**INTERVIEWER:** We're speaking today with Professor Linda Griffith, the School of Engineering Teaching Innovation Professor of Biological and Mechanical Engineering at MIT, where she directs the Center for Gynepathology Research. A biotechnologist, Professor Griffith is shaping the frontiers of tissue engineering and synthetic regenerative technologies through cutting-edge research at the intersection of materials science, cell surface chemistry, physiology, and anatomy. Her research areas include biomaterials, drug metabolism, women's health, systems biology, and bioinformatics.

She's currently directing an exciting project called Human Physiome on a Chip, which we'll talk about. Linda, you've been at MIT since 1988, initially in chemical engineering. You were the driving force behind the creation of the Biological Engineering major, which has served as a model for similar curricula around the world. You've earned many awards, including a MacArthur Foundation Fellowship, and your recent appointment as a MacVicar Fellow testifies to your outstanding teaching career at MIT.

So we have a lot to talk about. Let's get started, perhaps with your early days because we'll do a little chronological look at how you got to where you are now. And we'd love to hear about your life growing up in Georgia and influences.

**GRIFFITH:** So I grew up in South Georgia down near the Okefenokee Swamp and have an older brother, a younger sister, and a younger brother. And grew up in a neighborhood with lots and lots of kids, so we were outside all the time riding bikes, playing games, running around barefoot nine months a year. And it was a place to really discover nature, from fishing to learning about how plants grew. There were snakes and all kinds of crazy things.

So it was a very relaxed time that people focused on children and having good experiences. I went to public school, and again, a small town public school where the focus was on education. My mother had not finished college before she was married, but she was finishing college and getting a Master's degree. So she was always in school. So we got the impression, school is really important. We also were locked out of the house pretty much of the day so she could study, which was good. We got to discover nature and really learn how to be independent and do things on your own.

So--

**INTERVIEWER:** Was she studying science at all?

**GRIFFITH:** No. She was getting a sociology degree. Back in those days she felt that if something happened to my father she needed a career. So she became an elementary school teacher. And so she also, though, taught lifeguarding. She was a very active swimmer. She taught lifeguarding.

My father was the kind of person-- and this was true I guess of a lot of people back then-- but who fixed everything around the house. He built a stereo system and he was infinitely patient in teaching all of us children who were interested things like how to solder, how the system was designed. But he also was a very accomplished gardener and he did all the landscaping and we had a pretty large yard. This was deep South Georgia. And so taught me a lot about plants and grafting and propagation of plants and so on.

So it was a very rich time of learning about nature and about technologies. And back then there was only one kind of LEGO set. So we had LEGOs. And it was a time of just having time. There weren't the pressures I think there are on a lot of kids today. We played a lot. We built things out of LEGOs. We built things out of erector sets. We built mud pies. We built forts in the woods. And really got a sense of confidence, and also learning about resolution of differences and things among groups of kids playing different kinds of games.

And so it was a very wonderful place to grow up and be a child.

**INTERVIEWER:** And were you particularly gravitating towards science subjects in school at all?

**GRIFFITH:** So, I loved school. And I loved reading. I loved all aspects of things that I studied in school. I think as I got older-- we moved to a suburb of Atlanta when I was in middle school. As I got older, I really liked-- I had always liked math. But it seemed that math gave you a lot of power because you can figure things out. And being able to quantify things and everything from measurement if you're building a fort, designing something.

As a child, a younger child, I did all the things that girls did back then. Maybe they still do them. The embroidery, sewing. I made clothes for my dolls. I actually grew cotton and made some of my own cloth to make clothes for my dolls.

**INTERVIEWER:** Wow.

**GRIFFITH:** I knitted. I crocheted. And then as I got older, when I was 12 I took a sewing class. I made most of my own clothes. My parents were not particularly well off. And it was an it was an era that was maybe all-around less consumption than now. But I didn't have a lot of money for extra things. So I learned to sew. And you could get cheap fabric on sale and I could make very creative outfits from sewing.

And so this idea of designing and being quantitative, even when you knit you figure out how to make a pattern in a different way. It's permeated. And I think one of the things I think now is I've always liked making things. And I think an underappreciated, arguably, facet of women going into STEM careers-- because there's so much interest in that now-- is there's a natural creativity and building and making that's very quantitative in doing things like sewing and knitting and crocheting and macrame.

I also did wood shop. I just love making things. But this whole process of conceiving an idea-- getting an idea of something you want to build or make and then coming up with the way to do that, both the tools, but a lot of times there's some quantitative step in that design. Even if it's knitting.

And the ability to capture that there's an intrinsic stage of life. When I'm 12 I'm knitting, when I'm 30 I'm building molecules that are used in regenerative medicine. This idea that you design and build is a very natural engineering bent. Here's the problem. Here's a general tool that could be used to solve that problem. How do we really do it?

So for me, I kind of look back and I think a lot of things from when I was very young up through high school that I do now naturally as I-- I am an engineer who builds things. I build things mainly out of molecules. I build things out of biology. But that intrinsic process of defining something you want to build that has a purpose and going all the way back to first principles to the tools you have to build it and going through some kind of model, design, blueprint process. That's engineering.

And one thing that I'm hoping to spend more time on is really helping people appreciate that it's OK for girls to not go use erector sets. That the process of making a sweater and making it fit to a different size or changing the pattern, that's also an engineering approach. And it's building the kind of skills you need to do the things I do now, which are-- I have a lot of patents and things translated into use that are really hard core mathematical engineering design projects. But they really started with this idea of conceiving of something, even as a small child, and then realizing how to build it through some design, process, pattern, and build process.

**INTERVIEWER:** Were their mentors along the way too who were important? Or did you find your way?

**GRIFFITH:** Yeah. So I have a really terrific family. My parents. Of course, my mom in school. My dad was an engineer. He worked for the power company. And my older brother was also tremendously-- he was a Boy Scout, so it was interesting. Back in those days, I was a Girl Scout. And Girl Scouts would go camping in the leader's backyard. Boy Scouts went on jamborees and all kind of great trips.

But my dad became the troop leader and I got to do a lot of things with the Boy Scouts. So I learned a lot of the kind of things that they do outdoors. But my brother was a really-- older brother-- really terrific because he was very adventuresome and fearless, but he also loved teaching. So he would learn something in school, whether-- I remember when he learned, even in college the first time he learned multivariable calculus. He was so excited. He came home and really explained it all to me. I'm three years younger than him. And it was fascinating. And he got really excited about it.

And you're very receptive to learning math. There's not an age particular to learn math. And I think this joy of learning and then applying it to things was just imbued in my family.

And also another important thing is my mom in school, four kids. There were a lot of just things that needed to be done. And everybody had chores. But there were also, especially as I got older, things like the car would break down. My father traveled a fair amount. And whoever was standing in line in our family did the chore. It wasn't girls' chores and boys' chores.

So one time my dad left town and the car died. It turned out the radiator-- he calls. He says, well, you gotta take the radiator out and have it boiled out. And we had this huge old station wagon.

**INTERVIEWER:** You were how old?

**GRIFFITH:** Then I must have been at least 16. I must have been 16 because I was old enough to drive. He says, you know, the transmission line goes in the radiator. I loaned the tool to disconnect it to so-and-so down the street. So you gotta go get the wrench for that from him and then you take it out and here's where to take it. And then if it's no good, then you have to go to this place that sells the radiators for stock cars.

And, yeah. So it was this whole thing he just tells me on the phone. And he knows I'll do it. And it's like, we need the car. And so you just-- OK. You just do this.

**INTERVIEWER:** Did you do that on your own? Or with your brother or--

**GRIFFITH:** This one I did on my own. My brother, I don't know where-- he wasn't around at that point. So I was just sort of the confidence that-- there was no drama like, is your brother there? It's like, of course you can do this. And I think that really was important because there was an expectation that I could do the same things by and large from a professional standpoint that my brother could.

And so that was really an important thing, I think, in helping me just not feel any kind of pressure about what to do. It was actually socially very different because back then, especially in the South, like when I was in elementary school, girls were not allowed to wear pants to school. And, in fact, one day even though it didn't frequently get that cold where we lived, it was really cold and my mom dressed me in a very cute pants outfit and I got sent home from school. Even though it was like this matching jacket and pants, I got sent home from school in fifth grade. Because girls weren't allowed to wear pants to school.

And we were allowed to go to school barefoot. It's very cute, because we did.

**INTERVIEWER:** There were other rules.

**GRIFFITH:** But it had to be in a dress.

[LAUGHTER]

So I think this just kind of just blanket expectation that we could do anything. And again, socially there were things like my father wanted to meet the boys I went out with. And I wasn't allowed to call boys on the phone and things like that. But otherwise, from the expectations in terms of could I fix a car, could I change the brakes or whatever? It was, OK. Of course you can do this. And--

**INTERVIEWER:** How empowering. Yeah.

**GRIFFITH:** Yeah. It was incredibly empowering. And you don't realize at the time how empowering that is. We also, when I was in high school my younger brother-- he's six years younger. There was this show called *Kung Fu.* I don't know if anybody remembers this. But it was very fascinating show back when there were only like two or three TV channels. And about this immigrant from China who practiced Kung Fu and solved all these problems.

And so karate studios grew up in the US. And there was one in our-- we lived in then a suburb, a little town still. And my younger brother wanted to take karate. So everybody in the family ends up taking karate. And it turned out to be really fun. All our siblings did it.

And I really liked it because it was really great. It was exercise, but it was also-- there was a lot of-- you do katas, but you get to fight. And so I ended up going to the karate studio every day except Sundays. And one of my first jobs was teaching karate. And I passed up through, by the time I graduated, half my black belt test.

But it was a really-- again, a very empowering thing. And also I got in really great shape. But it also was mentally good and it was-- I entered tournaments and I fought against boys. And one year I had a crush on this guy and I really wanted him to ask me to prom. He was a guy at my-- and he wasn't paying attention me and we had a sparring match at the karate studio. And I actually knocked him out.

And this really impressed him because he was kind of a cocky guy. He couldn't believe he got knocked out by a girl. So--

[LAUGHTER]

So the freedom to explore and get into trouble and stuff was my generation of growing up. Getting yourself in a little bit of trouble or making mistakes was something parents let kids do. And it's incredibly valuable for later in life.

**INTERVIEWER:** Given that kind of background, did other of your siblings go into engineering as well? It just sounds like one-- I could really see how that might--

**GRIFFITH:** Yeah. So my older brother actually ended up going to Georgia Tech and majoring in chemical engineering. He started out as a chemistry major. We had a really fabulous chemistry teacher in high school, Mr. Chapelle. And really inspired us. Also a really great math teacher. And he went to Georgia Tech and he-- back then chemistry majors had to pass certain language requirements because a lot of the chemistry literature was French or German.

So he was taking German. And he really didn't like it. And I took four years of Latin in high school and two years of German. And so I would do his German homework for him because I liked it. But it meant he didn't pass his German class. So he switched his major to chemical engineering because he figured he was never gonna pass his German. And I'm sure there are other reasons, but that was the one from my view that I saw.

And I actually, up until my senior year, thought I would go to school-- I lived reading. And actually Georgia has this governor's honors program.

**INTERVIEWER:** This is Georgia Tech as well?

**GRIFFITH:** No, no. Georgia the state for high school students.

**INTERVIEWER:** Oh, I see.

**GRIFFITH:** And each school gets to nominate one person in each of the areas that they have for the governor's honors. So it's literature, English, math, drama, music, various categories. And I got nominated in both math and English. And I thought, oh-- back then I thought I would become a writer and so I went in English. And did that for the summer.

It was really fun. It was in Macon, down where Flannery O'Connor-- yeah, so it was a really good summer. I made a lot of really close friends. But my senior year of high school, I took calculus and my math teacher said he thought I could do really a lot better than I was doing. I was sitting in the back of the class gossiping with my friend. And I kind of took it to heart and I really started applying myself and I started realizing that thinking my daily life, I would really miss-- I really enjoyed knowing how things worked. And I really enjoyed math and math was a really calming thing.

I had a lot of drama in my life for family reasons. My mother ended up having a lot of mental health issues. But I also had a lot of health issues. I had a disease-- I have a disease called endometriosis. And I would get very, very ill. It wasn't diagnosed until much, much later. But math was just something you could do and there was an answer. At least back when you were in high school there's always answers in the back of the book.

And it was a really-- I realized how grounding the sciences were because it was something that could never be taken away. You had a skill that-- you started getting to that age and you think about different careers and careers that are based on-- if you're in the hard sciences where there is an answer ostensibly, there's less issues around social things and how you're-- I just kind of started to get this impression that I can be right. And therefore, who could argue. In a way whereas if you're writing or other professions you may have more of a struggle.

**INTERVIEWER:** It's more subjective.

**GRIFFITH:** It's more subjective. There's less clear criteria for how you succeed and how you build a career. And I was just thinking-- it appealed to me because I was-- also it was easy to do math. I found it easier than writing.

So by the end of my senior year, I decided to also go to Georgia Tech and major in chemical engineering. Because I loved chemistry and I loved math. And I love making things. Engineers really are about making things. So that's what I did.

And back then it was-- I had to really support myself in college. So going out of state. Georgia Tech, I got a scholar-- I was a National Merit Scholar and they gave every National Merit Scholar a scholarship, which was a huge thing to me to be able to do that. And I, at the time, had gotten an interest in-- my dad made a lot of money. He didn't make a lot of money [INAUDIBLE]. He actually learned how to invest in the stock market. And I would read the magazine-- *Forbes* and stuff. And I invested my babysitting money in the stock market and actually made enough money to pay for college.

**INTERVIEWER:** Wow.

**GRIFFITH:** And--

**INTERVIEWER:** So when you were at Georgia Tech then, you were very clearly on this trajectory in chemical engineering. That was clear.

**GRIFFITH:** Mmhmm.

**INTERVIEWER:** And then did you go straight to grad school? Or was there something at Georgia Tech that you would want to talk about that was somehow, I don't know, noteworthy?

**GRIFFITH:** Yeah, actually. Let me say a few things. First of all, because I couldn't go away to college I really needed to get away from my family situation for a while. So I went to Denmark as an exchange student at a gymnasium. And I lived, I think, with probably the only family in Denmark that didn't speak English. I lived very far from Copenhagen on a farm. And they owned a gravel pit. So that was its own experience.

So I actually-- I did that for six months and I started Georgia Tech in January. And at the time, Tech was not the research powerhouse that it is now. And there were not that many professors who actually had active research programs. It was very focused on undergraduate teaching.

And I was a pre-med. And I really loved-- because I loved biology. I'd taken a human physiology class in high school. And I ended up by the end of my junior year when I took the MCATs, by then I realized how much I loved engineering and that this idea of going to medical school was just sort of-- it was an ill-informed idea because it's like, what do you do? I didn't even know about graduate school.

And so I did really well on the MCATs but I had a kind of-- I wasn't sure what I wanted to do. I had been working in the summers for the State of Georgia Department of Natural Resources looking at water quality control. So my partner and I would go test lakes in Georgia for how polluted they were. It was really great because we would go camping and spend the summer outside. There was a little bit of science involved. It was mostly a kind of fun summer job.

And I realized I needed to figure out what to do. So fall of my senior year, you start getting recruited by Exxon and so on. And I got an exam back from a professor and it said, have you thought about going to graduate school? And I hadn't really, but I had been doing some things like-- I had to make extra money, I was a teaching assistant for freshman calculus. And so I went to see the professors and they talked it through. And this sounded like this is really what I want to do because I had, by then, really liked making things. I really wanted to learn how to do research. I got involved in a little research project as an undergraduate.

And so I ended up applying to graduate school. And at the time, Minnesota and Berkeley were really the two top chemical engineering programs. And there was no way I was going to go to Minnesota. And MIT, I decided not to apply to MIT. There was just not even a question because, kind of a silly thing. Number one, I didn't want to go where it snowed. But also Georgia Tech back then was seven to one men to women. And almost all the women were in the management school. So I would be the only woman in a class sometimes.

And you really don't frequently notice it except you do get asked-- I was very cute when I was young. I'm old now. But there just weren't a lot of women. And so it was hard to-- you have a lot of friends. And it was just a weird social situation. So it's like, I'm not going to go to another school for graduates. I want to go to a place that has equal numbers of women and men. And plus I had--

**INTERVIEWER:** In engineering they had?

**GRIFFITH:** Well, no. No. I want to go to a school.

**INTERVIEWER:** Oh, Georgia Tech as the campus.

**GRIFFITH:** Just the school has-- yeah, the campus.

**INTERVIEWER:** Right.

**GRIFFITH:** But I also had gotten very involved. I wrote for the undergraduate newspaper and became editor of the features section. So all the bands and stuff I'd go review them. And I was very involved in music. And so I wanted to see the Dead Kennedys, a band that never came to play Atlanta when I was in school. It's like, OK. I'm going to go to Berkeley.

So I ended up going to Berkeley in chemical engineering. And they had a lot of biotechnology in the chemical engineering department. And so it was a very attractive school. And so I went there right after I graduated.

**INTERVIEWER:** That was through to the PhD then? At Berkeley?

**GRIFFITH:** Yes. So I did a PhD at Berkeley.

**INTERVIEWER:** So then you come to MIT. There's probably stuff in between, or--

**GRIFFITH:** Yeah. So I did a PhD at Berkeley. And it was a great place to go to graduate school. I got married and then my ex-husband got a job at MIT. And we had a lot of-- he was from California. And we agreed that-- he was ahead of me. That if he moved to MIT-- that if we left California, he would get to pick. So I ended up here and I interviewed for jobs. And it turned out-- it was an era when the biotechnology industry was getting started and they didn't really know quite what engineers did.

**INTERVIEWER:** This was late '80s, you said?

**GRIFFITH:** It was the late '80s.

**INTERVIEWER:** And I didn't mean to short anything--

**GRIFFITH:** Nope. Nope.

**INTERVIEWER:** --about Berkeley if you wanted to talk about your time there.

**GRIFFITH:** No. I enjoyed riding my motorcycle. Made a lot of great friends.

[LAUGHTER]

**INTERVIEWER:** All right. Yeah. So late '80s at MIT then.

**GRIFFITH:** Yeah. And so I interviewed for jobs-- so I had actually faculty offers before my ex-husband did. Because I was in a really hot area. And also a lot of schools were interested in hiring women. So I had sort of a lot of things. I was from a really top program, really top lab. I had a research area that was really, really demand.

So I got invited for faculty interviews in my third year of graduate school. And I got offers before my ex-husband did.

**INTERVIEWER:** Wow.

**GRIFFITH:** So it was a complicated two-body thing. But we agreed that I would turn down my offers and he would take MIT. And so he came here. And then MIT was the only other school that had really strong biotechnology. So it was clear that if I wanted a faculty job, I was going-- so I agreed, I will do an industry job. And I got a job at Dow Chemical two months before I was done with my thesis. They closed that lab and moved it back to Midland.

So I ended up with no job. But I looked for postdocs and people didn't do postdocs back then. So I ended up finding in the back of *Science* an ad for a postdoc that Bob Langer had with a transplant surgeon, answered the ad. And I love Bob and I love Jay Vacanti. And it was just great. And so I ended up doing a postdoc. And that's really how I ended up ultimately joining the faculty at MIT because I had a fabulous postdoc experience. Bob is very, very nurturing and Jay Vacanti is an-- both awesome mentors. And really, really opened my eyes to a lot of things. My PhD thesis was in reactor design from mammalian cell culture. This was more medical, the beginnings of tissue engineering.

And so I really got a great experience during the postdoc working over at Harvard Medical School with the surgeons. And got a chance to develop a lot of my own ideas. Bob was growing a very, very big lab and the postdocs had a lot of independence and he expected you to really reach out and learn from other people. So it was a fantastic time.

And then he encouraged me to apply for a faculty position at the end of the postdoc. And so I did that and ended up on the faculty.

**INTERVIEWER:** Wonderful. And you did some fellowships too? Those are a little bit later, I guess.

**GRIFFITH:** Mhm.

**INTERVIEWER:** You had various-- but basically you've been here. And then you've had various collaborations, I'm sure. So this was the beginning of systems biology? Is that what was going on would you say? You said biotechnology, so how was that--

**GRIFFITH:** So biotechnology was really making therapeutic proteins. Things like EPO making insulin and E. coli. So it was really the start of connecting engineering and biology. And at MIT, Professor Danny Wang, who's an Institute professor, had done this amazing thing. He created an NSF engineering research center called the Biotech Process Engineering Center. And this started in the mid-80s before I was here, but it cast a long shadow because in graduate school I knew about this and I had friends who were part of it.

And it was really a time when he really started initiating connections between engineering and biology to do therapeutic protein production. And so I joined in a program actually with Harvard Medical School and taught at the medical school for a while. But it was a time when the ascendance of understanding biology at a molecular level was-- it was just growing very fast. And once you have a revolution in a basic science-- so you think late 1800s, early 1900s, chemistry became molecular. Now you could predict reactions. So that's how chemical engineering got born. It got born at MIT.

And you think about electrical engineering came from revolutions in physics. Maxwell kind of understanding of physics. And so when biology became molecular, it's only natural that you grow a new kind of engineering out of the underlying science of biology. And so new engineering disciplines come along every few decades, really, because it takes a true revolution.

So the late '80s was before systems biology. But it was kind of really starting to connect engineering and biology. And a whole bunch of us at MIT. So I ended up in chemical engineering, was teaching standard chemical engineering. But a whole lot of people at MIT in different engineering departments, as well as in biology, could see that we needed to be more holistic about the approaches of translating discoveries of biology into things society uses through the prism of engineering.

So we got together an ad hoc committee. We would meet literally over beers on Fridays and talk about what we should be doing. Because other schools were starting biomedical engineering programs. And there was a foundation giving money out to do that. Huge amount of money, actually. And we got together and we decided it was really not appropriate to have a major in biomedical engineering because medical engineering is all kind of engineering applied to medicine. It's sort of like--

**INTERVIEWER:** More clinical.

**GRIFFITH:** Yeah, but it's interacting with the industry, whereas doing engineering based in a fundamental science is a discipline. So we proposed-- I was leading the committee by then even though I was an assistant professor. We proposed to have a minor degree in biomedical engineering. It was a MIT's first interdepartmental minor. And MIT said, oh, you can't do this. You're not a department.

And MIT, being very thoughtful-- this was actually a great experience for an assistant professor. Because there's like different committees. Committee on Curriculum, Committee on Undergraduate Programs, Faculty Policy Committee. And there's a process for everything at MIT. And it can be very frustrating, because you want to do something but you gotta go to all these committees.

On the other hand, it's amazing. Because there's an institutional memory of why you do things a certain way. And there's flexibility that if you can argue that, here's why I want to do a new thing, you'll take it through the prism of, here's the things that could go wrong. So when you're a young person who doesn't have that institutional memory, you hear from people who've seen a lot of things. And they can say, well, did you think about this? It's like, no. Yeah. I could see.

And so the process of proposing this interdepartmental minor, it was the first time that had been proposed. And the Institute needed to react. And they actually helped us make it happen. It took a long time.

**INTERVIEWER:** So there was some push back, or--

**GRIFFITH:** Of course there was push back. Because there was no mechanism to do an interdepartmental minor. And I learned a lot about the incredible, incredible seriousness with which MIT takes undergraduate-- education in general, but especially undergraduate education. Thinking about experiences of students and the things that could go wrong and if you do something haphazard.

So it was a much longer process. It was a very long-- I had to get by, but it helped me meet people all over the Institute. I got connected, understood how the administration worked at MIT. So it was a fantastic experience. And we got it instituted and it started in 1995 as MIT's first interdepartmental minor. Became the most popular minor within two years, over 80 kids a year.

But it also led to a group of faculty proposing to the administration that we start a whole program connecting modern molecular life science to engineering. And that led to creation, ultimately, of the Department of Biological Engineering.

**INTERVIEWER:** And the major, yeah.

**GRIFFITH:** And the undergraduate major.

**INTERVIEWER:** Wonderful. So you-- other universes weren't quite doing that at the time either.

**GRIFFITH:** So what was different about MIT and special-- MIT is special in so many ways. First of all, from an intellectual standpoint, other schools had departments of biomedical engineering. So they had electrical engineers or mechanical engineers. Like Hopkins and UCSD and so on who had started to work with clinicians, but not necessarily thinking about biology like, let's make a pulse oximeter. Or an imaging.

So there were things-- a lot of things that engineers can do that don't require biology or much knowledge of biology. Where this was different, very different, was to say the real thing is to think 10 years down the road. So one approach to liver disease is to grow a liver and transplant it into the patient. Another is to figure out the mechanisms that cause liver disease. It's actually an engineering problem, believe it or not.

So our vision was instead of building a machine to correct something that went wrong in the patient or a prosthetic, let's figure out how to prevent it from happening by really bringing a whole new level of understanding and manipulation of the biology that is an engineering appreciation. So it was really this mid-late 90's was when systems biology really got started around this engineering. Understanding biology from a molecular systems level through bringing all the things engineering mindset does to analyze things and then to build things.

So that was really when it got started. But other schools were not really fortunate enough to have the humongous number of faculty. We have a huge engineering school. And a lot of interaction. We also have a long, dark winter and something called the Infinite Corridor. And people just are stuck together.

And we actually also had this really great thing, which has kind of gone by the way. We had a faculty lunch room. And Joel Moses started this when he was-- I think it was Joel Moses. It was this really low-key place over in Walker on the second floor that you could go and for $3 get a very basic lunch. And just picnic tables kind of thing.

**INTERVIEWER:** Faculty only, did you say?

**GRIFFITH:** It was faculty only. And it was great because you could run over there after class and in 20 minutes get lunch or you could stay there for an hour, but you met-- it was a chance to talk to people in other departments and just over anything. Because I would go by myself. I'd sit at the table with the chemists. And I got to know a lot about what was going on in chem-- you just learned a lot about other people and what they were doing by I'm just going to sit here and eat my lunch and just, what's going on?

And unfortunately, when they created the R&D, the new one, it didn't really capture. And then they decided to open it to-- it would be great if we could bring that back, because it was a very-- really nice thing. Even though it may seem elitist. But it was a really good thing because you could talk about things with your colleagues in a very low-barrier way.

**INTERVIEWER:** You mentioned the Infinite Corridor too. And I've heard about this. But really did you go out in the hallway and-- how did you-- I know that the departments--

**GRIFFITH:** Well, the Infinite is-- everything is on the same hallway. So everybody is down the hall. And this was crucial because without going outside in a coat or anything you could literally meet people by just running down the hall to their office. I'm going to come over and talk to you in your office. And in the middle of the afternoon when you're just-- you're frustrated about something, you get up and you take a walk and you stop in and see someone in another department.

And you can do that. And people do that all the time. People just stop in and see each other. Maybe not so much now. Certainly this was done. And that fostering and people-- dark, long winter-- you're kind of forced in together. So it was a really great environment where there was a lot of communication. And so that really helped us.

And the other thing that made it possible is-- things have changed a lot in the past 15 or 20 years. But MIT really values people at all stages of their academic development. It's much more hierarchical now than it was in the past. But there used to be a very thin administration and the idea that your faculty are people that you hired as assistant professors and brought them up through tenure is extremely valued. It's not like Harvard where when somebody's up for tenure you go ask, is there a senior person that we could bring in?

MIT really values bringing people up through the ranks. And they really value that undergraduates and graduate students have enormous things to contribute intellectually and otherwise to the functioning of the Institute. And that you may not have the experience level as someone older than you, but you certainly are capable of that someday. So there is this more valuing the energy, ideas, and so on and people at earlier career stages at MIT than there are at some other schools.

And that makes a lot of things possible. Because grassroots up frequently is very enduring compared to administration level down. Because when people get to-- you bring something up from the grassroots, you have to convince your colleagues that your idea is good. So you figure out the right way to do it because you've gotta really hone your reasons for wanting to do something when there's all these other people wanting to do things too.

So I love that about MIT.

**INTERVIEWER:** It sounds more collegial in general. You're not looking to-- you're not so-- maybe you're more, I don't know, nurtured. And therefore less, I don't know-- and the whole tenure battle I think must be a difficult one.

**GRIFFITH:** Well, tenure at MIT, everyone that we hire, we expect to get tenure. So every single person who's hired. There's no weeding out. There's no expectation that we've hired three people, we only have one slot at the tenure level. There's an expectation that every single person who's hired will ultimately get tenure. And there's a sense of failure if they don't. So the department feels like someone-- it is-- at MIT there is a sense that it's a community endeavor to help people develop professionally and become all the things you want an MIT faculty member to be.

And that really was-- I had an amazing experience as-- my tenure process here was fantastic because I had fabulous mentors in many departments. I had an amazing department head, Bob Brown, who's now president of BU. Was just really incredible.

**INTERVIEWER:** So at this point, you had started the biological engineering major.

**GRIFFITH:** No--

**INTERVIEWER:** Are you in a different department now? Are still in--

**GRIFFITH:** So the brief history of what happened is I started out in the HST program and then resigned from that my third year because it wasn't a fit. I didn't want to be at the medical school. I really needed to build the bridges to biology. And I got hired by the chemical engineering department. Bob Brown was the department head and he had real vision for-- he could see that biology was going to become a discipline, I think.

And so he then hired a whole bunch of us, proposed to the administration to start a research center to kind of bring together these ideas. And we also proposed that we hire a particular person from the outside to come head it. And that was Doug Lauffenburger. And so that started in 1995 and Doug came into chemical engineering and I was in chemical engineering.

And it grew out of this-- we had the interdepartmental curriculum committee. It was just an ad hoc interdepartmental committee that I was chairing. And kind of the idea that we needed a formal academic unit to handle bioengineering came out of this committee. But it started incrementally and in a logical process. So it started as an academic division. And this was Bob Brown and Doug Lauffenburger came up with this idea that we would put half of our appointments into a new kind of academic structure that hadn't been done before.

And this was-- Bob Brown was a very creative dean of engineering. And he said, well, we could do an experiment and see if there's something really there. So we had-- there was a committee that evaluated and assessed, would this be a good idea? How should we go about it? And Bob Armstrong, the Chem E department head chaired it. And they so we had a charter and we had certain expectations. We were going to be reviewed after five to seven years and either could continue as a division, be a department, or get killed.

And it turned out we got reviewed after four years because it was incredibly successful-- we started a graduate program. And it became one of the most competitive in the school of engineering very quickly. Nationally it was the only real biological engineering graduate program. And then our visiting-- MIT-- every department has an external advisory, something called a visiting committee. And they, after they saw the success of the graduate program, said you really need to develop an undergraduate major.

So advised us. And I then led, starting in 2000, a committee to develop an undergraduate major. And then that got launched in 2005. So it was really a process that happened from 1998 when the division started up through-- we actually didn't become a department, I think, until 2006.

**INTERVIEWER:** And were you also collaborating with other departments more and more? Was that part of--

**GRIFFITH:** So there's-- a way to think about research at MIT is the-- MIT is organized around academic departments that grant degrees. And so the degree programs are pretty much within departments. But there's all kind of interdepartmental research centers that have people from all different departments participate in programs.

So for example, when Doug Lauffenburger came, he headed an interdepartmental biomedical engineering research center. And this got grants-- we were part of collaborative grants. And this happens all over MIT forever. Two people get together, they write a grant, and you do this. So there's all kind of research collaborations.

And that is not at all unusual. And so I had collaborate-- one of my most seminal-- most important ones as an assistant professor was with a chemical engineering professor named Ed Merrill, one of the real pioneers in biomaterials. I didn't know that much polymer science. He really taught me polymer science. Amazing guy. My first student was co-advised with him.

And so there were research collaborations where you learned something or put two things together with other people. But there were a lot of teaching collaborations because we started out with not enough faculty to do the major. And there was a real humongous set of teaching collaborations.

**INTERVIEWER:** And in fact, let's talk about teaching and your experience about teaching the MIT student. Was that because you've been recognized with your-- with a MacVicar Faculty Award because of your passion in teaching undergraduates. Has that been something that you are continuing to do?

**GRIFFITH:** Oh, yeah. You shouldn't be at MIT pretty much if you don't enjoy teaching because-- and it's interesting. The creation of the undergraduate major is partly because if you were pushing a research frontier, whatever you really learned you bring into the classroom and teach other people how to do it. And so teaching is a synthesis of what you've really learned. Even though now I teach a very-- I teach thermodynamics and statistical mechanics, which has been around for a long time.

But it's always changing because the applications change and the way the kind of tools we use to study it and apply it and measure things change. So you bring that into the classroom. So teaching-- MIT students are amazing. You always learn from them. And anyone at MIT will pretty much tell you this. That you learn stuff. And it's incredibly enriching for the research program to teach a class, especially to undergraduates. Because you can't explain it to them. You don't understand it.

And by teaching things that are outside your comfort zone, as it was-- when we started the new major I had to-- we needed a thermo class. And I ended up developing it. And it was an incredibly wonderful experience. We teach now-- or we ended up teaching jointly with the chemistry department for a while. And it's been great. Several research projects got launched out of teaching together with chemistry.

In fact, one of the project-- Moungi Bawendi is a chemistry professor. We started a small project funded by the cancer center. And it's now in clinical trials to do better resection of tumors during breast cancer surgery. And amazing small circle. The project actually--the person leading the clinical trials is actually the surgeon who did my breast cancer surgery five years ago.

So it's actually doing very well. So it's kind of amazing. And it completely grew out of a teaching collaboration. And we would not have started that project if we hadn't been teaching together. And we just learned about each other. And then we had a chance to just try this idea. And here we are. Together started a company and now it's actually going to be-- I know exactly why we need this technology to help women who are having breast cancer surgery.

**INTERVIEWER:** I want to get to that. I want to hear more about that. But I want to talk about-- so you have your personal experiences and health issues. You mentioned earlier endometriosis. And I'd like to talk about what-- how did you decide to do this research center in gynepathology? And what was involved in getting that put together?

**GRIFFITH:** Yeah. So I currently direct a center that has an unusual name. In fact, my surgery collaborator, who's fantastic, one of the best gynecology surgeons in the world, extremely renowned. He's like, gynepathology, we can't call it that. That's not even a word. And we did a Google search. There were only three hits and none of them were from English-speaking countries.

But we decided-- so it had a lot of different origins. So a few things. One, I'm pretty much a tomboy. I rode motorcycles, karate. You kind of figured this out. And I always considered myself or MIT to be sort of gender neutral. I never really thought about these things.

But there were-- men and women are different because our anatomies are different and there are different kinds of things that happen to us on a monthly basis. And one of the things I had-- I have had endometriosis, which is a disease where bits of the endometrium grow outside the uterus, typically in the abdominal cavity. And it can invade underlying tissues. It can be-- but it can be inflamed and bleed and it can cause excruciating pain. And that can be related problems with the uterus, something underappreciated and underdiagnosed now called adenomyosis, which is essentially the uterine lining actually growing in the muscle of the uterine wall. And again, causing a huge amount of bleeding, a huge amount of pain.

And I had this in high school. There were no drugs. And I would get very sick. And the driver's ed class would have to bring me home sometimes. And there was nothing to do but just cry. And I was-- through the years then when I went to graduate school, they would give you birth control pills. But kind of controlled it a little bit. But no one ever mentioned that I really had any-- this is like, you have bad cramps.

And in graduate school, over the counter NSAIDs like ibuprofen and naproxen became available. And I would take like 50 a day because I was in so much pain. And I remember going to the doctor and they would get so excited that I didn't have any stomach ache from taking 50 Advil a day for several days in a row. And they'd bring all these other doctors in. Look, she has no stomach ache. I'm like, hello. Can we please talk about why I'm taking 50 Advil a day?

And no one-- so Berkeley, it's like, well, there were all these things. Very cute. Well, you're just not accepting that you're a woman. You're not accepting it. Like, hello. I don't think that's it. Or it's always you-- because you always go in the middle of your cycle when you feel the best. And it's like, oh, it really wasn't that bad. And you actually don't have a great memory for pain.

**INTERVIEWER:** Were you the only one you knew that had this?

**GRIFFITH:** So it affects about 10% of women. And I just didn't-- my sister had no menstrual problems at all. But it-- it was just not something-- there weren't that many women in my life. So, yeah, there was my sister, my mother, who did have fibroids, which is a very common disease in women when they get older and she had a lot of bleeding.

But it just-- I didn't actually have-- most of my friends were men. And so, no.

**INTERVIEWER:** It didn't come up.

**GRIFFITH:** No. I knew-- like I had maybe three or four close women friends in graduate school. So statistically, they wouldn't have this problem. And so when I was finishing my thesis, my husband was-- my ex-husband was at MIT already. And in my lab, there was a phone that was on-- my desk was here and there was a shelf that the phone-- before cell phones. And the phone would ring and it was so painful to reach like that and open it. It was just-- so I wouldn't answer the phone.

And people would get mad. And somebody yelled at me. There's something really wrong with you if you can't answer the phone. I'm like, you know. There really is something wrong with me. And so I started going to the-- by then I moved here, had started postdoc. I went to the doctor every month for six months and kept insisting, there is something wrong with me.

They finally sent me for an ultrasound and found a little cyst and told me, oh, it's nothing. We'll do this outpatient procedure. You'll go home the same day and you'll go to work maybe the next day. And it's like, fine. Great.

And it ended up I didn't even wake up until the next day because it was 1988 and anesthesia was not so advanced back. I didn't wake up until the next day because I had extremely advanced stage of the disease. And I woke up. That was the first time anyone had mentioned endometriosis. And I had-- it was all my internal organs were involved.

So I'd had an open procedure. I was in the hospital for a week. And then went on--

**INTERVIEWER:** They could treat it? They could it in that way or they just--

**GRIFFITH:** So they-- so it's interesting what happened. Interesting in a scientific sense. And I'm getting to why I started the center. So they said, well, you can take this drug, anabolic steroid, essentially. Or you can have a baby. And those are the two things you could do. And my ex was like, oh, we're going to have the baby. And I'm like, I'm taking the drug.

And so it's actually a very powerful drug, which is used much less frequently now because it's on the drug-induced liver injury list. It can cause liver failure. And it was amazing because I gained 20 pounds in two months, but I got very muscular. And I could run very fast. But I had really, really diminished my pain for the first time in my life.

But they'd only let you take it for six months because it was considered-- and so that kind of got me on a path. So I took it, but then I went off of it. And then I had recurrence of symptoms. Then there was this other drug that would cause menopause that had come into the clinic and was being used to treat it. It was actually drug developed to treat prostate cancer, but then they decided they could use it for endometriosis.

And I actually went in a clinical study to take it because I was afraid to take it. I was 30 years old. I didn't want to be taking a drug-- very powerful drug. And I was by then an assistant professor and I was worried about side effects.

And it actually was a bone mineral metabolism study. And they wanted young women who were induced to have menopause to study a potential treatment for osteoporosis. And I ended up being in the control group. I lost 12% of my bone in a year. And had terrible side effects from-- terrible side effects from this drug. But more importantly, my disease actually progressed while I was taking this drug that was supposed to treat it.

And yet I learned because the drug companies were really-- like gynecologists thought this drug was a miracle drug. And so it's sort of-- I felt like I was in an alternate universe because I wasn't responding and I was having these terrible side effects. And meanwhile I had become an assistant professor. And it was really challenging because the expectation was I should be getting symptom relief and be fine but I wasn't and I'm trying to teach and you take a drug that causes these terrible profound menopause effects and it affects memory and sleep.

And so there were some different experiences I-- it was a difficult thing to talk about with my male colleagues. Because there wasn't really anybody I could talk to. So this kind of shaped my thinking at the same time. I did well on my research. I became well-known, I had great publications and co-inventor on three-dimensional printing with actually my ex-husband and Ely Sachs. And we started a company.

So there were a lot of things that were going extremely well. But here's this lingering problem, health problem, which is quite debilitating that I'm trying to always juggle. But it's not something that other people at MIT-- if you're a guy and you get a hernia, as one of my colleagues did, everybody knows. Oh, you've got a hernia and you've got to have the operation. Or a heart problem or whatever. There's an understanding because other people in the community have it.

And here I was-- not only was it not known in my community, it wasn't even known in the medical community, really, what was going on. So that was part of it. And I ultimately ended up having five surgeries at Brigham and Women's and then realized I kept having these recurrences. And ended up finding a new surgeon going through my medical connections and finding a young guy who was then at Mass General, Keith Isaacson, who's now my collaborator.

And he essentially saved my life because he was an incredibly good surgeon. And what I learned-- and this isn't-- it turns out that the disease is highly invasive and you actually have to cut it out, whereas most surgeons would just burn it on the surface. They would see something and they'd burn and they'd think that they'd gotten it, but in fact it had very deep roots.

So it's just always growing back because the surgeon was never taking it out. Yet I was being told that because you've had surgery you should feel better. And it just like-- and I was getting sent to psychiatrists because I should really be better. But it's like, I'm not better.

And so this was-- it was interesting because it really-- now I can, in hindsight, understand how primitive the understanding of most physicians is about this disease, even surgeons who operate on the majority of patients. It's really a subset of very good surgeons who understand this disease. So that was one thing.

But then a couple other things prompted it. Number one was I did get the MacArthur Grant in 2007. And you're expected to do something creative. You're given freedom to do something creative. And so I thought it's a chance to really do something new. So that was number one.

Number two was I was becoming a bit-- and my friends, a lot of us were becoming a bit-- let's just say we felt that there were different experiences that women faculty had that were not necessarily being captured adequately in the mainstream press. Namely, that a lot of us felt that there weren't quite the gender discrimination things that got a lot-- like the women in science and the women in engineering reports, while I think they serve certain purposes, there was not a lot of enthusiasm by the people who ran those studies to highlight people who had positive experiences.

So I had some dramatically complicated, unfortunate things happened to me at MIT. But I had amazing things. And it was an amazing place to start a career and amazing male mentors and people who did things for me. And a lot of things that happened to me that some people urged me to count as sexist, but they were not-- they would have happened regardless of my-- there were other explanations. There were often-- and I'm very data-driven. And there were almost always other reasons that something bad that happened to me happened not because I was a woman but because I was in some other category. Or that somebody said something to me that some people might perceive the sexist, but I would perceive, this person is always trying to push somebody's buttons and he thinks that's going to push my button and I see him saying this thing to a man because he thinks-- something really nasty to a guy-- because he's just like somebody who acts like that.

So I tended to have a very high bar on what I considered actual sexism. And because it was always-- almost always-- an alternate explanation. And a lot of women of my generation felt this way. So one thing was-- also I got asked to be on a billion committees. You always had to have x chromosomes on committees where you really-- I had nothing special to say as a woman on the committee on-- whatever. And it was just onerous.

And so these percolating things about, well, what I could really do for women is actually help them get-- there's all these diseases that affect the gynecology-- like my experience, I finally admitted, this was a terrible thing for me to deal with while I was trying to go through tenure. And it was really hard for me to deal with it in high school and in college and in graduate school. I had to completely run my life around it.

And other women who maybe didn't have as many supportive family, it would be the thing that knocks them off a professional career, whether it's science or whatever. So maybe the best thing I can do to help women in science is actually help women be able to get out of bed and go to work. If you fix-- and 10% of women have endometriosis. There are a host of other diseases that affect young women that could similarly just make it hard for them to have a demanding career.

And so it suddenly dawned on me, I'm at MIT. If MIT is going to really do something for women in STEM, let's help them make it possible for them to even come to MIT. So that was one thing.

**INTERVIEWER:** So you want to make sure women continue from the fact that you want to make it possible for women to not be debilitated.

**GRIFFITH:** Yeah. And so, as anything, MIT is great because you have the chance to go in new directions, but still there has to be something that really pushes you over the edge. And the thing-- because I was-- it was possible for me to get funding in areas of liver and bone-- things that I was doing and I was very productive and visible. You can get research funding for that because you have a track record.

To do something new, it's scary. Because you don't know the field. You try to go in from the outside. So you gotta to have-- it's like jumping off a high dive. And you can have an easy life or you can do something that makes your life very difficult. But what happened, it ended up I couldn't have children because of the endometriosis. And I'm very close to my nieces and nephews. And I have-- my younger sister had has a daughter, who from the time she was able to crawl, everyone says, oh, she's just like Aunt Linda. Which, of course, drove my sister nuts.

Because my sister-- my older brother and my younger brother, we all majored in chemical engineering. She majored in journalism. And she's amazing. She is so amazing. She's so accomplished. But she's just not got the mathy brain as much as-- it's just not her thing. So we shared a room growing up.

So when Caitlin loved math-- Caitlin-- was she really-- but she also started having symptoms of endometriosis when she was 12.

**INTERVIEWER:** This is--

**GRIFFITH:** My sister's daughter.

**INTERVIEWER:** Your sister.

**GRIFFITH:** Yeah. So she started having symptoms. And my sister would call-- because my sister never had menstrual problems. She would call. Caitlin-- what do I do? And I would say, do this. And Caitlin is amazing. She's very level headed. And I would say, well-- and then so she got put on birth control. It didn't really help. She was having a lot of pain and my sister would call. She would take her to the emergency room. And there were certain symptoms that were really scary.

And so then I'd write the doctor or contact the gynecologist and the gynecologist says, butt out. You're not a patient. And then the gynecologist-- so I said, oh, I think she has endometriosis because she's got exactly, exactly, what happened to me in high school.

**INTERVIEWER:** I'm sorry, this is your niece that you're--

**GRIFFITH:** It's my niece.

**INTERVIEWER:** OK. So--

**GRIFFITH:** Yeah. My sister's daughter.

**INTERVIEWER:** Right.

**GRIFFITH:** Who lived in Atlanta. I'm here. She's in Atlanta. And so I don't see here all the time. And so then my niece-- so then she decides she has a food allergy. There's all these alternative explanations. There was a lot of family drama. Because you're 14, 15 years old. You want to be told you have-- because Caitlin has seen me go through a lot and she doesn't want to have this terrible disease. And so it's a food allergy. And then the OB/GYN says that she needs to have a colonoscopy to investigate because you get a lot of GI symptoms. And this is a-- you can have terrible GI symptoms and it's because it gets on your GI tract and inflames it.

And I told the doctor, I said, you know, this is really not-- because a colonoscopy is pretty invasive. You have to miss two days of school. I said, she could have diagnostic laparoscopy just to go in and-- because I think she has endometriosis-- and would be the same amount of missed school. It's about the same amount of invasive procedure, same amount of anaesthesia.

And the gynecologist got really testy. And so Caitlin has a colonoscopy. They obviously don't find anything. And I then got-- and so then the OB/GYN tells my sister, Caitlin has started going to this very competitive private school. She had been at an all-girls school. She had changed schools. And so the OB/GYN tells my sister, you know, I really think she's just making things up to get out of going to school. I think she's under a lot of pressure and she's just really exaggerating and I think we just need to deal with that. And you're going to just need to take her to counseling.

And so my sister calls me and says, what do I do? How do I find a counselor? And I just-- it's just like my head exploded. My head exploded. So I called my endometriosis surgeon. I said, who should she see in Atlanta? And he got her referred to a fabulous surgeon in Atlanta. And she had surgery and she had endometriosis and a lot of it. It was an obvious reason.

**INTERVIEWER:** And you don't know until you're in there.

**GRIFFITH:** Yeah, you have to have surgery. Now you can kind of tell in some cases. But at that time not. And it was eye-opening Because Keith says the only person she should go to in Atlanta is Ceana Nezhat. And as soon as my sister goes there, the OB/GYN says, oh, I can do this surgery. Why are you taking Caitlin to him? And really denigrates this surgeon in front of-- and my sister called, what do I do?

And I said, you tell the doctor call me and I will explain the facts of life to her. Anyway, so she was diagnosed and she's on therapy. She's actually had another surgery. This was maybe 2007 that she got diagnosed. And she was the top student at her school. She loves school. She was amazing. She was like a one in every five year student. She won every award when she graduated. She got full scholarships to really good schools. She was an amazing student. She loves school. So this just was ridiculous.

And that just threw me over the edge. So at that time, around that time, I got asked by a lot of women on the corporation at MIT who are on the board of the Museum of Science to do a Women-- 10th anniversary of a series they sponsor called the Women in Science Lunch Series at the Museum of Science. And I often am on the edge about doing women things. But this-- they were friends of mine. Susan Whitehead, who was our visiting committee chair. Amazing, amazing person. And she's a member of the corporation.

So I said of course I'll do this because they're my friends. And they said, well, it was a panel. There were two speakers and a panelist moderator. And they said we want you to talk about how your research benefits women. And this was prior to my niece-- around this-- but I'm like, why should I say-- my research is on livers and bones and it benefits everyone. I kind of got a little not happy about that.

But then I started thinking, all of this stuff came together. And in the Q&A after-- there was a nice, long Q&A because there were students and postdocs there. A student said, where do you see your lab in three to five years? And everything just kind of came together. And I said, I'm going to have a center that studies endometriosis at MIT to put a scientific language on it. And that's what I'm going to do.

And it just kind of came out. And so then it just became obvious. I had to do it. And because all of that was boiling around together and that all kind of came together. And it's like, OK. I'm going to do it.

So Keith Isaacson, who was my surgeon, had been asking me to start a research project with him. And it was a weird kind of thing to-- he had by then done surgery on me three times. Because I had a hysterectomy, but I had actually a whole other thing. I ended up in the MGH emergency room on 9/11 and had to have an emergency hysterectomy. It was really a weird experience to be there because they canceled everything because they thought they were gonna get people from New York.

**INTERVIEWER:** Wow.

**GRIFFITH:** But he had been saying, there's no new drugs, there's no new therapies. And then Caitlin got diagnosed. And then what was interesting is systems biology. We had started BE. A lot of people in the department, and especially my second husband, Doug Lauffenburger, who is an amazing--

**INTERVIEWER:** Oh, you've mentioned him. Yes.

**GRIFFITH:** Yeah. So he became the department head. We ended up getting married because we had to share a lab. He moved to MIT. We shared a lab. We both ended up getting divorced. I'm gonna leave all that part out. But he is--

**INTERVIEWER:** A good collaboration.

**GRIFFITH:** He is a phenomenal collaborator, phenomenal department head. Just really fabulous mentor to so many people. But he also-- he had been really founding this field of systems biology together with others. And he had-- he was really building the department, hiring faculty who take a multifaceted approach to study chronic inflammation, which cancer is in a lot of ways an inflammatory disease. And for multiple-- really bringing some engineering approaches to understand the diseases and figure out, how do you develop therapies?

And he made a commitment to study endometriosis as a prominent example of inflammatory disease. And we got a foundation grant for about-- not quite $1 million to establish the Center for Gynepathology Research. The foundation wants to stay anonymous. But also MIT alumni. [? John and Corrine ?] [? Beg ?] then donated UROP funds and they donate to the center. So they were alumni who were very excited about this and have been very, very generous in providing support.

And it was just like this enthusiasm that MIT should be doing something. And so it was a completely new area. We contacted-- because Keith Isaacson knew everybody. We contacted some great scientists-- Kevin Osteen of Vanderbilt-- and they came up and advised us. How do we get started? And so we started the center and we hired some postdocs. And it's been a really great experience.

And we really have done some significant work. I have been welcomed by the gynecology surgery community. They are so excited to have scientists. Fabulous group of people who really want to help women. And it's just-- it's a really, really busy life because I still have all my other research funding. And part of the way I fund this is actually the Human Physiome on a Chip. That I wanted to do because a huge barrier to developing any new drugs in endometriosis is having model systems that let you predict whether they'll be effective in people.

**INTERVIEWER:** I want to get into that.

**GRIFFITH:** Yeah.

**INTERVIEWER:** I just want to quickly ask, did you say that the MacArthur Fellowship helped fund some of this--

**GRIFFITH:** Yes. Thank you for bringing that up. So the MacArthur Foundation, you get an unrestricted money. At the time it was $500,000 over five years. And it's not enough to really do much research in my field. I burn-- my program now is over $5 million a year in funding.

But what it does is it gives you the money to just say, I'm going to go to this conference. I can spend $3,000 and go to this-- I can go to Brazil. I can spend the money to go to Brazil. And I have a great collaboration with Mauricio Abrao in Brazil as a result. And I can just pay for dinner. I can go to a really nice restaurant and I can buy dinner for five people and just talk about this thing.

And I can-- I want Kevin Osteen to come visit. And I have discretionary funds at MIT from various things. But you don't always--you just kind of feel like you're empowered to just-- things I might not even be comfortable charging to MIT, I can just pay for this because I feel like it. And I want to learn about this. I'm just going to go do this. And because they want you to be creative.

And it's just-- you really do feel like you have this mad money that you can just go in this new direction and learn something new. And so it was very-- it was a good push to have that happen.

**INTERVIEWER:** Great. Fabulous. And I want to hear-- there's so much-- I have so many questions about tissue engineering and all the things you've been doing, which is-- and then you'll tell me what's come out of the center. But do we go back a little to get to the work you did with the liver and the bone that you discussed already?

**GRIFFITH:** Mmhmm.

**INTERVIEWER:** And there was some 3-D--

**GRIFFITH:** Yeah. So let me do a quick kind of-- hit some highlights.

**INTERVIEWER:** That's be great.

**GRIFFITH:** So what I started my career in was really-- was when tissue engineering-- people think about it from building regenerative technologies. Your liver fails, build a liver in the lab, transplant it. And so a lot of what I started is like you need a scaffold, something that gives the cells cues to survive and grow. So a lot of my early work was and where I got interested in engineering really hard core biology was the molecular interactions between materials and cells. How do we really control those? And how do you think about these molecular interactions in a quantitative way and design polymers that control them at both the molecular scale, the cell size scale, but larger scale?

So engineers do things molecular up to system scales. So we really need to understand and design our systems to influence the biology. So we clearly need to understand the forces that govern development of tissues. So it's really around doing what I'll call quantitative biology, is part of it. So you've got to understand the biology quantitatively. That lets you design the things that will influence the biology. So that's a principle.

So we did a lot of work developing the materials. But then you've got to make a device, a scaffold, a tangible thing that helps a tissue grow. So we did some primitive things. And a famous thing I did was to build the scaffold for the human ear on the back of a mouse. This was in collaboration with Chuck Vacanti and Joe Upton. And this got a lot of attention to tissue engineering. And I figured out how to take a biodegradable polyester and make it in the shape of an ear so you could put cartilage cells on it and they would grow into the shape of an ear.

And that was kind of a project at the time I didn't think was that scientific. But it was really good for generating people's imaginations about what the field could do.

**INTERVIEWER:** What was it made of then? It was--

**GRIFFITH:** It was made out of a suture material type polymer. A polyester that degrades in the presence of water.

**INTERVIEWER:** I see.

**GRIFFITH:** So my innovation was figuring out how to craft it with a mold into the shape of an ear.

**INTERVIEWER:** Was that the 3-D printing?

**GRIFFITH:** So it was-- but it's what made me want to do-- that plus something else made me want to do 3-D printing. So the other thing that made me very interested in 3-D printing was that we were trying to grow liver. And there the surgeon I was working with wanted to grow a little tiny liver that would have an artery and vein that he could sew in to a patient. And then there were forces of liver regeneration might let it grow. And there were reasons to believe if you had something small it could be stimulated to grow.

But we needed to build a scaffold that had a branching architecture that you could put cells in and have sort of a semi-vascular structure to start. And we needed a way to do that. And so at the time there was a tremendous interest in what's called solid freeform fabrication in manufacturing and prototyping. And so the Laboratory for Manufacturing and Productivity where Ely Sachs in mechanical engineering was a prominent member, had started actually working with my ex-husband to develop three-dimensional printing to build 3-D objects as a series of very thin 2-D layers where you sequentially print a binder or glue into layers of pattern.

And so I was in that mix. And I became involved in the project and helped write the patents and figure out how to apply it to polymers and biomaterials of things like that. And we started a company and that commercialized it to make bone regeneration scaffolds and Johnson & Johnson invested in it and ended up owning the company.

And I developed a fabulous collaboration with an orthopedic surgeon at the Cleveland Clinic during that time, one of the very few orthopedic surgeons who does a lot of basic research. He works in how do you use stem cells present in bone marrow to help bone regeneration. Really fantastic person and scientist. Very close to him and his family. His wife is an artist. I collect her art. And I met him because he was a consultant on that project when we started the company.

**INTERVIEWER:** He was a surgeon you said?

**GRIFFITH:** He's an orthopedic surgeon. He is.

**INTERVIEWER:** Orthopedic surgeon trying to put himself out of a job, basically.

**GRIFFITH:** No.

**INTERVIEWER:** No?

**GRIFFITH:** No, no. There will always be jobs for orthopedic surgeons because people ride motorcycles.

[LAUGHTER]

And I rode a motorcycle and my siblings and nephews had motorcycle accidents and broke bones and things. So--

**INTERVIEWER:** But you were successful with the bone regeneration?

**GRIFFITH:** Yeah. And we continued. So then George and I got NIH grants together. We still work together. In fact, I just saw him last month. I stay at his house. So we're very good friend-- very visionary guy. And we've worked together ever since then with NIH support.

And so at that time the idea was to make these scaffolds for tissue engineering. Got very involved in that. But designing sort of both the materials and the ways to process them into scaffolds that could help tissue grow. And so the ear, we needed a better way than molding. We needed something that you could take a computer program and build it up.

And so-- but at the time, I then-- in liver regeneration, I got very interested in-- well, it's one thing to grow a liver for someone. But really, there's a whole bunch of things that lead to liver failure. And what if we had better ways of understanding those things and preventing them? Because you'd really rather prevent a bad thing than to fix it later.

And we were starting the bioengineering program then. And we had a program in toxicology that had been in the Whittaker. They moved into the School of Engineering and joined our-- what became our department. People like Steve Tannenbaum, who was the head of toxicology. Applied chemist. Really mapped out a lot of ways that chemicals cause cancer and things like that.

And so it made us in the department really think about prevention, which is not always what other biomedical engineering programs were doing. We really had a molecular-- but a long view--

**INTERVIEWER:** And this was again focusing on the liver at this point?

**GRIFFITH:** Yes. So, yeah. So in terms of liver, it's like, well, what if we use tissue engineering to build three-dimensional liver? Not to do implants, but to actually study liver biology and liver disease and drugs and things like that.

So we got a big project from DARPA in the mid-90s with Steve Tannenbaum. And it was DARPA tissue-based biosensitive program. And let us start to develop these ideas of growing liver on a chip. So that was where Liver on a Chip started.

**INTERVIEWER:** How big is it?

**GRIFFITH:** So it can be-- so the size of a hair is a little piece of liver. And then you put a lot of them together. It depends on the kinds of measurements you want to do.

**INTERVIEWER:** But the microscale.

**GRIFFITH:** Yeah. It's a microscale. So we spent a lot of time thinking about how do you get fluid flow, how do you build scaffolds that let cells organize. So it was a lot of the engineering of the sort that, yes, it's building a thing. But there was an enormous amount of really understanding how a minimal number of cues could make a collection of cells turn into a tissue-like structure. And that is an ongoing process and I'm still very-- that's going to go on for a long time.

So I'd say as a theme, this is why we needed a biological engineering department. Because you do what you can now, but you have to keep improving it. The first telephone was not an iPhone. But you know the first phone was on that path.

So we started that and it really started to help-- at that time there were people who'd been growing skin and things to do cosmetic testing. But it was a very under the radar field. And there was a company called Advanced Tissue Sciences that was very high profile in California-- I had consulted for them-- that was making a skin diabetic ulcer product that was a living dermis. It's called Dermagraft.

And they got a lot of interest in tissue engineering. So Gail Naughton was the CEO. She and I wrote a really well-cited article together for *Science,* a solicited review article perspective for *Science* about-- they said, well, we want you write about the future of tissue engineering. And so she was interested in regenerative medicine, but I insisted at the end-- I said, you know-- or we said at the end, the real future may be applying these approaches to study human physiology. Because what we're really going to do, we'd love to just get-- if you were in a room of people and you say, who wants a liver transplant I built in my lab versus who wants to never need a liver transplant because of something I did in my lab that prevented the disease, everybody's going to raise their hand that they want the cure rather than the transplant.

So that's really the path we set down starting in the mid and late '90s and going on. And these are really difficult challenges because there are so many constraints around them. You have to pull together a lot of different-- you gotta have a lot of different kinds of engineers. But at the heart of it is, what is it about the biology and the person that you need to represent in the culture dish?

And so this brings us up to the Human Physiome on a Chip. This is an area that I've worked in and we have wonderful collaborators at the University of Pittsburgh over the years on this as well, is really you cannot represent the entire body in a culture dish. At least not for the foreseeable future. So how do we take the process that we're trying to understand and really build the right model?

So that's where we need systems biology. Because you've got to figure out, what is it about the disease that's important-- you need a hypothesis about disease mechanism. And it can be a complicated mechanism. And mostly we're very interested in things involved in the immune system and inflammation. And that is fun because it's super challenging. How do you then represent this in culture?

So that's really where when DARPA came along and said, we want to put these 10 organ systems together. It's a grand challenge. And we came at it in a very different way. There's another program funded at Harvard where they came at it that they're very interested in these microfluidic devices. But we'd worked with drug companies for years and years. We'd commercialized the liver chip. And one of the really crucial things is that you be able to do-- measure what's called the pharmacokinetics. The disappearance of a drug and what happens to it.

And it turns out that the silicon rubber that you use in microfluidic devices absorbs all kind of drugs. And especially drugs like for treating cancer and stuff. So we weren't ever going to go there because you would never be able to quantitatively study them. And so when we applied to DARPA, we had some systems that-- we'd been working a lot with drug companies over the years and had commercialize it. And CN Bio Innovations had commercialized it and had worked with drug companies.

So we came out with a pragmatic approach to go to the next level and have interconnected organ systems. And we especially are interested in inflammatory interactions because those govern a lot of the things that go wrong in clinical trials. So that's kind of how the organs on chips came about. That we felt that we really had something important to contribute to the field in terms of not just building a piece of hardware but actually conceptualizing, how do you go from the patient to what should be cultured and what kind of measurements you make? And then how do you translate that back into the patient?

**INTERVIEWER:** But just so I understand it, you've gone from the Liver on a Chip, you have now 10 organ systems?

**GRIFFITH:** Well, we're not at 10 yet.

**INTERVIEWER:** But that's the goal?

**GRIFFITH:** That's the requirement by the end of the program. We're at four now and we're heading towards seven. So we'll have seven this spring, this coming next spring. And then we'll have 10 about a year from then.

**INTERVIEWER:** And they're interacting somehow.

**GRIFFITH:** Yeah. so they're all-- what we did is we developed an innovation. And it sounds like it's not that big of a deal, but it turns out it solves really two key little problem, which is that a lot of the microfluidic systems, people put pumps outside the incubators and pump stuff around. And if you want to pump a lot of different things around, then you're going to end up with gazillions of pumps sitting on-- you're gonna run out of space.

So what we did is we figured out a way to do it with microfluidics that don't really absorb drugs very much and to pump things in between organ systems on like a platform. It looks like the same kind of assay plate that you use in drug companies now. So it's not really a chip per se, even though the individual cells are kind of on chips. But the whole thing is more of a platform.

And we invented a way to do the pumping in a very controlled way within an organ system and between organ systems so that you could quantitatively study the fate of drugs and what the effects are on little mini-organs.

**INTERVIEWER:** But different from microfluidics you said didn't work. Would that--

**GRIFFITH:** So microfluidics is a word like-- so let me do something semantic. Because I'm a Virgo and I'm like one of the grammar police. But semantics are important.

So the popular press says 3-D printing when they mean any kind of solid freeform fabrications. So solid freeform fabrication is when you build up a complex 3-D object as a series of very thin two-dimensional layers by an additive process. And there may be a post-processing step where you take material away, but there is generally an additive process.

There's a humongous number of so-called SFF. Three-dimensional printing is one of them, and that involves actual printing of material. And it's actually a trademarked name. The 3D PTM process. Printing process.

But there's sterile lithography. There's fused deposition modeling. There's a whole host of approaches that let you build 3-D objects. But *The New York Times* and the *Boston Globe* don't say solid freeform fabrication. They say 3-D printing. Because that's so visual.

But it's not strictly semantically correct because there's other kinds of-- they're incorporating sterile lithography and other things when they say 3-D printing. So it's a misnomer. And it's sort of similar when you say microfluidics. So almost all microfluidic systems that are commonly used in laboratories and even in practice are made from something called PDMS, silicon rubber. And it's a rubber. It's great for prototyping. And it was a huge innovation.

We use PDMS microfluidics all the time in my lab for various things. It's not like it's horrible. It's just that you have to recognize its strengths and its limitations. And so most people when they say-- just as they do for 3-D printing-- they say microfluidics as a shorthand for PDMS based. So microfluidics strictly means that you're doing something, moving fluids around on a micron. 1 to 100 micron kind of scale.

And so we use-- our systems our microfluidic. We happen to machine. We do micro machining rather than PDMS. So we have microfluidic devices, but they're not made out of PDMS. So it's a complicated semantic landscape where people adopt a shorthand for convenient reasons. But it actually-- it's sort of like in my endometriosis work-- and I'm going to segue there in just a second.

When we started working with Keith Isaacson, who's a fantastic person in addition to being an exceptionally wonderful surgeon, he would always say endometriosis is a benign disease. And I would push back. I'm like, it's not benign. It's not malignant, but it's not benign. And so he finally quit saying-- because there is a perception. Even-- he says, yes, but that's what we say medically. I'm like, well, you've got to quit saying that because it enters your brain.

And so he finally invited me to give a keynote talk at the American Association for Gynecologic Surgery one year. And I said, well, Keith, what do you want me talk about? He says, you're talk's going to be titled "Endometriosis is Not a Benign Disease."

[LAUGHTER]

And it was a recognition that he and I learned from each other. And so there has been an impact in the surgery community from the things that we've done. And partly through this conversation we have about the meanings of words and the unintended connotations they can have when you use them in ways that are not precise.

**INTERVIEWER:** Precise. Now in addition to all this amazing basic research, you've done, you've obviously-- there have been companies that have formed or patents that have been done. Have you worked with the MIT Industrial Liaison Program?

**GRIFFITH:** So one of the things-- doing a postdoc with Bob Langer was amazing in a lot of ways because he's so-- he's so incredibly helpful to people's careers. But he also teaches you how to think about commercializing your technology. And it's not crass at all to commercialize things because what is the definition of an engineer? An engineer plays a Janus role. We translate discoveries in basic science into things people use.

And we also are there to probe what needs to be done in society. How can we solve society's problems? So we're there probing society for problems we can solve. And at the same time, we're going to basic science and saying, how can we translate those advances into things people use?

And the only way a company can make money, ultimately, is to sell things that they uniquely can sell. And so you have to patent anything that's unique or you're never going to get a company interested in-- well, never is a strong word. But it's really difficult to commercialize something if you haven't protected the intellectual property at the basis of it. If you haven't shown that it's novel and proven it's novel and gotten protection for it. So to be a good engineer means you've got to translate what you did. It's not about just writing a paper.

Now if you're a basic scientist and you make some huge discovery, maybe that's what it is. But even these days with like CRISPR and Cas9, you make a lot of money off those patents. But it's really about being enough to realize the importance of what you did and that it has to get out of your lab and that people are going to invest their time and energy in building it into something society will use if they get compensated for doing that. And they get compensated for that if they build a business around it. And there's nothing wrong with that. There's nothing unethical about having a business.

**INTERVIEWER:** And getting things out there.

**GRIFFITH:** Yeah.

**INTERVIEWER:** And have there been lots of patents and--

**GRIFFITH:** Yeah. So I have patents in biomaterials, composition of matter. And we actually had some really exciting things come out. We designed some biomaterials specifically to do systems biology measurements for cancer and inflammation. And really, really excited about that.

**INTERVIEWER:** So things that are being used clinically?

**GRIFFITH:** No, no. These are things that would be used to study inflammatory processes in our culture. They could be used clinically, but the main driving force is to fill a tremendous gap in our ability to study cell-cell communications and figure out networks of when things go wrong in patients and how could you intervene to fix it.

So we file for patents. We get patents. And then you either-- we have things that are commercialized by a company licensing or we have things commercialized by starting a company. And all different flavors of these things. And MIT really, of course, facilitates that across the board. And, of course, a lot of MIT students are really gung ho in doing that and participate in that process.

**INTERVIEWER:** Well, I can see why your-- among other awards, you got the NIH-- what is it called? The Director's T--

**GRIFFITH:** Oh, Transformative R01 Award.

**INTERVIEWER:** A Transformative-- oh, OK. And it's for innovative exploratory research. So--

**GRIFFITH:** Yeah. So that's a program that the NIH director came up with to try to be able to explore different areas. In fact, this innovation in making materials for systems biology came out of the transformative R01 Award.

**INTERVIEWER:** That's what I was gonna ask, how you use that.

**GRIFFITH:** Yeah. So that was a lot of things are-- that was funded even before I got cancer. And then a lot of times it takes a long time for innovative ideas to really get into practice. And we now actually just got a really nice research grant. We've discovered these things.

But one of the things I really like to do is make sure that we've figured out how to make things useful. You can publish a paper, but if you send something to another lab that's interested in using it and you teach them how to use it and they can use it and find it valuable, that's really important.

And so the Center for Gynepathology Research, we just got a grant from the Manton Foundation to teach other labs how to use our biomaterials for growing endometrium to study inflammation. And so we've got-- one lab has already started using it and gotten-- really fun, fun collaboration. And then another one is coming in December. So they're going to come and they work in the lab with my students and postdocs and then they take the reagents back. And we are all, as a community, going to try to figure out how we build the best models for these diseases.

So I develop things. But I want to get them out into the research community. And part of that will be once they work well enough and people really like them and have validated that they're useful, then there's a commercialization-- there's a company that is very interesting in commercializing them.

**INTERVIEWER:** And just since you mentioned the breast cancer that you had, this is a thing of the past?

**GRIFFITH:** Yeah. So the breast cancer-- I actually learned a tremendous amount of valuable research things when I got breast cancer. So it was really something I was really upset-- anybody's upset when they get cancer. But I was on sabbatical. I had gotten this Radcliffe Fellowship, which is an amazing program. And the beginning of the Radcliffe Fellowship, I had, in August-- I'd had a major surgery for endometriosis. I'd actually had two surgeries after having a hysterectomy. So I'm in that category of-- it's just a very invasive disease.

And I wasn't really happy about that because it was actually a pretty serious surgery at that time. And it took me a long time to recover from it. And so I was just getting better. And I had a project [INAUDIBLE] part of the MIT Singapore program. And I was going to Singapore a lot. And in Singapore, I was-- just in January I was adjusting my bra strap and I felt something weird. And I feel the other side.

And I was in a room-- we were at a symposium. And it was like filled with mostly men, mostly Asian men. And I start going like this and feeling. And people are looking at me. And so I go to the ladies room. I was like, wow. I must have a cyst. And it's a Friday afternoon in Singapore. And I emailed my doctor. And I was actually going home on Sunday. And I, on Tuesday, was supposed to go to chair a meeting, actually with my orthopedic surgeon collaborator. I was going to Florida and I was helping him chair a meeting.

And so I was only going to be in Boston one day. And so I emailed my doctor. I said, look. I found this thing. It's actually kind of big. And can I get it checked out on Monday when I'm home? And so they set up so that I could go to Mount Auburn and have a mammogram. And it didn't show up on the mammogram.

I get in at midnight from Singapore and I go to Mount Auburn at 10am. And it doesn't show up. Everybody can feel it, though, and they keep doing the mammogram. And then they did an ultrasound and they could see something. And they did a biopsy. And they said, oh, it's a fibroid adenoma. And I'm like, OK. Because I have to go to this meeting in Florida.

So I decided to delay my departure for a day because I'd been at Mount Auburn all day and the next day I'm super jet lagged because I'd just got home from Singapore. And my doctor calls around 4:30 just as I'm getting ready to leave. And she says, you want to come over and talk about the results of your biopsy? I'm like, oh, no. Doug is waiting for me downstairs. I already told him I left my office. And she's like, oh, Doug's here. Why don't you both come?

And so I knew. But it was interesting. So I immediately the next day saw one of the best breast surgeons in Boston, Barbara Smith at MGH. And then the next week, because of our connections in the research community, one of Doug's collaborators is Joan Brugge, who's a really amazing cancer biologist. And she knew Eric Winer, who directs the Breast Oncology program at Dana-Farber So she-- I got to see Eric and became his patient.

Because it turned out I had a kind of breast cancer called tripled negative, which sounds really good. But it turns out it's negative-- they test you for three markers-- estrogen receptor, progesterone receptor, and a growth factor called HER2. And if you're negative for all three, those tumors tend to be very aggressive. They grow really fast. They also recur with a high probability at distant sites. And if they recur, it's almost impossible to treat. Almost nobody survives more than a few months.

So you do a very intensive chemotherapy regimen and radiation and so on. And then for the first three years, there's a pretty high probability that it will recur and kill you very quickly. But if you get past the first four to five-- and I'm five years out now. There's almost zero probability there will be a distant recurrence.

**INTERVIEWER:** Wow.

**GRIFFITH:** And so you just kind of get the lottery. Because 25% of patients don't make it. And I won the lottery because here I am. It's more than five years out. So my chance-- probability that I'll have a distant recurrence-- but it was really instructive because I had a complication from the chemo that Eric Winer had never seen. It was really awful. And I started out really doing very well in my first few rounds and running and people could see.

But I got extremely ill and my colleagues-- I was running my lab and I still came in to work. But my colleagues could see and students. And I would go to our joint group meetings and things. And people think when they read papers about chemotherapies they think that the patients who have the side effects must be the couch potatoes and weren't healthy to begin with.

And it was really this--

**INTERVIEWER:** But they knew you.

**GRIFFITH:** --of seeing that even though I was doing everything I could, something happened. It happened to be due because of my endometriosis problems. A consequence of that. So Keith Isaacson ended up helping me get treatment appropriately.

But it was devastating because I got really anemic and I could barely walk a block. And it was dispiriting to have that happen.

**INTERVIEWER:** Did that inform your work too?

**GRIFFITH:** So it did because I learned a lot about how clinical studies are done because I had to make a decision about whether to take-- it turned out it was ambiguously positive for Herceptin. So I was on the border--

**INTERVIEWER:** So only two negatives.

**GRIFFITH:** --of being positive and negative. Well, so I ended up on the front page of*The New York Times* because it was a time that there was a lot of controversy about how the testing for this was done and how the tests were interpreted. And Gina Kolata was writing a story about it and she called Eric Winer for his opinion. But she said, I want to talk to a patient. And he gave her my cell phone number. He told her nothing about who I was. He says, I have a patient who's willing to talk to you.

So she calls me and she explains-- I was like, of course I know who you are. It turns out she was a student, a graduate student, of Harvey Lodish. Harvey and I teach together for 20 years, we've had graduate students together. And so she knows Harvey. It's like we're all in the-- and I ended up explaining to her a lot about the biology of her too. Because I actually do a lot of research on her too and a lot of-- and Doug and I both. We know so much about the biology of it. It was ironic.

But I knew a lot about it. Just really-- and I had read all of the papers about the different ways of testing and had a discussion with Eric Winer. And we decided that there would be no benefit to taking Herceptin for me. I couldn't decide any benefit. And it was an important thing to have my story in the Times *because* there comes a point where you say, I'm going to do everything I can, but I'm not going to take on added side effects for no obvious benefit.

And so Herceptin, even though it's biotechnology drug, it has side effects. And I decided they were not worth the benefit I might get. And so it was really instructive because it really made me think about the complexities of clinical situations. But it also made me really, really aware of how stratified-- what we call patient stratification is done. How do you divide patients into categories to decide their prognosis and their therapy?

And in breast cancer, the three markers are all related to the mechanisms of disease. So they're important not only for your prognosis. We know that triple negative has the worse prognosis. But they're important for therapies. Because if you're receptor positive for estrogen receptor. You take hormone therapy. You take tamoxifen. Or you may take letrozole.

And so there's targeted therapies for each of those markers. We had nothing like that for endometriosis. So it actually was this big aha moment and informed our endometroisis this work. So our very first big paper was about trying to figure out how we could do a molecular classification of endometriosis patients. And you're not going to do it on the basis of genetic studies. You're gonna do it on the basis of protein network states.

**INTERVIEWER:** So what's coming up in the future in terms of your research? Obviously the DAPRA project, but--

**GRIFFITH:** Yeah. So the vision is, one, is that we are-- I really, at the end of my career, want to have a huge impact on women's reproductive health. And so I've pulled in like John Guttag, the former head of the EECS department, is helping us write software to help better manage endometriosis patients. It's really to bring all the wonderful things that MIT could do for the gynecology, gynepathology community and make this a real science. Do for gynecology what has already been done for breast cancer. So that's number one. And to really push that forward.

I've applied, put in a pre-proposal, for an NSF engineering research center to continue and really bring together the community and really change the way we do drug development by using these organs on chips to model disease. I want to bring into the future really thinking about differences between men and women and how they respond to drugs and respond to disease processes. A lot of disease, particularly immune-related diseases, are more prevalent in women.

So there's tremendous things to be done by combining systems biology with tissue engineering and organs on chips. And always with the theme for me of thinking about helping women's reproductive health, which right now needs kind of a boost up. And so there's tremendous enthusiasm for people in the MIT community about this. We work with surgeons and other doctors all over the world through our center and through other endeavors in MIT.

So that's really where the future is going. And of course, to continue to interact with the amazing students at MIT and continue teaching and helping our department curriculum evolve. We work closely with biology to continue to evolve their curriculum. These always are living things that evolve in time. And they have to keep up with what MIT is all about.

**INTERVIEWER:** Well, thank you so much. This has been fascinating and uplifting. And I wish you good health and good work.

**GRIFFITH:** No. I'm in great health.

**INTERVIEWER:** Fabulous. Thank you so much.

**GRIFFITH:** All right. Thanks so much for having me.