

**NJS Presents***Invited Talks***In this Issue:**

*Now that we have a State Microbe, where do we go from here?*

**By Dr. John Warhol**

**DOI:** <http://dx.doi.org/10.14713/njs.v5i1.187>

*This lecture on the state microbe was initially delivered at the annual fall meeting of the Medical History Society of New Jersey on Thursday, October 10, 2019 at the Nassau Club of Princeton. Select images from the presentation are included and are courtesy of the author unless otherwise noted.*

**Introduction: We Have A State Microbe!**

Thank you for having me here. The question before us today is: “Now that we have a State Microbe, what on Earth are we going to do with it?” First, some background. Number one, we have a State Microbe. Number two, getting it was a big deal. It was a big deal because in the entire history of the known universe, “Lots of stuff has happened a bunch of times.” Galaxies have been created and destroyed; civilizations grew to great heights and collapsed into dust; babies have been born, billions of times. There are some things that happen only rarely, like a really good cup of coffee; or an easy, painless commute home. Some things, however, happen only once, like when that giant asteroid hit Mexico and killed all the dinosaurs. But more recently, precisely five months ago to this very day, for the first time in the history of the universe, a duly elected representative government of the people, by the people, and for the people declared unanimously, “We have an Official Bacterium!”

The bacterium was *Streptomyces griseus*, and the state was New Jersey. Yes, that's right! The New Jersey legislature enacted a law that names *Strep griseus* as the Official State Microbe. It joins the pantheon of other official New Jersey symbols like the Goldfinch, the Honey Bee, the Bog Turtle, and of course Square Dancing; not to mention our own dinosaur *Hadrosaurus foulkii*, discovered in Haddonfield. To be fair, it's the "Official Microbe of New Jersey" not the "Official Bacterium of New Jersey," and in the interest of transparency, it's the *second* Official Microbe in the world, but the *first* Official Bacterium. The credit for the first Official Microbe goes to the state of Oregon, which in 2013 enacted a law that recognizes Brewer's Yeast (*Saccharomyces cerevisiae*) as its Official Microbe, in honor of its \$2.5 billion a year craft brew industry, and also the role of the organism in baking and genetic engineering.

**Why that microbe?** You might ask me: "John, why did we pick *Strep griseus*?" And the answer can be found in a 2-minute elevator pitch that I had the honor of making to lots of politicians on a bunch of different occasions. The 2-minute elevator pitch goes something like this: "New Jersey absolutely positively needs to have its own official state microbe, and here's why! New Jersey is home to the microorganism known as *Streptomyces griseus*. *Strep griseus* produces the antibiotic streptomycin. Streptomycin is: the first antibiotic after penicillin; the first American antibiotic; and the first antibiotic to kill tuberculosis. Streptomycin *changed the world*. The streptomycin producing strain of *Strep griseus* was discovered in New Jersey, in New Brunswick, in dirt, in 1943 by Albert Schatz. Dr. Schatz was supervised by Dr. Selman Waksman, who won a Nobel Prize for his work on streptomycin, *Strep griseus*, and the systematic study of soil microbes. *Strep griseus* and streptomycin gave birth to the American antibiotic industry, an industry that employs thousands of people, starting with drug discovery and ending with clinical use in patients. Recognizing *Strep griseus* as the State Microbe honors

the contributions of all of those people. But the bill does more than honor New Jersey scientists. It creates the opportunity to teach basic science to people; to have them learn that microbes are essential to all life on Earth; and that most of them are beneficial.”

Although that talk was only 2 minutes long, it was still pretty “sciencey.” There’s an alternative message that is more memorable. It’s simply this: “Without the State Microbe, rock and roll music as we know it would not exist.” Why? Because The Beatles would not exist. Because Ringo Starr would not exist. How could this be? Well, as a kid, Ringo was sick a lot; when he was 12 he had tuberculosis. His mom took him to the Liverpool Tuberculosis Hospital where he was treated with streptomycin. He recovered fully and went on to be the drummer in the world’s most influential band.

### **Teamwork and the Legislative Process**

Now, getting back to the State Microbe. Doing all this was not easy; getting a group of people to believe in something they can’t see and never heard of, was a challenge. You need a team to accomplish this, and we had a great team. Shown below are some of the people who worked on it; of course there’s me, and next to me are several Rutgers professors. The first is Jessica Lisa; she was instrumental in getting Senator Vin Gopal to sign on as a sponsor. In the middle is Doug Eveleigh, professor emeritus, who is absolutely the most important and influential person here. Doug knows everyone, and when he sends out a letter or an email, or calls other colleagues around the world and says “Hey could you help us out with this? Could you send a letter to our Senators?”, they are more than willing to agree and comply. Someone calculated that more than 60% of all microbial ecologists and industrial microbiologists were students of his; he’s just a really excellent human being and a great resource. And to his side in the red State Microbe shirt is Professor Jeff Boyd who came down and testified with us, and

wrote letters, and got his students motivated to participate in the process. Not shown in this picture is the Microbiology Department Chairman, Max Haggblom, who also testified before the Senate, and was instrumental in getting the legislation passed.



**Some members of the State Microbe Team in the State House in Trenton: (left to right) John Warhol, Jessica Lisa, Douglas Eveleigh, Jeff Boyd. We are standing on a mosaic of New Jersey State Symbols that now needs to be updated. Photo courtesy the author.**

You need a team because democracy is a participatory endeavor, and you need a lot of people to participate successfully. Participation is easy, or at least it's supposed to be. It's supposed to be as easy as getting on the phone, or writing a letter in the mail and dropping it off, or sending an email. Mostly what you *think* happens, is like what you think happens when you send a letter to Santa, and you say, "Please Santa I've been really good. I want a new iPhone" or you say, "Santa I want an 'Official Red Ryder carbine-action 200-shot range model air rifle'." (I

hope some of you remember the cultural reference there!) You think it goes straight to Santa. But in truth the pathway is more tortuous. It's not direct.

The reason it is not direct is because there's all these people in between you and your legislator: there's the first phone person, the second phone person, the third phone person; there's letter openers, readers, and sorters; there's aids and assistants; there's constituent relation people; there's Twitter readers and writers; all sorts of people in between you and the legislator. And all those people are there to protect the legislator from talking to people with crazy ideas like "I want a State Microbe."

The legislative process is like a big black box, and things only get accomplished when you fill that box. It's really important to understand that 10,000 letters from individual people are much better than one letter representing 10,000 people because you need to fill that box. This is not new news; if you remember the famous song *Alice's Restaurant*, Arlo Guthrie said: "If one person starts singing lyrics to *Alice's Restaurant*, they will think you're sick. If two people start singing it in harmony, they'll think you're married. But if 50 people a day sing it, they'll think it's a movement!" And they'll take it seriously.

Medical Society of New Jersey 2019

## Volume is Important



- |                     |                             |                 |            |
|---------------------|-----------------------------|-----------------|------------|
| First phone person  | Legislative Aid             |                 |            |
| Second phone person | Legislative Assistant       |                 |            |
| Third phone person  | Chief Legislative Assistant | Regional Office |            |
| Letter opener       | Constituent Relations       | Main Office     |            |
| Letter reader       |                             | Trenton Office  | Legislator |
| Letter sorter       | Twitter reader              |                 |            |
|                     | Instagram reader            | Volunteer       |            |
| First Email reader  | Facebook reader             | Intern          |            |
| Second Email reader |                             | Temp            |            |

**The greater the volume of input on grassroots legislative issues, the greater your chances of success. There are many filters to pass through.**

One more thing that you need to know is that none of those couple of dozen people between you and your elected representative is a scientist. Can you imagine anyone who invests four years to get a hard science degree, or anyone with graduate credentials, or medical training saying, “I’m going to answer phones for my legislator!”? It simply does not happen.

### **Where Do We Go from Here?**

**Tell people!** So now here we are, 50 slides in from the beginning, and I get to the actual topic of the talk “Now that we have a State Microbe where do we go from here?” Well the big number one thing to do is tell people. We still have around zero public awareness that we have a State Microbe. We’ve had some good press, and my colleagues and I were on TV, the radio (sorry, podcasts), printed papers, and electronic media in the US and overseas. Doug Eveleigh was notably on National Public Radio, NPR. We’ve been out there in the news, but frankly more people need to know. So I would ask you to tell your friends, tell people in your department, tell your students. If you’re out in public and you see someone in surgical scrubs, tell them. Chances are they have at least a passing interest in medical science. When you go to the pharmacy to pick up your blood pressure meds, tell the pharmacist. When you go to your physician, tell the doctor. Tell anybody that you can, anywhere you are.

**Easy Big Ideas.** There’s two other sets of ideas that I had; one was for “Easy Big Ideas” that wouldn’t require too much work on my part; the other was for “Hard Big Ideas” that would require a lot of work on my part. So, for the “Easy Big Ideas,” it would be awesome to have an Official Microbe for every state, every nation, and every region on Earth. Wouldn’t that be cool? It’s good for education, it’s good for science, and it’s good for regional and national pride.

*France.* My first thought for the easiest one would be the town of Roquefort sur Soulzon in France, the home of Roquefort cheese, with the characteristic organism *Penicillium roqueforti*.

I mean how hard could this be? The village only has seven hundred people, it can't possibly have a complicated legislative process! There are six cheese making companies in Roquefort, each one has its own website, three of them have active email sites, so just this morning (actually earlier in the week) I emailed three of them and I said, "Hey we just did this great thing in New Jersey and got a State Microbe. Maybe you can try and do it in your city too, and make *Penicillium roqueforti* your Official Organism." None of them have gotten back to me yet, but I hope they do. If they don't, I discovered there's a grade school there, and one of the really good ways to influence legislators is to get school kids to write to their legislators and say, "Hey there Mr. or Ms. Legislator, this is a wonderful idea. We need an Official Microbe, just like they have back in New Jersey."

*Illinois.* The great state of Illinois started their own State Microbe Adventure. Drs. Gary Kuzniar and Neil Price together worked to introduce legislation that would make *Penicillium chrysogenum* their Official Microbe. Actually, the story goes that Dr. Kuzniar heard the NPR interview with Douglas Eveleigh on August 7<sup>th</sup>, 2018 as he was driving to work. That interview moved them to act to get their own State Microbe. Now *Penicillium chrysogenum* is the American version of the strain of *Penicillium* that makes penicillin. As you all probably know, penicillin was discovered in England by Alexander Fleming about a decade prior to World War II. The problem is that the British version of *Penicillium* was kind of like a British sports car. It looked good but it didn't run all that well. You know they stall, have bad electronic systems, the roof leaks, the doors rattle, and they aren't really super dependable. Our version, the American version, was built like a Chevy truck, a Ford truck, a Dodge truck; it was dependable, it ran, and it produced massive amounts of penicillin. It became the penicillin producing strain of

*Penicillium* that got us through the war. Our friends in Illinois are in the process of getting it through the legislature right now.

*Korea.* And the third really big idea, it would be would great to have a national organism for someplace like Korea. North and South Korea can't stand each other and have been divided since the 50s. What they have in common is kimchi, their common national dish of fermented cabbage. There's around 36 different organisms that are known to be involved in the fermentation process. One that comes to my mind is known as *Weisella*, and the particular species, *Weisella koreensis*. *Weisella koreensis* is named after Korea; it's a cool organism, in fact it is a very cool organism because it functions below freezing temperature. In Korea, you would take your cabbage, put it in an earthen pot, burry it in the ground for the winter, and the *Weisella* and the other organisms and go in there and fermented into a stable, staple food product. Would that be cool? We could unite these two warring countries over an invisible microbe that they share!

*Publication.* The other thing we're working on is a publication, with the running title: *The New Jersey State Microbe, a Clinical Trial of Microbial Literacy and Activism*. We actually have data on how democracy works, because I have records of every email, and every tweet, and every everything we did. From that, we can have a sense of the response rate of our legislators to the process. This was an eye-opening experience! I will say that our law went through and it passed unanimously. I sincerely thank all the bill's sponsors and everyone who voted for it (which was everyone), but getting there was hard. My take on the political processes is that if democracy was a drug it wouldn't get FDA approval, more on that when the paper comes out.

**Hard Big Ideas.** The "Hard Big Ideas" are going to require a lot of work on my part and on the part of others around me. If you remember from the 2-minute elevator pitch, the important



aspect of the bill is that it does more than honor New Jersey scientists; it does more than honor old guys in black and white photos. The real reason for having this State Microbe is that it creates the opportunity to teach basic science to people. To have them learn that microbes are essential to all life on Earth and most of them are beneficial. This is important because in developing the State Microbe it became apparent to me that “Nobody knows nothing about microbes.” And by microbe I mean a bacterium, an Archaeon, a fungi, a virus, a parasite; small stuff. I’d go so far as to include Tardigrades which are on the order of 20,000 cells big, but they’re small, and you really still need a microscope to see them. Tardigrades, by the way, are awesome!

Not knowing anything about microbes leads to tragic things like under-vaccination. Anti-vaxxers, I would believe, have never had any microbiology or immunology classes. It also leads to the overuse of things like Purell, and the inappropriate use of antibiotics. Not understanding soil microbiology leads to poor soil conservation, and has vast implications for agriculture. Microbes impact our health and ecology, and knowing more about them will only have positive effects.

*Overcome Microbe Ignorance.* But you can say “Oh John, are you sure nobody knows nothing about microbes?” Well yeah, I really am; I talk to people; I go out; I look around; and I would say ignorance is bad. This particular picture below is the modern version of the punch clock, where you clock yourself in at work. So, instead of having a piece of paper you slide in that records your time in and out of work, what you do now is scan your fingerprint. The sign on this fingerprint reader says, “Do not spit on finger and place on reader.” This is significant because this comes from the Foodtown store right down the street from me! This is a sign that should not exist. People surely know that spitting on your finger and putting it on the reader has

epidemiologic consequences! You spit on your finger, put it on the reader, and connect with everybody else's spit, and then go off and handle food products that people are going to take home and eat?! This is not a really great idea. But then, as I looked at this, I said "Well it could be worse. It could have been worse if someone actually licked the reader and then put their finger on it." But I don't think they could fit their head against the wall so that's probably why they were just licking their finger.



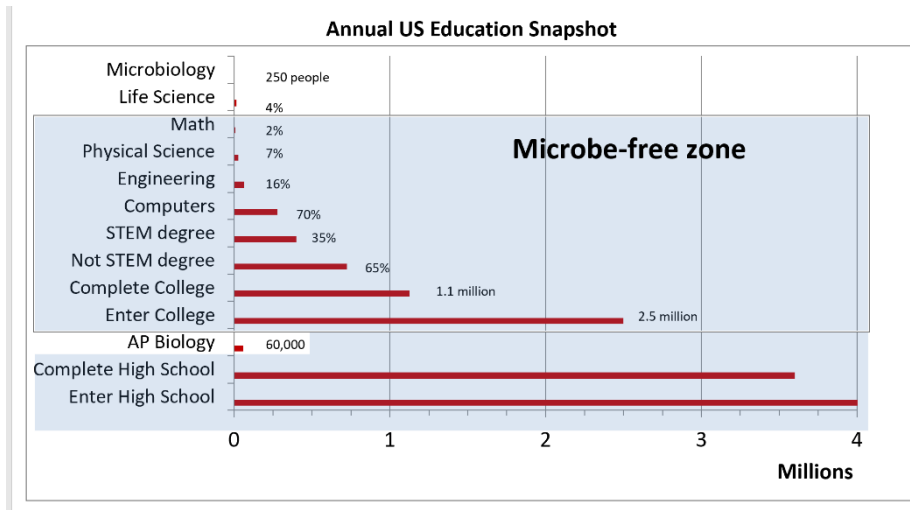
**Modern digital punch clock at Foodtown with essential information for employees.**

And, in trying to get the micro-organism as the state symbol, I came to learn that New Jersey has the best educated legislators in the USA; the overwhelming majority of them are college graduates; we have lawyers and engineers; there's some MDs, and a couple of PhDs; but

it really became apparent that nobody knows nothing about microbes. Except for Senator Dr. Sam Thompson, who was the primary sponsor of the bill, when I spoke with most of them, they looked at me like deer in the headlights. This was worrisome because these are smart people and most of them were educated in New Jersey.

I talked to teachers, I talked to students. I said, “Are you teaching or learning any microbiology?” The answer I got was always “No not really.” And I asked “Why? Why is it that nobody knows anything and nobody is learning anything about microbes?” And the really scary reason that I found is that there is zero microbiology in the K-12 curriculum in New Jersey and the rest of the US. For a lot of people, this is the only science they get in their whole lifetime. If I’m wrong, someone please correct me.

This slide shows a snapshot of the US education system for any one year. I could spend a half-hour just talking about this slide, but notice that almost the entire slide is a “microbe free zone.” Roughly 4 million people enter high school every year, and in addition there are a total of 12 grades to consider, so there’s 48 million people in the K to 12 school system. Anyway, of those 4 million entering high school only 60,000 a year would get any microbiology, and those are Advanced Placement Biology students. So we graduate an overwhelming number of people that are absolutely illiterate in microbiology.



**A snapshot of a typical year in US education from high school through college compiled from several sources. Few people learn any microbiology.**

I thought that was scary, and I said, “What about STEM and the Next Generation Science Standards that I’ve heard so much about?” So I did some investigating. And STEM is based on a book called *A Framework for K-12 Science Education* published by the National Research Council of the National Academies of Sciences Engineering and Medicine. I thought this would be an extremely forward-looking document written by people with large bulbous heads and huge cranial veins who look like the Talosians from Star Trek. I was expecting to be inspired. I wanted Next Generation! I wanted to look at this thing and come away thinking about Captain Jean-Luc Picard and Dr. Beverly Crusher and the whole Star Trek Next Generation team. And if I couldn’t get Picard, I’d be happy with New Captain Kirk and New Mr. Spock (Chris Pine and Zachary Quinto) , and if I couldn’t get them I’d be happy with Old Kirk and Old Spock (William Shatner and Leonard Nimoy), because it’s still futuristic and it’s ahead of our time. So I got the document, and when I read it, I was disappointed. I was so disappointed that I was moved to count every word in it. The Next Generation Science Standards has 144,407 words. It mentions bacteria 11 times. One of those times it says “... bacteria live in your intestines and don’t require oxygen.” The other time it says “...bacteria can cause disease.” The other nine times it talks about bacteria being part of the Great Cascade of Life. Things are even worse if you look at the terms “microbe” and “virus.” Microbe is used three times and virus is used twice. This is an underselling of an important piece of educational literacy. We’re basically creating a microbe illiterate society under the best of circumstances.

*Improve Microbe Education and Awareness.* The answer ultimately is to change K to 12 curriculum, but I personally don’t know how to do that. I would need help from all of you. I suspect and expect that a lot of politics and egos are involved, and I imagine it would be like Sisyphus trying to roll that rock up the hill. But I’d love your help. What I do know, or what I

suspect, is that making this happen will involve a lot of advocacy and education. And to paraphrase the words of Mark Watney in *The Martian* who said “I’m going to have to science the hell out of this” to get off Mars, we will need to “communicate the hell out of this” to make people aware of microbes. So my suggestion is: whenever possible talk to teachers and students and school boards; if you’re a microbiologist, volunteer to teach a microbiology class to non-scientists or non-microbiologists; if you’re not, find somebody who is! I’m more than happy to go talk anywhere, anyplace, anytime.

One of the greatest examples of outreach and education is conducted by my friends at Rutgers. Every year there’s an event there called Rutgers Day. It’s an outgrowth of something that was called Ag Field Day, which was traditionally the day in the spring when all the agricultural students on Cook Campus would show off their prized chickens and pigs and horses and cows, and everybody would go out and have a festival, and it was a really wonderful thing. The rest of the University took great advantage of that initial interest and they expanded it to include the whole rest of the Rutgers community. So it’s grown into an event that draws up to 60,000 people, depending on the weather. Every department has a display in front of their building. The absolute best one is put on by the Rutgers Microbiology Department in front of Lipman Hall. They have interactive colorful exhibits, and they have really smart, intelligent, motivated students and faculty explaining to people who walk by what’s going on, and giving them a chance to see something of microbiology. It’s fantastic! But the problem is, the only people who see this are the ones who go to Rutgers Day. As important and essential as this is, we’re still missing everybody else in the state who doesn’t go!

*Close the gap between science and nonscience.* There are other reasons why microbe and science literacy are important, other than the obvious one of not licking your fingerprint reader.

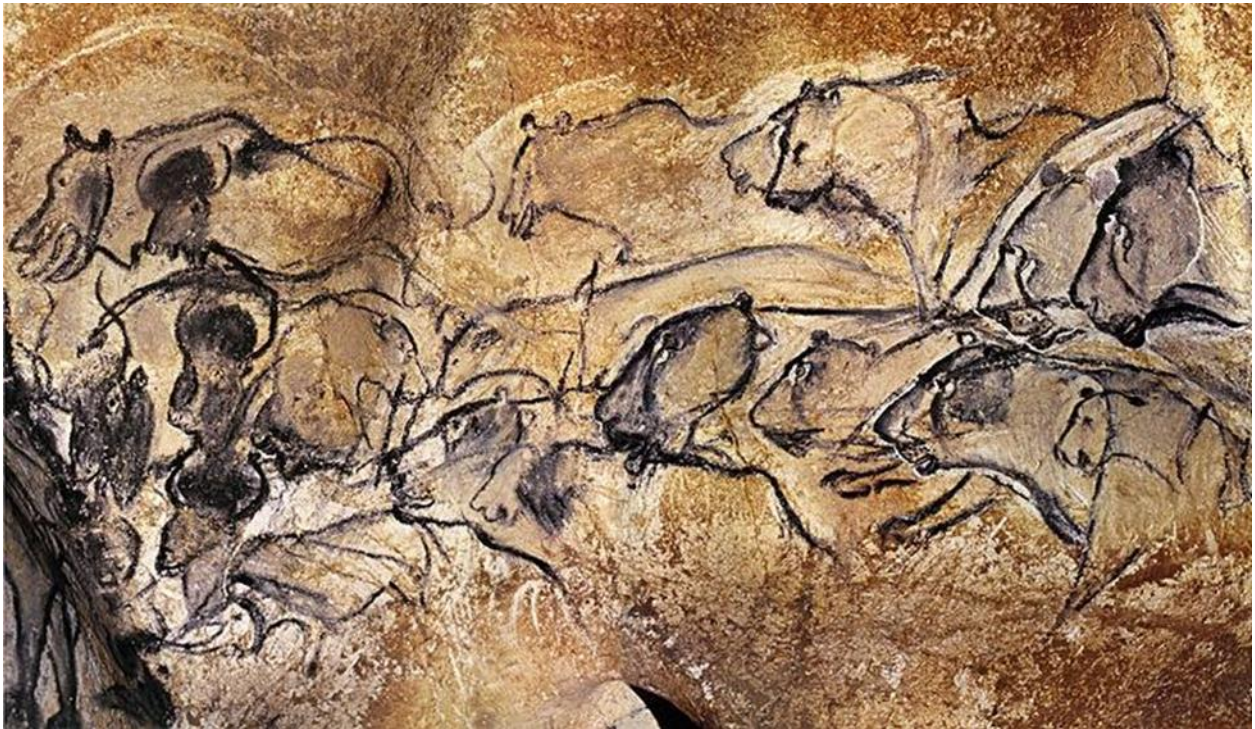
Going back to my slide of the educational snapshot, all of those people in the blue zone who don't get any microbial education, they can become legislators and administrators and journalists, and are put in positions that have power over your life, and they just don't have the training to do so. On a bigger scale, there's an understanding gap, not just for microbiology, but between all "science" and "not science." That leads to bad things, it always has. Here's a slide: on the left, the black and white version, this is what happens when villagers, the people down in the valley, don't like the science that's going on up on the hill. So they gather pitchforks and torches and yell and scream and storm the castle. The color image on the right was taken more recently, and shows what happens when scientists in the village don't like what's going on up on the hill; and you can see that they're carrying things and they're yelling. My suggestion is that these strategies were similar and neither one improves understanding.

# Understanding Gap



Lack of understanding leads to unpleasant outcomes. Villagers, black and white image, *Frankenstein*, 1931.  
Scientists, color image, *The Atlantic*, March 7, 2017.

One of the things I think you can do to make life better is to fill that understanding gap with microbes. Don't laugh, microbes are undoubtedly cool, but the problem is that you can't see them to appreciate their coolness. What's most important here is that microbes have stories, and we as humans are hard-wired for stories. These two slides are of 35,000 year old cave paintings from Southern France. These are the original PowerPoint presentations given back in our prehistory. This was people conferring information from one individual to another, from one generation to another, using stories and illustrations. It worked then it can work now. It's compelling narrative and great story telling.



**35,000 year old cave painting from Chauvet Cave, France. Lions, Chauvet Cave, France; from the [Chauvet Cave Project; Archaeology](#).**

It's not necessarily about mixing chemicals, and measuring and weighing things to understand something scientific. A compelling narrative helps, or is essential, in a lot of cases, and I've given you three stories about microbes already. I slipped them in. The first was dirt cures disease; streptomycin came out of the dirt. Second, bacteria saved Rock and Roll. The

third, I haven't told you yet, but there's a story running around the East Coast about some crazy guy who went into every bait shop in New Jersey and said "I need 200 miles of fishing line!" And all the bait shop guys said "Why?" And he said "I need to do this to create a demo to show people how long 200 miles is! You know there's 200 miles of *Streptomyces griseus* in every square foot of soil on Earth, and a square foot is about the size of a Domino's Pizza Box."

*Billions and Billions.* If I were to stand here and say really big numbers, like "... billions and billions ..." or "... trillions and trillions ..." you might think I was doing an impression of Carl Sagan, but I'm really not. Microbes have big numbers, too! For example, on this slide we have the numbers 4.4 trillion and 50 billion. Four point four trillion; this is a big number and I'm not talking about the number of bacteria in your intestines or the number that could be on your skin. Any idea what 4.4 trillion could relate to? 4.4 trillion is the number of pounds of cheese made and consumed on Earth every year! Cheese is an entirely microbial product, except maybe for Cheese Whiz, but it's a microbial product that comes from little microbes and fungi that you can't see. The other big number up here 50 billion; 50 billion is the number of gallons of beer made each year in the world! That's enough to float 2,000 aircraft carriers. And beer is a microbial product, ask the people in Oregon!

While I'm talking about huge numbers and trying to be Carl Sagan, if you were to go out into your neighborhood with a pair of really microscopic tweezers and start unraveling all the *Streptomyces* and its cousin the *Actinomyces* and string them end to end, you'd end up with a string of bacteria that was 8 quadrillion miles long, which is coincidentally longer than the length of our galaxy. You can get from one end of our galaxy to the other on a strand of bacteria, if you had sufficient time and small enough tweezers. I find that fascinating! And I think if you tell that



to people, it would be enough to make them say “WOW” when you mention bacteria instead of saying “EWWW.”

*Talk Passionately and Plainly.* I’m near the end here. “Where do we go from here?” What you really need to do, or what I need to do, and what I do do, is talk passionately and plainly to people who have no idea what you’re talking about. In the short-term, microbiologists and other scientists need to engage local legislators and teachers. Invite them to your lab so that they can see what you’re doing, so they can understand science better. You should be able to explain it to them in terms that they understand. And the long-term the answer for microbial literacy is to change the educational system. We need to get people up to speed about microbiology and immunology if for no other reasons than public health and global ecology.

### **How Did We Get Here?**

And now a word from our sponsor, which of course, is me. Everything I’ve talked about is an outgrowth of something that I created called *Dr. Warhol’s Periodic Table of Microbes*. I made it because I looked around the world and said to myself “People don’t know anything about microbiology, how can I fix that?” And I looked around and I saw the periodic table of elements – it’s the most iconic scientific thing on the planet. It’s in every classroom from third grade onward, but it hasn’t really changed much in about 150 years. So I took the periodic table of elements, grabbed it by the edges, and shook it really hard, and all the elements fell out! Then I repopulated it with microbes whose names could be abbreviated by the old chemical symbols. So this way H for hydrogen is now H for *Haemophilus*, and Li for lithium is now Li for *Listeria*. I went through and hand-selected organisms that were really cool, and had interesting stories to tell, and stuck them in the table. I need to mention that the starting material was a list of over 15,000 named microbes; I’m just a little bit obsessive.

### Dr. Warhol's Periodic Table of Microbes™

**Guide to the Periodic Table of Microbes**

Gram stain - Gram negative (pink) + Gram positive (blue)	Shape R rod C coccus T twisted, spiral, helix B branched F filaments D dimorphic	Features P pathogen W water S soil E edibles X extreme
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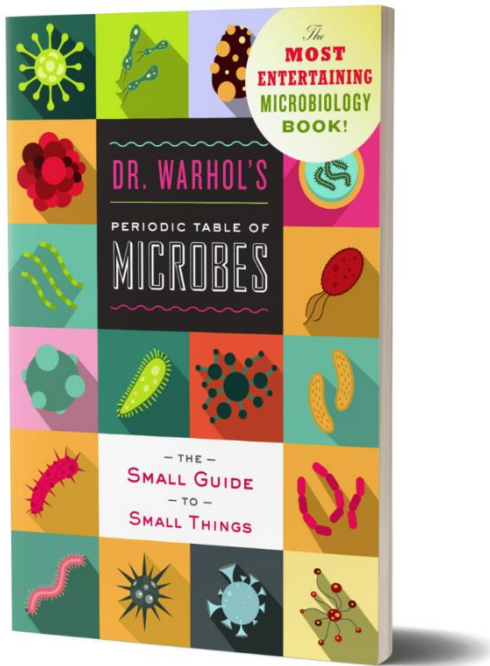
Microbes vary greatly, this is a general guide

R.P. 1																	T.P. 2						
H Haemophilus																	He Helicobacter						
Li Listeria	Be Bordetella																	B Borrelia	C Clostridium	N Neisseria	O Oceanobacillus	F Flavobacterium	Ne Neorickettsia
Na Nitrobacter	Mg Morganella																	Al Alcaligenes	Si Sino rhizobium	P Pseudomonas	S Staphylococcus	Cl Chlamydia	Ar Arthrobacter
K Klebsiella	Ca Coxiella	Sc Spirochetes	Ti Thiobacillus	V Vibrio	Cr Cryobacterium	Mn Methanobacterium	Fe Ferriomonas	Co Colwellia	Ni Nitratireductor	Cu Caulobacter	Zn Zymomonas	Ga Gallionella	Ge Geobacillus	As Actinomyces	Se Salmonella	Br Brucella	Kr Kurthia						
Rb Rhodospirillum rubrum	Sr Streptococcus	Y Yersinia	Zr Zeaxanthinibacter	Nb Niabella	Mo Mycobacterium	Tc Tenacibaculum	Ru Rubrobacter	Rh Rhizobium	Pd Pantoea	Ag Agrobacterium	Cd Candida	In Ignicoccus	Sn Syntrophomonas	Sb Salinibacter	Te Thermococcus	I Idiomarina	Xe Xenobacter						
Cs Cellulomonas	Ba Bacillus	La - Lu	Hf Hafnium	Ta Thioalkalivibrio	W Weissella	Re Roseomonas	Os Oceanospirillum	Ir Isotriacontobacter	Pt Pasteurella	Au Aureococcus	Hg Hydrogenophaga	Tl Tsukamurella	Pb Paenibacillus	Bi Bifidobacterium	Po Porphyromonas	At Atpobium	Rn Ruminococcus						
Fr Francisella	Ra Ralstonia	Ac - Lr	Rf Roseiflexus	Db Desulfobacterium	Sg Shigella	Bh Bhargavaea	Hs Herbaspirillum	Mt Marinobacter	Ds Dactylosporangium	Rg Ruegeria	Cn Corynebacterium	Nh Novosphingobium	Fl Flexibacter	Mc Magnetococcus	Lv Lechevalieria	Ts Tessaracoccus	Og Oligella						
LANTHANIDE		La Lactobacillus	Ce Cellulivibrio	Pr Prevotella	Nd Nocardia	Pm Promicromonospora	Sm Streptomyces	Eu Eu bacterium	Gd Gordonia	Tb Tepedibacter	Dy Dyadobacter	Ho Holo spora	Er Escherichia	Tm Thermus	Yb Youngiibacter	Lu Leuconostoc							
ACTINIDE		Ac Acetobacter	Th Thalassomonas	Pa Paracoccus	U Undibacterium	Np Neptunomonas	Pu Pusillimonas	Am Amphibacillus	Cm Campylobacter	Bk Burkholderia	Cf Chloroflexus	Es Enterococcus	Fm Fusobacterium	Md Modestobacter	No Nonomurea	Lr Leptospira							

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The [Periodic Table of Microbes](#) is a learning tool that life scientists everywhere can hang on the wall with pride.

And then to help people better understand what it was they were looking at in “The Table,” I wrote a book called *Dr. Warhol's Periodic Table of Microbes: The Small Guide to Small Things*. This book explains each one of those 118 organisms in 300 words or less, and all of those words find a way to relate those bacteria to something that goes on in day-to-day life, so that it's not just an abstract concept. These are stories the people should remember and form a matrix in their mind, and then say “Hey, bacteria are cool.”



**The Small Guide to Small Things** talks about 118 fascinating microbes in 300 words or less.

The whole reason for doing this, *Dr. Warhol's Periodic Table of Microbes: The Small Guide to Small Things*, is to create a bridge to get people from being like ... "I don't know and I don't care" to being the kid at the front of the classroom with a hand up in the air saying "Wow that's cool tell me more!" The goal is to get the world eager, active, and engaged with microbiology in particular and science in general.

And that's it, I'm done. I thank you all very much for having me here.



I don't know and I don't care.



Wow, That's cool! Tell me more!

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*John Warhol is the lead advocate on the team of scientists who won unanimous legislative approval of Streptomyces griseus as the Official State Microbe of New Jersey. John is the author of Dr Warhol's Periodic Table of Microbes, The Small Guide to Small Things. The Table and Small Guide were created to help people understand microbes and get them from "I don't know and I don't care." to "Wow, that's cool, tell me more!" The Small Guide emphasizes the connections between the microscopic and larger worlds in a humorous and enthusiastic way. John has been developing science and medical education programs for pharmaceutical and healthcare companies for several decades. His major clients have included Johnson's Baby Products, Ethicon, Ortho Diagnostics, Merck, Schering-Plough, as well as biotechnology companies like Ortho Biotech, Centocor, and ProChon. Throughout this, his focus has been on making science and medicine understandable. John is President of The Warhol Institute. He received his doctorate from Rutgers and the University of Medicine and Dentistry of New Jersey. He followed that as a Fellow in Science and Diplomacy with the American Association for the Advancement of Science, based in The Department of State in Washington, DC where he worked on international health care and science issues. After that, he was awarded a Fellowship in the Rutgers Graduate School of Management in pursuit of an MBA.*

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