Narrator: Plastic pollution is a global problem. Images of the Pacific Garbage Patch – a floating accumulation of marine debris almost twice the size of Texas – vividly illustrate the effects of plastic pollution on ocean and marine organisms.

However, large pieces of plastic in the environment are only a small piece of the picture. Scientists are focusing on an emerging area of environmental health research: microplastics, small plastic particles that are less than five millimeters in length.

In this episode, we speak with Dr. Christy Tyler from the Rochester Institute of Technology and Dr. Katrina Korfmacher from the University of Rochester, co-directors of the Lake Ontario MicroPlastics Center. They will discuss the center's research on microplastics in aquatic environments and what we do – and don't – know about their effects on human health.

To start off, what are microplastics made from, and where do they come from? Dr. Tyler explains that the term is actually quite broad.

Christy Tyler (CT): Microplastic is a kind of catch all term for hundreds of different kinds of materials. The plastic particle itself is made up of both the plastic polymer and then the chemicals that are added to it, like dyes or plasticizers or flame retardants. There's a huge variety of types of plastic and sources of plastic, and so that means there's a huge variety of microplastic in the environment.

Micro plastics come from two different routes. One is plastic particles that are already small when they're manufactured. The other way that you can get microplastics is from the breakdown of bigger materials, and that's what we think is the more common source of microplastics.

Narrator: The Lake Ontario MicroPlastics Center, one of the Oceans and Human Health Centers jointly funded by NIEHS and the National Science Foundation, is a collaborative effort between the Rochester Institute of Technology and the University of Rochester to untangle some of the unknowns related to microplastics. Researchers at the center focus their efforts on microplastics found in Lake Ontario, the smallest of the Great Lakes but the 14th largest lake in the world. Lake Ontario provides drinking water to over nine million people. But how do microplastics get into the lake in the first place?

CT: The microplastics can get into the lake through many different routes. One of the most common, and one that we've been looking at in our research at RIT is through storm water. This is when it rains, or when you have snow melt and you get run off from lawns and streets and parking lots that can pick up the plastic, any kind of litter that's on the ground, and it would get washed into the storm water system.

Narrator: The different chemicals and polymers that make up microplastic can have a dramatic effect on how the particles move in the environment and the resulting environmental impacts. The sheer number of variations in plastic composition can make research into the effects of microplastics difficult. One of the things Dr. Tyler's team investigates is how the composition of the microplastic affects the paths these tiny plastic particles take once they enter Lake Ontario and where the microplastics end up.

CT: The ultimate fate of a plastic depends on the density. All of these different kinds of polymers because of their chemical makeup and the structure of the polymer, have a different density, and that will affect how quickly it breaks down, and will also affect how far it moves. Something floating around is more likely to travel further and maybe get washed back up onto shore. The density of the plastic is one of the first things that really impacts how quickly it might move around in the lake.

Narrator: Previously, there was ambiguity about what happens once microplastics are introduced to the environment. Dr. Tyler and her team are some of the first to shed some light on the issue. They observed that microplastics in Lake Ontario may become new habitats for microorganisms that prefer to live on hard surfaces, rather than floating around in the water.

CT: We've seen that plastics have a very different set of microbes that live on the surface of the plastic than what you would find, say, in the water or the sediment. All those microbes have different kinds of functions that they carry out, whether it's processing carbon or they help to cycle nitrogen, which are really critical processes for overall how an ecosystem functions. We've done a number of different investigations showing that the different kinds of plastic can change the way nitrogen is cycled and the way carbon is cycled, and we found that certain types of micro plastics have a negative impact on those processes, and that it varies by the type of plastic, and that's likely because it's having an influence on the microbial community.

Narrator: Dr. Tyler's team is also looking at how changing weather patterns may affect microplastic quantities in Lake Ontario as extreme weather events become more common. They believe that increased precipitation and runoff, as well as extreme heat, influences the amount of plastic that gets washed into the lake.

CT: Especially in the summertime, rather than having just a rainy day with a little bit of rain, we're getting really big storms. These will be two- to four-inch rainstorms in a day, which is a lot, and it's coming in urban areas where there's a lot of impervious surface, which

means the water has to run right off. Those impervious surfaces force the water really quickly into the storm water system, which ultimately can get overwhelmed, and the storm water can't be treated at the wastewater treatment plant. And when that happens, and we can't store all of the water, that water has to be released to the lake as it is, including the wastewater.

Other potential effects are the change in temperature, so the water is warmer, and so that may lead to more rapid breakdown of the plastic. There's also going to be changes in pH of the water because of having additional CO2 in the atmosphere. One of the things we're working on right now is setting up some experiments, both in our laboratory and then also in field chambers, to look at the effect of changing temperature and changing pH on the fate of plastic.

Narrator: The biggest question about microplastics is what effects they can have on human health. But, as Dr. Katrina Korfmacher explains, that research is still in the early stages.

Katrina Korfmacher (KK): It's really difficult to answer that question now, because we do know that there are microplastics everywhere in the environment and in the ecosystem and in human bodies, and we don't know the mechanisms by which plastics that get into the human body are affecting health. We don't know the most significant exposure routes for the most harmful plastics, and we don't know what we can do about it, and because there are so many different levels of uncertainty, it's really difficult to answer those questions.

Narrator: The Lake Ontario MicroPlastics Center leads two biomedical projects related to microplastics. The first examines the ways that a person can be exposed to microplastics, including through skin contact, drinking water, and inhalation. The second project uses frogs as a model system to investigate how plastics can be taken up by the body and what kinds of effects they might have on development and functioning of the immune system. The center also features a community engagement core directed by Dr. Korfmacher.

KK: In our center, our community engagement core has several aims. We are both involving people in local communities directly in the research and through community science and doing outreach and education to groups that may not think about microplastics as core to their interests right now, but through thinking about the human health impacts, trying to help different partners, think about how it relates to their overall

goals, and then using those partnerships to help us translate the work that we're doing into practice and educational outcomes.

Narrator: Through the community engagement core, the Lake Ontario MicroPlastics Center works to engage new groups in strategies to reduce the plastic waste and mitigate exposure to microplastics. In particular, the center brings in organizations that may see the effects of microplastic pollution in the future to understand what concerns they have and how researchers can provide answers.

KK: We decided it was really important that we interact with people whose work either affects or is going to be affected by future knowledge, regulations, and impacts of microplastics in doing our research and our engagement. That includes local partners from our county health department, environmental services, Sea Grant, our state health department, environmental conservation, and various non-governmental groups. And together, those groups are talking to us about the kinds of decisions that their organizations are facing and how they see microplastics interfacing with their work down the pike, how those questions may help drive the things that we study, and how what we are learning can help them answer the questions that members of the public and their stakeholders are asking them now.

Narrator: With so many unknowns about microplastics, translating the research for the public to understand is an important task. Dr. Korfmacher and the community engagement core are taking on the challenge of helping people think about microplastic not only on the individual level, but on a community and global level. One way the community engagement core is doing this is by emphasizing the One Health approach, which recognizes that the health of people is closely connected to the health of animals and our shared environment.

KK: As we're trying to transition to helping people think about plastics as an issue that affects all of us, the One Health framing of how plastics get into the environment, affect the ecosystem, and that has implications for human health, is really important to us, so we're really trying to take a One Health holistic view and help people think about plastics more broadly.

This is a problem that no individual can solve, and individual action is not going to be the solution either.Helping people at the same time is thinking about their individual risks, their individual actions, their individual responsibilities, with a social component of how they can talk to other people about the problem, how they can engage at more of a systems level. That requires a pretty sophisticated approach to engagement. So that is challenging,

but it's also really exciting, because there are so many different levels that we can engage at.

Narrator: This reframing of the issue from an individual one to a global one is critical for tackling microplastic pollution, because plastics are constantly moving within countries and between them. Although the Lake Ontario MicroPlastics Center is looking in a specific geographic area, the implications of their research can be applied globally.

KK: We've shown that the microplastics are distributed through an entire environment and getting into everyone's bodies. So rather than thinking about plastics pollution as something that's happening over there in tropical beaches or only affecting people who care about marine mammals, it's something that has come home to roost for every person on the planet. I think that's one of the most important things that we can do is reframing this problem as one of human health that affects everybody.

The other thing that's really important is that we've only been producing plastics for a measurable number of decades, that production is expected to increase, and plastics essentially are an accumulative pollutant. They're not going away, they don't degrade in the environment in any reasonable time span. It's something that we all need to think about as a growing problem going forward

Narrator: Plastic is found everywhere – from the bottom of the deepest ocean trenches to the top of Arctic glaciers. The Lake Ontario MicroPlastics Center's work is the first step in characterizing how microplastics are affecting us and deciding what can be done to protect human health. As Dr. Tyler Notes:

CT: It's no longer novel to publish a study that says, "Hey, I found plastic," because it's everywhere. And so the research that we're doing here and that others all over the world are doing right now is all relevant everywhere. We all rely on fresh water, and we all live in an environment where plastic is really common. By figuring out which plastics are the most common in the environment, and which ones have the potential to have the most harm, that result can be shared globally, and we can work on creating solutions to the problem.

Narrator: The National Institute of Environmental Health Sciences funds research to better understand the health effects of environmental pollutants, like microplastics. You can learn more about the institute's research by visiting our website at www.niehs.nih.gov/GEH.

Thanks again to Dr. Christy Tyler and Dr. Katrina Korfmacher for joining us today. You've been listening to Environmental Health Chat, brought to you by the Global Environmental Health program at the National Institute of Environmental Health Sciences.