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0:00:04.7 Sarah Crespi: This is the Science Podcast for June 17th, 2022. I'm Sarah Crespi. Each week we talk about the most interesting news and research from Science and the sister journals. First up, Staff Writer Jennifer Couzin-Frankel. She shares a snapshot of the current state of long COVID research. We're gonna hear about what scientists think might be causing this lingering illness and some potential ways to treat it. Also this week, researcher Debra Mathews tackles the use of DNA testing kits designed for law enforcement, but also being used on biomaterials for research. In her policy forum, she talks about why this is a bad idea and what should be done instead. And in a sponsored segment from our Custom Publishing Office, director of Custom Publishing, Sean Sanders, asks Bobby Soni from BII for his advice for scientists wishing to commercialize their research.

0:01:06.0 SC: Long COVID is like this rising shadow behind the pandemic. We don't know how big it will be, or the impact it will have on the world. We don't even know why it's happening. Now we have Staff Writer, Jennifer Couzin-Frankel. She wrote this week, she took a stab at trying to figure out the state of long COVID research. Who has it, what might be causing it, and how we might either treat it or even one day prevent it. Hi, Jennifer.

0:01:33.0 Jennifer Couzin-Frankel: Hi, thanks for having me.

0:01:36.8 SC: Oh sure. Yeah, I'm really excited to talk about this. I think it's on a lot of people's minds these days, and I just... It's good to get a view of what is happening this month at least.

0:01:45.6 JC: Yes, [chuckle] this month.

0:01:48.5 SC: [chuckle] I hate to throw what might be the hardest question at you right up front, but what is long COVID?

0:01:55.3 JC: So long COVID, and it goes by a couple of different names, is basically the persistence worsening or sometimes onset of new symptoms after an acute infection with SARS-CoV-2, the virus that causes COVID-19. I would say most doctors tend to define it as symptoms that persist for at least 90 days. People who are still struggling three months, four months, five months, and many would say that they do have long COVID.

0:02:23.5 SC: Right. Brain fog, fatigue, breathlessness, what other kind of common symptoms are associated with long COVID?

0:02:31.6 JC: Probably one of the most common is fatigue, and when we say fatigue it's more than just, "Oh, I feel tired this morning." It's a really crushing disabling fatigue, brain fog, real difficulty thinking, difficulty with cognition is also really common, joint pain, abdominal pain, headaches, heart palpitations or sort of a rapid heartbeat, often breathlessness when exercising and by exercising that could just be walking down the block.

0:02:56.5 SC: How common are researchers thinking long COVID is after infection?

0:03:02.6 JC: The numbers range anywhere from like 10% to upwards of 30%. Many of the studies that have been done so far were done prior to vaccination, or are done in mainly people who are unvaccinated, and there is a lot of uncertainty about whether and to what degree vaccination might change that frequency and that's certainly being studied as well.

0:03:25.8 SC: One of the big questions here, besides what is long COVID, how long does it last and is it gonna stick around forever, what exactly is causing it after acute infection? So what are people doing to try to figure out a cause?

0:03:41.5 JC: To answer what is causing long COVID, there are a few steps. So first of all, we have to show that some trait is unique or far more common in people who have long COVID than in other people. Now the challenge is, that even when you figured that out, that doesn't mean that what you're finding is causing the symptoms. So then you have to do a lot more research and basic biology and other studies to determine that what you found is actually fueling specific symptoms, or all the symptoms, or something. Another way to test that and to understand it is via treatment. So if you give somebody a treatment that eliminates like a biological abnormality they have, and then their symptoms get better, that can help you deduce that that problem is causing the symptoms because getting rid of it made them feel better. You have to almost think like really step by step in how to prove this.

0:04:34.8 SC: One of the main focuses of your piece here is looking at these potential causes that people are starting to investigate. Let's take those one at a time here. The first one I wanna talk about is micro clots.

0:04:46.9 JC: Yeah, so micro clots are a potential cause that are getting a lot of attention right now, to take a step back, we know that acute COVID, people who are really sick, particularly hospitalized with COVID can have blood clots. The virus can attack the cells that line our blood vessels and cause big clots, and small clots, and strokes, and heart attacks, and all sorts of other things. What scientists are starting to see or deduce is that some patients who have long COVID also appear to have blood clots. Now, these are not the big blood clots that you would see on like a CAT scan, these are teeny-tiny clots that are thought to be gumming up the circulation and then causing problems. They're also maybe kind of a propensity for the blood vessels in general to be chronically damaged and that can be affecting circulation and other things as well.

0:05:37.0 SC: If you have this damage to your circulatory system ongoing, what does that look like for symptoms?

0:05:43.9 JC: If you can imagine, if your circulation let's say in your brain isn't running the way it should, you could have difficulty thinking. For example, if it's affecting your lungs, you might have breathlessness. So you can imagine if this is happening all over your body, that it could cause a number of different symptoms. Again, we haven't quite made that link between clots and symptoms, but there's certainly a very reasonable argument.

0:06:07.8 SC: The tricky thing here seems to be that you can't see micro clots exactly. You can't

find them in the body and pick them out.

0:06:15.2 JC: Yeah, so there are a couple of different ways that people are starting to look for them. One is with a very sophisticated kind of imaging study called a SPECT-CT scan, and essentially what it shows you is blood flow in the lungs. There have been several cases now with long COVID patients who've had these scans where we see that often it's one lung, basically has a very limited blood flow. And the presumption is that may very well be caused by these teeny-tiny clots or also possibly by other problems with the blood vessels in the lungs. This whole web of tiny blood vessels that run through our lungs are somehow disrupted in these patients. That's one way to look for this. Another way is to look in the blood. Right now, it's a pretty kind of laborious research method to take blood and analyze it in certain ways. And you can in that setting, kinda figure out if there's a high burden of micro-clots. And so there have been studies that were started by a researcher in South Africa who began looking at this. And she has since teamed up with a number of other researchers around the world to study this. But she has found these signs of excessive clotting in long COVID patients as well.

0:07:25.6 SC: Looking at the treatment side of this, this is obviously way too early to be treating people in mass in this way. But individual cases have been treated with things that prevent clots or remove clots. And there has been some alleviation of symptoms from that.

0:07:38.6 JC: Doctors get a little nervous about this. Because anticoagulants as a class of drug are pretty heavy-duty drugs. They have side effects. And they can also cause severe bleeding in somebody. So you have to be careful. You really want patients doing that under a doctor's supervision. But there have been some people who have been prescribed anticoagulants who have evidence of this abnormal clotting. And those people in some cases have experienced improved symptoms over time. So that is very interesting. And I think there is interest in running trials to study this more rigorously, to really see, is this fixing a problem and fixing the symptoms?

0:08:19.3 SC: Yeah. Another major candidate for what might be causing long COVID is residual virus hanging around in the body. What is the evidence for this? Don't we clear the infection and then we don't have virus anymore, and we don't have the antigen anymore, it's not detectable on test, it's not detectable in PCR?

0:08:40.8 JC: Yes, the virus will clear from parts of the body for sure. But there is now evidence that while it often clears from the blood and the nasal cavity, it can persist in certain tissues. This has come up in autopsy studies of people who died. Actually not all of them even died of COVID. Some of them had milder infections and died of something else months later. And then on autopsy, they were found to have RNA from the virus in all different parts of their body. And that was really interesting to researchers because it suggests that the virus is hanging around. And another area that people are now looking is in the gut. Because the gut, the intestines are a lot more accessible to doctors. It's a lot easier to do that than get a sample of someone's brain or someone's lungs. So the gut is a place to look. And people are now looking there. And those that have looked have found some virus. They're still trying to figure out what the virus is doing exactly. Just because we find it in someone with long COVID, it doesn't mean that it's causing their symptoms. So we have to be really careful. On the other hand, I think it's intriguing to people that we're finding this. And there have been some studies that are finding it more often in people with long COVID than not. So that's

that first step of, "Let's see if this is something that turns up in the long COVID patients and doesn't turn up so much in other people."

0:09:56.2 JC: And once you start finding that, that's a path you can go down. So now what some people wanna do is try and understand what, if anything, this virus is doing. It doesn't matter that it's there. One way to do that, you can take tissue samples and look for the virus, and then you can look at the immune cells that are hanging around around the virus and see, do they have genes turned on and off in a way you wouldn't expect? Are they behaving in a way that seems not what would normally happen? And if you start to see that, then you think, "Well, maybe the virus is doing something."

0:10:27.1 SC: Has there been an intervention approach where they try to get treatment to kill off that virus that's residing in the body and see if that changes anything?

0:10:35.7 JC: It has not happened yet. I think people are hoping it will. There's a question of how do you design that trial. Right now, the anti-viral that's commonly used, Paxlovid is just a five-day course. Is that enough for these patients that would have to be run through the company? It takes a number of steps for it to happen. But I think there is impatience and a hope that something like this will happen as a way to help us learn more about this and see if this is a potential treatment for patients, for some patients, at least.

0:11:04.1 SC: Yeah. Alright, let's talk about the third possibility here that you focus on in your story. And this is definitely not the least likely at all. This is an over-active or kind of an out-of-whack immune system. What indications have been seen that this might be at play in long COVID?

0:11:23.4 JC: Yeah, so this is something that researches started looking at pretty early on, I would say. Part of that gets back to this idea that what does acute COVID do versus long COVID? And we know in acute COVID, in people who are really sick, the immune system can go crazy and become just absolutely hyperactive to the extent that it kills patients. It is a cause of death. So in a sense, it's maybe not so surprising that in long COVID, there could also be these immune abnormalities. And there are definitely groups that are trying to understand that. So what people have been doing is again, looking at patients with long COVID, looking at people who maybe have the virus and recovered, taking their blood and then studying their immune cells in all different ways. They certainly are seeing abnormalities, and importantly abnormalities that persist for many months after the infection, that sort of reflect kind of a state of chronic inflammation, maybe an over-activation of different immune cells. It's like they still think they're fighting something. And they're trying to figure out, "What's going on here? How common is this in long COVID patients? And what can we do about it?"

0:12:30.2 SC: So we've touched on these three kind of main research topics right now, micro-clots, residual virus, immune system abnormalities. Could long COVID be all three of these? Are these interacting? Or maybe some of them, in some cases, acting alone.

0:12:48.2 JC: Yes.

0:12:49.2 SC: All those things.

0:12:49.9 JC: That's the short answer. I would also say that there could be other causes. I picked the three big ones right now. But there certainly are other causes that people are interested in. But absolutely. I think one reason why long COVID is considered so complicated is that it's very unlikely that there's one cause, like blood clots, that explains everything, even in a subset of patients. Most people probably have more than one thing going on.

0:13:14.2 JC: They can fuel each other if you have virus that's hanging around that might activate your immune system, for example, and so there's this interplay among these. And many people think the immune system in particular is overlaid across all of this, so yeah, it's very complicated. And I think one goal of researchers is to try and, if possible, identify subsets of patients. There may be patients for whom micro clots are a big issue, and there maybe patients for whom they're not an issue at all, and we wanna figure out who is who, because that will help us ultimately target treatments, which is really what we need to do at this point.

0:13:49.6 SC: Yeah, and now I hate to do the math and say, we've had this many people with COVID, and so we must have an enormous number of people with long COVID, so I'm not gonna do that, but this does seem urgent. But the research and even the money for the research seems to be slow in coming. What's happening now? Are there trials you're keeping an eye on? Is there more research ramping up as we speak?

0:14:15.1 JC: First, I would point people towards a story by my colleague, Meredith Wadman, that's going to accompany this one, and that's talking in particular about US funding for long COVID research and that is definitely worth reading. But yes, I think the funding has been slower, I think there was a lot of urgency in finding treatments for acute COVID, that's easier to do if you just have a lot of people hospitalized, it's easier to test treatments, this is a lot harder to find, it's harder to study. But even with all of those challenges, the money has been slow, the trials have been slow. One trial that I was really interested in is one that's starting up, starting to recruit in the UK this month, and it's going to include more than 4000 people. It has a number of different components, including creating a biobank of blood and tissue samples and doing a lot of imaging, but it's also testing several treatments, including immune system treatments and blood clot treatments. So it'll be very interesting to see what happens there and whether some patients are helped by some of those treatments.

0:15:12.4 SC: Thank you so much, Jennifer.

0:15:15.2 JC: Thank you so much. It's been great talking with you.

0:15:17.2 SC: Jennifer Couzin-Frankel is a staff writer for Science based in Philadelphia, Pennsylvania. You could find her article and the one on funding in the US by Meredith Wadman at science.org/podcast. Don't touch that dial. Stay tuned for my interview with Debra Matthews about the downsides of using DNA markers associated with law enforcement in research settings.

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0:15:48.3 SC: You may have heard of CODIS, this is a database maintained by the FBI that seems to come up a lot in crime shows. CODIS is a nationwide database of different kinds of forensic evidence, including a standard set of genetic markers for identification, it turns out that many criminal justice databases around the world, all use the same markers and similar kits to identify people by their DNA, and researchers are using these same kits for their work as well. Debra Matthews wrote a policy forum this week on why everybody using these same sets of markers is a bad idea. Hi, Debra.

0:16:26.7 Debra Matthews: Hi, how are you?

0:16:27.8 SC: I'm good. How are people typically identified by DNA in the criminal justice world? This is not whole-genome sequencing, this is something a little different.

0:16:38.0 DM: Law enforcement uses something called Short Tandem Repeats or STRs, and these are places in the genome that are highly repetitive, just for example, 80-80, 80-80, 80, a big string of them. The machinery that replicates DNA, sometimes that machinery gets a little bit confused at these highly repetitive spots, so it'll slip a bit. As a result at those areas of Short Tandem Repeats, you end up with areas that are expanding and contracting across the generations. If you take enough of these spots across the genome where there's this occasional slippage, you can take those numbers at those different sites and create a unique fingerprint of that individual.

0:17:31.3 SC: It's just an arbitrary value from your genome rather than a characteristic associated with you, like eye color or anything like that.

0:17:39.7 DM: Exactly.

0:17:40.4 SC: I did mention that this is not just the US, it's not just the FBI's CODIS database.

0:17:44.8 DM: Yeah, across many, many law enforcement agencies across the world, including Europe and Japan, and the EU and Interpol, which includes 84-member countries, they all use a common core set of seven markers.

0:18:04.0 SC: Wow, so we have these markers for millions of people worldwide.

0:18:08.1 DM: In the law enforcement context, we do.

0:18:10.9 SC: In what way are STRs or Short Tandem Repeats being used in the research world?

0:18:15.3 DM: The market for these kits was created by law enforcements, need for them for identifying suspects from samples at crime scenes, that meant that there were these inexpensive kits available to the research community when we discovered that we actually needed a way to track samples as well.

0:18:35.3 SC: We have to start with cell lines, right?

0:18:39.5 DM: Exactly right. Because many of your listeners will be familiar with the HeLa cell line, the cell line that was derived from the cancer cells of a woman named Henrietta Lacks, who came to Johns Hopkins for care in the 1950s. Her cells created the first human cell line, and it turns out that they're really, really good at it, so much so that if it gets into other cultures or other biospecimens that it will help compete those other cells. In the '50s and '60s and '70s, it was repeatedly discovered that the cell line that a scientist thought they were working with was actually HeLa.

0:19:17.8 SC: Yeah. You think you have kidney cells? You think you have ovary cells? No. [chuckle] HeLa cells.

0:19:22.6 DM: Exactly. And that makes it really hard to repeat experiments. Scientists themselves, of course, and the NIH got quite concerned about the impact of this kind of bio-specimen misidentification on the reproducibility of research and therefore the forward progress of research.

0:19:44.6 SC: Why is it not a good idea to use these forensic tools to keep track of research materials? Is there a worry that it will help identify a suspect in some way, that it'll compromise people's privacy?

0:19:58.5 DM: That is one of the issues. But when we import the language of law enforcement into the research context, we risk not only the privacy of the people we are asking to participate in the research, but also we risk undermining the trust that they have in the research system. We are asking people to contribute their tissues to science for important health, medicine, wellness, human needs, and our goals in science and the justification for the research we do is very, very different than the goals of law enforcement and the justification for what they do.

0:20:43.1 SC: What's an example of the language of law enforcement?

0:20:46.0 DM: I mean, CODIS. I mean the CODIS markers, we are using law enforcement markers to describe and identify research participants.

0:21:00.8 SC: That also makes these data sets or these markers interoperable, right? They can be compared to each other from a criminal justice world and from the research world.

0:21:09.7 DM: The argument might be made that, well, law enforcement will get access to what law enforcement wants to get access to, regardless of whether you use CODIS markers or not. We don't need to develop data on research participants on their bio-specimens that is directly translatable into the information that law enforcement needs. As we say in the paper, well, oftentimes, particularly in academia, it's really productive to break down silos, and then there are other kinds of silos that are critically important to maintain, and this is also happening at a time where the research community is finally waking up to the fact that the lack of diversity at all levels of the research enterprise, from the people who fund, the people who propose the research, the people who are conducting the research, and the people who are participating in or subject to the research are all way too white. [chuckle] So there are tons of efforts at diversifying science at all of

those levels. I'm worried that using these markers for research purposes is going to undermine the goals of the research more than further the goals of research.

0:22:32.1 SC: So as you said, marginalized groups are mistrustful of the police, but they're also distrustful of scientific research and the scientific community, specifically African-Americans, we've talked about Henrietta Lacks. Do you think that stopping using CODIS markers and going to a different system is really going to register with these groups and make them be more trustful of scientific research?

0:22:56.3 DM: The folks that we are now trying to recruit are often the same folks who not only have been exploited in the past, including the story of Henrietta Lacks and her family and many other stories, but also the current structural racism that is present and ongoing in the research and health systems that undermine the willingness of folks from historically marginalized and excluded communities to participate in research. So is switching away from CODIS markers going to put a dent in that at all? I don't know, maybe not. And yet, it is still the right thing to do.

0:23:42.3 SC: Why are you writing about this now? Why raise this concern at this point?

0:23:47.8 DM: Part of it is that it came to my attention recently, [laughter] and it strikes me not only as a problem that needs to be fixed, but as a problem that we can fix, there is no reason to use these particular short tandem repeats for this purpose, there are lots of STRs across the genome that we could use instead of these particular ones that have this other use in a different domain.

0:24:13.8 SC: Is that something that other outfits have developed their own set of repeats that don't overlap with this global kit that everyone else is using for law enforcement?

0:24:24.4 DM: Yes, I'm aware of one, and I should probably say that, and this is disclosed in the paper as well, that for a number of years, I was a member of the scientific advisory committee of the National Institute of General Medical Sciences, Human Genetic cell repository at the Coriell Institute for Medical Research. And it was as part of my work on that committee that this issue came to light. Coriell had a in-house set of STRs separate from CODIS that they had been using for a very, very, very long time, and the repository I was working with was looking to transition to a more robust set of markers because for a small number of bio-specimens their six markers set didn't work to distinguish them, so rather than transitioning to a CODIS based kit, they developed six new STR markers that do not overlap with CODIS at all, so now they are using these two sets of six markers that are able, according to their research, to uniquely identify all of the 48,000 bio-specimens from the repository on which they tested the new markers.

0:25:46.1 SC: Wow. This is not some magical formula that someone came up with for CODIS this is something that you can just use a different set, and it's fine. I wanna ask though, why aren't we just doing a whole genomes at this point?

[laughter]

0:26:01.9 DM: Well, there is this new technology that they're saying is now only gonna be 100

bucks, if we did switch the whole genome or a large, highly dense snipper ray, these kinds of data are still identifiable Absolutely, 100%. No argument there.

0:26:16.3 SC: Do you see this as a growing problem, do you think that more and more different labs or institutions are using the CODIS kits to identify their participants in their research?

0:26:28.1 DM: Well, in theory, if researchers are following the 2015 rule from NIH requiring authentication of key resources including cell lines and other human tissues, then there should be more authentication happening, but we don't know the true scale of the issue because this isn't a conversation the community has had as yet, and I'm very much hoping, honestly, that rather than have the conversation of how many researchers are doing this and how many samples have been typed using these markers, we can have instead the conversation about how do we transition from CODIS to something else that's unique to the research community.

0:27:13.5 SC: Thanks, Debra.

0:27:14.4 DM: Thank you so much, I really appreciate your time.

0:27:17.6 SC: Debra Mathews is the Assistant Director for Science Programs in the Berman Institute of Bioethics and an Associate Professor of Genetic Medicine at Johns Hopkins University. You can find a link to the policy form we discussed at science.org/podcast. Up next, we have a custom segment sponsored by BII. Custom publishing director Sean Sanders chats with Chief Business Officer Bobby Soni about what researchers need to know and do to turn their brilliant ideas into a successful startup.

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0:27:54.9 Sean Sanders: Hello to our podcast listeners and welcome to this custom sponsored interview from the science AAAS custom publishing office, brought to you by the BioInnovation Institute. Based in Denmark, BII is an international non-profit foundation supported by the Novo Nordisk Foundation that operates as a start-up incubator to accelerate world class life science innovation for the benefit of people and society by supporting early stage life science startups. It is also the sponsor of the new BioInnovation Institute & Science Prize for Innovation. My name is Sean Sanders, and I'm Director and Senior Editor for Custom Publishing at Science. I have the pleasure today of talking with the Chief Business Officer of BII, Dr. Bobby Soni. Bobby grew up in New York City, but after completing his PhD in Biology at the University of Virginia, he moved to Denmark and has spent the majority of his career there, he has a passion for science and for helping innovative scientists bring their new discoveries into a commercial space. Bobby, I'm delighted to welcome you. And thank you so much for making the time to talk with me.

0:29:03.9 Bobby Soni: Thanks Sean, thanks for inviting me.

0:29:05.7 SS: So the first question I'd like to ask you, Bobby, is why should academics consider commercializing a research discovery that they developed in the lab?

0:29:16.4 BS: I would say the biggest reason for doing this is that is the path of highest impact, if we want that research to become a product that benefits people. In our view and in our experience the founding academics are the actual product ambassador for their own science, for talking about the science and for commercializing or starting the journey of commercializing their science.

0:29:36.9 SS: What are some of the critical considerations that should be top of mind if somebody is considering commercializing their research?

0:29:44.4 BS: There's a lot of questions to think about. I think the most important one is to have a very deep look at the science itself and ask the question, "How is it fundamentally different from the way technology is used today?" So more specifically, how does this potential technology work in today's world against current approaches? And it's that sort of fundamentally leap of understanding of how we can use technology to create better products that are critical in creating better product.

0:30:12.0 SS: So Bobby, where do scientists find the sort of information? Where can they start their journey to commercialization?

0:30:19.1 BS: The way we think about this at the BII is the best way to start is to start. What we find as academics, because it's a brand new world out there of how to do this. They experience a bit of paralysis in the process, so clearly there's the university innovation office speaking to them, they should be able to help with regards to setting up a patent, filing the patent and also providing guidance as to how this technology can be used out in the real world, but in many ways, it's very much up to the founders themselves as well, you're going to have to ask the question, maybe to your network, do some research and try and ask the question, as to how is this different and could it be used and then eventually potentially talk to investors or pharmaceutical companies or industries to ask the question, "Why not this could be used?" And use that feedback in an iterative way.

0:31:08.3 SS: Are there any particular skills that someone interested in establishing a startup should bring with them or perhaps learn along the way?

0:31:17.9 BS: The thing that we tell our academics when they start in our programs is that they are absolutely required, but insufficient for success, so they are the heart and soul of the commercialization endeavour that they're on, and it's actually their ability or the academic's ability to understand the new framework of commercialization, that it's the limiting factor, and it is extremely difficult, it's a new world, it's a new way of communicating things that were super important in the lab are less relevant when speaking with investors in the commercialization world. And the ability to adapt to the environment, the commercialization environment you're in is really important, and then to add new people into the mix, working with new people to help make that happen, that's absolutely critical, because it's very difficult to do it alone.

0:32:06.4 SS: What are some of the most common pitfalls that you've seen in the startup process that someone commercializing their work should look out for, and how can these be avoided?

0:32:16.5 BS: So when we work with our academics in our program, we point to two things. One is

messaging, and the key thing that's missing with commercializing is typically funds for the startup company. So when speaking to investors, many... We have former academics believe that it is the science that drives the investment, and it does, but that comes later. The first step is just driving interest. And that act requires less science and more vision about the product unmet needs and how this is going to change the world. And the second part is in this team approach, because it not only matters what you say and how real it is, but it also matters who says it, so when speaking investment or trying to commercialize, teaming up with people who have done this before, basically adds more balance to your messaging and makes it even more real when you say it.

0:33:07.9 SS: Now, you talked earlier about universities having innovation officers, especially the large universities probably have these and maybe even have incubator facilities. Do you think these have been successful and what if a research is at a smaller university that doesn't have some of these types of support facilities?

0:33:26.5 BS: That has to do with scale, the larger the university, the more deals or more academics they've been working with, the more times they've tried to commercialize something, the better they become. We have to remember that universities have a vested interest in promoting what's coming from their university, and not everything that comes from their university is investable or commercializable. Those universities that have lots of academics and commercialization opportunities have the best opportunities to find out what's going to have trust in and work with them. So I would say that it is difficult when you're at a smaller university because they simply just don't have the scale of operations to be very experienced at it. It's similar to a surgeon doing surgery, the more you do, the better you get at it.

0:34:12.8 SS: So let's say I'm a researcher at a university, I have an interesting product that I'd like to commercialize, what would I do as first steps to think about whether it's even worth starting the process, whether I have something that is even possibly commercializable?

0:34:29.5 BS: And we would recommend an iterative process, so start the journey by talking to people in the know. And in our experience, the investors, people in the industry, they do want to help, so if you're not... Especially if you not asking for money, if you're just asking for a view, you wanna meet someone, people are willing to help. I think that's sort of a broad outreach to people in the know, ask them about their needs, tell them about the science and is there a fit, is there something here that at least will start the journey? After that, I would recommend finding accelerator hubs that have scale, that work in your area of interest to try and apply to that program and see if that can help accelerate the science.

0:35:12.6 SS: Bobby, are there ways that researchers can structure their work that they're doing in the lab today to make a future commercial venture more successful?

0:35:22.8 BS: Yeah, I would say it's important to keep the idea that everything you do in the lab could be commercializable in play, and that it's important to do so. As a PI, those PIs that set the tone, that the things that we do in this laboratory are meant to help society and the commercialization of it is an important part of that process, those are the labs that tend to do commercialization well, because they're always thinking about it and then working with it. Of course, you have to patent your discoveries in good time, practice publication and then develop a

network of people that can help, and that's beyond the university innovation office, that could also be local VCs and local players in the industry that you have good contact with to help commercialize your work.

0:36:09.5 SS: Do you have any suggestions about how a scientist can start developing a network in the commercial space? If they've been in academia all of their lives, they perhaps don't have that particular type of network.

0:36:20.5 BS: There are a lot of conferences dedicated to translational science to partnering meeting, I'm not saying it's easy because what we also experience in our programs that many of our academic founders that are former post docs and are running a startup company, they find this type of cold calling and networking quite difficult 'cause they're outside of their field. But our experience is those that go all in and just do it, they tend to do well, so in that respect it's about going to events where investors who are interested in early state science are present, and then introducing yourself, and then setting up an opportunity to talk to them at a later time.

0:36:56.5 SS: Do you think that creating a startup is something that anyone is able to do, and what questions would I ask myself to determine if I have what it takes?

0:37:07.2 BS: At the BII this is basically our core belief, is that academic founders can be wonderful startup leaders, and that's a key point. So I do think everything that drives academics to be great at science is useful in the startup world. We're talking about smart, driven, ambitious people that want to do something well, so those are the skills that can be use in a startup as well. I think the two question academics need to ask themself is, what is it that they really enjoy doing. If it is basic discovery and publications in early-stage time, then working with the startup or helping your science in a new startup is the way to go. However, if you do enjoy working with new people, trying new things, and I'm thinking more about post-doctoral scientists, they can be excellent startup leaders and we work with them at the BII to try and get their startups funded, and also for them to maintain key positions in their company as more money is put into the company.

0:38:08.5 SS: Well, Bobby, thank you, this has been very interesting, but we're going to have to end things here. I really appreciate you taking the time to talk with me today.

0:38:15.5 BS: Thank you, it was a pleasure talking to you.

0:38:16.7 SS: All thanks to the BioInnovation Institute for sponsoring this interview. I'm Sean Sanders, thank you for listening.

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0:38:24.5 SC: And that concludes this edition of the Science Podcast. If you have any comments or suggestions, write to us at Science Podcast at aaas.org. You can listen to the show on the Science website at science.org/podcast, or search for Science Magazine on any podcasting app. This show was edited and produced by Sarah Crespi with production help from Podigy and Meagan Cantwell. Transcripts are by Scribie, Jeffrey Cook composed the music. On behalf of Science Magazine and

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