Note: Guidelines were changed from 5000 characters to 2-pages

[redacted]

Flocks of birds and insect swarms are mesmerizing. Imagine holding a swarm of organisms in your hands like a beach ball and squeezing. How would it respond? Would it deform like an elastic solid or flow like a fluid? These questions motivate viewing a flock through the lens of materials science. Unlike typical materials, *active matter* has constituent elements that are active/animate. We will explore active matter and ask to what extent conventional material descriptors (e.g., elasticity, viscosity) apply. Active matter is a growing field and may reshape how we think about swarms/flocks and transform how we assemble things when not limited to inanimate building blocks. As a model active matter system, we use vinegar eels, a species of nematodes just barely visible by eye. Worm care is easy; they feed on bacteria in vinegar. This is an ideal system for a new student.

To measure properties of collections of these nematodes, we will use a *rheometer*, widely used in materials science. Outside of academic labs, rheometers are common in many industries (e.g., pharma). Training in rheology opens doors to many jobs.

We will answer: *how does the viscosity of a collection of living nematodes change with time*? We will place a dense suspension of worms on a rheometer. The rheometer applies forces and measures the resulting flow, revealing viscosity and elasticity. We suspect that as the suspension continues to flow, the viscosity will decrease as worms align and swim with the flow. We aim to: 1) develop protocols for raising and concentrating nematodes and measuring their densities; 2) quantify the time-dependent viscoelasticity of worm suspensions; 3) take images of worms suspended in a flowing fluid; and 4) quantify how worms align/swim with the flow from the images. These are attainable goals given [redacted]'s prior coursework and preliminary data I have collected. Mentoring: I hope that my students feel the excitement of research and develop ownership of their project. I train students with frequent one-on-ones, by having new students train together, and having experienced students instruct new ones. Students know they are valued for their unique contributions, and I emphasize the importance of teamwork in tackling tough questions and driving innovation. In addition to learning project-specific methods, they learn to communicate their findings, document their work, read papers, and craft manuscripts and posters.

[redacted] is a biophysics major. Originally planning a biology major, she switched to biophysics last year. To complete her degree in a timely manner, she's taken some biophysics courses where I waived pre-reqs because she is so driven and bright. In F23, she took my lab course where she learned to use a rheometer, microscopes, and basic data analysis. She was very interested in a module on biofilm rheology. That sparked an interest in materials science.

This project is tailored to [redacted]'s interests and to deepen her understanding of materials science. Given the lab course she took with me, she'll start using the rheometer quickly. The project will expose her to new aspects of biophysics. She will learn to work with a common model organism, advanced microscopy techniques, and to code and analyze data.

While currently considering graduate study in materials science, she has a general interest in interdisciplinary science. I intend to work with her to explore materials science and adjacent interdisciplinary fields. We will do this by meeting weekly to discuss research papers, by planning a conference presentation, and by learning about other lab members' projects. Plan: [redacted] will work with other new students on a set of training modules. I will assist them to complete this "bootcamp," checking in multiple times daily. We will then meet daily for more training, including continued training on the rheometer and its microscope attachment.

I maintain stocks of nematodes. She will explore ways to place these worms on the rheometer and protocols for measuring the rheology. We will meet daily to review her data and its interpretation. [redacted] will take responsibility for maintaining nematodes.

We have weekly lab meetings; [redacted] will present research updates and hear from lab mates. [redacted] will be one of 2-3 others using the rheometer; we will have a Slack channel designated to discuss the rheometer and interpreting its data.

Next, we will take images with the rheometer's microscope which I will help set up. [redacted] has not worked on image analysis methods. I will work with her on computational tools and help grow her confidence in coding and data analysis.

[redacted]

I will lead [redacted] towards designing experiments herself. We will plan out how to present the data for publication and a presentation. I will involve [redacted] in conversations with collaborators who are familiar with this project to grow her network. This will be [redacted]'s last summer at USD; I will ensure she learns a variety of skills to prepare for her next steps.