR hangs heavy over Section 1 - it's painfully obvious the author is using those pages as part of her argument (FWIW - as a lawyer with a strong interest in genetics and a thorough understanding of CRISPR and the patent dispute, I think (and hope!) Jennifer should win).

Mary says

If you want to learn about the future of gene therapy and gene editing, read this book. It was published in 2016, and things are moving quickly in this field, but the basics, the problems, and ethical concerns are addressed here.

Written by leaders in the field Dr. Doudna and Dr. Sternberg, it provides clear and concise explanations. I did need to go back and refresh what I may have learned and forgotten about bacteria or I may just have been learning about the developments that have taken place in the field since my college biology days.

I read this hoping for some information and insight as to how close scientists are to finding the cure for Cystic Fibrosis. It seems to me that the fix for children not yet born will come much soon than for those living with this fatal systemic disease. But we can hope. Science is amazing.

Dillon says

I want to say this book is a must-read. It is really, really good. The scientific explanations are concise and

distill what I'm sure are really complex processes into something digestible - and does a much better job of this than Siddhartha Mukherjee's book, in my opinion. The technology of gene editing is going to have some serious ramifications in perhaps the near future. Jennifer Doudna gives a future with gene-editing a thoughtful treatment and encourages us all to understand and be a part of the discussion, while trying a really exciting story of the technology's discovery and development to date.

Bria says

I won this book in a Goodreads giveaway! Definitely a subject I'd be interested in but maybe I wouldn't have pursued it otherwise, so thanks Goodreads.

Me being me, I found myself turned off by the personal element of the book. It's a good writing technique - it personalizes all the scientific information, which could be otherwise dry or hard to follow for some readers, and lends a natural timeline around which to structure the unfolding of the tale of CRISPR. So, objectively, very well done. Subjectively, I don't particularly want to hear about the story of anyone's life as it relates to and has been changed and affected by this technology. Why I am a curmudgeon like this, I do not know. But I guess the only legitimate complaint I could actually come up with is that the illustrations seemed pretty pointless and not very illuminating.

But other than that, I was fooled into thinking I had a pretty decent understanding of how CRISPR gene editing works and the surrounding fields in which it lays, which definitely speaks of clear science writing. And though I sort of fussed and fumed over Doudna's frequent laments of 'oh what have I wrought' throughout the book, she came together at the end with a beautifully measured summary of the relevant issues. The frequent laments served to put her on the side of the hand-wringers and others with concerns about the downsides of the use of this technology; starting from a point of disquiet she walked us through a calm and informed discussion about many many things to take into consideration, addressing common objections people might have with sensible responses - for example, pointing out that all new technologies, such as computers and cell phones, were once prohibitively expensive and thusly reserved for the rich, but this only enabled the technology to improve to the point of being affordable for everyone, rather than resulting in a technology gap between haves and have nots. She successfully exemplified everything she is hoping to have in a conversation about how to actually discuss a complex issue that consists largely of trade-offs. For this, I suppose I will forgive the slight hysteria of the title.

Mehrsa says

This is simply amazing research and I am in awe of Doudna. The book is really sciency, which is good, but I was less interested in the play by play than in the possibilities (no, I am not a scientist). Nevertheless, a great read.

Clif Hostetler says

This book's coauthor, Jennifer Doudna, together with Emmanuelle Charpentier published a seminal 2012 paper that demonstrated that CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) could be used for programmable gene editing. The whole field of CRISPR has since become the hottest focus of

biological research because its use now provides a relatively low cost and simple way to make precise changes to the double helix DNA strand.

This book is written in the first person voice of Doudna and first tells of her academic training and how she came to learn about CRSPR. Then the book provides a short history of the development of gene splicing techniques. Various methods of gene targeting and splicing had been developed (TALEN and ZFNs) prior to the discovery of CRISPR, but they were difficult and expensive procedures.

The book then reviews possible future applications of CRSPR in congenital and infectious diseases (cure MD and prevent AIDS), medicine (immunological targeting of cancer cells), surgery (growing human compatible organs for implantation), zoology (bring back the wooly mammoth), entomology (get rid of mosquitos), and agriculture (disease resistant super crops). Science is in the early stages of research that will bring these applications into popular use, but it seems that almost anything imaginable may be possible. The applications listed above within parenthesis are examples selected from the many discussed by this book.

The book also describes various possible means of delivery. It also discusses the difference between making changes outside (in vitro) versus introduction of change agents directly to a living body.

Toward the end of the book Doudna discusses her role in organizing the first conferences to discuss the ethics of making changes that will be inherited by future generations (a.k.a germ-line modification). Humans now can influence the future evolution of species, including humans.

The discussion of possible future changes that might be desired by humans beyond the eradication of congenital diseases can lead to unexpected possibilities. One hilarious possibility that caught my eye was the ability of reduce underarm odor (a known simple change to the DNA is known to make a difference).

The history of the discovery of CRISPR reminded me of the following quotation:

> The most exciting phrase to hear in science, the one that heralds new discoveries, is not
> “Eureka!” (I found it!) but
> “That’s funny …”?
> — Isaac Asimov

It's my guess that the initial observations of the existence and biological use of CRISPR may have included a version of the above quotation.

What was so strange about CRISPR is that it appears in all biological families including Archaea which means the pattern developed extremely early in evolution. Its persistence and prevalence must mean that it is essential for life, but in the early years after its discovery its possible purpose was a mystery. It even had been thought of as "junk" DNA since it seemed to serve no purpose.

Another "aha moment" came in the early 2000s when a yogurt manufacturer in Denmark noticed that their bacterial yogurt cultures were able to steal bits of DNA from attacking bacteriophages and use them to make themselves immune from attack. CRISPR appeared to be used in finding the locations on the DNA strand to be changed. It was this and other papers at this time that alerted the research community to the fact that CRISPR appeared to be nature's own method of making gene edits at precise locations.

It can be argued that the possibility of controlling biological evolution may prove to be the most significant scientific breakthrough ever made toward the relief of human suffering. Of course, there may be unintended consequences.

The following link is to an article about UC Berkeley's lawsuit challenging MIT's Broad Institute's CRISPR patent:
https://www.theverge.com/2017/4/13/15...

Nikki says

If you haven’t heard of CRISPR before, chances are you’ll be hearing of it again pretty soon. It’s starting to be used in clinical trials to edit the genes of human embryos, and it’s already being used in countless research projects. It’s an amazing tool which could completely revolutionise gene editing, allowing very precise changes to be made with very little unintended impact. Doudna is one of the people who has been involved in developing CRISPR and recognising its potential, and her book covers exactly how it works and the potential it has — and some of the philosophical questions around how we’re going to use it.

The explanations of how CRISPR works are perfect: clear and precise, along with diagrams which help elucidate the processes described. Even if you already know a little about CRISPR, this account will probably help you understand just how it works and why it’s so revolutionary.

As far as the ethics/philosophy goes, Doudna says nothing particularly revolutionary. (It’s very much framed as her book, despite Sternberg’s involvement.) What struck me especially was her conviction that this is a decision that has to be made by people in general, not just scientists — it’s something I agree with very much, and why I have a science blog of my own.

An important read, I think — even if you’re not hugely into science/gene editing.

Reviewed for The Bibliophibian.

Kerry Oliver says

The biology of CRISPR/CAS in book are well done, but the ethics of its use less so -both in terms of clarity and thoughtfulness (not surprising given authors' background), but also some very wishful thinking (including little consideration of the inevitability of the race to the bottom (due market forces and large differences in regulation among countries). nonetheless, cat is out of bag, so the limits of the technology will ultimately decide where this goes.

David says

This is a wonderful book, written by the scientist who discovered that the CRISPR reaction could be applied as a powerful gene-editing tool. In the first half of the book, Jennifer Doudna writes a powerful story about the history of gene manipulation and eventually, gene editing. With this technique, scientists can edit an *individual DNA letter*, replacing or inserting mutation or error in the DNA code. The first half of the book is very technical, and I cannot say that I followed it completely. The book is illustrated with numerous diagrams, but unfortunately, these diagrams did not shine much insight into the discussion. I am not really sure why they were included, at all.

The CRISPR reaction is a method that evolved in bacteria, to defend against invading viruses. Jennifer Doudna, in collaboration with other scientists, discovered how that very method could be used to edit genes with very high efficiency. Moreover, the method is relatively simply, and does not require an expensive laboratory.

The second half of the book is much less technical in nature. First, the book describes a number of successful uses of CRISPR, in the manipulation of genes in plants, animals, and even in humans. Then the book changes course somewhat, and describes the ethical dilemmas that await society, as we discover the capabilities and limitations of gene editing. These dilemmas will occur when attempts to edit the human genome are begun in earnest. What will be the unintended consequences? The techniques have the greatest promise in curing genetically inherited diseases, like sickle cell, Tay Sachs, some types of cancer, and many others. Right now, there is the possibility that CRISPR might edit no only the intended DNA sequence, but other DNA sequences as well. Perhaps in time, such problems will be overcome.

I just love books by scientists who have been at the forefront of research--provided that the books are well written. This book certainly qualifies, and I whole-heartedly recommend it to anybody who is interested in the new revolutionary advances in the forefront of science and medicine.

Rakesh Nair says

http://science.sciencemag.org/content...
This was the ground breaking paper (not sure if I should post the link to the full article here) published by the authors of this book along with other researchers that made way for a technology that has alarmed scientists with its potential to the extent that comparisons with nuclear fission are ubiquitous. Being in an unrelated field of Engineering, the scientific article was difficult to fully comprehend over the years since it was published, but having read this book I have found myself able to truly appreciate the incredible potential associated with this technology and exactly why it has scientists concerned across the globe.

If you are reading this review and are even lightly inclined towards science and can tolerate non-fiction, read this book. Public awareness about such topics and what they entail from a scientific perspective as soon as possible is the best way to avoid getting swept-up in the social media galore created by groups claiming things similar to 'evolution is wrong' or 'vaccines cause autism'. As an upside the book is also well written and goes into just enough details that most people should be able to understand it. Compared to this book there are bestselling thrillers that have invoked less of a thrill.
