STEAM FORWARD – EPISODE 4
Journey of Water [Teacher Version]

Welcome to STEAM FORWARD!

Technology's vital role in keeping the mill safe!

Career: Waste Water Treatment Coordinator
Episode: Journey of Water

Inside every single plant is a specialty fiber called cellulose. You might not realize this, but inside a lot of the products that you use everyday, and even the foods you eat contain cellulose.

We're visiting Georgia Pacific's Foley Cellulose Mill to follow the journey of water as it helps extract the cellulose from trees.

Millions of gallons of water flow in and out of the facility every single day. And the goal is to send the water out just as clean as how it came in.

During this episode, hosted by Dr. Meisa Salaita, Waste Water Treatment Coordinator Bretty Lundy will show how the technology Foley Cellulose uses to make that happen.

OBJECTIVES: Why am I learning this?

At the completion of this mini-unit, you will be able to:

1. Analyze data in a table
2. Use data to support a claim
3. Understand that not all species of bacteria grow similarly even if kept in the same conditions

THE ESSENTIALS: ASK & ANSWER

1. Understand that bacteria can be used to help clean water
2. Use data to support claims and develop bioengineering systems
3. Understand that not all species of bacteria grow similarly even if kept in the same conditions

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Activity 1

Video segment: 00:00–2:09

OBJECTIVES: Why am I learning this?
At the end of this lesson, you will be able to:

1. Analyze data in a table
2. Use data to support a claim

Introduction
We are going to set up a system to reduce the contaminants in water flowing through a Georgia Pacific facility. Use the data below to create your design!

Students should work together in pairs or small teams to work through the plan. Have students help each other understand the material. To extend the lesson, have students go online and do research on beneficial bacteria in environmental clean up. They may be interested to see how bacteria help clean up oil spills.

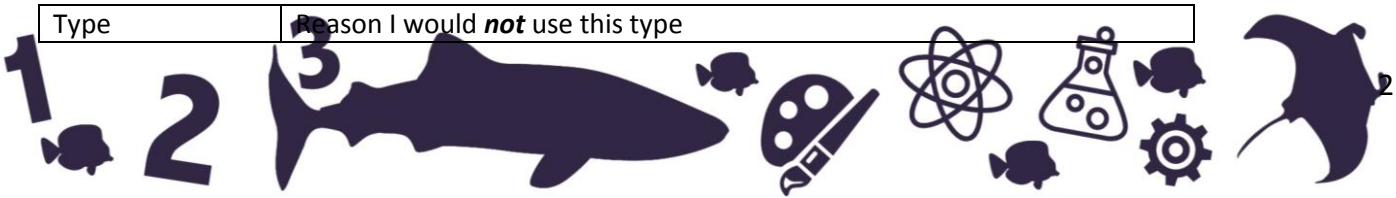
Table 1. Ability of different bacterial types to reduce the amount of four common contaminants in water.

Bacteria Type	Percent reduction in **contaminant 1**	Percent reduction in **contaminant 2**	Percent reduction in **contaminant 3**	Percent reduction in **contaminant 4**
A	0	99	10	0
B	0	5	0	6
C	0	0	0	90
D	98	0	0	40
E	0	0	0	55
F	0	0	99	0
G	0	0	0	0

1. Based on the information in Table 1, organize the types of bacteria into a group of bacteria that that you would use and a group that you would not use. Provide your reasons for deciding to use a type of bacteria or not.

Type	Reason I would use this type
A	A reduces contaminent 2 by 99%.
C	C reduces contaminent 4 by 90%
D	D reduces contaminant 1 by 98% and contaminant 4 by 40%
F	F reduces contamiant 3 by 99%

Type	Reason I would ***not*** use this type



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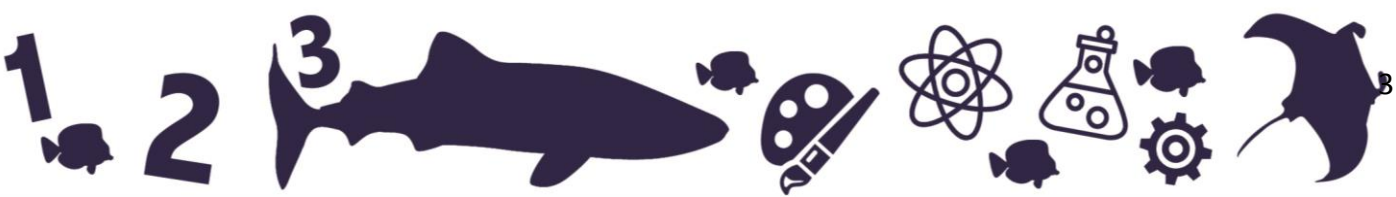
B	This reduced contaminants 2 and 4, but not by very much.
E	This bacteria reduced contaminant 4 by 55%, but bacteria C reduced it by 90%! Note – if students suggest that this is used to help bacteria C accept the answer.
G	This bacteria did not reduce any contaminants.

2. Is there any other information you would want to know before you choose to use a particular type of bacteria?

Answers may vary, but students may come up with ideas about whether the bacteria is safe for people, whether it can live with other types of bacteria, what kinds of conditions it can survive in.



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Activity 2

Video segment: 2:14–5:00

OBJECTIVES: Why am I learning this?
At the end of this lesson, you will be able to:

1. Interpret data to support claims
2. Understand that not all species of bacteria grow similarly even if kept in the same conditions

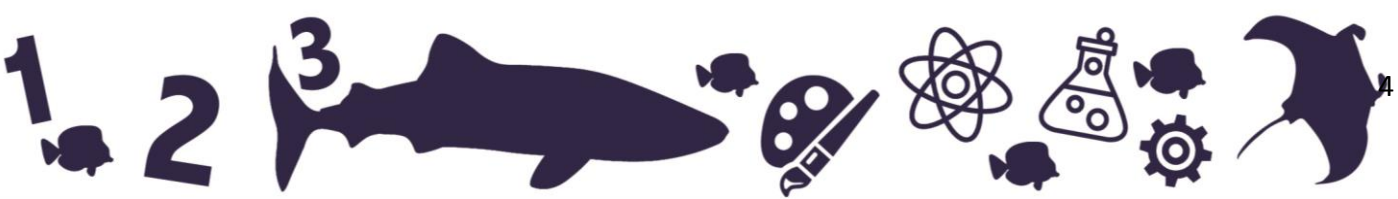
Introduction
Now that you have selected the bacteria you might want to use in your treatment system, lets see if they can all be kept together in one treatment pool. Not all organisms grow well under the same conditions, and some bacteria that use similar resoruces might compete with one another. Use the data in the tables below to see how many treatment pools you might need.

Table 2. Growth rates (or survivial) of bacteria under different temperature conditions

Temperature (°C)	Bacteria A	Bacteria B	Bacteria C	Bacteria D	Bacteria E	Bacteria F	Bacteria G
22.5	Moderate	Moderate	High	Low	Low	Moderate	Moderate
25.0	Moderate	Moderate	Moderate	Moderate	Low	High	High
27.5	Moderate	High	Moderate	High	Moderate	High	High
30.0	Moderate	High	Moderate	High	Moderate	Moderate	Moderate
32.5	Moderate	High	Low	Moderate	High	Moderate	Low
35.0	Moderate	Moderate	Low	Low	High	Moderate	Low
37.5	High	Moderate	Low	Low	High	Moderate	Low

Table 3. Growth rates (or survivial) of bacteria under different pHs

pH	Bacteria A	Bacteria B	Bacteria C	Bacteria D	Bacteria E	Bacteria F	Bacteria G
6.5	None	None	Moderate	High	Low	Low	High
7.0	None	None	Moderate	High	Low	Low	High
7.5	Low	Low	High	Moderate	Low	Moderate	Moderate
8.0	Low	Low	High	Moderate	Low	Moderate	Moderate
8.5	High	High	Moderate	Low	Low	High	Low
9.0	High	High	Moderate	Low	High	High	Low
9.5	Moderate	Moderate	Low	Low	Low	Moderate	Low



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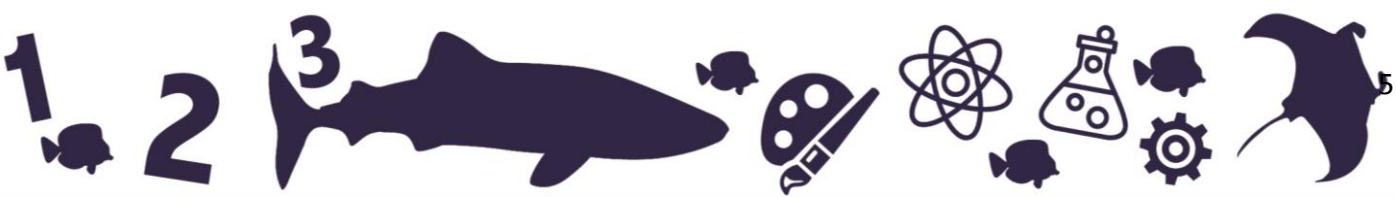
1. Use the data in Tables 2 and 3 to fill in table 4 for the bacteria you decided should be used in your treatment system.

Table 4. Optimal conditions for the growth of bacteria I would use in my treatment system.

Bacteria Type	Optimal Temperature	Optimal pH
A	37.5°C	8.5-9.0
C	22.5°C	7.5-8.0
D	27.5-30.0°C	6.5-7.5
F	25.0-27.5°C	8.5-9.0

2. Can the bacteria you choose for your treatment system be in the same treatment container? What evidence do you have to support your claim.

Students should remember that only Bacteria A, C, D, and F were useful for removing contaminents. Based on temperature, of these only D and F grow well in similar temperature conditions. Based on pH, of these only A and F grow well in similar temperature conditions. That means that none of them should be in the same container to achieve high growth rates.



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Activity 3

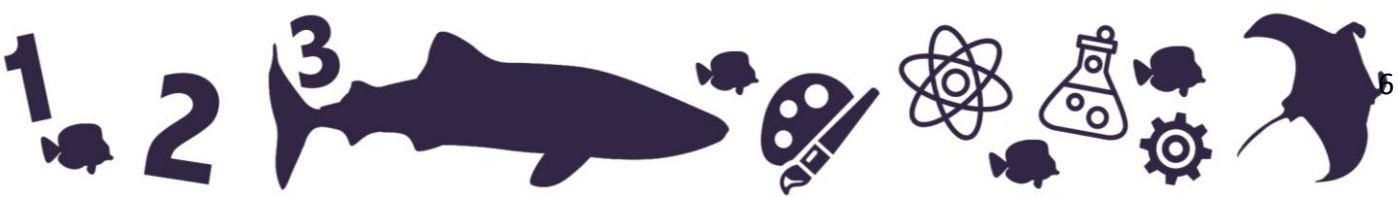
Video segment: 5:05–6:44

OBJECTIVES: Why am I learning this?
At the end of this lesson, you will be able to:

1. Design a schematic diagram

Introduction
Now that you have the right bacteria and know about the conditions where they grow best, we need to create a design for a treatment system!

1. Draw a schematic of a treatment system. Label all of the tanks/parts and insert notes about why it is designed this way. Include the environmental conditions in the tank (temperature, pH) and the type of bacteria that is in the tank. Include technology sensors you would want to install in each component of the system. Finally, label what contaminants are being removed from the system in each tank. Hint: Design your system so that big tanks house bacteria that can do well in the same conditions and are useful in treatment. Have the tanks connected by pipes. Think about what conditions you would want to measure in each tank to be able to track whether the environment is ok for the bacteria in the tank.
   Schematics should show four tanks that are connected by pipes. The pools should have the information below included (order is not important). Students might link the tanks in order of temperature to need less heaters and might suggest temperature, pH and contaminant sensors.
   - Tank 1
     - Bacteria: A
     - pH: 8.5-9.0
     - Temperature: 37.5°C
     - Removes Contaminant 2
   - Tank 2
     - Bacteria: C
     - pH: 7.5-8.0
     - Temperature: 22.5°C
     - Removes Contaminant 4
   - Tank 3
     - Bacteria: D
     - pH: 6.5-7.5
     - Temperature: 27.5-30.0°C
     - Removes Contaminant 1
   - Tank 4
     - Bacteria: F
     - pH: 8.5-9.0
     - Temperature: 25.0-27.5°C
     - Removes Contaminant 3



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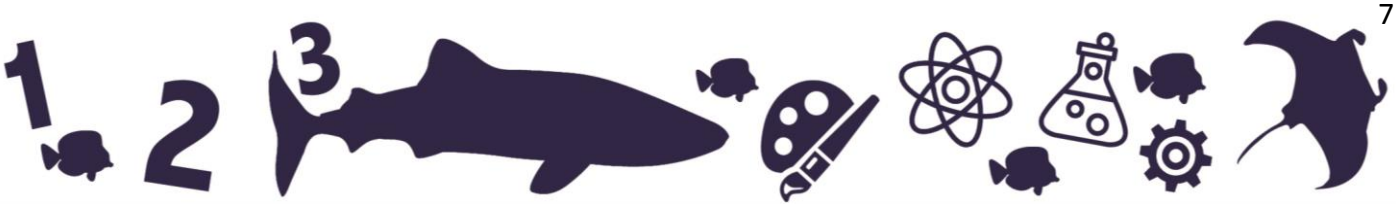

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In The Field

What better way to bring STEAM FORWARD alive than to meet an expert at Georgia Pacific? Here, you will learn more about the background and experience it takes to be a member of the STEAM TEAM. Let's get up close and personal!

MEET AN EXPERT

Meet: Brett Lundy, Waste Water Treatment Coordinator
University of West Florida
Major: Environmental Science

What is the most exciting part of your job at Georgia Pacific?

The most exciting part about my job with Georgia Pacific is working with new technologies. Being able to take an idea or product and apply it in the field and see what happens. Did it work? How can I make it work better?

What advice do you have for students interested in doing what you do?

My advise would be to learn all you can about biology, chemistry and math. Look at the new technologies that are coming out and how they work. Do not be afraid to work outside.

What is something surprising or unexpected about your career path?

The one thing that has surprised me during my time as both an Environmental Consultant and a Waste Water Treatment Coordinator is how much you continue to learn when you graduate college. Everyday you learn something new.

What do you say to students who ask "Why am I learning this?"

You are learning this because this type of waste treatment is based on naturally accuring biological organisims. These bacteria that you are studying are found in nature, doing the same thing, breaking down waste and using it as food.