Project Brief

Project Title: Filtering microplastic using a semipermeable membrane filter

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First statement (problem statement):Millions of particles of microplastics pollute the environment from human activity. Although they can be filtered out, it is difficult to do so efficiently.

Second statement (aim/goal of project):
The aim of this project is to engineer a reusable apparatus that is portable and filters microplastics from water efficiently.

Background:

There are millions of particles of microplastic in the ocean and other bodies of water. Although some can be filtered out, there hasn't been an efficient way to do it. Microplastic pollution is contaminating the environment and many of the foods people consume. Not only can microplastic get into human and animal tissue, it also acts as a medium to absorb other pollutants which may cause even more damage to wildlife and humans (Van Cauwenberghe, Vanreusel, Mees, & Janssen, 2013). Microplastics concentrate pollutants, thus increasing their toxicity. For example, an increase of salinity increases the adsorption capacity of microplastics (Ma, Zhao, Zhu, Li, & Yu, 2019). This means that when microplastics reach the ocean, they can exacerbate the toxicity of other present pollutants. When microplastic can get into the human body, jagged edges can cut tissues and cause inflammation (Sun, Dai, Wang, van Loosdrecht, & Ni, 2018). There may be no immediate threats to having microplastics in our tissues, and most plastics typically pass through the digestive system, but the build up of plastics in the body can release toxins.

Wastewater treatment plants are one of the culprits that release microplastics into the environment. When water is treated, most of the microplastics are filtered out and end up in sludge. This sludge can be used as fertilizer and other products which releases the microplastics into the environment where they end up in our marine biomes. Of the microplastics found in the wastewater treatment plants, microplastic fibers are much more common than microplastic particles (Lares, Nicbi, & Sillanpaa, 2018). This poses a problem because they are much harder to filter due to the fact they can pass through many mesh filters. Meshes bigger than 250 nanometers allows too many small particles to pass through (Oßmann, Sarau, Schmitt, et al. Anal Bioanal Chem 2017).

Plastic comes from many of common plastic items in commercial products. When plastic wears down, it breaks down physically into smaller and smaller pieces, and are transported into waterways. Plastics are polymers which are composed of smaller units, so its molecular structure stays the same while it physically gets smaller. There is so much microplastic litter that

there is a big patch of microplastic in the Pacific ocean, known as the Great Pacific Garbage Patch (The Great Pacific Garbage Patch, n.d.). Due to ocean currents, plastic particles are gathered in the Pacific ocean to create a mass of plastic particles that weighs tons. The Great Pacific Garbage Patch isn't the only collection of plastic, others exist too where ocean currents gather them. There has also been plastic found further down in the water than just on the surface. Deep sea sediments have also been found to contain microplastics. This poses an issue since it is much harder to filter plastic found that far down due to the ocean life dwelling there.

The issue with filtering microplastics is that there are many types of plastics and those different plastics which have different shapes and sizes. Most define microplastic as plastic particles that are less than 5 millimeters. Plastics are have different densities which makes filtering by density difficult.

References:

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Project Definition:

The goal of the project is to make a membrane filter for microplastic that can be used to extract plastic particles from sewer sludge.

Experimental Design/Research Plan Goals:

Major Parts of the Project (rough outline) will continue to evolve over time and should be updated frequently. Make sure the goals are SMART oriented.

1. Create a sample of microplastic.
    a. Heat water until 80 degrees celsius.
    b. Cut a tea bag into strips and place it into the water.
    c. Add a magnetic stirrer to stir the water.
    d. Wait 10 minutes then remove the large bits of teabag
2. Measure the amount of microplastic present in that sample using spectrophotometer.
3. Make the filtration device with membrane filters that have pore sizes less than 1 micrometer. Cut them so that the membranes fit inside the filter holder.
4. Filter the sample of water through the device by using a syringe to push the water past the filter.
5. Measure the concentration of microplastic that is filtered out with the spectrophotometer.
6. Record the data.

IDV: Concentration of the microplastic original sample
DV: The amount of microplastic left in the filtered water
The control is the unfiltered microplastic

Control group will be the unfiltered water.
I will have multiple trials with different concentrations of microplastic, and I can test different prototypes.

Potential RoadBlocks:

Material size may not be small enough to stop smaller pieces of plastic.
Sewage plants may not have a way to give me microplastics, in which case I will have to find another way to obtain the material.
The concentration of microplastics in the sewage sludge may be too small for me to detect.

Timeline: (with action steps identified- sub-deadlines will continue to evolve):

Rough timeline of major phases. As these phases get established, specific tasks under these phases will be defined further.
*Better timeline in the Gant chart google sheets

September 21 - October 31
- Research materials and methods of current forms of filtration.
- Research microplastic detection methods.
- Get in touch with an expert to talk about the possible methods and materials.
- Procure the materials for the experiments that are to happen later.
- Decide what materials I want to use for the filter

November 1 - January 5
- Proform experiments
- Collect and organize date
- Create multiple prototypes
- Write up the process

Background Knowledge Goals:

Date	Topic	Completed Date
September 21, 2019	Methods of Microplastic detection	October 16, 2019
September 21, 2019	Methods of microplastic filtration currently being used	October 16, 2019
September 21, 2019	Composition of common plastics	October 16, 2019
September 21, 2019	Other problems with filtering microplastic	October 18, 2019
September 21, 2019	Common materials used in filters	October 20, 2019

Don't Want to Use	Why?
Extract plastic out of organisms	It is very difficult to detect the plastic as is. There hasn't been too much proven harmful effects in the body yet.
Attach microscope to camera lenses to find microplastic	Phone cameras are not that detailed and detecting plastic based on sight may not be accurate
Bacterial breakdown of plastics	It takes too long for bacteria to break down plastics and they may not survive in all the environments microplastic exists in. My goal is to clean the environment through extraction of the plastics not breakdown.

Want to use to Develop Further?	Why?	Assumptions Making With this Idea	How can these assumptions the challenge?
Microfiber filtration	It might work on the microscale and filter out the plastic	The microfibers will allow water through and the plastic bits are bigger than the space between the fibers	I can try to find cases where the microplastic may not be caught and try to fix it.
Obtaining ocean real samples	It will help me see what real samples look like and the	I can actually get in contact with a university that has	I can contact multiple universities to obtain samples

	concentration of those samples	these samples	
Usage of polarity of particles to attract microplastic	It may offer a new way of filtration that may leave ocean organisms alone	The polarity of water and the organisms are different from the plastic and won't also be attracted by a device that uses polarity I'm assuming that there also won't be negative effects to the organisms living there	I can do more research into the chemical structure of the plastic, organisms, and ocean water