

# DESTINATION BIOTECH Teacher Notes

Episode 2

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Dr. Michelle Soupir



## Topic Overview

Learning about water quality is crucial as it directly impacts human health, ecosystem vitality, and the economy. Clean water is fundamental for drinking, agriculture, and industry. Woodchip bioreactors are an innovative method to improve water quality, serving as a practical, cost-effective solution to remove nitrates from agricultural runoff before it enters the water system. Understanding the function and management of woodchip bioreactors helps mitigate the detrimental effects of excess nutrients on aquatic ecosystems and provides a sustainable way to maintain the balance between agricultural practices and environmental stewardship.

## Conversation Overview

Michelle Soupir discusses her journey as an engineer and scientist interested in learning about and improving many facets of water quality. She outlines some basic tenets of water quality science, and she delves into her favorite edge-of-field practice: woodchip bioreactors!

## Included NGSS Dimensions

**Science & Engineering Practices:** Planning and Carrying Out Investigations

**Disciplinary Core Ideas:** MS-, HS-LS2 (Ecosystems: Interactions, Energy, and Dynamics); ETS1.B,C (Engineering Design)

**Crosscutting Concepts:** Cause and Effect

## Terms from the Podcast (in the order discussed)

Sediment: particles that settle in a liquid

Scouring: removal of sediment from a riverbank

Nitrogen: chemical element commonly used in fertilizer, often as nitrate ( $\text{NO}_3^-$ ) or nitrite ( $\text{NO}_2^-$ )

Soil profile: a vertical section of soil layers from organic to bedrock

Lab group: a team of researchers working towards a common goal or outcome, usually including students, scientists, and professors

Edge-of-field practice: a nitrate-removing strategy located between a farmer's field and a runoff site

Microorganisms (or microbes): microscopic organisms, like bacteria and fungi

Cover crop: plants grown in between a farmer's main crop to absorb excess nitrates and improve soil health

## Ideas & Notes for Classroom Use

### Podcast

- This podcast is approximately 20 minutes long and is available in two versions – video with audio, and audio only. A transcript is also available for download.
- Vocabulary words that may be new to students are highlighted in the video version.
- Best practice may include pausing the podcast for in-the-moment whole-class and small-group discussions

### Student Reflection Sheet

- Begin by providing students with the basic information about the podcast
- Ask students to consider the “Before the Podcast” prompts and discuss them before watching or listening to the podcast
- After enjoying the podcast, consider the remaining questions

### Activity: Bioreactor Exploration (station activity)

In this activity, students use various forms of data to determine the relative effectiveness of several woodchip bioreactors. The results from gel electrophoresis (DNA fingerprinting), water quality sampling, and general information about the bioreactor are used to do this. Students visit four different stations (bioreactors) where they collect relevant information about the bioreactor's activity and effectiveness in removing nitrates from flow-through water. A discussion can be had upon conclusion of the activity using these questions or similar:



- What evidence seemed most/least useful in determining the effectiveness of a bioreactor?
- Was any ONE of the bioreactors more effective than the others? What evidence did you use to make this determination?
- If you were a researcher at Iowa State University, what might be your next steps in this project? What else do you want to know/learn?

### Preparation:

1. Download the activity files from the Destination Biotech podcast website. *Teachers who have completed professional development with the BOEC may request the activity materials from the BOEC lending program.*
2. Print out the station information sheets, as well as the electrophoresis gel pictures. Place the gel printout in the empty square on the datasheet. Scatter these around the classroom, creating four stations for students to visit.
3. Make copies of the student pages (front/back, flip on the short side) and fold them in half, if desired. Students may work alone or in pairs/small groups.
4. Provide students time to visit all four stations, collecting necessary information from each one.
5. Use the discussion questions above to help students process and make sense of their findings.

### Take-aways:

- Data collected from the bioreactors is not “clean”. Some data may contradict other findings, making it more difficult to determine a “winning” bioreactor.
- Research scientists use a variety of data when trying to discern the effectiveness of a project/system. This serves as the basis for evidence to answer scientific questions.
- Data sets vary in size/scale. Sometimes they are messy and require analysis from many perspectives.

### Additional links and resources

- Dr. Soupir's information: <https://www.cals.iastate.edu/people/michelle-soupir>
- Dr. Soupir's research publications: <https://www.researchgate.net/profile/Michelle-Soupir>
- Woodchip bioreactor handout: <https://store.extension.iastate.edu/product/Woodchip-Bioreactors-for-Nitrate-in-Agricultural-Drainage>
- Short video introduction to woodchip bioreactors: <https://www.youtube.com/watch?v=LwVpdvTxMQg>
- Woodchip bioreactor one-pager: <https://store.extension.iastate.edu/product/14530>

