PLASTIC PANIC

An exploration of microplastic pathways at the wastewater treatment plant

Activity Outline

Overview

Model the journey water takes at a Wastewater Treatment Plant (WWTP) through a series of hands-on steps. Learn about microplastics and discover what happens to them as they enter and pass through a WWTP.

This exploration station was developed for an informal drop-in program held at the Chazen Art Museum at UW–Madison and can be adapted for use in other settings.

Photo Credit: Eric Baillies

Key Lessons and Background

- *What are microplastics?* Microplastics are plastic particles 5 mm or smaller.

- *Where are microplastics coming from?* Microplastics are divided into two groups. Primary microplastics are those that are deliberately made (for example, small pellets for filling stuffed animals, beads added to personal care products). Secondary microplastics are formed by larger plastic products breaking down. Tires wearing on roads and fibers shed from synthetic clothing during laundering are two common sources of these secondary microplastics.

- *What happens at the WWTP?* Wastewater treatment plants are complex and use a variety of different methods to clean our water (mechanical, chemical, biological). However, these plants aren't designed to filter out microplastics. While some microplastics may be removed during the treatment process, others may pass through WWTPs and be released into the natural environment along with the cleaned water, called "effluent." Additionally, some of the microplastics that are captured and removed from the water are concentrated in sewage "sludge." This sludge is sometimes sold to farmers and spread on fields as fertilizer. As public and scientific awareness of microplastics increases, we recognize that much research needs to be done to fully understand the impact microplastics may have on a wide range of organisms and

ecosystems. As of 2019, "no specific treatment process aimed at microplastics removal has been applied in any full-scale WWTP yet and the microplastics-targeted treatment technology is still at the preliminary research state" (Sun 2019).

- *What's so bad about microplastics?* Fish and other organisms sometimes mistake microplastics for food. A belly full of plastic can make them feel full without providing any nutritional value. Additionally, heavy metals and other pollutants tend to be attracted to and stick to plastics. These can be harmful to the organism that ingests the plastic, and they can work their way up the food chain.

Materials

All materials are included in the kit except for the items noted with asterisk (*).
Tablecloth
Small clear jars with lids
Microplastic samples, Clothing and fabric samples
Safety Glasses
Sand sieves and buckets (2)
Funnel
Mesh Strainer
Blacklight
Coffee maker and filters
Microscope (plug and play with any PC)
Water jug, recommended 3-gallon size *
6-foot table *
Optional: photos and/or maps of your local WWTP and where the effluent is released *

Set Up

15 minutes. Place supplies on the tablecloth, fill the water jug and set up the microscope.

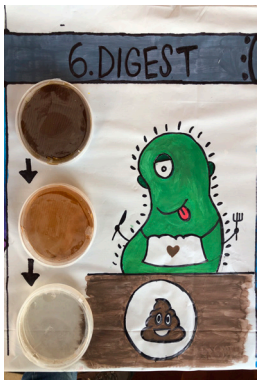
Run Through

20 minutes. Walk students through the first eight action steps to test their sample of contaminated "wastewater." At each station make predictions and observations about what's happening to the sample. After completing the wastewater treatment process, take action step 9 — bring the remaining sample to the microscope to uncover what made it through the plant.

Debrief

Discuss the potential impact of microplastics released into the natural environment. Brainstorm solutions.

Action	Picture	Instructions	Questions
Fill		We're going to model what happens to water as it goes to the wastewater treatment plant. Fill a sample jar with water ¾ full.	What is "wastewater"? Any water that has been used/affected by humans. Where does wastewater come from? Whatever we send down the sink, toilet, etc. from our homes, schools, businesses, and factories. What happens to the water we send down the drain? In most communities, wastewater travels through the sewer system and gets pumped to a WWTP to be processed before being released to the environment.
Add		Microplastics have gotten into the wastewater! Add one sample of microplastics to your jar and, with the lid on, give it a shake to mix it up. Notice the different kinds of plastics in your sample.	What are microplastics? Microplastics are tiny (smaller than 5mm) pieces of plastic. Where are they coming from? Microplastics come from many sources including clothes made of synthetic fibers, contacts flushed down the sink and microbeads in soaps, tires, and road markings/paint. More than 2/3 of global primary microplastics in the oceans comes from laundering synthetic textiles (63%) and abrasion of tires while driving (28%).)
Safety		Put on a pair of safety glasses before entering the treatment plant! Scientists and engineers of all sorts wear protective equipment during their work.	Why do scientists need safety glasses? Safety glasses protect eyes from cuts and splashes and are an important part of PPE, personal protective equipment. Have you ever had to wear safety glasses before?
Filter		When water enters the treatment plant (called "influent") it passes through fine screens to remove rags and other large materials like paper towels, hygiene products and "flushable wipes." Pour your sample through the sieve to see what it might catch. Use the funnel to return the filtered water from the bucket (and any microplastics that made it through the filter) to your jar for the next station.	Why do you think the WWTP has a filter at the very beginning of the treatment process? What do you think would happen if WWTPs didn't have filters like this? WWTPs have a filter to prevent clogging or damage in other parts of the treatment system. What are the costs of having a filter? WWTP staff have to constantly remove debris and clean clog Make a prediction: what's going to happen to the microplastics in your sample when you pour it through the filter? How much, and what, will get caught?

Action	Picture	Instructions	Questions
Skim		In the WWTP's "settling tanks" heavier solids settle at the bottom while greases, oils, and light solids float to the surfaces. The settled and floating materials are skimmed off, allowing the cleaner middle water to keep moving through the treatment process. Use the mesh strainer to try to remove microplastics from the surface of your sample in the jar. Make sure to hold your sample in another bucket or over a tray while you do this to catch any spills! After a few (we recommend 3) attempts, take your sample to the next station.	At this station, notice how the microplastic pollutants in your sample separate into different layers in the water. What water is the cleanest? Top, middle, or bottom? Why do some plastics float and some sink? Plastics have different densities that impact whether they float or sink. The size of the particle might also have an impact. What do you notice about what floats vs. what sinks? What do you think would float and sink at the real WWTP?
Digest		In what's sometimes known as "secondary treatment," the wastewater is pumped into large tanks and mixed with bacteria. These important microorganisms "eat" organic matter and nutrients that we don't want in our water. Use the questions to the right to have a conversation before moving on from the aeration tanks.	What are the microbes doing here? They are digesting the organic materials and excess nutrients that get into the water from things like human waste and food that goes down the drain. What happens to the microplastics during this step of treatment? Nothing. The microbes don't digest nonliving or inorganic things. This is a crucial part of the treatment process, but it doesn't help our plastic problem.
Sanitize		In the final step of the cleaning process at this WWTP, the water passes through disinfection chambers designed to kill bacteria that might cause disease. In the chambers, ultraviolet (UV) light kills bacteria by harming their DNA. Pass your sample through the sanitization chambers and look at it through the view hole.	This step kills bacteria. Are all bacteria bad? No, not all bacteria are harmful. Bacteria, like the ones used in the digest step above, do many important things for humans. Does anything in your sample look different under the black light? Some remaining microplastics may appear more or less visible under the light. What other ways to sanitize water do you know about?

Action	Picture	Instructions	Questions
Exit and Sample		The treated water, called "effluent," is returned to the environment, in this case a stream. Scientists are working to learn more about microplastics, where they are in our environment, and where they are coming from. Imagine you're a scientist sampling the effluent to check for microplastics. Pour your sample into the coffee maker with a fresh filter paper. The microfilters will catch remaining particles as the water passes through. Then, remove your filter paper and take it over to the microscope to study your sample.	What didn't the WWTP catch and remove from your sample? Most likely some of the initial microplastics made it through the plant. In addition to microplastics, WWTPs aren't designed to remove salt, pharmaceuticals, and other emerging pollutants. What sorts of things could we do to prevent microplastics from getting through the WWTP to streams? We could use less plastic in our daily lives, make efforts to create less microplastics, install filters on washing machines, engineer and design processes at the WWTP to catch microplastics, and more. Are you satisfied with the cleanliness of your sample? Do you consider it clean enough for fishing, swimming, or drinking? What might we do with microplastics once we've collected them? Who do we need to work on this problem? All people with lots of different skills are needed: policy makers, WWTP staff, scientists. What about the WWTP process makes you curious?
Examine sample		Examine your sample under the microscope. Notice what kinds and how many microplastics there are. Compare your sample to the clothing and fabric samples. Optional Extension: Collect data on your sample and compare it to your classmates.	What shape are your microplastics? Are they fibers? Beads? Something else? What do you think could be the source of your microplastics? Do you notice any patterns with what types of microplastic make it through the WWTP and which get caught in the treatment? What can you do to help stop the plastic panic at the WWTP?

References

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