Ask-a-Biologist Vol 013 (Guest Valerie Stout)

Bugs in Films -

Microbes are everywhere, but what are they? We get the inside story from microbiologist **Valerie Stout** about these tiny life forms including a slimy and gooey material many microbes make called biofilms. In fact, you have a daily encounter with biofilms and bacteria that can impact your health.

Transcript

Dr. Biology: This is "Ask-A-Biologist", a program about the living world, and I'm Dr. Biology.

Microbes. We hear their name, but what are they? Are they good? Are they bad? Plant or animal, or maybe something entirely different? Our guest scientist today is Valerie Stout, who is a professor in the School of Life Sciences at Arizona State University.

Dr. Stout is a microbiologist, which is someone that studies microbes. We'll get a chance to talk to her about these tiny life forms and another very interesting area called "biofilms." As we learn today, biofilms play a very important role in our health. In fact, I think, after learning about microbes and biofilms today, you might even be more motivated to brush your teeth than ever before.

Welcome to the show, Professor Stout.

Professor Valerie Stout: Thank you, it's good to be here.

Dr. Biology: Before we start out, I want to make something very clear: not all bacteria are bad. In fact, there are some very important bacteria that live inside us, and we depend on them. I bet you could tell us a little bit about that.

Valerie: Yeah, actually, there are so many bacteria inside of our bodies, there are more bacteria than there are human cells, and most of these live in your intestines.

And in your intestines, what they will do is, they will make some vitamins for you that you aren't able to make for yourself. And they start digesting the food, so that you can actually use the nutrients in the food. If you had no bacteria in your intestines, you wouldn't be able to digest the food as well, and you wouldn't get the nutrients and probably wouldn't live very long.

Dr. Biology: You know, when you talked about how many bacteria are in the body, and actually there are more bacteria in the body than human cells, just to give another big number: the average human has between 60 and 90 trillion cells. So that's an awful lot of bacteria that are in the body.

Well, you talked a little bit about where they live in the body. Where else do we find microbes?

Valerie: Well, besides inside the body, our bodies are coated with bacteria. And these bacteria that are on the outside of us actually protect us against the harmful ones, so that we have bacteria on us that are acting to prevent further infections from the bad bacteria. So there are good bacteria on us, not just inside of us.

And then there are bacteria everywhere in the world. There are bacteria on tables, there are bacteria in streams, and there are bacteria in the air. You just can't find a place where they aren't found. They are found in extreme environments. They are found in the ice in the Antarctic, they are found in hot springs in Yellowstone National Park, they are found in the deep-sea thermal vents where the temperatures are above boiling.

Dr. Biology: We actually got to talk a little bit about that because they refer to those as "extremophiles", these life forms that can live in areas that no one can even imagine something living actually existing.

The other thing I want to know about, we talked about microbiology and we talked about bacteria, but there are other small living life forms.

Valerie: Right. So microbes cover not just bacteria, but they also cover viruses, and small protozoas, and parasites, and fungus. So it is actually quite a large group of microbes that bacteria are just one small piece of that.

Dr. Biology: Small, yes, that's a very good word. "Microbes" comes from the Greek work "micros" meaning "small".

So actually, if you could gather all the microbes up in one big group and call it biomass, it would account for 60 percent of all the living things on Earth, which is pretty impressive to me.

Valerie: Right. Because we don't see them, lots of people don't think that they're important, and don't even think they're there; but they are there, we just can't see them because each cell is so small.

Dr. Biology: This is another place where we can have exploration. We've been looking for new species, and this is probably one of the frontiers that, we're going to find a whole lot more because of some new techniques we have.

Valerie: Right. People have estimated that we, as microbiologists, have only been able to isolate maybe one percent of the bacteria and other microbes that are out there, but because we can now look at DNA without trying to grow these bacteria, we are able to make estimates that there are many more than any of us ever thought.

Dr. Biology: You also do some research in an area called "biofilms". And the biofilms actually become really important for microbes in general. Can you tell us a little bit about them?

Valerie: So biofilms are when bacteria, and other microbes, are able to form a layer, and this is often happening where there is a solid and a liquid that are close to each other and

touching each other.

You can imagine there are lots of examples of that if you think about it. One would be rocks in a stream, another would be your teeth in your mouth, and another would be faucets or any kind of pipes where the water is running.

Bacteria will coat these solids and form a slimy, slick layer on them, and if you have ever slipped in a stream, you have probably slipped on a biofilm composed of bacteria and some other types of microbes.

The other place that is really interesting for biofilms to grow is in your mouth. If you ever wake up in the morning with that slimy layer on your teeth that just is kind of gross, that's a biofilm.

Dr. Biology: What does the biofilm do?

Valerie: The biofilm is like a little city of microbes, and they are in this slimy layer that is almost like an apartment building. Inside the apartment building there are lots of little bacteria inside there, just like people would live in an apartment complex.

And just like the apartment complex, the building is going to protect the bacteria, just like it would protect the people. So the bacteria can live in there and be protected from chemicals, or our immune system if these are germs that are inside of us, or they can protect from being attacked by other, larger creatures that might eat them normally.

Dr. Biology: So they have this kind of gooey, slimy force field that keeps the bad things out; but in this case, if they're bad, this isn't good for us, right?

Valerie: Right. So it protects the bacteria from being eaten, but yes, it makes it very hard for us to treat any kind of infection due to these bacteria that are growing in biofilms.

They become very resistant to any kind of treatment like antibiotics, that lots of times when you have a bacterial infection, a doctor will prescribe antibiotics. And antibiotics are not very effective against the bacteria once they are in this biofilm.

Dr. Biology: If you have figured out a way to keep them from producing the biofilms, then we have a much easier way or a more likely method of getting rid of bacteria that are bad.

Valerie: That's right. That's exactly what we are trying to do, is find ways to prevent the bacteria from forming these biofilms or, once the biofilm is formed, how to disperse the bacteria out of these biofilms so that they become much more susceptible to the antibiotics or any other kind of treatment.

Dr. Biology: We've been able to talk about these biofilms, and you gave us a really good description of where you can find them, on those slippery rocks, which I can tell you, I have slipped on those rocks and I have ended up in the stream. But, also on your teeth, and at the beginning of the program we said we are going to have people more convinced

to brush their teeth than ever before, and I'm sure it has to do with those biofilms. Can you tell us a little bit more?

Valerie: That's right, Dr. Biology. Those biofilms on your teeth are, like all other biofilms, resistant to being removed. They aren't easy to get rid of. The biofilms on your teeth are sometimes 300 or 400 layers thick, and this is what we call "plaque".

When you go to the dentist and he tells you you have plaque on your teeth that he needs to remove, that's really just a biofilm. So you could tell your dentist that.

These 300 or 400 layers of different bacteria, they can't be removed just by swishing around a little mouthwash. You really have to brush to get rid of them, and you have to brush regularly, because if you let it go they'll just get deeper and deeper and deeper, until you can't remove them at all.

Dr. Biology: Right, and I actually found out recently, when we switched to an electric toothbrush, how much more efficient they are than a regular toothbrush. You actually talked a little bit about this, just a little bit before the show here. So can you tell us a little bit more why those are working better?

Valerie: There have been studies that have shown how the sonication of some of those electric toothbrushes really is good at kind of vibrating the bacteria off your teeth, even better than the mechanical brushing that you would get from a manual toothbrush. Both of them are really good, but that extra electric charge from the sonication really helps to remove more.

Dr. Biology: Now you've heard it, and you want to go out and make sure you're brushing your teeth multiple times a day.

Valerie: So your parents really were right, you need to brush your teeth.

Dr. Biology: When we talk about bacteria, one of them that we hear the name in the news a lot is E. coli. There's an initial "E" and it's actually Escherichia. You hear it a lot in the news when there's a breakout of E. coli at a certain restaurant that has made people very sick.

Well there are two things I'm asking. One is, why do we have those times when they do get sick, and the second thing is, aren't there other kinds of E. coli, different types, and they're not bad?

Valerie: Right. So let me address that second question. There are what people have called "good E. coli" and there are "bad E. coli." E. coli was named that--the coli part--because it lives in your colon. So this is one of those many, many bacteria that live inside of our intestines and actually help us. So those are thought of as the good E. coli.

But the ones that make people sick? It's the same organism, but it has a few extra genes inside this organism, that allows it to make some toxins, and the toxins are what make us

sick. So there really truly are good E. coli and bad E. coli, based on whether they make this toxin that can make us sick.

Dr. Biology: So what are the restaurants doing or not doing that causes us to have an outbreak of E. coli.

Valerie: Right, so the bad E. coli, where does that live, normally? The most common place it lives now, actually, is inside of cattle. So cattle, just like us, have E. coli living inside them, but they sometimes have this bad E. coli, and it doesn't hurt them as much as it hurts us.

So what happens is that sometimes when cattle get slaughtered, that E. coli will spread into the meat, and so you can have outbreaks caused by bad meat that doesn't get cooked. If you cook it, it's fine.

The other kind of outbreak you get is in vegetables, like lettuce or spinach, where the E. coli that were excreted by the cattle are sometimes in the field next to where the spinach was grown, and so the E. coli get from the cattle into the spinach, and again, if you don't cook your spinach, it can cause you to have sickness, and it will cause diarrhea, and vomiting, and really fun things like that.

Dr. Biology: So the message here is cook your meats, make sure that they are fully cooked.

You know, one of the questions that comes to us on "Ask-A-Biologist" is, what's living and what's not living? I want to bring this up for you because viruses pose a very interesting dilemma, and I will let you actually explain the dilemma.

Valerie: So viruses are right at that point of being alive and not alive. I have had discussions and actually, arguments, with other biologists about whether they are alive or not.

Most microbiologists consider viruses to be alive. The reason for that is if you put one virus inside of a human body, let's say, it will multiply inside there. So one virus can become millions and billions of viruses in a very short period of time. The ability to replicate is one quality that makes people think they're alive.

But viruses are not considered alive by a lot of biologists, because they aren't able to conduct metabolism like a normal cell would. It doesn't have a lot of the proteins and a lot of the enzymes that have to go on in order for the cell to grow.

Viruses are not considered cells, they don't look like cells. They have very different qualities. They are very simple, and in fact, the only way they can replicate is to be inside of another cell. So without having that other cell to provide all these nutrients and pathways, the virus is not considered alive.

Dr. Biology: So this is going to be one of those gray areas in science, where you would think you can pull out a book off the shelf, and say, "Is it alive or is it not alive?" and a book will tell you, "Yes it is," or, "No it isn't." But that's not true, and that's why we need young scientists and people to be working on these kinds of questions.

I'd like to switch into a few questions I like to ask all my biologists. When did you first know that you wanted to be a scientist or a biologist?

Valerie: The first memory I have is in fifth grade, and in fifth grade my teacher organized a science fair for us. And we invented all kinds of little experiments, and that was when I realized, "Ooh, this is really cool, figuring this stuff out," and designing experiments to test ideas that we had. They were not very complicated; but it made me realize that that's what I really loved to do.

Dr. Biology: Part of the problem-solving type of thing, figuring out what's wrong and how we can figure out what it's doing, right?

Valerie: Right, yes. I think that's what I really love about science, is that it's kind of being a detective in the natural world that we get to try to figure out how things are working.

Dr. Biology: Well, I'm going to take that all away from you. You've gone through this great career, and you're a biologist in the School of Life Sciences, and doing all this research, and I'm going to take it all away and I'm going to say, what would you be and what would you do if you couldn't be a biologist.

Valerie: My first answer is I'd be some other kind of scientist. I'd want to be a chemist instead. But if I couldn't be a scientist, it's a hard question actually. I can't, I really can't imagine myself not as a scientist.

Part of what I get to do as a scientist at Arizona State University is that I get to teach, and I really love that part of what I do, is I'm teaching science but it's different than doing science. And if I can't do that, I think what I'd do is go into landscape. I love plants and I love working in the soil.

Dr. Biology: So landscaping. Very good.

All right, now I'm going to bring you back to your teaching mode and your mentoring mode. What advice would you have for young scientists, or someone that might want to switch a career from maybe landscaping to science?

Valerie: The things that would help a young person to get into science are concentrating on taking science classes and taking math classes. But I think more important than that is to really pursue your curiosity. Don't let adults, or other people, try to prevent you from being really curious that's the number one quality in any good scientist, is being curious and observing what's out there.

You can do little experiments every day--everybody does them without even knowing it.

If your cell phone doesn't work, you try to figure out why it doesn't work--that's an experiment. So you can do experiments without having a laboratory, without having bottles of solutions. You can do experiments every day.

I think everybody who wants to be a scientist should go out and try to do those little experiments.

Dr. Biology: Well Valerie Stout, thank you very much for visiting with us.

Valerie: Oh, it's been great to be here.

Dr. Biology: You've been listening to "Ask-A-Biologist", and my guest has been Professor Valerie Stout from the ASU School of Life Sciences.

"Ask-A-Biologist" is a podcast produced on the campus of Arizona State University, and even though our program is not broadcast live, you can still send us your questions about biology using our companion web site. The address is AskABiologist.asu.edu, or you can just Google the words "Ask a Biologist".

I'm Dr. Biology.