One Health Research Project Abstract

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Research Abstract:

Introduction:
Per- and polyfluoroalkyl substances (PFAS) negatively affect people, animals, and the environment. Due to PFAS's unique chemical structure, they do not degrade and remain in the environment, giving them their popular name, "forever chemicals." PFAS are found in many water sources, leading to bioaccumulation in fish and wildlife. Studies indicate that PFAS in humans and animals affects reproduction, thyroid and liver function, and even the immune system. Due to the disturbing possible health effects, the Environmental Protection Agency has regulated the safe amount of these chemicals in drinking water to 4 ppt, and over 20 states have adopted drinking water regulations for PFAS. In my research, I aim to expand the preliminary research done in the Biosensors Lab in detecting PFAS and apply those principles to the remediation of PFAS.

The Biosensors Lab has shown it is possible to detect PFAS using PFAS-interacting components [bovine serum albumin (BSA), casein, lysine, etc.] and smartphone-based flow analysis. Utilizing the competitive interactions among PFAS-interacting components, PFAS, and cellulose fibers, a unique flow velocity profile can be obtained to detect the presence and type of PFAS. We have demonstrated the low limit of detection, below 1 ppt. This research shows that PFAS-interacting components can be loaded onto membrane filters to bind to PFAS molecules in wastewater. I aim to exploit this property and use it for remediation.

Remediation of PFAS:
In the first year of research under the One Health Research GRA, I will create a method for capturing PFAS by binding them to PFAS-interacting components. First, I will simultaneously test multiple (5-6) PFAS-interacting components in a single paper microfluidic chip. Using multiple components and machine learning analysis, I can determine the specific type and concentration of PFAS in a sample and select the best-performing PFAS-interacting component. Then to accomplish remediation, I will run PFAS-contaminated water through a cellulose fiber filter preloaded with a PFAS-interacting component. As the contaminated water runs through the filter, it will bind to the PFAS-interacting components. Once the filter no longer has any available PFAS-interacting components to bind, it will be flushed and reloaded with PFAS-interacting components, and the process can start again. I will research the strongest design and optimization of this technique, including the type of filter and the machine for pumping the PFAS-interacting components liquid and capturing the resulting sludge.

Application to nano-plastics:
In my second year as a GRA under the One Health Research Grant, I will apply this technique to nano-plastics (NPs). Much like PFAS, NPs have adverse health effects and, due to their size, a traditional filter cannot remove them from contaminated water. This means that a similar approach to that used with PFAS could have applications in the remediation of NPs. First, I will look to find the optimal components to interact with NPs. Then, a similar device can be created to remediate NP-contaminated water.