Winogradsky Columns, Ecosystem Homeostasis, and Microbial Importance Sustainability Activity – Population Ecology

Pre-lab Addition:

Niches

Another important concept in ecology is a niche. A **niche** is the total ways an organism obtains and uses resources in its environment. Niches include anything from an organism's physical spatial requirements to sound space, to food requirements (and much more). All organisms in an ecosystem have their own niche and interactions between each other determine how much of a niche an organism uses.

Ecosystem Homeostasis

All of the above concepts play a crucial part in maintaining ecosystem homeostasis. **Ecosystem homeostasis** is when an ecosystem can sustainably maintain itself at a set balance. When an ecosystem is not in homeostasis, this can have devastating consequences on the populations and the environment. A recent example of this was the removal of wolves from Yellowstone.

The Gibbon Meadows wolf pack in Yellowstone National Park (2007).

After their removal in 1926, the landscape and species community of the ecosystem drastically changed. Watch the video below to learn more about how wolves literally changed rivers in Yellowstone after their reintroduction in 1995!

https://www.youtube.com/watch?v=ysa5OBhXz-Q&t=43s

(Now 'the circle of life' song from the Lion King makes a little more sense, does it not?)

During this lab, you will act as wildlife conservation managers for six real-world case studies of current conservation issues. In addition, you will finish your experiment with your Winogradsky Column, and learn how these columns represent so much more than just the microbes in the tube.

Activity:

<u>Case Study VII: Winogradsky Column</u>

Throughout this semester you have been observing your Winogradsky Column that you made during your first lab. Now, you will finish your experiment by making final observations, evaluating your hypothesis, and extending your findings to explain real world problems of microbes.

To begin, make final observations of your columns. How has the color changed over time? Are there layers, and if so, how many and what type of microbes are in those layers? What does it smell like? Which type of microbe is most present in your column? What do you think this

means? Use the table below to help answer these questions. Also, feel free to reference the first prelab for reminders on what the different microbes are.

Color	Environment	Types of Microbes
Clear or Light Green	This is an oxygenated zone with access to lots of light. Microbes that are aerobic and use light as an energy source will live here. Some of these microbes will also produce oxygen as a leftover product of photosynthesis, so this zone will remain oxygenated.	Protozoans, Fungi, Cyanobacteria, Green algae - All Metabolic Types
Light Brown	This is an oxygenated zone, but only has some access to light. In addition to some sunlight, sulfur can be found in this region, so microbes that use light or sulfur for energy will reproduce here. These microbes will get their carbon from their environment.	Aerobic photoautotrophs and chemoautotrophs.
Rust or Reddish Brown	This region contains lower levels of oxygen but still has some access to light. Because of this, the microbes use light as an energy source but must 'eat' carbon from other organisms.	Anaerobic or aerobic photoheterotrophs
Green or Purple	This region contains no oxygen but does have some access to light. These microbes do photosynthesis; however, they do this process using sulfur compounds instead of water, so sulfur must also be present. Like chlorophyll (where plants do photosynthesis and makes them appear green), these microbes have bacteriochlorophyll, making them appear green or purple.	Anaerobic photoheterotrophs
Black	This region contains no oxygen and has little access to light. However, there is plentiful access to carbon and some sulfur. Therefore, the microbes that survive in this region are anaerobic and use carbon or sulfur as an energy source. They must also obtain their carbon from other organisms.	Anaerobic chemoheterotrophs

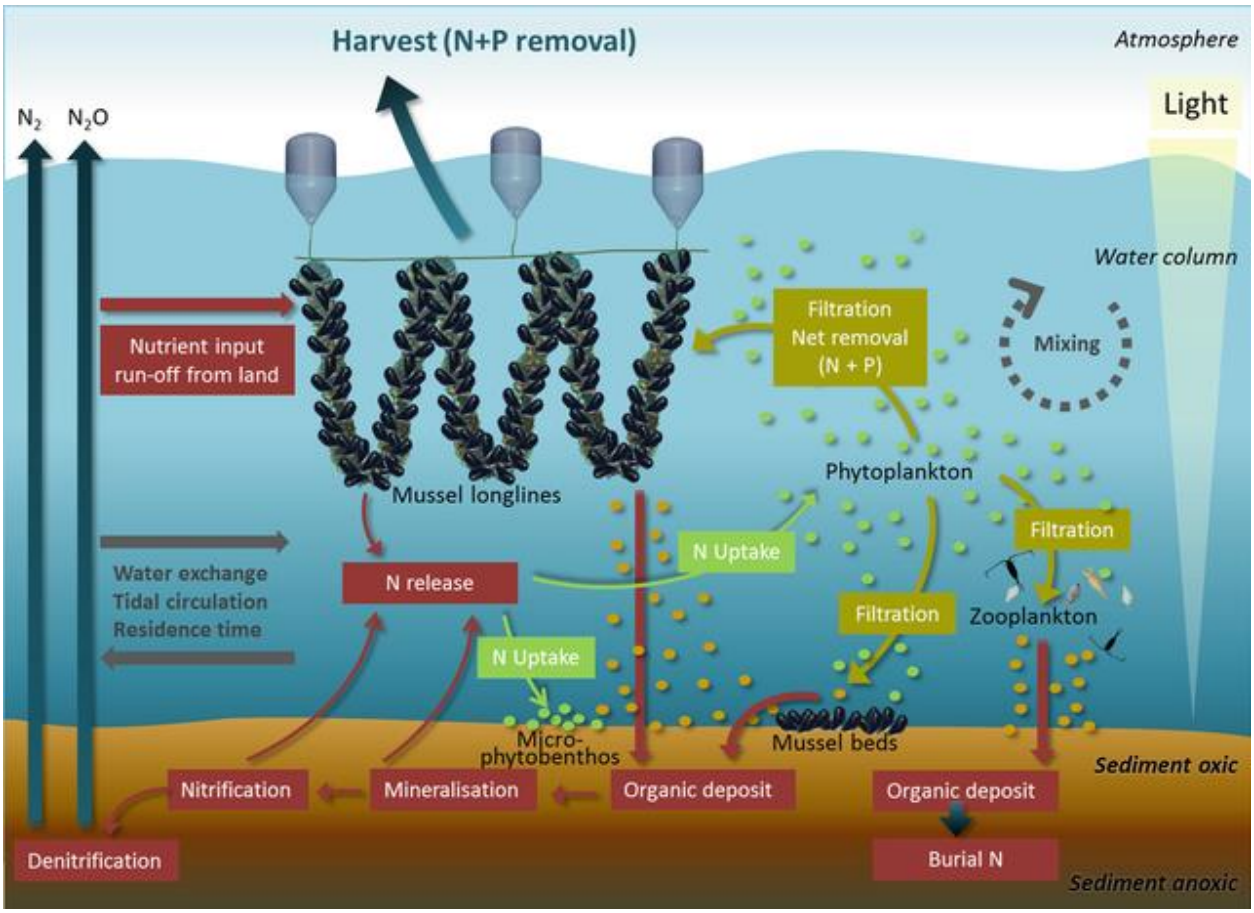
Next, make a wet mount of the top layer. Try to count how many microbes are in your sample, and try to identify them using the posters on the side bench. How does this sample compare to the first wet mount you did?

Now that you have made your final observations, it is time to interpret your observations from the past 16 weeks to support (or fail to support) your hypothesis! Discuss with your group whether you supported or did not support your hypothesis and explain why using evidence from your experiment. **Call over your TA after you are done to discuss your experiment and reasoning.**

Believe it or not, the Winogradsky column that you have made is an example of an ecosystem. You made an ecosystem (isn't that cool!). In fact, microbiologists use these columns as models for real world microbe ecosystems in aquatic environments, such as oceans, marshes, rivers, and ponds.

You could make a Winogradsky column of the Cache la Poudre River if you used mud from the river edge.

As mentioned in the beginning of the semester, microbes play an important role in soil by performing nutrient cycling. Winogradsky columns help soil scientists understand the roles each microbe plays in nutrient cycling and in maintaining ecosystem homeostasis. You can think of these roles as the microbes' niches. Based on your observations, what do you think the niche's are for each layered microbe in your column?



Microbes in soil play an important role in nutrient cycling, such as for Nitrogen and Phosphorus.

In order to maintain ecosystem homeostasis, everything in the environment must stay balanced. An easy way to throw microbe populations out of balance is by polluting the environment. This, of course, also affects the plants that rely on the microbes for nutrients, the animals that eat plants as a food source, and the animals that eat other animals. So, soil health plays an important role in maintaining homeostasis of an ecosystem. Moreover, we rely on health ecosystems for our own food, entertainment, and even our health!

Read the article, *Releasing the microbiome's potential to restore European soils* (https://www.labiotech.eu/in-depth/microbiome-soil-agriculture-europe/) to learn more about how we can reverse the impacts of pollution on soil microbes to make soil fertile again.

After reading the article, discuss the following questions with your group:

- How are scientists combating soil depletion?
- How do researchers determine what bacterial stains to use?
- Why do you think some farmers do not want to use the new fertilizer? How could you convince a farmer to use a new biofertilizer?

Management Question:

- Do you think developing biofertilizers of microbes is a sustainable solution to microbe depletion in soil? Why or why not?

Post Lab Question:
In lab, we discussed how pollutants are affecting microbes in ecosystems, effectively throwing the ecosystem out of homeostasis. One solution suggested is to fertilize soil with biofertilizers consisting of microbes. Do you think developing biofertilizers of microbes is a sustainable solution to microbe depletion in soil? Why or why not?

[0.5 pt for explaining biofertilizers,1 pt for your opinion for why microbial biofertilizers would be effective or not, 0.5 pt for a clear and concise answer that is grammatically correct and in full sentences.]