Intro 00:00:01 Inventors and their inventions. Welcome to radio Cade, a podcast from the C museum for creativity and invention in Gainesville, Florida. The museum is named after James Robert Cade, who invented Gatorade in 1965. My name is Richard Miles. We'll introduce you to inventors and the things that motivate them, we'll learn about their personal stories, how their inventions work and how their ideas get from the laboratory to the marketplace.

James Di Virgilio 00:00:37 Welcome to Radio Cade, I'm your host James Di Virgilio and a long aside me today is Christine Schmidt. She has done quite a few things during her career thus far. I'm very excited about having her here. She is the Pruitt Family, Professor and Department Chair of Biomedical Engineering at the University of Florida. And she was recently inducted into the Florida Inventor's Hall of Fame. Christine, welcome to the show.

Christine Schmidt 00:01:01 Thank you, James. I'm really excited to be here.

James Di Virgilio 00:01:03 It seems prudent to start with a definition. What exactly is biomedical engineering?

Christine Schmidt 00:01:08 Biomedical engineering is the field that is focused on applying engineering principles and engineering processes and problem solving approaches to the biomedical space. So usually oriented towards human health. So biomedical engineers may work on new devices for detecting early disease states or for new devices that might be implantable that can help with different types of ailments. For example, like, um, hip implants and different types of orthopedic implants, or they may work on engineering, new vaccines that we all very familiar with or computational approaches and models to better understanding cognition and memory. So it's very broad. It's basically any sort of engineering principles, quantitative principles that are applied to health and biomedicine that can help facilitate better outcomes for people.

James Di Virgilio 00:02:02 I sort of like to imagine a Tony Stark like character from the Marvel comics, that's working on improving human health with emerging technology.

Christine Schmidt 00:02:09 That's how I envision myself too. It's Tony Stark.

James Di Virgilio 00:02:11 I like that. <laugh> as we dive into your story, that's sort of what you feel like you've done all these amazing things, emerging technology and health to improve health outcomes. Let's actually dive into a few of those. You've done a lot. So I'm gonna let you take this story where you want, but let's just start by talking about some of the things you've created. And I suppose it's probably best to start with with the first one and then, and let you take it from there, but A.) how did you desire to create anything in the biomedical engineering field and then B.) how did you come about the first discovery and then we'll, we'll walk through more of them.

Christine Schmidt 00:02:40 Yeah. So how did I come about wanting to actually create and design inventions in a sense? So that's really because of seeing a need, I guess, in this space. So, faculty member, the University of Texas at Austin love educating students, love research, love the sciences, love, biomedicine love, just exploring and discovering. And as part of this process in educating students to do this in the biomedical engineering space, a student of mine at the time and myself, we sort of looked at the field and realized that there was space for possibly new technology. So in this case, we started working in the area of trying to create, create a product that would help with neural repair. So nerve regeneration, after somebody has an injury, for example, in the hand or the face, if you have a cut to a nerve, there are some limitations in terms of how these nerves can regenerate.

Christine Schmidt 00:03:33 And we started looking at what was in the clinic and realized that there was a lack of really good alternatives for physicians to work with. And so this was motivating to try to come up with another approach. And that's where we came up with this whole idea of taking nerve and removing the cell components that cause the immune response and creating something that could be off the shelf that surgeons could use to aid with regeneration. This is called the field of decellularization decelerating tissues. And at the time there wasn't that much that had been done. Some groups had done decellularization of dermal tissue, for example, for possible skin grafts, but nothing really robust for nerves. And so we thought, how can we take this approach and apply it to nerves so that then you could use donor tissue for people who need nerve repair applications.

Christine Schmidt 00:04:24 It's necessary to kind of remove the cells because again, that causes the immune response. So you wouldn't wanna take a piece of nerve from somebody else and implant it into a patient because that can cause immune rejection. And so removing those components is essential for having a quote unquote off the shelf therapy that could be used by physicians in the clinic. So it was really seeing that there was something missing and an area where we had expertise. So I'm a trained chemical engineer working in the biomedical engineering space. You know, understanding how chemistry works with materials is something that we do. So how can we apply chemistry? And in this case, using different types of chemical and detergents to strip the cells out of nerve tissue and leave behind a scaffold. And then that scaffold is essentially serves as a pathway or roadway for regenerating axons, which are part of the nerves in the body. So it's really just seeing a need and something not there and in an expertise that we had it, we could say, Hey, let's apply ourselves to this and let's work on solving this problem.

James Di Virgilio 00:05:26 Let's actually branch off from there and go a little further here because you basically create this nerve graft, right? Mm-hmm <affirmative> and let's dive into it at a little bit deeper level. So previous to your technology being available, you discovered this, you get it out there. Of course it's been in the market now for more than a decade, what was the solution, so if someone had an issue, yours solves it now, but what were people doing if they had nerve issues where they didn't have a way to do this?

Christine Schmidt 00:05:49 Yes. So there were, at the time, a couple of artificial devices that were in the clinic that could be used in the clinic. And so they were basically like different types of polymers, synthetic polymers, some natural polymers, like a collagen base, just hollow tube or a synthetic polymer tube. It almost looks like these little finger puzzles where you put your fingers in the two ends and then try to pull your fingers out. And they kind of <laugh> snap close. It looks something like that. Just to hollow, empty conduit, a synthetic or natural polymer based conduit. The problem with those devices is that they lack any sort of organization, especially any organization on the inside. They were just hollow. Um, they were not very biological in nature, whereas we're able to design something that has biological components to it. And as such, because they were hollow and lacked a lot of bioactivity, they did not provide or promote regeneration over longer distances.

Christine Schmidt 00:06:41 So even though there was something in the clinic, the physicians were limited in what the applications they could use it in. They could only use them in areas where it was very small defects and as such, it just limited their ability to repair defects over longer distances. So in some cases, somebody had a very large injury. They may for amputation instead, or other more dire consequences because there were not really alternatives to these very crude hollow conduits that were limited to only very short defects. So the other alternative that surgeons could use is just taking tissue from the patient's own body and transplanting it. So that's called autologous nerve grafting. It's very similar to when you take a vessel from somewhere else in the body and use it for cardiac bypass. So they could take a piece of nerve from the patient's leg and then transplant it to the site, like for example, their hand, where they wanna restore that motor function and that work, that was the best approach that's been used in the clinic.

Christine Schmidt 00:07:34 The problem with that is it requires two surgeries or risky to patient, more opportunities for infection. And also the patient loses some function from somewhere else in the body. It might be minor. Maybe they're losing just sensory function in their foot to regain motor function in their hand, which is important, but it's better not to lose any function from somewhere else. So the strategies that were in the clinic were either sub par in terms of their ability to aid Regener ratio of longer distances or resulted in some possible detrimental outcomes and some losses to the patient in terms of having to have two surgeries, possible risk of infection or losing some sensation from somewhere else in the body. So when we develop the nerve graft, it basically functions very similar to an autologous nerve graft, except that you're not taking it from the patient themselves, they source this material from cadaver tissue, that's been processed and cleaned and treated and completely safe. And so you're not losing the patient, isn't losing anything in the process and it's completely off the shelf, which minimizes surgical time. So there's less time that somebody's in surgery, which you always wanna minimize. And that also reduces cost for the patient and for our healthcare system as well.

James Di Virgilio 00:08:43 So essentially you enter into a world as you're Tony Starking, what's going on. That has, that has a problem. You see the problem you solve the problem. And then it sounds like what that resulted in, as you mentioned is obviously a much better result for patients who now perhaps have avoided the amputation they've avoided loss of function. They have reduced pain. I mean, there's a whole host of things that have been improved by this innovation, correct?

Christine Schmidt 00:09:05 Yes, that's correct.

James Di Virgilio 00:09:06 And that's the beauty obviously of, uh, of innovation in general. I think that's a great story. It's been in the market now, as I mentioned for a long time and obviously, a lot of people have been helped with this, but of course you didn't stop there. You had other innovations of your sleeve. Tell us about what you worked on after that.

Christine Schmidt 00:09:21 Yeah, so I love working with students. So we always have a team of students when working in the university setting and we love partnering with our clinical collaborators as well. So innovation involves multiple different aspects and it's having this creates having insights into what these problems might be that sort of drives new inventions. And so I had a very, very creative student in the lab when we were working together on his dissertation project. That created a way, one of the things that has always been part of my lab is how can we guide cells? How can we guide tissues to regrow and tissue have a lot of structure and a lot of architecture and as such to be able to grow cells and to be able to recreate tissues and to encourage regeneration this micro architecture and this structure is very important. And in fact, if I step back to the desell nerve, that story that I just told, one of the beauties of that is when we took out the cells, we retained intricate micro architecture of the nerve, and that was essential in the success of it being able to help facilitate the axons of the nerves to regrow. So we knew as part of this project as well, that this structure is absolutely critical for any kind of healing tissue in general, you know, in that case nerve, but it could be, or other healing tissues. So one of the things that we're doing in the lab is how can we work with other kinds of bio polymers? So we work with materials in the lab that we can form into structures that we can use for various biomedical applications. How can we impart structure and micro architecture into these polymers that we're working with these biomaterials so that we can help guide cells and tissues to regenerate. And so I had a very creative student when we were talking about that. He and I came up with the idea of using salt crystals to basically put into our bio polymer solution and then to induce crystallization inside our materials and then lock the material in place around it, in a sense, lock it around it and then wash out those crystals and leave behind the template of the crystal in structure that we had created inside these biopolymers, with the goal that using this technique, we can create pores and micro architecture that cells would follow and grow along for regeneration.

Christine Schmidt 00:11:39 And so this very creative student helped to create this Institute crystallization process. And it was just amazing. We, it was just like really cool that we could create this micro architecture in these biopolymers again, knowing that this would help with cells to grow. And so we had actually then said that we need to scale this up. We need to use this for nerve or for other applications. And so we started talking to people about this, how can we now get this into a product? Or how can we get this to help people? Because we know we can create these really unique micro architecture in a very easy way, in a very inexpensive way. We don't have to use expensive equipment or anything like that. We're just inducing salt crystallization. And so we started talking to multiple different people. We had talked, we filed the intellectual property.

Christine Schmidt 00:12:21 We had talked to various venture capitals. So we were exploring ideas. And eventually we started talking to surgeons at neurosurgeons down at the local hospital, and this was back in Austin, Texas. And so we went there, met with a neurosurgeon who does back surgeries. And he said, we don't necessarily need to grow tissues in, but could we use these materials in other ways? And so we looked at the materials and I had a new student who had joined as well onto the project. She's now Dr. Sarah Mas, but Sarah Mas, at the time we looked at these materials that we created and not only did they have micro architecture. And then we realized that they had some other very interesting properties that we didn't predict, and that is they were stretchable, and they were also more robust. And based on the materials we use, we can either make them so that cells don't like to adhere to them, or we can make them such, that cells do like to adhere to them so we can make them not adhesive or adhesive.

Christine Schmidt 00:13:12 And so when we're talking to the surgeons, they said, wow, this could be really useful if we use it in the, the non-adhesive way because of its stretchability and other properties, not the guiding the sales property that we had originally thought, but using a different property that these materials had, that we hadn't really thought would be applicable. So what came out of that is use these materials as ways of blocking adhesions after surgery. So implanting them using the fact that they are flexible and that they're stretchable, and that they're durable to be able to implant those around certain tissues, to help protect them. And you could do that in a fairly minimally invasive way, but as I would call the of wound protection devices, so they protect the tissue that you wrap them around. And that keeps other things from, because they're not adhesive, it keeps stuff from growing on it.

Christine Schmidt 00:14:04 So it prevents scar tissue from forming and minimizes what are called postoperative adhesions. So now this is used as a wrap around tendon that has been any kind of tendon surgical procedures it's being used in back surgeries as a way to protect the healing tissue and keep scar tissue from forming and stretchable properties. And the robust properties are what allow it to be used and implanted in a very efficient way. So it's kind of neat because we were looking to create materials that would go row cells and encouraged cells to grow down certain pathways because of the micro architecture. And then what we found is that this micro architecture that we could introduce into the biomaterials created different properties that we hadn't planned on that were useful in a different way. Now, these are being used as again, what we call sort of adhesion barriers or materials that prevent postoperative adhesions in patients that have different types of surgeries for their tendon and back and so forth.

Christine Schmidt 00:15:02 So it's kind of neat to look at when you think about innovation and invention, to be open to the fact that what you're doing may have applications in different spaces and that you may take turns enjoying those turns versus resisting. Those turns may lead you to some interesting pathways, cause if we had sort of stuck to the pathway of no, no, no. We need to use this for growing cells and for directing cells, not for preventing scar tissue from forming that would've had a very, very different outcome than what we had listening to the needs of the clinicians is absolutely critical because they're the ones in there doing these surgical procedures, they know what's missing. And so they knew they needed something in this space. And what was used in that space at the time was suboptimal. And so it just a different story and a different pathway.

James Di Virgilio 00:15:52 A lot of wisdom there, of course, a lot of the world's greatest inventions and innovations came originally for something they intended to be different. Mm-hmm <affirmative> and much like your story, right? They found that it actually worked perfectly and something else. So that's a lot of wisdom to listen, to feedback, to be flexible, to be nimble mm-hmm <affirmative> and to move through this. And now Christine, how many patents do you currently have or have you set up through your affiliates?

Christine Schmidt 00:16:12 That's a good question. I'm not positive. I think it's between 10 and 20.

James Di Virgilio 00:16:18 So 10 to 20 patents. Yes. The question that I think a lot of listeners may have is why, why spend all of this time? And of course I know you're passionate. I know you love it, but you're an entrepreneur and I know what the answer's gonna be, but I have to ask it. Why spend all of this time, your story right there just involves so many twist and turns and a lot of work and a lot of effort, it may not come to fruition. I'm sure many of your patents have not gone to market. Have not made it there. So why spend so much time attempting to make this happen?

Christine Schmidt 00:16:43 I think it's because that's what keeps things moving along. And I mean, that's how we create. That's how we invent everything around us is because of an innovation because of patents and patenting always comes alongside of our research. And so we do our fundamental research in an academic setting. Now I'm here at the University of Florida. And so I do this research alongside these students. And then when we see something that has a potential utility, I mean, it's not our focus to innovate, it's our focus to do research and to explore and to understand what we don't currently understand. And along the way, we have the goal of hopefully being able to create innovations that could help people again with biomedical engineering, the whole goal is to have an application that's gonna help human health. And so it's part of my training, part of my education of our students, that we do the research.

Christine Schmidt 00:17:34 And then as part of their training, we always try to look to what can we patent? What can we possibly move into the clinic? Again, like you say, not everything that we patent get into a commercial product, but it's also a good experience for the students too. It's part of their education, learning how to do this in this process, because they're gonna be going and working in companies or they're gonna be going and working in their own laboratories or working at the FDA or working at the FDA that actually approves various products and so forth. So them having that insight and that knowledge is absolutely critical for the whole ecosystem to exist. And for us to have these future innovations, the future products that are gonna tackle cancer earlier, the future products that are gonna help with vaccine development, you can't do that without this part of the process. And so I see that it's important for the actual outcomes and the actual devices and therapies that are gonna help patients. But I also see this as really part of the education, my students and trainees who are gonna go out there and be another part of this important ecosystem that helps all of us stay healthy.

James Di Virgilio 00:18:36 So, you know, what's really interesting about your answer there, Christine, and I've interviewed hundreds of people on this very show, getting to talk about these things and not a single person, not one has ever said, well, I do these things because I wanna make money or I want to get it rich. Mm-hmm <affirmative>, it's always because they wanna help people no matter what the field is, whether it's space or biomedical engineering or any advancement, any idea, any problem solving arena, it's always to help people. I see a problem. I wanna fix it. I wanna make the world around me better. I want people to have better health outcomes. And it's interesting to me because I think oftentimes we have a society that may paint innovators, entrepreneurs, and inventors, as people who do things to get rich, or they do things for the profit motive. But the reality is often exactly as your story is, you've had a desire, as you've mentioned throughout this podcast to use what you've learned and what you continue to learn to help those around you, to inspire other students, to do those things and to improve the world around you, which I think is when humans flourish the most, right.

James Di Virgilio 00:19:30 When we're creating, we're innovating, we're helping our neighbors succeed. And your story has been one of that. So now that you have this plethora of experiences, your day to day, life is literally infusing up and coming, right. Biomedical engineers, and others to learn these things, share with us some words of wisdom. And first, let me start by asking you, given what you know, now, if you could start over again, what is something you would've done either more quickly or right away or not done? What's something you would've changed given what you know now?

Christine Schmidt 00:19:58 That’s a great question. First of all, I, I don't know if I would change anything because I think the pathway that we went that was not necessarily as efficient as it could be leads to other innovations and leads to a lot of knowledge. So in a, also is responsible for where we are today. So in that respect, I don't know how much I would change because I think we learned a lot through the random walk process, but there are a few things that we did do that could have been more efficient <laugh>. So one was thinking about sterilization, how do you make products that are, are going to be perfectly sterile for human implantation? It's not something that researchers normally think about. So we're a research lab, an academic research lab, and we try to pay attention to certain things, but that was not something that we really paid close attention to, which I think in retrospect, we could have known a little bit more about that.

Christine Schmidt 00:20:49 Like, okay, what are the common sterilization processes in the biomedical industry? How might we think about the desal process or the non-adhesive reps that we've created? How could we think about making those sterile for various applications? So we didn't really have any clue about that and that's fine. It all worked out in the end. And I think we've learned a lot in the process. We learned a lot from our clinical partners, a lot from our industry partners as part of this, as they help to educate us. But now having that knowledge, I think it makes it a little easier, cuz we can think about those things ahead of time, as we're doing things in the laboratory and say, well, why don't we test this out and sterilize it this way? So if it changes the properties of the material, we can more efficiently go in and tweak the design.

Christine Schmidt 00:21:29 Cause I know back when we were originally doing, like for example, the non-adhesive reps, we were just using basic sterilization that we do in the lab, which is great for cell cultures or for implanting into preclinical types of areas, but not human subjects. But what happens when we went to do the sterilization that would be out of quit for human implantation, it kind of changed some of the properties in the material. So we had to go back and retool some of the design. And so we did have to take a step back that cost more money, that cost more time. And it just took a little bit longer to do that. So that's one area is just sterilization and how it's gonna actually get into a patient. But other than that, I don't think there was too much else that I would change because I really love the process. I mean, being in an academic lab, I love the process, getting lost a little <laugh> when you drive on your own and get lost, you really learn your way around, right? It's the same thing with innovation as you go through having opportunities to get lost, lead to additional innovations that you may not have thought of, you really learn through that process.

James Di Virgilio 00:22:31 That's true. And a few things are better than when you're lost and you have that spark, that next idea, exactly that way to improve what you've been working on. That's one of the most exciting things about innovating. All right, let's finish with some words of wisdom sure. That you have for other innovators.

Christine Schmidt 00:22:44 Oh, that's great. Words of wisdom. I would say really follow your passion, listen to advice, but be cautious of all the advice that you get. I mean, don't listen to everything. And so I know that when I started down this pathway with the D cell nerve that has now been implanted into over 50,000 patients heard senior faculty saying, don't do this, don't go down this path. This isn't good. It basically discouraging me from doing it or because they thought that this would not help me with my tenure case and so forth. Don't do anything that's too applied, da da, da, da, da. So be careful and follow your gut and your passion. So in my mind I kept doing that because I knew that it's something I felt like it's something that we could use, the skills that we had to make a difference in people's lives, regardless of whether or not it resulted in the, a lot of high impact publications, which academics tend to focus on.

Christine Schmidt 00:23:34 So follow that passion, but do know when to back away from something, if it's not working. So that's really important. I think there's a saying, if you're gonna fail, fail quickly, <laugh> so get out of it quickly. So don't spin a lot of wheels. If something is absolutely not working, but get input. I think any clinical input, if you're working in the biomedical space is very important, but getting input from whoever the end user is going to be, I think is critical because when we were working with these anti-adhesive films in the labor crew, we were creating things that looked and felt like something that we thought could be applicable. And then when we met with our clinician, he had a lot of insights, but then he came into the lab, he says and helped us. And he said, no, I would never use that in a surgical suite.

Christine Schmidt 00:24:17 This is too thick. This is too big. This is not robust enough. And so getting that end user input is critical, is early in the design possible as early in sort of the innovation process as possible. So that you're going down a pathway, that's going to be effective and get money wherever you can. So we have research dollars that support basic research, but sometimes these preclinical studies, it's hard to find money to support that. And so find resources wherever you can and be creative. Their are pots of seed funding from the federal government for helping with preclinical studies. There's venture capital that sometimes you can look to. We had our, our clinical partner, when we were doing the anti-adhesive films, he had a group of surgeons that were very interested in investing. And so they just gave money and it's like, take the money where you can, you're gonna burn through a lot of money with trying to develop these prototypes. Especially if you're doing anything in the biomedical space, it gets very, very expensive doing preclinical animal studies. So find money where you can spend it wisely and then don't be shy to accept money for the studies that you're working on. I think those are the basic bits of wisdom.

James Di Virgilio 00:25:27 Those are great. Those are great bits of wisdom, especially the part I think about being careful with what advice you need. We mentioned earlier that many of the best innovations didn't start off the way they finished and many great innovators have been told, do not do what you're about to do. And then couple that with your fail quickly, that's a great recipe for figuring out if maybe you advisors were right, that this is not a good plan to follow and also be persistent when you're not failing quickly and things seem to be moving in the good direction.

Christine Schmidt 00:25:54 Exactly. Oh yeah. Persistence is absolutely key.

James Di Virgilio 00:25:56 <laugh> yeah. That's excellent. Excellent stuff. Well, Dr. Christine Schmidt, it's been wonderful having you. Oh, thank you. Our guest today, of course again is the Pruit Family Professor and Department Chair of Biomedical Engineering at the University of Florida and an inductee into the Florida Inventors Hall of Fame. It has been a most wonderful discussion, Christine.

Christine Schmidt 00:26:12 Thank you, James. I appreciate it. It's been wonderful talking with you today.

James Di Virgilio 00:26:15 And on behalf of Radio Cade I'm James Di Virgilio and we'll see you next time.

Outro 00:26:20 Radio Cade is produced by the Cade Museum for Creativity and Invention located in Gainesville, Florida. This podcast cast episodes host was James Di Virgilio and Ellie Thom coordinates inventor interviews, podcasts are recorded at Heartwood Soundstage and edited and mixed by Bob Mc Peek. The Radio Cade theme song was produced and performed by Traci Collins and features violin, Jacob Lawson.