

## **This Week in Microbiology**

*With Vincent Racaniello and John Warhol*

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### **Episode 181: Dr. Warhol's Periodic Table of Microbes**

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Vincent: This is TWIM, This Week in Microbiology, a special episode recorded on June 9<sup>th</sup> 2018. I am Vincent Racaniello and you are listening to the podcast that explores unseen life on Earth. Today we are recording at ASM Microbe 2018, a meeting taking place in Atlanta, Georgia. My guest is the president of the Warhol institute, John Warhol. Welcome to TWIM.

John: Hi, I'm thrilled to be here. Nice to see you.

Vincent: This is happening because I met you two months ago at a conference at Seton Hall, right?

John: Yes, a conference at Seton Hall, and I was invited to talk about our activities in getting an official state microbe for New Jersey.

Vincent: So we will talk about that and we will talk about your new book which is all about the periodic table of the microbes, but first let's talk a little bit about you. What is the Warhol institute?

John: The Warhol Institute is the name of the company that I have. We've been in business for 20 years I think as an official LLC. Before that I had a company that just had my name. And institute gives a nice ring to things.

Vincent: It does.

John: I've been doing corporate science and medical communication for about 30 years. In fact, since I got out of the university, it's been what I've been doing.

Vincent: You're not related to Andy Warhol, are you?

John: Yes, I am.

Vincent: You are?

John: The family story is that we are in fact related and I use that to my advantage as much as I can.

Vincent: Did you ever meet him?

John: My parents did, my uncle Mike claims to have had. Our family is from Elizabeth area, the Warhols of Andy's fame are from the Pittsburgh area. He remembers as a kid, my uncle Mike, making the trip from Elizabeth to Pittsburgh and he remembers it vividly because he said I got sick as a dog on the way there, because it was the 1930s 1940s and it is a long ride. So they met, they said let's go to Pittsburgh and play with the Warhol cousins, and they did that a couple of times but they are just too far away. My parents met him when he was in New York a couple of times and, you know. We were scattered family.

Vincent: So you grew up in New Jersey?

John: I grew up in New Jersey.

Vincent: Where did you go to college?

John: Rutgers.

Vincent: You were a science major I guess?

John: I was a microbiology undergrad and a microbiology grad student.

Vincent: And also at Rutgers?

John: Yeah, they sucked me in and they wouldn't let me go (laughs)

Vincent: Who did you do your PhD with?

John: Morris Aterofski, he was one of the original TB researchers.

Vincent: How did you get interested in microbiology?

John: It's a long story and I think somebody asked me that yesterday and I believe the answer is when I was young, when there were only three TV stations, one of them ran a special on someone, I think he was named Roman Vishniac and he was a photomicroscoper and I think the show was called the Amazing Small World of Roman Vishniac.

Vincent: Yeah, that's right.

John: I remembered correctly?

Vincent: Yes, that's absolutely right.

John: It stuck in my head and I said this stuff is really cool and I want to do that. And at the time, I was really young, this is pre-cognition just about. And I just stuck with that, junior high school, high school, and I said I am gonna be a microbiologist. Not that you ever have the chance to do any of that in high school or junior high school. And I got a lot of strange reactions from the graduate counselors and even the science teachers. It was like, why would you pick that? I don't know, it's just cool. I heard about it and I want to do it.

Vincent: So after you got your PhD what did you do?

John: After that I had a really prestigious post doc with the American Association for the Advancement of Science, it was a science and diplomacy fellowship working with the AID which is an arm of the state department, Agency for International Department is the AID arm of the state department, I was working on international health issues. ORT, mother and maternal health, vaccine initiatives, the malaria vaccine program, managing—well, you're not allowed to manage but I worked on those kinds of problems. And the reason I got into that program was because I write well, not because I was a particularly brilliant scientist but because I was extremely interested in international health because I think it's cool. You get a lot of really cool diseases outside of the US you don't get here. I love parasites because they're so complicated and have the most interesting life cycles. I went there and did that. I was the youngest fellow they had at the time, and the idea was to get mid-career scientists involved and active in the government because as I'm sure you are well aware most politicians and government people have no background in science. So the AAAS started the program just a year or two or maybe three years before I got into it. And the idea is you would bring people with scientific expertise and put them in the staff of a congressman, a senator, or the various outlying kinds of agencies and contribute some kind of expertise to the project.

Vincent: How long did you spend in that position?

John: It was a year. It was defined to be a year because they didn't want people hanging around. And the end of the year, I had the chance to renew it because they signed me up for another couple months but then I was offered a fellowship again in the Rutgers again, Graduate School of Management, so I went back under fellowship to get an MBA. I did that for a year and then I started working in medical communications.

Vincent: So you started working for companies then.

John: Yeah, well it was, it's a hidden industry out there, unless you are involved in it you don't know it exists, and I imagine it was different 20 or 30 years ago. Whenever a new drug comes on the market, physicians need to learn about it, so physician education, pharmacy education, nursing education. Somebody has to make all that and it's really not the drug companies. The drug companies contract with medical ed companies and advertising companies. So my first job was writing for a medical company.

Vincent: And these positions still exist, I presume.

John: They're out there. It's a big hidden industry.

Vincent: It's a good point to make to listeners because if you are looking for other careers besides academic microbiology it looks like it is something to look into, right?

John: It is. It's something you can definitely get in to. What I find now in terms of medical communication as a career option, 30 years ago because I kind of decided I didn't want to spend any more time in my life pipetting if I don't have to. I wanted to do management of science, talking about science, and communicating science, and until recently, I felt dirty. Because I would be a PhD working in a communication company or an advertising agency and you'd be interfacing with scientists, people like you, and you'd be interfacing with physicians, and they'd say oh, why aren't you in a lab, what's wrong with you? And it's like, you just always felt a little off about what you were doing. But you need to have people in those fields. People like me who understand the science and can put it into translatable language so that other people can understand it. Even between physician specialties, like you have infectious disease physicians doing clinical trials on something and then you want to get it to a mainstream physician. You really have to pick your words carefully because it is a different language, and then you go from there to patients and nurses. It's all different languages and different ways of addressing the issues and I'm lucky to have skills in that area.

Vincent: Do you still do this or did you stop a while ago?

John: The company still exists, I've weaned off my client base because after doing it for as long as I have I'm kind of tired of it. My big clients were Johnson & Johnson and I did a lot of work for biotech startup companies.

Vincent: So this was a company you founded yourself.

John: Yes.

Vincent: And you had some other people working with you?

John: Yes, I did, I had art directors and editors and proofreaders and researchers and other writers who funneled things through me. What I found was when I was working for another company, I didn't like having a sales guy representing my work as something he did. I found that annoying. It was like, I'm the one with the talent, I should be getting the recognition. I freelanced for a while and I started the company so that people would know that when they are dealing with me I'm the one writing it and I'm the one managing the accounts, not some third party.

Vincent: So as of today you no longer do this kind of medical communication?

John: I still do, I still have one or two active clients.

Vincent: It pays the bills right?

John: It pays the bills, sort of.

Vincent: But some time ago you started the Warhol Foundation which has a broader goal of communicating?

John: I'm working on that.

Vincent: That is your company that you're still writing for at the moment, right?

John: Yeah.

Vincent: Okay, got it.

John: What I'd like to do is to turn it in to, or start a 501(c) 3, which would be a non profit so that I can get grants from either NIH or whatever from the federal government because they can make grants to companies, I don't think they can make grants to corporations.

Vincent: What kind of grants would you want to get?

John: It would be to forward and promote science education and literacy in the US.

Vincent: So the NIH does that?

John: I think they do, I've been told they do.

Vincent: Then I should make my LLC a 501(c) 3, right, and do the same thing. I don't want to compete with you but I do need to get some financials.

John: Well, we can work together but my accountant said, you gotta start making money at this (laughs)

Vincent: I know what you mean, my wife tells me that all the time.

John: Yeah, yeah, yeah. Well I was fortunate enough that what I was doing for a long time was profitable enough, so I didn't have to worry about making a profit for a while. But it's, you know, like doing the periodic table and doing the stuff with the bacteria, it's like, alright, it's time to start thinking about making money again (laughs)

Vincent: So let me ask you one question before we talk about your projects.

John: Yeah.

Vincent: You made a statement...

John: Uh oh.

Vincent: Which is a great statement, I think it's in your book.

John: Oh, okay.

Vincent: You can correct me. How microbiology is cooler than astrophysics but they have better TV shows.

John: Oh! Oh this is my soapbox, this is absolutely my soapbox, and I'll take a breath before I get started. Yeah, microbiology is way cooler than astrophysics. Growing up and even now every time you put on TV you have, you have Steven Hawking sitting there, you've got Morgan Freeman talking about how big the universe is, how

weird it is, you have Mike Rowe voicing over these great how the universe started, you have Neil DeGrasse Tyson who is like my idol but he's also my nemesis. I want his job for biological sciences.

Vincent: We need to have someone like that for bio but we don't have one.

John: We don't have one. I wanna be that. I'm willing to be up on stage in front of anybody talking about it because when astrophysicists talk about space they talk about how big it is, how wide it is, how far away everything is. And I think the reason why that latches in people's minds and people relate to it is because you are little, you look up, you see the sun, you see the stars, and it provides an inherent marketing base, an inherent audience base for everybody. You see the sun. And then the astrophysicists come and say yeah, the thing is so far away and yeah there's life on other planets and I'm like, there's no end to the universe in a big way. But microbiology, there's no end to microbiology in a really small way. You could study micro forever and never get to the end of it. And this meeting is symbolic of that. You can't know everything about all the organisms, it's an infinite amount of knowledge.

They have the better TV shows, we don't have anybody out there talking about that. And they're saying new things, and I'm gonna get attacked when I walk out of here, I can tell, there's gonna be an astrophysicist that's gonna club me to death. The stuff that they are talking about although it is new and cool, I'm kind of a closet historian, I'm not just a closet historian, I love history. A lot of this stuff is old. Like how hot the sun is, the sun is 10,000 degrees on the surface. That's not new but they keep recycling it in a better way because every year there is a new crop of little kids that are fascinated by that, and it's like every little kid is frightened like, doesn't wanna die, but people tell them yeah, the sun is gonna vanish in five billion years and that scares people and that makes them watch. It's an inherent kind of interesting thing. So yeah, they have the better TV shows. I want us to have as good of TV shows.

Vincent: How can we do that?

John: We gotta start talking to people and getting to work out.

Vincent: So here's a space virus story.

John: Oh, yeah.

Vincent: A factoid. If you took all the viruses in the oceans, they're  $10^{30}$  virus particles in the ocean, and laid them end to end, they would stretch 200 million light years into space.

John: That's far.

Vincent: That's very far, past the nearest galaxy.

John: I got one, too.

Vincent: What's yours?

John: When we were doing, and we're still doing it, but the work on the state microbe, right? *Streptomyces griseus* and actinomycete, Professor Eveleigh said you know, he scratched his head, he said I remember there's a lot of this stuff in the soil. He said I think I remember that as a graduate student I did some calculations to find out how much there is. So he called somebody at the US Department of Agriculture and then they looked and it turns out that per square foot of soil, just a square foot, and an inch deep, there is from 80 to 240 miles worth of actinomycetes threats, because it is a filamentous bacteria, right. That's a whole hell of a lot of bacteria. Now, if you multiply that by the square surface of the earth, and this is just actinomycetes, this is not like you know all the *E. coli* and *Pseudomonas* and all the other stuff in there. It's just the actinomycetes. I went and said well heck, multiply that by the surface of the earth, you get a strand of bacteria that will get you from one end of the galaxy to the other. That's a lot of bacteria, I forgot what the number is, but I wrote it down. That's a lot.

Vincent: That's cool.

John: Something like that can inspire kids.

Vincent: Yeah, I think those kind of measurements, microbiology measurements are important, and I use them to start talks as I'm sure you do because that grabs people in. Because you have to sustain it, you have to sustain it and not get into details, that's part of the problem that we have. We're trained about details.

John: Trained to be detail oriented, yeah.

Vincent: We have to get away from that. But I agree that I think scientists need to be the spokespeople for science. Other people write about it and so forth and they do well but it's us with the passion so it's our job to do it.

John: Yeah, and the passion shows through.

Vincent: For sure. So let's talk about the New Jersey State Microbe.

John: Yes, sir.

Vincent: You have a shirt.

John: I have a shirt, yes.

Vincent: SO tell us the name of it?

John: Well, we had these, Max Headlong the department head at Rutgers had these shirts done up for Rutgers Day, it's a big thing every day at Rutgers University, it started off as Ag Field day which was a small event and then the university said let's make it big so they shut down everything and invite everybody back, so it's an alumni day, it's ag field day, all the ag students get to show off the cows and chickens and pigs they raised during the year. It's really a cool event. So they had the t-shirts made that say *Streptomyces griseus*, New Jersey State Microbe. The hashtag I came up with is #NJMicrobe.

Vincent: Now, why *Streptomyces griseus*?

John: It's a beautiful and compelling story. *Streptomyces griseus* was actually first discovered in New Jersey in 1915 just as an organism. In 1943 Albert Schatz was doing a systematic study of soil microbes under Selman Waksman at Rutgers which was actually at the time called the New Jersey Agricultural Experimental Station. Systematically looking for soil bacteria that produce antibiotics. So on October of 1943 he pulled the culture out of the ground and he did antibiotic sensitivities on it and it turns out it made an antibiotic that would kill Gram positive and Gram negative organisms. He went and isolated it and, sorry, the organism was *Streptomyces griseus*, it was the second time it was found, the isolate produced streptomycin.

Streptomycin, they did all the work up on it, all the isolation, and it was the first antibiotic effective against tuberculosis and it was the first broad spectrum antibiotic in the US. And it was a proud moment, it was the first antitubercular. It went on to change the world because prior to streptomycin there was no effective therapy for tuberculosis. In fact, in doing the clinical trials for the streptomycin had the first placebo controlled trial in the history of medicine. They went and I think it was, I can't remember the physician's name, I will later, they compared traditional treatment for tuberculosis, which was rest and fresh air, versus getting a daily injection or two of streptomycin. 95% mortality in the placebo group, a lot of survival in the treatment group. From there it was a great.

Vincent: That's a good microbe for New Jersey.

John: It is.

Vincent: But we should say it is not yet the state microbe, but you are pushing to make it, right?

John: I'm pushing to make it

Vincent: So first why do you want to do that?

John: A lot of reasons. And I would start by saying that it provides an opportunity for us all to talk science to the rest of the world and to talk science to our legislators and it provides a way in to start a scientific and medical dialogue you normally would not be talking about such things with. Also, it is a, we are both from New Jersey, we often don't have a lot of things we can be proud of in the state (laughs) We have nice beaches but there are a lot of things that people are annoyed about a lot of times. The microbe is something that we can all get together on and say this is really cool, New Jersey made this, we made the world better because of this, we saved millions of lives, we put thousands of people to work, created the entire antibiotic and pharmaceutical industry started kinda 1943 ish with the production of streptomycin.

Vincent: Now, do other states have state microbes?

John: Interesting story there, yes. Oregon was the first to actually pass state microbe legislation. Their organism of choice was *Saccharomyces cerevisiae* also known as brewer's and baker's yeast and the cool story there is that Oregon is the home to one of the world's largest craft brew industries. They produce 2 and a half billion dollars a year in revenue for the state and they are enthusiastic. If you think about how easy that is to sell to the government, sell to your legislators, it's easy because, and to sell to the public, because almost everybody drinks. Beer is a happy thing. So it is easy for craft brewers to get on the phone and say hey senator, vote for this legislation. It's easy for people from the bars to call in and fill out cards and say hey, vote for this, it's good because it is a big happy thing. It's big, *saccharomyces*, baker's yeast, and it's also in genetic engineering and all the gene splicing work that was done with *saccharomyces*. And just tangentially, in doing some of this work it's like I ask myself, how much bread is made every year from baker's yeast, and I came up with, there's a baker's organization and it's something like 3 million metric tons of rolls and bread are made every year and it all comes from a microbial source. Like, wow! That's another one of those infinitely long how big is the universe, well if you laid every roll from end to end you'd get pretty far, too.

Vincent: (laughs)

John: So Oregon was the first one, and I congratulate them on that.

Vincent: How long ago was that done?

John: I think 2011, 2013? The first one to try was Wisconsin, they tried with *Lactococcus lactis* because it's involved in cheese production and Wisconsin is America's largest producer of cheese, they have like 700 varieties of cheese. They produce more cheese, I don't want to screw up the fact but they produce more cheese in Wisconsin than all of Europe does. It's like, you know, how much is there income? Like 3 billion dollars worth of cheese comes out of Wisconsin. So it's a big thing. That got through the legislature—sorry, it got through the assembly and then it kind of got killed. It didn't move forward. The story, from what I understand, I talked to people who were in Wisconsin at the time, and it becomes one of these science or not science issues. They all say that the governor, I never met the man, I don't want to throw stones, he was anti-science, he was not a science guy, so they let the legislation waste away. The funny and outrageous part of the story is they didn't have the personal integrity, strength and will to pass microbial legislation, right?

But shortly thereafter, the entire state of Wisconsin, the legislators, the people, everybody got together, they voted with a single mind and a single purpose to have an official state pastry. The Kringle. So they could see that we love the Kringle, and we're gonna have it, and we're gonna vote for it, and it's like a puff pastry with

almonds on it. So they said yeah, we're gonna do this, but they didn't have the internal strength to say oh, we're gonna go do a microbe. I was like, wow. It becomes, maybe microbes, I'm trying to rationalize how that happened, and I'm thinking maybe it's because the legislators did not have good science teachers?

Vincent: Could be, sure, yeah.

John: Why else would you do it? Or maybe the bakers have a better lobbying group than scientists do. I don't know.

Vincent: So could you make a case for other states having microbes? What about California, a lot of wine, right? What would you do for that one?

John: Well...

Vincent: I don't know if there's one microbe, right?

John: I'm trying to think, certainly because you've gotta ferment wine, any one of the yeasts would be good. I'm talking about state symbols in general, just because Oregon picked brewer's yeast doesn't mean somebody else can't.

Vincent: Sure.

John: Because milk is the official state drink of like ten states.

Vincent: I didn't know that.

John: I didn't either, I'm picking up all this state symbol trivia because there's people that run websites on states, there's a lot, a lot of repetition, there's state dances like the square dance is the official state dance of another ten states. So there's all these layers of stuff.

Vincent: Got it.

John: I was talking to some guys from Texas this morning and they're like yeah, we need a Texas organism, we need a Texas organism. We're talking back and forth and they're like there's something called Frackibacter which lives in fracking fluid, so that would be tough, but they were thinking we need something big.

Vincent: Because Texas, right.

John: Yeah, because it's Texas. So they're gonna brainstorm with some of their friends and see if anything really really huge grows in Texas.

Vincent: Well you know, the huge underground mycelia, fungal mycelia.

John: There you go!

Vincent: Some of them are 1,000, 2,000 miles in diameter.

John: That'll work. Do they have those in Texas?

Vincent: Yes, they're mostly up north. If you could let viruses into the act you could name a giant virus for Texas but you don't find it there, so. It's gotta be in the state, right?

John: Yes, I think that's the only requirement, and the reason I picked microbe instead of bacteria is because other states can do this and what if it's an aquatic state and they have a really nice algae? Algae is microbial. To me a microbe is anything you need a microscope to see, you know (laughs)



Vincent: Now, what is the process for doing this and where are you in New Jersey in that?

John: It's a long and convoluted process. Most of it involves a lot of luck. The process started, actually, I had been in communication with Doug Eveleigh and some of the other professors at Rutgers and we came at it from separate directions and we came up with the conclusion that *Strep griseus* would be a cool microbe. I found out about the idea of having a state microbe in doing some other research like for my periodic table and I saw that Oregon has a state microbe. So I was like, okay, just file that in the back of my head, and I said what would be reasonable choices for New Jersey? And my first thought was brewer's yeast because we had the huge Budweiser plant. *Strep griseus* because of streptomycin.

The other thought was *Azotobacter vinelandii* because it was discovered in Vineland, it fixes nitrogen and that's really important for growing crops and everything else. And I said *Strep griseus*, and I was talking to Doug and he says well, we've actually been having an unofficial poll for the past couple of years, it's up on their website, that I knew nothing about. He says well, we gave it two choices, it was *Strep griseus*, *Azotobacter vinelandii* and *Thiobacillus thiooxidans*. And he says that when the public votes in, *Strep griseus* wins by a 3 to 1 margin, and he says most of the faculty here and everybody we talk to says *Strep griseus*. So I said well, okay, it's confluent evolution, we all agree on it. And I just filed it in the back of my mind and it was like a snowball in my head and it kept getting bigger and bigger and I was like, I gotta act on this.

So I put together, and I knew Doug had worked on getting it, he tried to get it through the legislature but I think he sent it to Washington as opposed to Trenton. He sent it to Frank Pallone I think years ago, he said we should have a state microbe and Frank didn't respond at all. Which, well, politics is a weird thing, that I found out. So I said, alright, I took it on myself to do because I had been, I know some of the political people from other things that I've done. So I decided to take all of the, and I'm speaking with my hands here, you take the yards of information that academics are used to dealing with, page after page of theses and things that are really thick, boil it all down to one page of bulleted points that you can talk about in a minute or two minutes. And I had that, I prepared that, and I knew I was going to be at a meeting with a bunch of politicians and it's like, I had them in my pocket, and I walked up to a couple of them, I told them we should have a state microbe, and they were like yeah, go away. But we were lucky because the senator from, he used to be my senator but now he's a senator for the district next to me, Dr. Sam Thompson, he has a PhD I think in medicinal chemistry. I gave him the pitch--

Vincent: State senator, right?

John: Yes, state senator, not Washington senator, because the state senators are the ones who are responsible for what's going on where you live. And they represent you and you should know who they are. And if you don't, you should, you really should, because you are their interface with the government, they represent you and if they don't, you gotta vote for somebody else. So anyway, I gave the pitch, I handed him the proposal, anyway, you take all this stuff and you get it down to a page of bulleted points and then you hand it to him and you give your thirty second elevator pitch, and he scratched his head and said that's a really good idea. I'm gonna submit that. And a week later he got it, it was there, it was part of the record.

Vincent: So this goes to the state senate?

John: First, the process is that you find a sympathetic senator or assembly person. They write, I didn't write up the bill, so I don't even think Senator Thompson wrote it. They have their people.

Vincent: Yeah, their staff.

John: They have their staff. So it got written up, submitted, it got a bill number, I think the first one was S-1729, it gets worded, it has a bill number, and it goes, it's assigned to a committee meeting, it's an open committee meeting, and it goes up for review. There's like four, five senators on it. And then we went down and testified

before the committee. Max Haggblom, myself, and Doug, and we said why it was a good thing, and we got these committee to vote yes on it. And the cool thing about the committee meeting, it was on Robert Cox's birthday.

Vincent: Great (laughs)

John: So it was like an omen. So we did that, the committee voted unanimously, and then it goes to the full senate at some unknown point in the future and the senate voted unanimously for it, too. So it was like one day, everybody in New Jersey agreed on something.

Vincent: That's amazing.

John: Yeah, for a four one thousandths of an inch in diameter and they agreed.

Vincent: This is politically neutral, I guess that's why.

John: Right, right. Politically neutral and it's a happy thing. And then the assembly is the other side of the story. And what I did there was, as soon as Sam, as soon as Dr. Thompson agreed to do it, I said, I know how the system works, we need sponsors, we need cosponsors, we need all this other stuff. So I sent the proposal, and I sent emails and hard letters, you know, snail mail, to all the people in the assembly and the senate that were graduates of Rutgers. I figured, well, it's a good Rutgers connection. And that's like 25 or so people, and I got one positive response. (laughs) And it was from an assemblywoman, Annette Quijano, from like Elizabeth area. And that has a distinction, she was in fact born on the 4<sup>th</sup> of July, which I think is really cool. So she looked at the proposal and they said to me, this is a really interesting proposal, but tell me, if I submit this would you be willing to go and talk to students in my district? Would you be willing to go to the community colleges and the high schools in my district and talk about this piece of history from New Jersey because I think this is an underserved area. Nobody but you microbe guys know this and this is important for the history of Jersey and telling students this might open up career paths to people who would otherwise not be exposed to it. And I said, well, yeah, you're gonna give me a chance to be on stage and talk to people? And she said, yes. And I said absolutely.

So she submitted her bill the next week, they're mirror bills, and that's kind of the process. So any time the bill comes in it has to go through a committee. Last year the assembly bill was assigned to a committee that unfortunately did not meet. Not that anybody was mad at us, that was just how things happened. My analogy is there is in fact a black box in legislature that is between us and the people that are elected and also between the elected people and us. There's stuff that they don't even control, like scheduling of when the bill is gonna get voted on. I've asked senators and assemblywomen, when are you guys gonna vote on it, when is the committee gonna be scheduled, and they're like, we don't know because we're not really in charge of it.

Vincent: So right now, you're waiting.

John: Right now we are waiting for the second coming of the senate bill. Because it passed 100% last year we anticipate no problems with that this year. And the committee for in the assembly is the science technology and something or other committee and it has a PhD nuclear physicist on it from Princeton, it has a physician, an MD JD former army captain, so that's impressive credentials for an assemblyman, and a couple of other more academically oriented people. So we think that once it's in there it can get scheduled there and get through there. So we are 100% positive it's gonna come through, it's just a matter of timing.

Vincent: Okay. And it's gonna happen this year, I guess, calendar year?

John: I hope so.

Vincent: So then when it does, what do you do?

John: Oh, once it's done? That's a really, really good question! (laughs) Oh, when you hit the lottery, what are you gonna do? I haven't carried it that far yet. I think we would have a big party. It would be really good if it happened this year because I think it is the 75<sup>th</sup> anniversary of streptomycin. I don't know. I think we could get a road show together and go off and talk about streptomycin and *Strep griseus* to people. It certainly would mean that the state needs to update their website because now we've got another state symbol. Yeah, and all those social studies classes or civics classes that still may or may not exist in school systems.

Vincent: Maybe you could use it as a teaching tool, now you could go out and say look, we have this New Jersey state microbe and people would pay attention whereas before they might not. And then you could teach them about it and why it's important and why it's cool and so forth.

John: It's absolutely a teaching tool because unfortunately, even with, and here's my other soapbox about astrophysicists having a cooler life than us, when you look at STEM, science technology engineering math, when I look at that it's like science teaching except for microbiology. When I talk to science teachers and I'm a member of the national science teachers' association and I see what gets posted on the board, I don't see any microbiology on there anywhere and it could be because they are afraid of liability issues. It could be for a lot of things, but you don't really need wet labs to tell people about bacteria. For anybody who graduates high school, you graduate high schools, you go into different fields, you never had it and you grow up being afraid of everything because all you hear is the word "germ". You don't hear nitrogen fixation, you don't hear cellulose degradation, you don't hear all the good things. Cheese making, beer making. It's a shame, it's a niche that needs to be filled some how.

Vincent: So I wish you luck with that, I hope it works, but if you don't get it this year, will you keep trying?

John: Absolutely. I'm stubborn.

Vincent: Now the other thing you do to teach people about microbes is you have here on the table you have...

John: Dr. Warhol's Periodic Table of Microbes.

Vincent: And an accompanying book.

John: Yes, the small guide to small things.

Vincent: So tell us what is this periodic table of the microbes?

John: The periodic table of microbes is my novel attempt to educate the world about bacteria and microbes. There are several ways I can introduce the story as to how it came about, but the idea is that if you think about the periodic table of elements, it's the single most iconic thing in all of science. It's in every classroom from maybe 3<sup>rd</sup> or 4<sup>th</sup> grade on.

Vincent: College, too.

John: College, too. It's there.

Vincent: I went to see my son's college class and it was on the wall, it's amazing. It's a beautiful thing, it's everywhere. So it's like it's in our cultural DNA to see it and to know it's there and everybody knows it's the periodic table of elements. So people know elements, they know chemistry, they're at least familiar with it. I looked at it and said, well, it's only been used for chemistry, we need to be able to do something else with it. I said, it hasn't really changed for 130 years either, I could do something with that. So the idea was that because people are familiar with the periodic table of elements, and my philosophy of education and training is that you go from something familiar to something unknown and it's a progression rather than throwing a bunch of stuff at people and hoping it sticks. So you start from the familiar and you move to the unfamiliar and it makes it comfortable. Because they've seen this, you'd be able to get into it easier. So basically what I did was in the

nerdiest and most obsessive compulsive way a person could possibly be, I removed all the elements, I replaced them with microbes whose names could be approximately, yeah, I replaced all the elements with bacteria whose names could be reasonably approximated with a chemical symbol. So H instead of being hydrogen is now homophilous, He instead of being helium is now helicobacter, and so on for 118 organisms. And I also made a key, just like on the real periodic table, so that when you look at it you could tell is it Gram positive or Gram negative, does it live in the soil, does it live in the water, is it an extremophile, is it a pathogen, is it a food organism, is it one or more of them. So there is a little key to all of them.

Vincent: Shape, too.

John: Yeah, shape, too. Rods, spirals, helices, you name it. So it's a really quick study.

Vincent: It's really cool.

John: Thank you!

Vincent: I think if you put this on the wall of a classroom and went every day the teacher could say, okay, Johnny pick one and we'll talk about it.

John: Absolutely! That's the entire idea.

Vincent: And to help that you have a book that goes with it.

John: Yeah, because what happened was I did the periodic table first as the visual thing.

Vincent: And you're selling this, right?

John: Yeah, it's available on my Etsy site and it is also available, if you read the book, there's links to the Etsy site in it. So its like warholscience on Etsy.

Vincent: It's also on CafePress, too.

John: CafePress, you could buy t-shirts and what not. (laughs) I'll get the plug in. I should have worn my Warhol periodic table of microbes sweatshirt, but I didn't.

Vincent: Must be kind of compressed on the front, there.

John: Yeah, that's kind of the problem. I gotta do them one at a time.

Vincent: You sent me a couple of these, I think they're very cool. I've got one in my office.

John: Thank you. Yeah so immediately after I did microbes I did viruses and I did parasites.

Vincent: Are those for sale also?

John: No, because I didn't print them in bulk, but if anybody wants one just shoot me an email or a tweet and I could certainly print them off and send them. But after I did the poster, I realized that people that looked at the poster didn't hear the voices in my head that are saying what it is about each of these organisms that is cool, unique, or has a story to tell.

Vincent: Because a name is not enough, right.

John: Right. And just looking and seeing oh it's a Gram negative and whatever. So I had to write the book to explain to people what was cool or interesting about them. And a lot of them, I think the first eight are pathogens, and then after that it becomes more diverse. Pathogens are just because you hear of them every

day, so homophilous is the first one, anybody who has kids knows they have to get their kids vaccinated for homophilous, and if that is all a person or a parent takes away from this, good. You've heard the word homophilous. But then you start getting into the weirder and cooler stuff. I was just talking to people downstairs and it was like, Kr, krypton, kurthia, what's kurthia, i've never heard of it. And I was like oh, the kurthia story is when they found that 20,000 year old mastodon in Siberia they were able to culture live kurthia from its stomach. That's amazing! That's one of the coolest things I've ever heard. And the only other place you are going to find kurthia other than spoiled meat is in the mouth of a Komodo dragon, and Komodo dragons have the nastiest oral microbial flora on the planet. As far as I know they don't make a venom, but when they bite you, it is so polluted and contaminated that everything just grows and causes a polymicrobial infection in your body and you die. But it's like, it's neat. So each of the organisms in the table get 300 words or less, and I did a word count, and so at the end of it, it is 300 words for each organisms, and it's stories and it's relational. So it's not just talking about DNA sequences or this ferments that and this ferments that and you're gonna key it out on an entero tube or an agglutination test or something. It's stuff like that.

Vincent: So the book can be used by teachers?

John: Yeah.

Vincent: So a kid can say, Ru, and the teacher can open it to that and say okay, here's some cool things about Rubrobacter. By the way, these abbreviations match the original periodic table.

John: Absolutely, and that was the hard part.

Vincent: We've got H, Li, Be, Na, Mg, all the way out to the rare earth elements, it's very cool.

John: Thank you.

Vincent: And it's colored as well in the same way.

John: And there's a lot of word play that goes into it. One of the proudest, and pride is one of the seven deadly sins, but one of the things I'm proudest about is when I started on this, one of my heroes in the world out there is James Berk. He's a noted science historian, he wrote Connections 1, Connections 2, Connections 3, a BBC TV series, he had a series called The Day the Universe Changed, and he's really big on finding historic connections. And when I started to write the book and I had a draft, I found his contact in the US and I said hey, I just wrote this, could you give it to James Burke to review? And he goes, okay.

And a week later, I was the and-guest for my wife at a meeting she was at, and we're ready to go to dinner, and I get this email coming and it says hi, this is James Burke, I just read your book. And I was like, oh my god! This is like the best thing that's happened to me. And his response back to me was, I rarely enthuse but this is brilliant, and he said I love this, I will finish reading it over the weekend, and I'll get back to you. I was like wow, this is validation, this is my first time out doing this and this is my hero. And he said, my favorite, because there's a lot of weird stuff in there, you live in New Jersey, in your basement or garage you have those mutant camel crickets.

Vincent: Yeah, of course.

John: There's people who study mutant camel crickets and they isolated bacteria that are only found in those weird camel crickets, and they're in there somewhere. Stories like that.

Vincent: Do you have a favorite?

John: I have a couple favorites.

Vincent: Okay, what are they?

John: I really like the modestobacter story. Now who studies modestobacter? Not many people. But I like modestobacter because you would think it would be like--

Vincent: 101.

John: 101 (laughs) You would think it would be the mascot for the band Modest Mouse or something like that. But modestobacter is actually named because it has really modest food requirements, as opposed to like, I used to work on pathogens and they require really rich media. Modestobacter requires almost nothing to live on, and the reason it requires almost nothing to live on is because it lives on the Antarctic ice shelf. It lives in the place where forever scientists went and said this land is sterile because it's 200 mph winds, it's 180 degrees below zero, it's too cold, it's too inhospitable to live. And they tried to culture stuff and nothing grew until one day one really intrepid microbiologist went there and they said no, there's no such thing as an unfilled niche, and they went and they found that modestobacter, they found modestobacter and other organisms like it live there, and I think they're called cryptoendoliths or something. So they actually live in on or among rocks but it grows really, really slowly.

Vincent: It uses gases to grow, I think.

John: Yeah.

Vincent: We talked about that on a recent TWIM.

John: Really?

Vincent: There was a paper that came out recently where they reported the results and it uses the gases to live. You're right, they don't divide very quickly.

John: They don't divide very quickly.

Vincent: Enough to maintain though, basically.

John: Yeah. And the story becomes even crazier because I'm thinking, alright, even if you wanted to study this organism and go take cultures you really can't. You need to get special permission from the UN to go there and try and culture it because it is in these places where you are forbidden to go, and when you go it's like they don't even want you to land the helicopter because the helicopter is gonna disturb the earth. They don't want people walking because the colonies take 10,000 years to grow. You got to hang off the edge of a helo take your loop and scoop up some dirt. It's like, wow, what a cool story.

Vincent: Yeah, those are just a few examples. You got another favorite? You must like streptomyces, right?

John: I like streptomyces, it has good stories but it's not like, super humorous. Mycella is good, the example I use in there is it's the kimchi organism. It ferments at 0, and I tell a story about kimchi, kimchi went on a space shuttle, it produces massive amounts of vitamin C, it's like the national food of Korea, multivitamins and minerals and other stuff like that. There's modestobacter, I'm looking up, a lot of what I do is wordplay, like listeria, it's not an OCD disease of people who make lists. It's not about people who like waltzes. Listeria is an organism that causes food poisoning, but it's not the kind of food poisoning where you go out and you run to the bathroom and you crap your brains out or you throw up. Listeria will go and it will cause meningitis and it will kill you.

And listeria is responsible for something called the Great Hummus Recall of 2015. There was a hummus manufacturing company somewhere around us and it was like 70,000 gallons of hummus were contaminated by listeria and they had to recall it all. What a title for something, the great hummus recall of whatever. Other favorites, helicobacter has a cool story because it causes in certain people it causes ulcers, but if you remember all those scientist movies we used to watch growing up as a kid, the black and white ones and talking about the

scientists experimenting on themselves, that's the perfect example. The man who discovered it said I think this causes ulcers but I have no proof! And the government won't let me do a trial! So I'm going to drink some! And he drank some and he got sick. Oh, what's the good one. I like saying that thermus, it's way down at the bottom, it's like number 69. Thermus. Without thermus, there would be no CSI shows on TV. There'd be no CSI, no NCIS, there'd be no any of those other shows.

Vincent: Thermus aquaticus, right.

John: Exactly, you got it. The reason being that thermus is where Thomas Brock, he found the organism, but it's got Thermus aquaticus, it runs at high temperature, all the enzymes in it run at high temperature, including the DNA polymerase and that is the basis for all polymerase chain reactions and all the CSI shows so that when Gibbs comes in and says, Maggie, get me DNA results on this, it is because of that organism, and Taq polymerase was voted by Science magazine as Molecule of the Year in whatever it was.

Vincent: Cool. Now the Periodic Table of the Viruses and Parasites, they don't have a book yet. Are you working on it?

John: Not yet, no. I will as soon as I get this one off my (laughs)

Vincent: And you said you're working on a larger guide for the microbes with more words, right?

John: More words and more pictures. The challenge is the current thing is just eht icons because that took forever to do as it is. I really want pictures of each one of them because that enhances the story, but if you think about doing, there's 120 organisms, 118 organisms, if you do 3 or 4 photos or illustrations for each one of them to make the book more interesting, that's a lot of layout time, that's a lot of typesetting and layout and permissions and even if I don't get permissions it's just still expands it to a really huge project. So if I get a lot of positive feedback on this I will certainly do the more colorful and interactive one.

Vincent: So in the book, in the beginning, you have a nice introduction where you have the top three microbes in different categories.

John: Yes, the stinkiest, the loneliest.

Vincent: The hottest, the coldest, right.

John: The hottest, the coldest, and actually the inspiration for that was from my son. My son is not a scientist, he is a video editor, producer, that kind of thing. And I had him proofread, I had him read the first draft of the book. And he said, this is really good but you have to hit something up front that will attract people. He said how about doing the top ten or the top three of everything. And I was like, alright, I took my son's advice and I have the stinkiest, the smelliest, the hottest, the coldest, the deepest, the ones named after men, the ones named after women.

Vincent: Yeah, that's cool.

John: And it's a hook.

Vincent: Yep. The other thing you do is you say you are not going to use italics, why is that?

John: Good point. Actually, Doug Eveleigh pointed out that when I did it, he says you don't have anything italicized. I was like well, yeah there's two reasons for that, maybe three reasons for that. The first is that I did the table first and italics don't really look good on a table. It would not work and I wanted to emulate the look of the periodic table of elements. The second is italics don't really work on Ebooks. The third, when I thought about it more and more, is that italics sets up this, italics and Latin words set up this distinction between us who are scientists and them or the people who are going to read it, and it just creates what I perceive as a

barrier to learning. When we look at it, we automatically know it's an organism, and probably they would too, but because it's in Latin and it's in italics I really honestly think it is a barrier for people to try and understand what it is. And I can understand like for formatting, if you're going to put it in a journal, sure! If you're gonna, a textbook for the field, sure.

But for my wife or my son, for people who watch TV, it's a barrier, and the names themselves are hard enough. It's one of the things I think I talked about at Seton Hall was as biologists or microbiologists and virologists, we're dealing with things that are really small and really precise and really foreign to most people and they don't have common names. So when you talk to fisheries people, and again my favorite are the Hawaiian triggerfish, okay, it's the Hawaiian triggerfish. And people will say oh, it's the triggerfish. They'll get that. And if you're a fishery scientist it's the *Rhinecanthus rectangulus* which is stranger. But if you're Hawaiian it's the *hmuhumunukunukuapua'a*.

Vincent: Right, right, that's right.

John: Having a common name makes it easier for people to understand. Having it not in italics makes it easier for people to understand.

Vincent: Got it.

John: I was trying to make it less of an us vs them thing and more of an us thing.

Vincent: Another thing that I like is you say don't call them germs.

John: Don't call them, no, no, that's the worst thing. When the state microbes stuff first came out I don't know who talked to the press or gave a press release but the first press we got was awful. It was somebody from Philadelphia's paper, ew New Jersey's getting a state germ, isn't that stupid. No! It's not a germ, it's a microbe, it's a bacteria. None of us use the word germs, you could say it's a pathogen. Or it's something. But especially the state microbe is not a germ. It's a beneficial soil bacteria. But yeah, germ is disparaging, it's like using the word on a bacteria, call it what it is.

Vincent: I agree, but the press tends to call them germs. It's really unfortunate.

John: It's not good.

Vincent: I always rail against it so I'm glad to see you did as well.

John: It truly is unfortunate and it's like press education is something that we should all advocate for, too, because they were the journalism majors.

Vincent: Well if you need help with viruses I'm happy to help you out.

John: I'm looking forward to it. Viruses have cool names, did you look at the ones on the virus chart? You could see like, strawberry crinkle virus, the beluga whale virus, the crocodile pox.

Vincent: You have microbes, you have viruses, parasites, of course we have a podcast in each area so maybe we could do a tie in. We could do some giveaways and then maybe people will pick up on it.

John: I was talking to a mycologist this morning, he goes you should have one with fungi.

Vincent: You should, you should. Of course we have on This Week in Parasitism, Dickson Despommier, who is an expert, if you need some help there I'm sure he'd be able to help you, as well.



John: I just met him through connections, somebody who works in the CDC parasitology department, and I was like oh, I have this periodic table of parasites so I sent him one so right now somewhere in the CDC there's a periodic table of parasites hanging up.

Vincent: How is all this doing? Do you have any idea how the posters are doing, how the book is doing?

John: No, the book just came out last week, so I don't have any sales things. The posters sell mostly because it's not as broadly as I want it to, right now it's mostly nerd gifts at Christmastime. My first sale was actually an international sale, it went to some guy in Australia. But it's been all over the world, actually, people have bought them. But I want to try and get it more mainstreamed so they will be used in classrooms and people will say hey, there it is.

Vincent: And that's part of why you came to this meeting, right?

John: That's part of why I came to this meeting, yeah, definitely.

Vincent: Alright, that is a special TWIM here at ASM Microbe 2018. You can find TWIM at [microbe.tv/twim](http://microbe.tv/twim). If you have a mobile device and you listen to podcasts, just subscribe. It's free and you'll get every episode. If you have any questions or comments, [twim@microbe.tv](mailto:twim@microbe.tv). And of course, if you like what we do, please consider supporting us. You can go to [microbe.tv/contribute](http://microbe.tv/contribute). We have a number of ways including a Patreon account. We'd appreciate your support. My guest today has been John Warhol from the Warhol Institute, thanks John for joining me today.

John: Thank you very much, it has been my pleasure.

Vincent: Now people can find you, you have an Etsy shop, a CafePress, you are Warhol Science on Twitter.

John: Right, [@warholscience](https://twitter.com/warholscience).

Vincent: You have a Tumblr.

John: Tumblr is [@microminutes@tumblr](https://www.tumblr.com/microminutes). That was a carryover from my first YouTube account which was MicroMinutes which I started many years ago to do micro instruction in under a minute for the YouTube crowd.

Vincent: Does it still exist?

John: It still exists, I haven't updated it, it's an example of my not doing my homework because my daughter was really in to YouTube when she was in high school and I went to the YouTube conferences with her and there were people in the educational division doing like, here's minute physics, minute chemistry, minute math, and I said, okay, microbiology is cool, we need to do minute microbiology.

Vincent: That's nice, that's a good idea.

John: But what happened is I didn't know nobody taught micro in high school. So all the people who do minute chemistry, minute math, minute physics, they have a pre made audience there because all those kids need help with their homework. And I was spending hundreds and hundreds of hours doing the videos and it ended up like, I enjoyed doing them, I'm glad that I did them, but it's like as you said this morning, you gotta know when to stop because it was just hundreds of hours. But they're there, people can find them.

Vincent: I'm Vincent Racaniello, you can find me at [virology.ws](http://virology.ws), I want to thank ASM for their support of TWIM and Ray Ortega for his technical help, and Ronald Jenkees for his music. You can find his work at [ronaldjenkees.com](http://ronaldjenkees.com). Thanks for listening, see you next time on This Week in Microbiology.

(music)

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Transcribed by Sarah Morgan.