

## **This Week in Microbiology**

*With Vincent Racaniello and Mark O. Martin*

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### **Episode 180: Microbecentricity with Mark O. Martin**

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Vincent: This is TWIM, This Week in Microbiology, a special episode recorded on June 9<sup>th</sup> 2018. I'm Vincent Racaniello and you are listening to the podcast that explores unseen life on Earth. Today we are recording in Atlanta, Georgia, at ASM Microbe 2018. And my guest is a professor of biology at the University of Puget Sound in Tacoma, Washington. Mark Martin, welcome to the show.

Mark: It's a pleasure to be here, Vincent.

Vincent: I've known you for quite a few years now and it is about time we talked on record, anyway, we always talk, don't we?

Mark: That's correct.

Vincent: Let's start out by finding a little bit about you. Where are you from originally?

Mark: I was born in Compton, California, which surprises people. I am straight out of Compton.

Vincent: (laughs)

Mark: Well, it is true, I have the birth certificate to prove it.

Vincent: We believe you.

Mark: And I was raised in North Long Beach, so I am a native Angelino.

Vincent: I'm just pausing to take a picture of this little set up here which you have your microphone, there is an animal that you placed on it. What would that be?

Mark: That would be Gordy the Tardigrade.

Vincent: We'll get to tardigrades in a bit, I do have a tardigrade question for you. So you grew up in California, where did you attend college?

Mark: I went and got my bachelor's degree at UCLA and my first microbiology professor was Sid Rittenberg, who you might know of.

Vincent: Yeah.

Mark: And I at that time took a general kind of cell and molecular biology degree.

Vincent: What made you want to be a bio major at all? Or a science major at all? Do you know?

Mark: Sure, I know exactly why, and there are two basic reasons. This is something I'm talking about on Monday, but one of my brother's good friends, Terry Royal, rest in peace, had Duchenne muscular dystrophy, and he didn't have the use of his hands and I was his hands. I don't know if I have the plurals correct, but anyway I acted as his hands. He loved science, so I was his lab assistant for several years and he was the one that introduced me to luminous bacteria, I remember that very clearly, and then later on I did a science experiment with the memory of flatworms, planarians, and I remember at the time there was this fellow who claimed that if you trained a planarium to run a maze and you chopped it up and fed it to an untrained worm it would then know, which the science fiction lover in me adores this idea. And I found out it is very hard to build a T maze for flatworms.

So I did teach them a conditioned response. Normally they prefer a dark substrate, they live under rocks in fresh water, and I taught them to associate that with a mild electrical shock, I'm sorry to the flatworms. And then what I was able to show is that when you cut them in two the front half with the brain would grow a tail. The tail half without a brain would grow a head, but both sides remembered. And I won a pretty important award at the time because of this. I was a first generation to college, my father was a firefighter and my mother was a homemaker and nobody was interested in science but me, so I was kind of on my own. I wasn't subscribing to Scientific American. I didn't know about the holistic theory of memory, but what I do know is when I won this award I would get letters from people at CalTech saying you should consider a career in science and that is when I first thought a person born where I was born in the socioeconomic status I had could be a scientist.

Vincent: And why did CalTech tell you that?

Mark: Because a fellow who worked there whose name is escaping me at the moment, it will come to me later, actually worked on the holistic theory of the brain.

Vincent: Got it. So we have got you graduated from college with a science degree, what did you do next?

Mark: Then I went to graduate school at Stanford and I was Sharon Long's first graduate student. I worked on the association between Sinorhizobium melilot and alfalfa Medicago sativa. I also got a chance to meet Alan Campbell and Dale Kaiser and Charlie Yanofsky and all the rest, it was a very interesting time to be there.

Vincent: Kornberg?

Mark: Oh, I met Art.

Vincent: (laughs) Very interesting place, wasn't it.

Mark: Yes, and I was completely out of place, I have to tell you. I was Mowgli the Wolf Boy in this environment. But I, as I often say, I kind of apologize for my 20s but I eventually grew up. But it was such a wonderful opportunity.

Vincent: So at that point did you have some idea of what you wanted to do?

Mark: My last year of college I really fell in love with microbiology. Gary Wilcox taught me about the arabinose operon. Peggy Cotter swears up and down that she knew me when she worked in Gary's lab and I have no memory of it so I am glad she thinks of me fondly. So there you go. And I knew that was kind of where I wanted

to be, I learned about phages from Bob Romig. It was a lot of fun. And then I had an opportunity to meld my longstanding interest in symbiosis with microbes and Sharon's lab had just started off, she just led Fred Ostavels lab, and my specialty there was pretty much working on bacteriophages that infected rhizobium to develop a transductional system to move genes along. Very antediluvian now.

Vincent: But useful.

Mark: Yeah, very much so.

Vincent: So what did you do next?

Mark: So after that, I did a short post doctoral stint in San Diego working on luminescence with Mike Silverman. I didn't have any external funding so that was a very short period. I'm very grateful. And then from there I did again by that time I am paid to be personal but I was married and my wife really liked living in San Diego. I actually did some work with Michael Crawford on a arabidopsis.

Vincent: Oh, I know Nigel.

Mark: Do you know Nigel?

Vincent: He and I were in the same lab together. He was a student, I was a post doc.

Mark: Interesting.

Vincent: So he was a student with David Baltimore.

Mark: Yes, that's correct.

Vincent: We had the same bay. We used to talk a lot. And I left and I lost track of him, I know he did a post doc in a arabidopsis and I heard that he eventually got a job at UCSD, right?

Mark: That's correct.

Vincent: I saw him about a month ago at David Baltimore's 80<sup>th</sup> birthday celebration which was at CalTech and get this, Nigel is younger than I am, he's retiring!

Mark: (laughs)

Vincent: I said why do you want to retire, he said well, I want to do some other things with my life. So.

Mark: It's great work if you can get it.

Vincent: I can't argue with that, right? Why not experience varied things? But that is funny, yeah. Nigel and I used to talk on a daily basis. We don't always agree. He was philosophically a bit different from me, but he is a nice guy.

Mark: He was, he was very patient with me. Like I said, I've been very fortunate with that.

Vincent: So you learned arabidopsis from him, right?

Mark: I did.

Vincent: Okay, and that was a short stint of a post doc.

Mark: These are maybe a year and a half long each. And this is, it happens to a lot of people in my position, and then I had an opportunity to join a bio tech company in San Diego.

Vincent: What's the name of that one?

Mark: That was called CalCo, later purchased by Merkin company, and I worked on bacterial polymers. I have always liked undomesticated microbes, that is my thing.

Vincent: What does that mean, undomesticated?

Mark: They are not lab rats.

Vincent: Like E. coli K12, right?

Mark: Yeah. I am not upset about K12, I am not upset about Salmonella or B. subtilis, I think they are wonderful, but I like the weird ones. I always have. And so as a result I was working with some of the polymers like Xanthomonas campestris to make xanthan gum that is in a lot of salad dressings, also used in oil fields of all things. And then also another polymer, Pseudomonas elodea, made something called gellan gum which is in snack foods and is in agar replacement. Sounds like the beginning of a joke but it is quite true.

Vincent: Sounds good to me. So what's next? You were at this company for a few years?

Mark: 8 years.

Vincent: A long time.

Mark: A long time. So then there was some downsizing and I got laid off and I don't know if you care about this but I had published a couple of science fiction novels.

Vincent: Oh, really?

Mark: Uh huh.

Vincent: I didn't know that. I know you're a Lovecraft aficionado, as am I.

Mark: (laughs)

Vincent: I didn't know you wrote science fiction.

Mark: I did. A very good friend of mine, Gregory Benford, is a physicist and a well known science fiction writer, and he always felt that I should write. And so he took me under his wing, so I was able to get decent contracts and so I had a little money from that but I didn't really know what to do.

Vincent: But these books were published and sold, so if we look up we can find them, maybe?

Mark: You could, they're out of print, you'll probably read some unpleasant reviews, to my mind, was it Robert Heinlein said the most elegant language you can find in the English language is 'pay to the order of'? Followed by a number, right? I enjoyed writing them and it served an important purpose in my life. I am very grateful.

Vincent: So you wrote those while you were at the company, right? Very cool. Didn't know that.

Mark: And after I got laid off, what was I going to do with myself? And a friend of mine from graduate school, Daniel Cleonsky, I don't know if he's...

Vincent: I don't know him, no.

Mark: He's at, boy I gotta get this right, University of Michigan, I can't say Michigan State. He does work on autophagy over there.

Vincent: Or auto-phagy.

Mark: Oh, he's very specific.

Vincent: He says autophagy?

Mark: It's a very big deal to him and I just don't want to fight with anybody.

Vincent: What's the other word that's programmed cell death, what would he say to that? Apoptosis or a-pop-tosis?

Mark: (laughs)

Vincent: I always have these discussions.

Mark: Oh, you know. He sent me an ad for a teaching job, a short term teaching job, at a place called Occidental College in Los Angeles.

Vincent: I know it, I've heard of it, yeah.

Mark: And I got a short term position there and then I got a tenure track position there and I worked there for about 8 years.

Vincent: Teaching?

Mark: I did, teaching a small amount of research, and that is where I started working on vibrio and assorted bacterial predators and then that job didn't work out as sometimes happens, and I was fortunate enough to get a job at the University of Puget Sound where they did in fact award me tenure and there I am.

Vincent: How long have you been there, now?

Mark: I think 11 years, 12 maybe.

Vincent: Does it bother you when people say the state of Washington?

Mark: (laughs)

Vincent: Or Washington State, rather than just Washington?

Mark: It doesn't bother me.

Vincent: Some people it bothers greatly. Do you know Mark Crislip, have you ever heard that name?

Mark: No.

Vincent: He's a podcaster, he has a podcast called The Infectious Disease Pus-cast.

Mark: Oh my.

Vincent: And he always rails against Washington State. He says it is Washington and Washington DC. Anyway, Puget Sound, you said 18 years you've been there?

Mark: 12. I'm sorry.

Vincent: 12 years, that was my mistake. And there you have been teaching and doing research, right, which I would like to talk about. So I went to your website and I note the courses you are teaching. Quite a few, 1, 2, 3, 4, 5, 6. Is that right?

Mark: Not all at once.

Vincent: Of course not. Different semesters, different years.

Mark: That's correct.

Vincent: So Biology 111, Unity of Life.

Mark: Yes.

Vincent: Did you make that title up?

Mark: No.

Vincent: It was already there?

Mark: It was there when I arrived but when I was at Occidental College I also taught an introductory course much of the same type. So I actually like that. I teach it in the spring semester where I don't have as many biology majors because other majors require some kind of science requirement and word got around that they should take it with me, but I have to teach it the same way. So it is pretty much an introduction to cell and molecular biology.

Vincent: Who are the students, mainly? Are they students that want to go to medical school or are not sure or want to do science? Do you have some sense of the makeup?

Mark: Do you mean in my department as a whole?

Vincent: No, in the courses that you teach.

Mark: So in Biology 111 I would say half of my students want to be biology majors, small percentage are chem majors, psychology majors, and a few exercise science.

Vincent: No medical school?

Mark: No.

Vincent: That's interesting.

Mark: Undergraduate institution. 3,000 students total at the institution, maybe 3,500.

Vincent: I didn't mean that it was a medical school, but do any of them want to go on to medical school?

Mark: Oh, I'm so sorry for misunderstanding you. Sure! I would say probably about 20%.

Vincent: Yeah. That's what I figured. Columbia is like 50% in my virology class. A lot of people want to be doctors. We know why, right? But there has to be more than that. Some people want to do research, I guess you get some, people go on to get PhDs for example from these biology courses?

Mark: That is kind of my specialty, directing that. That's a big deal to me. So, in fact, when I was walking around the floor just a little while ago I ran into three students that I had never had in class but who knew me who were all here working on their PhDs in microbiology.

Vincent: So unity of life is kind of like an introductory survey of biology? You do microbes but you do planaria and other things as well, is that right?

Mark: Well, mostly, the way that we look at it, we have a series of labs that are being taught in multiple sections of this course. I surreptitiously will put in some microbiology, but there is a limit to how much I can put in there. So I will put in a little gene regulation, I'll put in a biofilm lab that I am very happy with, that kind of thing. We do a lot of PCR, we actually did the PCR experiment with PTC testing this semester which was a lot of fun.

Vincent: Cool. Then you have microbiology.

Mark: Oh, I do.

Vincent: Is that your favorite?

Mark: It is.

Vincent: And then you have another one called symbioses and parasitism, that must be a close second, right?

Mark: I enjoy that, and I teach it in two flavors. When I was awarded tenure, I was told I had to now do more for the institution, which I thought was fun. And they said that we want you to teach a freshman writing class and I said, I can't teach writing because it is very formulaic, as I am sure you know, in the university or college system. And they made the mistake of saying whatever I wanted to do. And then I said, well I want to make it about symbioses and parasitism. And they said oh, that class won't fill up. And I put my hand out and I said I bet you a thousand dollars it will fill up the same day you post it, and I should point out that my youngest son says dad bets but he never gambles.

Vincent: (laughs) That's great, I love that.

Mark: It fills up every year, and they are first semester students, and they are wonderful young men and women, they are wonderful, wonderful people, but that is a big adjustment.

Vincent: Sure.

Mark: So we will have for example in that class I have had Ed Yonks, that was wonderful. Irene Newton I skyped in to talk about Riftium. It's a lot of fun.

Vincent: I'm sure, I'm sure you make it fun. Is there a course you would like to teach but don't at the moment?

Mark: I would like to teach the symbiosis course with a lab.

Vincent: I see.

Mark: I think that would be good.

Vincent: Okay.

Mark: When I was at Occidental College I would teach the introductory course in one semester every year and then the other semester I alternated between genetics and microbiology. So I am delighted to be teaching microbiology every year, but I have to teach an additional course now and so it would be wonderful if I could kind of trade out from the introductory course and teach another specialty course. I would love to teach a virology course. I know how much you would appreciate that.

Vincent: I would, and you could use my lectures as a guide to sort of help you construct the course, right.

Mark: Yes.

Vincent: And that's why they are there. Many professors at undergraduate institutions tell me they use them to help not only design their course but to learn the subject, as well, right. Because unless you do virology, you just don't know all of this, right. So you should do that, and if you do, I can help you. I can give you all the slides and anything you need.

Mark: That's very kind of you.

Vincent: So how do you keep the students interested in all these science courses? I know you do a lot of creative things because I see you online, I see you on social media, I see you on your blog explaining what you do, and wonderful artworks that your students make. So how do you get them motivated and interested in this subject?

Mark: One word. It's ownership. A lot of students are passive. I think it is part of our media culture, they are staring at their phones, just like I do. They are staring at a screen, just like you are.

Vincent: (laughs)

Mark: That's how everyone is. And take a breath and ask them, what are you good at? What do you enjoy? And what is interesting is that if you give them an opportunity to express themselves not in a way they are used to,

say filling in a bubble on a form or answering a short answer on a test, they do amazing things, and can I give you a couple of examples?

Vincent: I would like some, yes.

Mark: So in my introductory class, I had a young woman who was just deathly afraid of intermediary metabolism, and I'm not teaching it at a very high level. I'm teaching concepts. I describe it as you need to have like a holiday tree and then you later put all the ornaments on the tree. But you need to have that tree first. And a lot of times when you teach a survey course they kind of throw it all at you at the same time as a student and it is hard to make it gel. So for me, having some kind of central structure is really important, and that is what I told the students, and that is the best way to learn things, so when it came to central metabolism this young woman put together a board game. And this board game is called the Game of Life. It was amazing, Vincent, I mean, there were pieces and cards and rules and I have a picture of it up, I will send it to you if you'd like. It's in my lab on the wall and that young woman did really well on the final exam because historically the metabolism exam is challenging. Well, she owned it on the final, and it is because she had a different way of looking at the questions and how to put it together.

Vincent: Did you suggest she make a board game or was that her design?

Mark: No, that's all her.

Vincent: You didn't even say do something different? Just let her go and she just did this, right.

Mark: That's correct. But you have to be careful, you can't just turn it loose.

Vincent: Yeah.

Mark: Do you have the experience of the evils of the first draft?

Vincent: Of course, yes.

Mark: You and I say first draft and what students hear is whatever I put on the page. And that is not what a first draft really is. So the only answer to that is structure, and so I scaffold things pretty carefully, so they have to meet with me to talk about their creative project and we talk about what is possible and what is not. I might make some suggestions and they might spark off some ideas from what I'm saying, and then what happens is that they have to give me like an outline or a couple of paragraphs a week later and then that gives them a direction to go when they finish finish it. And that seems to work pretty well. Some students choose not to do it. I can't really, I could require it but I don't feel quite right doing that.

Vincent: Another example?

Mark: Certainly. Another example...I was trying to come up with, I had a student who actually did not go through the process and said to me and I can show you a picture of this as well, that she had made something for me that helped her during ceramics class and I said, what do you mean? And she goes I'll bring it and she takes off her backpack and she brings a huge sculpture showing bacteria with the three different shapes that you find in bacteria, a phage on there, and I said, how did this help you? She goes well I would look at it and it would remind me of what was inside each thing. So it is a different way. I think a lot of students again are too passive and it could be actually building the things is how that works.

Vincent: I like that. A lot of these are on your blog, right? [Microbesrule.blogspot.com](http://Microbesrule.blogspot.com). If people want to check it out.

Mark: I need to of course update it. This is something you've been telling me for some time.

Vincent: I did.

Mark: Yes, and this is why. And that is something I am going to be doing this summer because I do think it is important to get that out there and the different things that people have done.

Vincent: It is a good example of what you are doing. You have a lot of photographs of things your students make.

Mark: Yes.

Vincent: There is one thing that someone made, let me look at it here. It was very, and of course they thank you, that's lovely. The buttons, here we go. Doc Martin, thank you. Oh, the microbial supremacy tree of life, right.

Mark: Oh, this is Mariko's work.

Vincent: Mariko, right.

Mark: This is a really important story to tell and if you look here you'll see there is a particular button that I'm wearing.

Vincent: And she's holding it here in the picture.

Mark: She is, indeed, because she came up with it. Mariko, I don't think that she was terribly, I mean she was afraid of the class, she thought it would be too difficult. There is often a dichotomy at undergraduate institutions between people who do work in, and I hate the expression big and little biology, I really hate that. But certainly cell molecular versus evolution and population biology and I think they are all part of biology but that dichotomy exists regardless of what I wish. So Mariko wasn't sure she could get through this course, and I noticed that she did cartoons on her exams, and they were always relevant and they were really well done. And I said, are you an artist? And she goes, oh, I just doodle.

Vincent: That's what Picasso said, right?

Mark: Right, that's true. But it is interesting to me because at first I thought well, maybe she is just being very modest about it, but I honestly think many of these students don't appreciate their skills.

Vincent: Yes, totally.

Mark: And so on the last day of class, after she turned in, well not the last day, the day of the final, after she turned in her final she handed me a folder and that is what you are looking at there. And this folder is this drawing of all the things that I talked about in class. There is an attenuator, if you see for the TRP operon there.

Vincent: Right, right.

Mark: There's a petri dish with shoes because I've been known to call people petri dishes with shoes.

Vincent: (laughs)

Mark: There's the tree of life itself, there are many other things there, but over in one corner you will see a rocket ship, and it says Micronauts: We Soar.

Vincent: Exactly.

Mark: And I would call them all micronauts.

Vincent: All the students.

Mark: Yeah, because you are all my micronauts.

Vincent: Lovely.

Mark: And in fact, this is become like a button that I make and emblems and I think it is a good way to look at it and I will tell you that when you do the stuff like with the buttons and the t-shirts that I've done it creates a sense of camaraderie in the classroom.

Vincent: So this particular one, Micronauts: We Soar, you had Vex and Mariko make it in a cartoon and then you had a button made.

Mark: I did.

Vincent: And it is beautiful.

Mark: Yeah.

Vincent: It's beautiful, it says Micronauts: We Soar, it has a rocket and in the background are microbes. And so you gave it to the students in the class?

Mark: Yes.

Vincent: It was made in time for that, right. You also make other pins, as you've just said.

Mark: I do.

Vincent: I have some here. You used to have one called microbial supremacy but you said people don't like that word anymore, right.

Mark: Yeah, some people I really like and admire that really disturbed them, and, no, I don't belong in this century, I often feel, and if it really bothers people that's valid. So what could I say instead? May I explain where microbial supremacy came from?

Vincent: Yes, of course.

Mark: So this is a story many people have to listen to from me and I apologize for repeating it. But years and years ago in my current department, before a department meeting started, two of my colleagues who happened to be botanists were saying, if we get more money, what kind of tenure track position could we get? What kind of area would we want our scholar educator to be in, research wise? And they are both botanists, of course they felt that botany should be the area, because it is after all the center of life, as they said. I didn't

cough, I didn't roll my eyes, I just sipped at my coffee. And Betsy Kirkpatrick in fact, who has since retired, said well, Mark here thinks that bacteria are more important than anything else. Mind you, I didn't get involved in this. I looked at her and I said Betsy, I think plants are very interesting, it is just that all the really cool parts they have they co-opted from bacteria and archaea. And she snorted with laughter and said, you, sir, are a microbial supremacist.

Vincent: Wonderful.

Mark: And I said yes, I am.

Vincent: But they were here first.

Mark: Yes. And last.

Vincent: And everything depends on them.

Mark: I agree.

Vincent: So I would agree with you.

Mark: First evolved, last extinct, right?

Vincent: I think it's great. I love it. I'm sorry that you're not making more microbial supremacy buttons, but you have some others. So you make these every year and they are different and you give them to the students at the beginning, the middle, and when?

Mark: So I have the buttons the first day of class. I also, I make themed candy for them that has sayings on it.

Vincent: T-shirts also?

Mark: T-shirts are later in the semester, I want to see if they are going to drop first.

Vincent: (laughs) Yes.

Mark: Because guess who is paying for this? That would be me.

Vincent: Of course.

Mark: And CafePress and I'm not taking a position on it, there are other vendors that do this stuff, that's just what I've used, and I do it every year. I usually work with an artist and a science artist and I've worked with Kaitlin Reese who has done a lot of my earlier stuff, my wife Jennifer Quinn has done some, and the person, the artist currently known as Vexed Muddler has done a lot of my stuff as well.

Vincent: Right. Vexed Muddler and Michelle Banks designed the logo for my little LLC, Microbe TV. That's very nice. And every year I see you I get some of these buttons. Here's some I found. We have Occupy the Curriculum. We Are the 99.9999%. Those are the microbes saying that.

Mark: That's what they're saying, and they're saying No Euks.

Vincent: Oh, I can't even see it, no euks, right. And what does the other one say, microbial supremacy now?

Mark: See, it still sneaks in, doesn't it.

Vincent: It does. So what do you mean by occupy the curriculum, is that like occupy Wall Street?

Mark: (laughs) Well, one of the things that I've found and I'll talk about this later in the week but if you were to go to a hundred people and ask them what is your response to the word "bacteria" or the word "germ" they have to give a one word response. Some students are very resistant or they'll copy the next person. It's hysterical to me. It's almost always negative. There is a very negative microbial PR thing going on. This is why I have deep concerns about what I call swab stories, we can talk about that later if you want to. So part of my job is to be a, I can't say the word prokaryote anymore, I used to call myself the prophet of prokaryotes but I can't really say that. But the point is, I think it is at the center of everything. It's not original with me, there are so many famous people that have said the same thing. And I don't think students really appreciate that. When I tell them, for example, that rubisco and nitrogenase are bacterial enzymes because they are, and we wouldn't have efficient carbon fixation and wouldn't have bioavailable nitrogen without them. Think of Jack Gilbert and, I'm trying to think of the other gentleman, Josh Neufeld did a wonderful article in PLOS about a world without microbes. And it really deals with this and other issues, and I find that very few of my students know this. In fact, Vincent, I don't know if you are aware of this, but many high school students are not taught that mitochondria and chloroplasts were originally bacteria. It's just thought not to be terribly important when I think it is the important issue in cell biology. And so I am going to be fighting the fight. I know that several people like Dianne Newman, is she at CalTech or has she gone back?

Vincent: She was originally, yeah.

Mark: Okay. Well, Dianne Newman, wherever she is being fabulous, and then Margaret McFall-Ngai, the University of Hawaii now. I know that they've done a lot of work with the Howard Hughes Medical Institute about trying to revamp the undergraduate curriculum to make it more microbially centric. And I will be a hundred percent aboard on that, but that is way above my pay grade.

Vincent: Dianne Newman is at CalTech.

Mark: Good.

Vincent: The power of Google. So these buttons you can also buy, right? People can buy them if they want.

Mark: Yes, if they wish to.

Vincent: Where would they go to buy them?

Mark: CafePress.com/microbesrule.

Vincent: Microbes rule. So I have here, Micronauts: We Soar, so that's great. I have my mind on my microbes and my microbes on my mind.

Mark: Now, you probably don't know where that's from unless you're really a part of the hip-hop community, Vincent.

Vincent: I'm not part of that community.

Mark: So, Snoop Dogg has a song called Gin and Juice and part of the song, he says, with my mind on my money and my money on my mind. And based on that rap, I thought it would be funny to have I have my mind on my microbes and my microbes on my mind. And then Kaitlin Reese did what looks, what is meant to look like a brain.

Vincent: Yeah, the squiggly red thing, definitely.

Mark: With the microbes. Yeah.

Vincent: You think there are microbes in our brains?

Mark: That brings up the whole kitome issue, whether we have things in the kit, but I find it very hard to believe there aren't some in there.

Vincent: Yeah. They're everywhere, right. And another one, if microbial centrality is wrong, I don't wanna be right.

Mark: I don't wanna be right.

Vincent: What's that from?

Mark: Well, that's the same one as supremacy, but with the more PC kind of title.

Vincent: Got it. I love these, I think they are great. It's a great idea. I should really do this for my class, but you'd have to plan ahead of time, I guess. And these are all working with your artists, right? It's nice that you can do that. I guess I could do the same thing.

Mark: And it's interesting to me, if you look at t-shirts and you do searches on Google, you'll find that people steal images all the time. They'll steal my images. I'm not going to fight about things but I think it is really important if you are going to use artwork to commission the artwork which I always do and to give credit for that artwork.

Vincent: Sure. Do the students wear these buttons after you give them to them?

Mark: Yeah.

Vincent: They do, that's great. Now, you're here because you are getting what is called a Karski Award.

Mark: Yes.

Vincent: What is that for?

Mark: You must understand that my mother, rest her soul, was psychologically Amish so you can't really brag about anything, but what the award says is something along the lines of excellence in teaching microbiology and mentoring students in their future endeavors. And I am ultra uncomfortable saying that, but there you go.

Vincent: But it is all true, clearly, from what we've briefly discussed now and people can go online and see for themselves, you are clearly highly deserving so congratulations.

Mark: Thank you very much.

Vincent: I think it's great, and the part that is hard I guess is you have to keep doing this, keep it up and get better and do more, right (laughs)

Mark: It's very interesting, I am always thinking about what to do differently. I mean, in my microbiology class for example I am thinking about trying different modules, I used to have a series of labs that everyone would go through and then for the last four weeks they would have independent projects that they came up with. And I'm just not as happy with that as I could be and even though some times the people that help me with setup are not happy with this, they would like to just do the same thing every year, I am thinking about making some changes to it. Vincent, there have been some wonderful things that my students have done for their independent projects. Do you know about pink pigmented methylotrophs?

Vincent: I do not, tell me.

Mark: These are bacteria that use methanol which is part of plant biochemistry, plant metabolism, and these organisms are pink hence the name, and they will live on methanol as a carbon source. And you can take, you can print a leaf onto this plate and you will get the outline of that leaf in these pink organisms.

Vincent: Nice. So you have the students do that?

Mark: I had one student do that. What is each student interested in? Remember these are not large classes, I have no more than 20 students in microbiology, and so that, I am able to meet with each of them and talk to them more and find out what they are interested in.

Vincent: I think that's great.

Mark: Yeah.

Vincent: So I do, here's what I do, tell me what you think. I teach a virology class to undergraduates at Columbia and I have about 90 students every year so I have them do an extra credit at the end. They watch the movie Contagion and I say tell me three things that are wrong with it and they really like that. Many of them say, you know I watched it two years ago but it's totally different now that I took this course. That's really the goal, right?

Mark: It is.

Vincent: To get them to see it in a different light. So is that good, do you like that?

Mark: That's wonderful. You know, it's, we used to do that in genetics, we would watch the movie Gattaca which is a fun movie, what's right, what's wrong, get them thinking critically about things. And this is very similar to what you were just saying, one of the fun exercises I give students, I tell them that most people, when they look at microbes in general, they originally were like devil microbes.

Vincent: Sure, of course.

Mark: And I had Vexed make me an illustration of what that would be. And all microbes were bad. And then you have other people that seem to go in the other direction, angel microbes, when mostly most microbes are like, meh. They're indifferent. And I'll have students go out into popular literature and find examples of each of these things, and as you say, they really enjoy doing that because their opinion matters. They say, hey, that's not the way I learned it in class, and that is very important.

Vincent: Is this a good time to talk about the swab story?

Mark: Whatever you'd like.

Vincent: Because I'd like to next move into a little bit of research, does this fit in at this point?

Mark: Yeah, if you want me to talk about swab stories, I'm happy to. So a swab story is basically and again, I don't want to pick on people who publish in this area, if you look around there are tons and tons and tons of articles about there are bacteria on fill in the blank, your shoes, the bottom of your handbag, toilet seats, toothbrushes, wherever it is. It is buying into the idea that microbes are bad when in fact that is not true, and what these people are doing is taking a swab, swabbing an area, and saying oh my goodness, there are bacteria on that swab! It's so bad I want someone to do a paper on the bacteria found on swabs. You know. The whole problem is how do you get around this? And you find that people get really scared and they will do things like, I've got to wash my hands, I've got to use antibacterial soaps and all the rest. So I send students out looking for swab stories. You probably saw the one recently, I got quoted on this one, where they were making hay out of the Dyson hand driers spraying things all over the room.

Vincent: Yes, right, right, I saw that, yeah.

Mark: What do you think happens when you flush a toilet?

Vincent: Oh yeah, big time aerosol.

Mark: And you were talking to me about viruses being spread by the process of urination. I remember that from a couple of years ago. This is the kind of life we have, folks, talking about this. In any event, they enjoy looking for swab stories. It changes the way they view everything. I used to say, I wish I had microbe colored glasses to have them put on for that reason. So that is what swab stories are.

Vincent: You know what bothers me, Mark, is often they don't even culture. They just sequence. So what does that mean, if you find pieces of bacterial DNA? Who knows, right?

Mark: It could be the necrome.

Vincent: The necrome! I like that, the necrome. So there was a study done in New York City recently where they swabbed all over the place and they found all this bacteria and they just looked for DNA so who knows if they were actually replicating bacteria there, right?

Mark: I agree, and also the proportions. I don't know what the statistics are, Vincent, but if I did a swab of a hundred people's skin, I bet you that I could find toxin genes for MRSA on some proportion of them. But the question is how many of them there are? And the question isn't answered that way.

Vincent: You can't, you absolutely can't. So this brings up a bigger issue, that issues with microbial reporting in the general press. You think about this, you may even have your students go looking for egregious examples, right?

Mark: That's exactly what we do with angel and devil microbes where they actually look for these reports.

Vincent: That's a course you teach? No.

Mark: No.

Vincent: Angel and devil microbes, oh I see, that's the thing you told me before, good ones and bad ones.

Mark: So just having, and, you know to some degree I do that even with my first year students when we are looking for the way things are being presented to them. Parasites, are they always bad? Well, you know better than that.

Vincent: Right.

Mark: You know, talking about the hygiene hypothesis, that means they're always good. That's not true either.

Vincent: Sure. I don't think there is much we can do about it, what I say to my class is some of you are going to be writers. Fix it.

Mark: Yes! You know, Vincent, one of the things that is funny to me is Kaitlin Reese made me something really amusing one year. It is an idealized set of hands holding hands with different spots of color representing microbes on them. And the logo, and I'm responsible for this guess, is when we're holding hands, so are they, right?

Vincent: That's great.

Mark: Students invariably make gagging sounds and carry on about this, and then I flash the title to that microbiome paper about the number of microbes transferred during, and I love this euphemism, deep kissing. And I point out, no one's givin up kissin. So you can't tell me you're grossed out by holding hands. So it's all about what you perceive as being dangerous. Right?

Vincent: Sure. What you can't see, you don't worry about, right?

Mark: I also have my students in my micro class, we swab their reusable water bottles, and they are lovely things that we found there, beautiful colonies, and I'm not saying that they are friends but they are part of their lives. This is a microbial planet, we are swimming in a sea of microbes at all times.

Vincent: I got an email from a listener, I believe in California who had her students, maybe this was 5<sup>th</sup> grade swab different parts of the school and they streaked them out to see which was the most contaminated. She sent me pictures of these lovely plates, potato dextrose plates, and they found that the gym mats were the most contaminated, and she said we are waiting for the principal to do something (laughs) I love that though, I love that you get engaged, but it's all about telling people it's not bad, don't worry about it. But the press, of course, will make a big deal.

Mark: Absolutely.

Vincent: You do some research, on your website you have 3 main areas. Bdellovibrio is one of them, two of them, three of them actually, and ensifer. What is ensifer?

Mark: Well, I can talk about my program in general because there have been some changes, I need to update my website.

Vincent: Oh, you need to update it (laughs)

Mark: Yes, there's a surprise. So basically I am very interested in predatory bacteria and the two types that I work at are *Bdellovibrio* and also *Ensifer*. *Bdellovibrio* I think you already know about. *Ensifer* was discovered by Lester Casida in the 1980s. He was seeding samples of soil with *Micrococcus luteus*, he had a grant from the Department of Defense for this. I guess you can connect the dots. He was trying to determine how long the micrococcus would survive in these different soil samples, and lo and behold he found that there are many predators. And this is a particular type of a predator, turns out it is very closely related to the fast growing rhizobium so it all comes back to my old home with rhizobium. And it is very specific, unlike *Bdellovibrio*, it just seems to like *Micrococcus luteus* and it does this fascinating thing where it tracks along a streak of where I've put *Micrococcus*, it doesn't do it to *E. coli*, it won't do it when the *Micrococcus* is dead. So we have a genome published on that with Dave Baltrus and Laura Williams, and we are doing some transposon mutagenesis to try and figure out what is going on with that bug.

Vincent: You could mutagenize and see how they lose track, right?

Mark: Lose track of tracking, yes.

Vincent: And then see what genes are involved. That would be fun.

Mark: I'm very interested in that. I also have a long term interest in some of the symbioses that I find in areas that my colleagues are involved in. For example, in the Puget Sound area there was a large wood industry. Sawdust mills everywhere. So there are areas, Vincent, that are under the sand, ten feet of sawdust. So the tide comes in and then the tide comes out. What this is is a ginormous bioreactor. And it is fermenting the cellulose. And so this next part I want to be very clear on. The effluent when the tide goes out that comes out of that sodden area is 4 millimolar hydrogen sulfide.

Vincent: Amazing.

Mark: That's 50 times higher than you find around hydrothermal vents. And so around these areas you find huge filamentous bacteria and Joel Elliot in my department and I are trying to study these organisms which seem very similar to what you find around hydrothermal vents. Students love this kind of work, especially because some of the crabs get covered by these same filaments. You are familiar, no doubt, with the Yeti crabs that are found around some of the hydrothermal vents, so I'm calling these Sasquatch crabs.

Vincent: Wonderful. Love it.

Mark: But what is really exciting about my collaborations is with Stacey Wiseman in my department, she studies a small lizard in southern Arizona, and we just got an NSF grant for this. Now what we found out several years—well, back up, this is what happened. Stacy studies these lizards and there are lots of reasons she is interested in them and I won't take up your time with those. But she said to me that when she dissected all the eggs versus having them naturally laid, the dissected out eggs tended to go bad. They clearly were infected by fungi or bacteria at a higher rate than the ones that were naturally laid. I said perhaps microbes are being deposited on them that help protect them against pathogens. There's evidence for that among the birds, for example, and there are elements like that in humans, even. But what we are dealing with with reptiles is they have a cloaca through which everything goes.

So we did cloacal swabs and there's a lot of humor in that because these are not big lizards, right. I won't do the jokes about it but the long and the short of it is they have very different microbiota. So the males, their cloacal microbiota seems quite similar to their gut microbiota, but the females tend to get them really streamlined at the time they are starting to lay eggs. So what this NSF grant lets us do, and we are very grateful for it, is to be able to do 12 months of the year to find out when these changes take place. My job was to look for

antimicrobial activities from some of the isolates and then use functional metagenomics to see if I could find other types of genes that could actually be responsible for the antimicrobial effects.

Vincent: Now, how much do you devote to this research versus your teaching?

Mark: I would say it is supposed to be 75% and 25%.

Vincent: 25% teaching?

Mark: 75% teaching, and then 25% research.

Vincent: And is that how it is, or it varies?

Mark: No, it's usually 75% and 75%, that's the answer you're looking for.

Vincent: (laughs) Very good. And do your students participate in that?

Mark: Absolutely. It's one of the things that is expected of each of us to do, active research with our students, and I consider it to be teaching, because it is. And I work with each student and I'm a little different than, say, my colleagues in the chem department because they will have everybody attack the same problem. I need to find out what interests the students, and they might not know what interests them and I'll get them on to that, but I've had a pretty good track record doing this, so they learn a lot from that. Do I produce as much in terms of publications as I should? Certainly not, compared to an R01 institution, but I have sent an awful lot of students to PhD programs because they learn how to think scientifically, learn how to ask questions and answer them.

Vincent: So will you typically pick up freshman and keep them for a couple of years, is that how it works?

Mark: We more trap them and put location beacons on them. No, I usually get them as sophomores if I do. Sometimes I get first year students, and that's great. In fact, one of my former students here, Kendall McFarland, was one of the ones that I had years and years ago. She now is Dr. Kendall McFarland. So nice to see them do this.

Vincent: And they come from your courses, I presume.

Mark: Yes.

Vincent: And they come up to you and they say can I do research with you and that's how it works, right.

Mark: Yes. If there's a student, I like to put questions on exams that are kind of open ended. I make them for extra credit, because some students there, they have three other classes and all the rest. But some students really get engaged. And I can see the spark, usually. Am I a great researcher, probably not. Am I a great teacher, I don't know about that. What I am is a good talent scout. And I'm really good at that.

Vincent: So you can see someone and you'll ask them, would you like to work in the lab, and mostly they do, right?

Mark: Well, I've had some that weren't interested, and that's okay, right?

Vincent: How many would you have in the lab at any given time?

Mark: 4.

Vincent: Four undergraduates? So there are no PhD students you don't have a PhD program.

Mark: No master's program no postdocs.

Vincent: So you are an entirely undergraduate driven research operation.

Mark: That's me.

Vincent: And you can publish your results right? And the undergrads are probably really happy to do that.

Mark: Oh yeah.

Vincent: And to help them right to the papers, right? And that is all learning experience in itself.

Mark: Yes.

Vincent: And for an undergraduate to do that that's pretty thrilling, right?

Mark: And there are more and more venues for doing that. If you sit there and say well, everything has to be published in JBacT, you're welcome Patt Schloss. What I'm trying to say here is that that might be hard to do. But there are ways to bite off a question that a student is interested in. There are a number of new ASM journals that would be helpful for that in that regard. And I am looking forward to that.

Vincent: Absolutely.

Mark: Especially as the technology gets better and better.

Vincent: And there are so many good technologies around now that you can use to answer some of the questions you are looking at. And they're not dangerous.

Mark: No.

Vincent: What you're working on is safe for your students to do. It is a great experience.

Mark: And everybody loves bacteria that eat bacteria, I mean I do too.

Vincent: Well that's great, predators are great. I just think that's a great story and understanding how they do that is great. But the four millimolar hydrogen sulfide, that's pretty cool too. The lizards.

Mark: I agree.

Vincent: You have a lot of projects.

Mark: Yeah. So if you throw enough stuff up to the wall some of it will stick.

Vincent: In many aspects of life we do that. We do that in science communication often, we do that when I write grants I do that all the time. I write lots and lots of them and throw them at the wall, and now and then

one of them sticks. And that's the way it works. I think you have to. We are scientists, we should experiment. Who are your professional heroes?

Mark: Oh. Microbial heroes. Do you know what shrinky-dinks are, Vincent?

Vincent: Shrinky dinks. I don't.

Mark: You have children.

Vincent: I do, they're grown up now.

Mark: So these are the plastic things that you cut out and decorate and put out in the oven and they shrink.

Vincent: That's right, yeah.

Mark: Shrinky dinks. You know, Vincent, you're a shrinky dink.

Vincent: I am?

Mark: I have a mobile that my wife made for me of my microbial heroes. And you are one of them.

Vincent: Really?

Mark: Yes.

Vincent: Well, I didn't ask for you to say that (laughs)

Mark: No, there's quite a few of them.

Vincent: Who else is on that?

Mark: Well, Sid Rittenberg, my first microbiology professor, Pat Schloss of course, Jo Handelsman who has been just fabulous, Heidi Goodrich-Blair. I honestly sometimes get directed to those we have lost recently and Abigail Salyers was very important to me and Ed Leadbetter very important to me. And you have to know that Elio Schaechter is high up there as well.

Vincent: Of course, I would guess that, yeah. This brings up something I skipped, the luminous bacteria. We featured one of your, your wife does these, Jennifer Quinn, right?

Mark: That's right.

Vincent: On an episode of TWIM. Tell us about those.

Mark: Well, as I mentioned before from the time I was I guess eleven when Terri Royal brought home this plate that he said, go look at this in the dark, and I realized it wasn't some 1960s glow in the dark blacklight thing, it was actually glowing, and it had that wonderful kind of blue green glow, which is because that is the wavelength that light travels best under water so it makes perfect sense in terms of evolution. I've always been playing with bioluminescent bacteria. I wanted to have some kind of venue where students could play around with bacteria in a way that didn't sound dangerous. So many people do demos where they will say, what's living in hamburger or let's see what's on your skin or whatever. I wanted to do something that's beautiful. And I

mean, I did a post doc in bioluminescence so I kind of like the area. So this is a particular strain of luminous bacterium, *Photobacterium leignathi*, and it was isolated by Eric Stabb and Ed Ruby from Kanehohe Bay in Hawaii. Just part of their normal work. And it is super bright. Over the years I've gotten able to grow it up where it is extremely bright. I thought, wouldn't that be nice to do painting with it? You probably have seen people take a swab and they'll write their initials, but students can do fabulous stuff.

Vincent: You have your students do it, right.

Mark: Oh yeah. We have the Lux Academy Awards every year, Vincent.

Vincent: Nice, nice, I like that.

Mark: Oh yea. And I give them prizes for their artwork. But what you are talking about is the work my wife does with what we call Lux portraits, where she is able to look at a drawing of someone or artwork or photograph and she is able with a fine paintbrush to use that culture and paint on to the surface of the nutrient media of the plate. And you can't really see what you're doing, can't you? So if you tilt the plate back and forth, light reflects off the surface, and you can see sort of where you've been. If I were to show you the first plates that Jennifer did, you would say well, okay, I could probably do that. But you look at what she does now and no, you couldn't do that. It is really quite wonderful. It's just practice makes perfect.

Vincent: Do you ever try it yourself?

Mark: I have blunt instruments for hands. I certainly have written microbial haikus and I tend to like to write words on plates.

Vincent: Now, your wife is not a microbiologist, right?

Mark: She is a mathematician.

Vincent: A mathematician. So do you bring home these bacteria and plates for her, or does she come to the lab?

Mark: Oh no, I bring them home. I know probably now I am going to get a visit from someone about that.

Vincent: No, I don't think it's a problem.

Mark: It's not.

Vincent: It's BLS1, right?

Mark: And I bleach things before I put them down the drain.

Vincent: And then you bring them in and put them in the incubator?

Mark: Oh yeah.

Vincent: And then you bring them back to show her.

Mark: Right. Now, I want to point out that some other people have done some wonderful work with this. I don't want to give you the idea that I'm the only person who has done this. Lots of people, Simon Park in England has done a lot of this kind of work. But Hunter Cole in Chicago is a fabulous artist that has done stuff that I can't do

with some of this. It is well worth your time checking that out. Of course, Siouxsie Wiles in New Zealand, she will use these quite large square plates that are \$12 a piece, and they will actually create a large montage and then paste them up on the wall to make large installations.

Vincent: That reminds me, a couple of years ago we brought some of these artists to ASM Microbe and they were part of a symposium, do you remember?

Mark: The one I ran?

Vincent: Yes. (laughs) I was interested because I tried to encourage that to be done by others and I am glad to see it happen, and one of the offshoots is we still have some of the artists here today manning booths and selling their wares, which is really good.

Mark: This idea of mixing science and art is not strange, it is beautiful.

Vincent: Totally.

Mark: It takes you back as far as you want to go. I mean, Leeuwenhoek did some of this work, Fleming did, and it is fun.

Vincent: I remember that the piece we used on TWIM was a portrait of Elio, it was really nice, really lovely.

Mark: Yes. You've had people paint your portrait in bacteria, I recall.

Vincent: I did! One year for the agar art contest, someone painted me and it was lovely, it was just beautiful. I really thought it should have won.

Mark: (laughs)

Vincent: It didn't even come in the top three and I still think it was the greatest agar art creation of all time.

Mark: Okay.

Vincent: Because I am biased of course, because it was me. But this year there were some amazing ones for sure. No one has tried again in my visage, although they should, because maybe they will win some day. I want to ask you two more things.

Mark: Certainly.

Vincent: First, when you came you put a tardigrade on your microphone stand, it is very cute, so what's with the tardigrade?

Mark: Tardigrades are sort of my spirit creature.

Vincent: You have a tattoo, right?

Mark: I do have a tattoo of a tardigrade.

Vincent: Cool, nice.

Mark: And in latin it says “survive through it” because tardigrades can undergo cryptobiosis, and in undergoing cryptobiosis they can spend decades in this dried state. In addition they are an extremophile’s extremophile. So I love the idea that they can live through anything. Personally I am interested in the microbiota associated with tardigrades because if they undergo cryptobiosis what happens to the microbiota?

Vincent: So you have them in your lab?

Mark: We raise them, yes.

Vincent: And you study their microbiome.

Mark: One of my students is in fact the official tardigrade wrangler.

Vincent: How do you grow tardigrades in the lab, what do you do?

Mark: You can’t grow them completely aseptically. What is the term where you don’t have perfect control? But we feed them single celled algae, the species that we work with live on single celled algae and in pond water. What is really interesting, Vincent, is if you put a tardigrade, and they are tiny, you can’t really see them very well with the naked eye, they will crawl all over the algae and it will tangle up so you actually know if you have tardigrades really quickly because they don’t like to walk on plastic. Instead, they will walk on the algae.

Vincent: What is a tardigrade actually? It is a eukaryote?

Mark: It is a eukaryote, there has been some wonderful stuff phylogenetically, I can’t pronounce the name, but it has been through 5 worldwide extinctions, mass extinctions, so I think they are a good thing for anybody in academia to use as a spirit animal, don’t you think?

Vincent: I love it, I think it’s great, yeah. It looks very nice on your microphone stand there. But this is a multicellular animal, right?

Mark: It is. I know, people are really surprised, and I say, you know there are some eukaryotes I like. This is one. My wife and children are two more.

Vincent: Any others?

Mark: My brother.

Vincent: All right, I’m getting the picture. One last question. What is next for you? Are you ever going to retire?

Mark: I don’t want to. My dream is just to have a little lab where I can putter around and do what I want to. But I don’t think they pay you for that, so I’m gonna have to hit the lottery or something.

Vincent: You could continue to teach and do research, I’m sure you could do that for a long time.

Mark: Oh, I would like to do that. When I say I have a large class, it does not sound large to other people, but you get used to what you have. So my intro class, I’m not happy it’s 48 students, 3 lab sections of 16. I wish it wasn’t so big because I want to be able to deal with these students one on one. I really do, and that’s what I like about the micro class and that is what I like about my little symbiosis course too, to get a chance to really hear what they are thinking and what they believe.

Vincent: Sounds like you'll stay at Puget Sound, right?

Mark: I don't, I think they can't get rid of me now, so there I am. And I am at an age now where it would be very hard for me to move anyway, and Jenny seems happy enough working at the University of Washington at Tacoma. It's a nice part of the world to live in. Have you been to Tacoma?

Vincent: I have not.

Mark: I'll have to get you out there and show you some of the stuff down at Reconciliation Bay with the large fibers that will freak you out.

Vincent: Cool. That four millimolar hydrogen sulfide.

Mark: I know! Isn't that amazing?

Vincent: I won't forget that.

Mark: You've probably seen this, how is your Latin?

Vincent: Not good.

Mark: So on my arm and this is funny, I got my first tattoo a few years ago and people quietly contacted my wife asking if I was having a mid life crisis.

Vincent: (laughs)

Mark: And she said she liked it much better than a red sportscar, which I thought was a good answer. So what this says is "Avete Parvuli Domini" with a diagram of a bacterium and that means "all hail the small masters".

Vincent: That's another good title.

Mark: It is, all hail the small masters.

Vincent: I like that, excellent.

Mark: A student saw that one year and you will recognize the artwork. That's Vexed. That's Maggie's work. And it says that I am a microbial badass because that is what that student called me.

Vincent: That's a microbe there, right, it's very nice.

Mark: Artistic license.

Vincent: Of course. Mark, is there anything we haven't talked about that you would like to talk about?

Mark: Yeah, I think that if you are going to do research, if you are going to teach, you have to have a real passion for it and I had someone I really like and respect tell me that I needed to be less Mark-ish. And I understand what that person meant and I adore that person, so I wasn't offended at all. But I think what works best with everyone is being genuine. I know it works well for students when you are teaching, there is no substitute for being genuine. And students will always respond well when you do that. When you say I don't

know, I have colleagues who are afraid to say that. Students don't have a problem with that at all as long as you are excited about finding out the answer. I can't think of a better job than doing science.

Vincent: Neither can I.

Mark: I mean I get to find out things that are new and interesting every day and in microbiology it is new and exciting every day, isn't it.

Vincent: It is. And I think you are yourself, you are being genuine, you're Mark!

Mark: Yeah.

Vincent: No problem.

Mark: I suppose I can cut back on the coffee here and there, but the point is I really adore what I do. I think the world of these students. I've learned so much from them. The way that they see things differently. We learn so much together that way. And truly, teaching—and that's at the bench, during research or in the classroom, it's a two way street. It is not somebody sitting at the end of a log and the patient, the patient, there I go, the student on the other. It is a collaborative process. The problem is we only have so many hours in the day, so you have to love it. And then it's not work.

Vincent: That's what I tell everyone. It's not work if you love it, and it's not a job, it's a career. I totally agree.

Mark: I would add it's a privilege to me.

Vincent: It is, I agree with you. All right, that is TWIM, and if you listen to podcasts on your mobile device, that means a phone or a tablet, you usually have a podcast player. You can search for TWIM, This Week in Microbiology, subscribe and you get every episode. We release them twice a month, they're free. And we would like you to do that, it would really help us. And if you like what we do, consider being a patron. Support us. Go to [microbe.tv/contribute](http://microbe.tv/contribute) and you can find out different ways. For example, you could give us a dollar a month and that would help us to travel and do other things. And of course, questions and comments to [twim@microbe.tv](mailto:twim@microbe.tv). My guest today from University of Puget Sound in Tacoma, Washington, Mark O. Martin. Thank you so much for joining me.

Mark: It was a pleasure to be here.

Vincent: I would like to thank ASM, the American Society for Microbiology, for their support of TWIM and Ray Ortega for his technical help, and Ronald Jenkees for his music. [Ronaldjenkees.com](http://Ronaldjenkees.com). I am Vincent Racaniello, you can find me at [virology.ws](http://virology.ws). Thanks for listening everyone, we will see you next time on This Week in Microbiology.

(music)

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Transcribed by Sarah Morgan.