Welcome to the Science Podcast for July 9th, 2021. I'm Sarah Crespi. Each week we feature the most interesting news and research published in Science and the sister journals.

First up this week, Editor-in-Chief Holden Thorp talks with journalist and author Patrick Radden Keefe about the role scientists, regulators and physicians played in the release of OxyContin and the opioid crisis in the US.

Next, researcher Katelyn Baumer is going to talk to me about 3D printing proteins using candy. Finally, book review editor Valerie Thompson takes us on a journey through some sciencey summer reads, from the future of food to a biography of the color blue.

Underneath the COVID-19 pandemic, another epidemic continues in the United States, the opioid crisis. Science's Editor-in-Chief Holden Thorp talks with Patrick Radden Keefe about his book, Empire of Pain, which mainly describes how the practices of Purdue, the OxyContin maker owned by the Sackler family, worsened the opioid crisis. In this discussion, they tackle what role scientists played in the drug's development, approval, and the very slow turnaround on its safety.

Congratulations. Everybody's talking about this book and it's outstanding, so.

Thank you so much.

And I appreciate the chance to get to talk to you. In a way, this is kinda like a lab accident. In a lab accident, something blows up in the lab and there was always a graduate student in there that knew it was unsafe, and it seems to me that there are a lot of scientists and physicians that were working for Purdue who probably knew that this wasn't going to end well. So I'm going to sort of go through the chronology a little bit, just to set the stage, and I think one thing that is surprising to a lot of people who may just come to this story with your book is the amount of codeine that's in an OxyContin compared to other painkillers that people think of as strong painkillers.

The real innovation in OxyContin wasn't the "Oxy" part, it was the "Contin" part. That had been developed actually with an earlier drug called MS CONTIN, which was a morphine pill. If you look at the whole history of this one drug company, Purdue, that's the one big innovation really that isn't marketing, everything else is marketing, but the one real innovation was this Contin codeine system, and the idea was that by regulating the flow into the bloodstream of the narcotic in a controlled, continuous manner, they could administer larger doses of opioids than would have been possible in the past.

What happened in morphine, in the case of morphine was that it meant that you could actually take the drug at home, so people didn't have to be administered morphine in a
hospital environment, and this was primarily cancer patients. With OxyContin, what it meant was that you could take oxycodone, which is the only active ingredient in the pill, and administer it in much, much larger doses than had been available in the past. So in the past, you'd have really quite a small dose, whereas with OxyContin, you're not just talking 20 milligrams or 40 milligrams, but 80 milligrams, and for a time they had a 160-milligram pill available, and the idea was that that meant that you only had to take it twice a day, you'd take it once every 12 hours, and that it would slowly filter into your bloodstream, and as a consequence, you could take safely these mammoth doses.

0:03:43.4 HT: What's the rationale for giving so much more?

0:03:48.1 PK: There were other treatments that were available in dosage strengths where you would take them every four or six hours, or eight hours, for that matter. So here's one we can take every 12 hours, and so that's a big advantage because it means that patients can sleep through the night. From a marketing point of view, that's a huge and promising hook. Maybe not so true in practice for a lot of patients, a lot of patients actually found that the pain started coming back after eight hours and it didn't last for 12 hours, and that had pretty dangerous repercussions, but that was certainly the marketing pitch.

0:04:17.6 PK: And then the other idea is that, particularly with opioids, the body does develop a natural resistance in which you need greater and greater doses to feel equilibrium. So if initially 20 milligrams every 12 hours is enough to make the pain go away, if you take that for long enough, it's not going to be enough. This is very analogous to the heroin addict who is always trying to chase the euphoria of that first hit and you have to take ever-ever greater doses in order to do so. And so what this meant is that Purdue could encourage physicians to, as they said, titrate up, which means graduate the size of the dose, and fortunately for them, they had this array of doses that they could offer, so if you had a patient for whom 40 milligrams wasn't doing it anymore, then 80 milligrams becomes an option.

0:05:11.3 HT: Now we get into some of the science that either didn't get done or got glossed over, so you talk a lot about how this 12-hour release either never was real or they thought it was real and then figured out it wasn't, but didn't do anything about it. How come there wasn't a more rigorous study done of that that had more influence?

0:05:30.0 PK: You've asked exactly the right question. In many instances, it's not the studies that were done, it's the studies that weren't. I think that if you look at the history of the development and marketing of OxyContin, that's very often the case, is that you had crystal clear commercial imperatives for developing and marketing and positioning the drug in a certain way, and a series of what I would think of as pretty clear disincentives from a commercial point of view, to ask the tough questions about, does it really last 12 hours? Do people start going into withdrawal after eight hours? Do some patients start doing so? Is it addictive?

0:06:13.0 PK: There were no studies done of the potential for abuse prediction of the drug before it was released. There was a kind of, I think, a wishful thinking, in part, probably driven by commercial greed, in part by ambition. In part, I would argue, actually, by a certain idealism, that the company hoped that they could crack the code on opioids, these drugs that we've known for
thousands of years have important therapeutic benefits, but also really significant downsides, and I think that the hope and the ambition of Purdue was that they'd packed it, they figured out how to create and market an opioid that didn't have the really serious potential for addiction, and of course, we know now they were wrong.

0:06:58.8 HT: And why didn't the FDA make them do more of that kind of thing?

0:07:04.0 PK: Well, the role of the FDA, and this is really fascinating. David Kessler, who was the head of the FDA at the time when Purdue got its approval for OxyContin, has said that, "The destigmatization of opioids in the American medical profession, which Purdue is a really significant driver of, is one of the great mistakes in modern medicine." That's the quote from Kessler. To me, this is a story about total system failure, a story about all of the institutional safeguards that are supposed to protect consumers breaking down in one way or the other, and I think at FDA there was a willingness to take the company at its word, to buy what the company was selling in terms of the marketing pitch, and more perniciously I tell the story in the book about the chief medical examiner at the FDA who signed off on OxyContin saying it was both safe and effective to be sold in the United States, but also approving some of these marketing claims, which in retrospect turn out to have been totally bogus.

0:08:05.6 PK: About a year after approving the drug, he took a job at Purdue for three times his government salary, so there's different words we could use to describe that phenomenon. I think corruption would be one of them, but certainly there appears to have been a conflict of interest there.

0:08:20.9 HT: And that's one of the people outside the company that could have stopped it, but there had to have been chemists and formulators and pharmacologists and regulatory people inside the company that saw all this coming for a long time.

0:08:38.2 PK: One of the real oddities of this story is the absence of whistleblowers. You would expect that, precisely what you described, people to come forward, to quit in protest, to try and alert the authorities. And there's not a huge amount of that along the way. I think there are few reasons for this. I think some of it is that this was a not a publicly traded company, this was a closely held family-owned business that had been owned by the family dating back to the 1950s, there were a lot of loyalists inside the company. There was an aspect of the company culture in which people thought that if you were loyal to the family and did what the family wanted, they would reward you. There was an almost Mob-like discussion about people taking the fall for the family and the family will take care of them later, and the family was very, very invested in OxyContin, doing all the things that they hoped it would do.

0:09:34.3 PK: Some of it, I do think is a matter of idealism and a certain kind of positive reinforcement, where you have to remember, there was sort of a re-assessment in the American medical profession of pain, particularly during the 1990s, and OxyContin was very much a part of that, but what that meant is that you had a lot of physicians saying, we have not been taking pain seriously enough, and we need to be more aggressive in figuring out how to treat it. And I actually think as a critique that was quite correct. The problem is that there was a vacuum of expertise, that pain was not something that was really taught in a serious way at most medical schools, and into
that vacuum rushed the industry, rushed big pharma, rushed companies like Purdue.

0:10:16.7 PK: And so a lot of the education that clinicians got in dealing with pain came care of pharma companies that had painkillers to sell. And so I think that what this meant was that for a lot of the scientists who worked at Purdue, there was a genuine sense that we're helping people. And that was reinforced, particularly in the early years, by these letters that would come into the company from patients who would say, "For the first time in memory, I can pick up my grandchild. I can go back to work." "You've given me my life back" was the line that they would always repeat. And so then I think you end up with a kind of collective wilful blindness by a lot of people who worked in the company where there's this beautiful idea that they're going to do right and do well, help millions of patients, make billions of dollars, there's no fly in the ointment, there's no downside.

0:11:06.9 PK: And to me, the really interesting question is how they dealt with it, or refused to deal with it, when the world started coming back to them and saying, "No, actually, this product is not as beautiful and uncomplicated a proposition as you have suggested."

0:11:22.9 HT: Right. So we talked about the FDA, but then there are lots of physicians who are having experiences with this. What happened when they tried to come forward?

0:11:32.3 PK: So there was a real range in terms of the physicians. You have physicians who are just criminals, it turns out, quite a few of whom, many of whom ended up in jail, who set up pill mills and were writing prescriptions left and right, and were driven really largely by, I think, a kind of criminal desire to make money. You had a great many physicians who I think were at best naive about the complexities of a drug like this. I've interviewed many physicians who said, "Listen, when you encounter a patient who's in pain, you want to help them, you want to relieve that pain, it's a big part of the job, it's why you got into medicine."

0:12:10.8 PK: So there was a fool's gold aspect of this, where I think a lot of docs when presented with this drug that could potentially relieve that pain jumped at the opportunity to prescribe it, even though they weren't necessarily thinking through the downsides, and it was very often the case that they had learned how to get people on these drugs from the drug companies, but nobody had ever taught them how to get people off these drugs. And then there were doctors who did blow the whistle from early on. I think in many instances, it was physicians who were in communities that had been really ravaged by the drug, and they organized, they wrote letters, they pushed the FDA to change the labeling, they reached out to authorities, they reached to Congress, they were really kinda screaming it from the rooftops.

0:13:00.4 PK: And I think the company did its best to neutralize these people and shut them down. To me, the harshest measure that you can take of Purdue and the way it behaved is actually not the decisions that were made prior to the launch of OxyContin, it's how the company dealt with it when the things started to go wrong.

0:13:18.1 HT: They were already starting to make a lot of money by then, so...

0:13:22.2 HT: That made it hard. Yeah, one other thing, this is outside the scope of your book, but ERs usually don't have enough psych support. When I was a provost or a chancellor, I used to go shadow the ER doc for the night, of course, there's tons of people coming in saying they have this pain or that pain, and there's not an obvious way to get the psych doctors to come in and say, "You're here for a different problem."

0:13:48.7 PK: Right.

0:13:49.3 HT: And so the silo, the stove-piping of medicine is a complicating factor, I think.

0:13:54.0 PK: I think that's right. I think there's a couple of other things that fit in with that. One is, and this is a story I try to tell in the book that dates back far beyond OxyContin, but the original three Sackler brothers in the 1950s had this, I think very American sense that if the chemistry is good enough, there's no human problem that cannot be fixed with a pill, that there's a silver bullet out there just waiting to be invented and patented and sold. On the one hand, I admire the inventive entrepreneurial gusto that drives that idea; on the other hand, I think it's a really dangerous idea, and I think when you look at the economics of medicine as it's practiced in the United States, a quick solution that will get somebody out of that ER is often a really appealing one, and the doctor who's writing that prescription is not necessarily going to give much thought to what might happen three weeks, six months, two years down the road to that patient as a consequence of whatever script has been written.

0:14:56.7 HT: Yeah, they're just trying to get to the next room.

0:14:58.9 PK: Exactly.

0:15:01.4 HT: Yeah. So what does all this say for scientists working in big pharma? You make it very clear, and I agree, that the Sacklers deserve most of the blame for this, but what's the responsibility of scientists who were working in the pharmaceutical business to foresee and contemplate all of this in addition to just being able to implement the technology?

0:15:24.9 PK: I think it's really significant. I mean, this is a public health crisis now, in which half a million people have died. You have two plus million Americans now who are struggling with addiction to opioids. It's an enormously complex issue, but I do think the crisis has many fathers and mothers. If you are a scientist working in that field, I do think that you have an individual moral responsibility to look at the kinds of decisions that are being made and the incremental compromises and the little lies that are told, and the lies of omission, and think about what those might add up to. 'Cause the thing about the opioid crisis is, half a million people have died, but it's taken 25 years, it's been a slow-moving crisis. There have been all these different junctures along the way in which concerned people with a conscience who could see what was happening could have stood up and said something and very, very often did not.

0:16:20.9 HT: Last question, which ties all this together, there is a lab accident that is part of the
story that happens at a Purdue facility that gets glossed over. So are there parallels between that and the glossing over of how OxyContin is dangerous?

0:16:38.8 PK: Yeah, absolutely. I'm so glad that you raised that because it's an episode in the book that a lot of people don't pick up on because it's not a pharma part of the story as much. But to me, that episode is a little metaphor for everything that came later. You have a chemical plant in which there are all kinds of corners that have been cut in the interests of profit that create a situation in which I think there is a significant foreseeable hazard, and then the hazard happens in the form of a massive explosion that kills five people and injures dozens of others.

0:17:16.0 PK: And when it does, the company does everything it can to mitigate its own responsibility. The family that owns the company, and that was sort of driving that push for profits, accept no responsibility whatsoever. They don't go to any funerals, they don't even make any expressions of regret. Their point of view is, what does this have to do with us? The company ends up abandoning the site and moving out of the town, so all of the employees who were lucky enough to survive the accident lose their jobs. To me, that was in a nutshell, a story of the ways in which a relentless drive for profit can blind people to the seriously dangerous consequences of some of the risks that they're undertaking.

0:18:01.0 HT: Thank you so much for doing this, and congratulations.

0:18:04.4 PK: Thank you.

0:18:05.1 SC: That was Science's Editor-in-Chief Holden Thorp talking with Patrick Radden Keefe about his new book, Empire of Pain. You can find a link to the book and the editorial at sciencemag.org/podcast. Stay tuned for Katelyn M. Baumer. We're going to talk about printing protein structures in candy form as a study aid.

[music]

0:18:31.9 SC: The paper we're going to talk about next actually came out a few weeks ago in Science Advances, but we couldn't fit it in this show that week, there wasn't room in the line-up, and I definitely didn't want to miss it, so here we are. The topic we're going to talk about: Printing 3D candy models of proteins. Katelyn Baumer, a PhD student at Baylor University, is here to talk about why. Hi, Katelyn.

0:18:54.7 Katelyn Baumer: Hi.

0:18:55.9 SC: So why would one want to print 3D models of protein in candy form?

0:19:01.6 KB: So the idea in 3D printing these was to have something tactile that blind and visually impaired students would be able to feel and get an idea of what their sighted peers are used to looking at on a daily basis. Blind and visually impaired children really aren't able to access the imagery that we typically use in chemistry and biochemistry courses through high school on, through college and graduate school if they're to go, especially because this imagery is a lot of time
what sparks interest in younger students for science and kind of keeps them going. And with making these out of candy-like material, we thought that these could go in the mouth, because the mouth is really under-utilized as a tactile sensor compared to the fingertips, even though it's more sensitive than fingertips.

0:19:49.0 SC: How are you able to print candy in such a complicated shape?

0:19:52.8 KB: We 3D printed actually in just a plastic resin, and then created silicone molds from the 3D printed models that we injected with a mixture of jello and a little bit of water and some extra corn syrup to make it nice and strong structurally.

0:20:09.9 HT: So it's a gummy candy and it has a very intricate surface?

0:20:13.4 KB: Yes, it does. The surface features of these range from about 2 to 4 micrometers across, so they're really tiny, but you're able to feel them when you put them in your mouth. As we were kind of developing these, we would all put one in our mouth every now and then, just to make sure. We were always blown away by how much detail we could sense.

0:20:33.9 SC: Yeah, I was really surprised about the size of the mouth versions of these printed structures, that they could be so much smaller than the handheld versions. Compare the larger version that you tested to a peanut and the smaller version to a grain of rice. Can you talk a little bit about why it's an advantage to print things like this so tiny?

0:20:55.6 KB: A typical biochemistry textbook has thousands of images in it, and to give a student that many 3D-printed models at a typical size, they would need buckets, fill an entire trunk of a car, it would be absolutely insane for them to try and carry around that many models. So a big part of it's portability, in that a student would be able to have way more of these models than a standard size, and the other big advantage is cost. The resin for 3D printing isn't super cheap, but when we're printing models this small, it's only a few cents per model.

0:21:29.8 SC: How did you test if these shapes were recognizable or memorable for students? How do they compare the ability to sense a shape with the mouth versus hands or with eyes?

0:21:43.9 KB: So we had a few different groups of students. We had one group that was only tested visually, and they were given a PowerPoint with images of these structures that filled their computer screen, so they were pretty large, that we're spinning across both axes. They could observe that for a minute. They were given a study protein that they were asked to really learn the structure of for three minutes before we started with the actual test, and then they were given one minute and asked if the protein was the same or different than the test protein that they were given originally.

0:22:16.6 KB: We compared whether they were able to recall the structure again. We used the exact same testing format for mouth and fingers, but in that case, students were brought in two separate times a few weeks apart.
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0:22:28.1 SC: They were masked, so they couldn't use visual cues?

0:22:32.4 KB: Right, so they had just little sleeping masks over their eyes just so that they couldn't be biased by anything they might notice at first as they were looking at these, and they were in very small containers, so that those of us giving the test could walk around and hand the model to the student without them having to physically touch it beforehand when they were having the oral testing.

0:22:53.5 SC: Well, when you compared their recall, students that were exposed to the visual, exposed to via mouth or exposed via hand, how do they stack up?

0:23:02.0 KB: One of the most interesting things we found in this was that the students were able to recall these structures just as well with their mouths as the students who were tested visually, which was a huge deal. Since the visual is kind of a standard, that's what most people are doing. About 30% of the students had equal recall with their fingers and their mouth. This is probably because we could have pushed the limits even further, so even smaller models potentially could have been used, allowing for a bigger differentiation between the two, but a lot of students had perfect scores with both their fingers and their mouths.

0:23:42.2 SC: I also noticed in the study that you used mouth models that were edible and some that were not edible that you could re-use, I guess. Why did you choose to compare those things?

0:23:53.6 KB: Part of this was just to make sure that the edible versions of the models were consistent and performed just as well as the 3D printed, make sure we weren't losing any of that resolution with the edible models. But additionally, again, just for ease and cost reasons, the reusable ones you could potentially give a set to a student, them carry it around for the entire school year, use what they need and then thoroughly sterilize those and give them to another student the following year.

0:24:21.5 SC: This point comes up later in the paper, the idea that so much of biochemistry, protein biology is inaccessible to our eyes, we use all kinds of tools to make pictures of these things because we can't actually see them, so we're just preferencing one modality over another.

0:24:40.0 KB: Yeah, exactly, so even when we are looking at a protein structure on the screen that we've downloaded from the Protein Data Bank, that's still a model, that's just the model that we've defaulted to as biochemists, and these tiny itty-bitty models are much closer in size to an actual protein, but still orders and orders of magnitude larger, of course.

0:25:00.2 SC: Do you think this is something that sighted students, students with visual impairments, should both use? Do you feel like there's an advantage no matter what's going on with your vision?

0:25:09.1 KB: Absolutely. So I remember when I was an undergraduate student going through organic chemistry, the ball and stick molecule sets that we would use were a huge help to me, and I kind of wish I'd had these when I was going through biochem, when you're starting to learn about
protein structure and folding. It's hard to tell exactly what's going on when you're looking at a 2D image, even if it is spinning around and you can manipulate it to see the whole thing. And these small models, especially since students are able to tell what they are just as easily with their hands and mouths as they are their eyes could bring a huge advantage to students learning protein structure for the first time.

0:25:47.8 SC: Do you envision teachers and students using their own printers or is this a mass production scheme where you can make them and sell them in little boxes?

0:25:57.4 KB: Either of those are totally feasible. So the 3D printing process is actually really easy. With the 3D printer that we use, you simply upload the files and click go, but it also could be something that our lab or a larger mass production facility printed out tons and tons and tons of these in bulk and then ships them off. Either of those would be very easy to do.

0:26:20.8 SC: Can you tell me some of the proteins that you modeled this way?

0:26:23.2 KB: We used a few sets of allosteric conformers, so we used hexokinase with and without glucose-bound. Apo and holocalmodulin, so calmodulin with and without its calciums, maltose-binding protein with and without maltose, and we also used superoxide dismutase, carbonic anhydrase and myoglobin.

0:26:42.0 SC: And you must be an expert by now. Can you tell them all apart with your mouth?

0:26:46.5 KB: I can. The trickiest ones are the two conformers of maltose-binding protein. Sometimes with the itty-bitty models, those are hard to tell even when you're looking at them and you've been staring at them for an hour.

0:26:58.4 SC: We talked about ball and stick models for studying molecules. Do you think that that should also be something that people are putting in their mouth?

0:27:07.9 KB: This isn't limited to biochemistry, this could go forward into the organic chemistry side of things with those small ball and stick molecules, into cell biology with organelles. There's a lot of different things this could be used for. We kind of stuck to proteins because that's our wheelhouse, we're biochemists by training, so that's what we already knew.

0:27:26.7 SC: I wanted to get a little bit into the motivation for this research. This is something that the lab that you're in, Dr. Shaw's lab, has been doing for a while now. Can you talk about how it started and where it's going?

0:27:37.2 KB: This actually started before I got to Baylor, and Dr. Shaw just hyping it up to me when I was going through the grad school recruitment process is one of the reasons I wanted to join his lab. And he always loves to tell the story of how he got the idea for everything where his son Noah had retinoblastoma, and at one of his birthday parties, they had invited some other family friends of theirs that also had children with retinoblastoma, and one of the kids that was at Noah's birthday party had lost both of his eyes during his treatment and was kinda crawling around Dr.
Shaw's backyard and kept picking things up and putting them in his mouth.

0:28:09.6 KB: And Dr. Shaw noticed it and was like, "Oh my goodness. This is something we can be doing. This kid wants to explore everything using his mouth, we need to take advantage of that." So that's really neat and kind of how it came to be. In terms of where it's going, we currently have a few of the undergraduate students who are also authors on this paper have put in some really hard work to kind of expand this even further, and they've been trying to print up some organelles so that we can branch out of pure biochemistry and get into another few areas. And we've also sent off models to a few schools, hoping that a few teachers can start implementing these in their curriculum.

0:28:50.0 SC: Wonderful. Alright, thank you so much, Katelyn.

0:28:52.3 KB: Great, thanks for having me.

0:28:54.5 SC: Katelyn Baumer is a doctoral student in the Chemistry and Biochemistry department at Baylor University. You can find a link to the Science Advances paper we discussed at sciencemag.org/podcast.

0:29:05.8 SC: Don't miss our summer books round-up next with book review editor, Valerie Thompson.

0:29:16.7 SC: First up this week, we have a round-up of summer science books with books editor, Valerie Thompson. Hi, Valerie.

0:29:23.7 Valerie Thompson: Hi, Sarah.

0:29:24.3 SC: We're going to talk about some fresh books, basically, these are coming out at the beginning of summer, and if you want to read something sciencey, there are some really good choices. There are maybe too many options, excess information, Valerie. I'm actually hinting at the first book, this is The Ascent of Information: Books, Bits, Genes, Machines, and Life's Unending Algorithm, but an astrobiochemist, Caleb Scharf.

0:29:50.6 VT: Yeah, so this book actually examines the deluge of data that we produce every day, which the author calls the datome, and it describes how it's changing us just as we are changing it. And we're not just talking about computer data, it's every sort of schematic and record and catalog you can think of.

0:30:08.4 SC: Don't forget tweets, selfies, memes and Tiktok.

0:30:11.6 VT: Oh, yeah, yeah, of course. So the author talks about how data has always existed in one form or another, but humans today are producing a lot more data than we have in the past, and like you said, all of these emails and tweets, they have a very real cost. Some estimate that by 2040, the world's computer chips will demand more electricity than is expected to be produced globally.
Oh, boy.

Yeah, so this author argues that we need to start treating information as a natural resource and it can't be extracted, refined or used without cost, which is kind of a new way to think about data, and one I don't think that we have traditionally thought about data in that way.

Maybe cut back on some of your summer photos.

Yeah, exactly, exactly. Or at least be conscientious that each of those things has material cost to the world.

Right, Valerie, this would not be a books round-up if we didn't talk about a food book. I love this title. Technically Food: Inside Silicon Valley's Mission to Change What We Eat. This is by journalist Larissa Zimberoff. I love Technically Food, because it makes me think of the controversy over cheese food or must be at least 10% juice, but this is way beyond that.

The title is perfect. So the book explores the latest trends in food tech, so cultured meat, AI-laden urban greenhouses and kind of gives readers an inside look at the progress that's being made in various sectors, meatless meat and chickenless eggs and non-dairy milk, things like that.

And that's really where the technology comes in, we're really starting to see leaps with cellular meat and things like that, where you don't actually have to have a living animal at the beginning of the process.

Yeah, and it's really interesting too, because high-tech foods are often lauded for being better for our health and for the planet, but they're often really highly processed and they're often produced using proprietary methods, and so there's kind of a lot to unpack with regard to the scalability of these things, how healthy they really are, their environmental cost.

Is there anything in there that you wanted to try? It's kind of fun, 'cause the book is like a travelogue, or she visits with food scientists and the people behind the startups that are trying to disrupt food, and so she tries all these strange foods. One that I found very evocative was her description of the yogurt made from peas, which I think there's a lot of protein in peas, and so there's a lot of interest in turning peas into various food products, but it sounds like the yogurt maybe is not quite there yet. I think we have a little ways to go.

What's next, though? What are we going to see after we get meat from labs regularly? What's on the food future frontier?

Yeah, so the book concludes with commentary from 19 experts. The one that our reviewer cited that I thought was really fun was author and animal rights activist Paul Shapiro was talking about what if restaurants could brew their own meat on-site, kind of like a craft IPA, but it would be some sort of craft steak or something.
I really like this next book because it kinda started with the debugging and then just built from there. It's called The Uncommon Knowledge of Elinor Ostrom: Essential Lessons for Collective Action by Natural Resources scholar Erik Nordman. So I guess it's not really a debugging.

It's a biography of a person whose research disproved something that was long believed to be true. This is a biography of Elinor Ostrom, who was the first woman to win the Noble Prize in Economics in 2009 for her work on the policies that govern common resources. Her research challenged the long-held dogma that was championed by ecologist Garrett Hardin in his famous 1968 science essay, The Tragedy of the Commons. In that essay, he argued that in absence of regulation, individuals are going to act in their own self-interest and they're going to deplete shared resources, but Ostrom's research actually proved that people can and do act in collective interests in the absence of formal oversight.

She found something different.

Yeah, so her scholarship was strongly informed by field work, so she did studies of irrigation systems in Spain and Nepal, and mountain villages in Switzerland and Japan, and fisheries in Maine and Indonesia.

Let's talk about the color blue. This book is by one of the news team's contributing correspondents, Kai Kupferschmidt. He's been on the podcast a lot in the last year talking about Coronavirus, but his other hobby is the color blue. His book is called Blue: In Search of Nature's Rarest Color. And yeah, we're talking sky, we're talking oceans, we're talking making pigments, it's a really broad topic.

Exactly, so it's basically like a biography of the color blue, so it touches on everything from mineralogy and Picasso's blue period palette to photonics and the micro-structures that give blue jay feathers their color. It's kind of cool because it answers all of the expected questions, like why is the sky blue, but then it really gets into these deeper questions that are more philosophical, so things like is the sky a social phenomenon, like do we all agree what the color of the sky is, how has that changed throughout the ages.

And my ears always perk up now when I hear about chemists making blue, because I learn from Kai that it's very difficult to make this kind of color.

I didn't really appreciate that either, but yeah, exactly.

And of course, he goes to that debate about how we identify colors, does it influence how we see colors.

This is really interesting to me and something that I didn't know anything about, but apparently Russian speakers are faster than English speakers at distinguishing shades of blue, because the Russian language splits light blue and dark blue into different categories, like how we do green and yellow, and something about that makes them quicker to identify those things. So
there is something to that idea that the way that we conceptualize color is culturally-dependent and language-dependent.

0:36:02.7 SC: Just like the last time we did a round-up, you included a first-person story, A Quantum Life: My Unlikely Journey from the Street to the Stars. Who's this by?

0:36:14.0 VT: This is by astrophysicist Hakeem Oluseyi. Like you said, it's his own account of the story of the challenges that he faced to become a scientist. So he grew up in this unstable home that was shaped by profound poverty. They moved around a lot as a kid. His dad was in and out of the picture. He talks about this drug problem that he overcame that almost derailed his aspirations to become a physicist, and then he also talks about the racism that he faced as a Black grad student at an elite institution, kind of never really felt like he fit in, he was too academically inclined for most of his classmates, but he didn't really fit in easily in academia.

0:36:52.4 VT: But he had this great PhD supervisor, solar physicist Art Walker, who was the only Black faculty member in the Physics Department at Stanford, and he plays a critical role in helping Oluseyi find his footing. And it's nice, it kind of highlights the critical role of mentorship for young scientists, and the writing style is really candid, it's really informal, I don't know, it's very disarming to read.

0:37:14.8 SC: Alright, Valerie. What else should we mention? We kind of talked over some of the highlights from this section. Are there any other books you want to shout out about?

0:37:23.4 VT: Yeah, there's a really nice book by former White House Chief Technology Officer Beth Simone Noveck called Solving Public Problems, and this book explores how we might prioritize human-centered public policies in a variety of sectors, so healthcare, transportation, housing, employment, education, stuff like that. I think folks that are interested in this sector will find this book very useful.

0:37:44.7 SC: And then the last one I wanted to mention is Unwell Women: Misdiagnosis and Myth in a Man-Made World by cultural historian Elinor Cleghorn. So this is a book of a history of how female anatomy and sociology and psychology have been studied and manipulated mainly by men and how these practices have been used historically and currently to oppress women.

0:38:04.9 SC: Alright, well, on that note, Valerie, everybody can check out this list of books on the site at sciencemag.org/podcasts, and maybe pick one up for the beach. Thank you so much, Valerie.

0:38:16.0 VT: You're welcome.

0:38:17.9 SC: Valerie Thompson is the Books Editor for Science. You can find a link to the books we discussed at sciencemag.org/podcasts.

0:38:25.8 SC: And that concludes this edition of the Science Podcast. If you have any comments or suggestions for the show, write to us at sciencepodcast@AAAS.org. You can listen to the show on the Science website at sciencemag.org/podcasts. On the site, you'll find links to the research and
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0:38:47 SC: This show was edited and produced by Sarah Crespi, with production help from Podigy, Meagan Cantwell, Joel Goldberg, and our new intern, Claire Hogan. Transcripts are by Scribie, and Jeffrey Cook composed the music. On behalf of Science Magazine and its publisher, AAAS, thanks for joining us.