This lesson plan was created by a teacher participating in the Research Experiences for Teachers program from the Precision Microbiome Engineering Research Center. Are you interested in spending part of your summer in a lab getting paid to do microbiome research and create lesson plans?

Learn more here: https://premier-microbiome.org/for-teachers-ret/

Bacteria, The Good and Bad

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Suggested Class size: Max 24 students

Overview:

Students will learn that there are good and bad bacteria. Discuss and identify the different microbes. Collect and swab everyday items around them to compare and contrast the amount of bacteria found on the item. Form a hypothesis on which items collected will have the most bacteria. They will model and convey proper handwashing and preventive cleaning methods to prevent bacteria from spreading. Students will understand why skin is important to our body. Then be assessed on their knowledge of bacteria through models, diagrams, slide presentation, oral presentation, or creating a video or digital animation on bacteria.

Key Search Words:

bacteria, microbes, microorganisms, skin

Learning Objectives:

Students will:

- Identify good and bad bacteria.
- Identify the different microbes/microorganisms.
- Form a hypothesis on which item they think will have the most bacteria.
- Learn to culture and plate bacteria.
- Observe and count bacterial colonies.
- Compare and Contrast the amount of bacteria found on everyday items.
- Explain and model why skin is important for protection and for our body to remain healthy.

Content Standards

This lesson is appropriate for [third grade life science] students and addresses the following Standards:

LS.3.1 Understand human body systems and how they are essential for life: protection, movement, and support.

LS.3.1.2 Obtain, evaluate, and communicate scientific information to explain why skin is necessary for protection and for the body to remain healthy.

Time Requirements (separate prep time 30 minutes, Total time on lesson 5 days, and after class time 60 minutes) **Plus additional time for students to complete and present projects.**

Materials:

Reusable materials:

- Smartboard or Apple TV
- laptop or iPad
- (1)10-100 ml pipettes for each student https://a.co/d/1FsotJE
- (12 cases) 20- 200 ml pipette tips https://a.co/d/8K7CMKK
- Items to swab for bacteria that are around the school/classroom
- microwave (not used for food or warming of consumable products)
- microbiology incubator
- Heat Lamp (to use if you don't have an incubator to grow bacteria) https://a.co/d/5guJnPA
- Phosphate Buffered Saline (Use in place of Premade Broth to put in 15 ml falcon tube if you are using premade petri dishes) https://a.co/d/guSTvzV
- Vortex mixer https://a.co/d/ikL5Tpe
- Magnetic Stirrer https://a.co/d/1G9wE0K
- Magnetic stir bars https://a.co/d/4rWatIR
- Plastic test tube rack https://a.co/d/dlAun7G
- Vial tube rack https://a.co/d/eikULHt

***** You don't need to have the following materials if you purchase LB petri dishes with premade agar******

- 1000 ml bottle
- 1000 ml cylinder
- 50 ml flask
- incubator shaker (set at 37 degrees) 135 roto by minutes (not required if premix is purchased)
- measuring scale (not required if premix is purchased)
- hot plate or microwave (for heating liquid)
- magnetic bar (used to mix broth and agar)

- distilled water (not required if premix is purchased)
- microwave (not used for food or warming of consumable products)
- Oven mitt (used to remove liquid media from hotplate/microwave)
- LB Broth (preferably premade)

https://www.carolina.com/catalog/detail.jsp?prodId=776362&gclid=Cj0KCQjwzdOlBhCNARIsAPMwjbyS9jpDZ69c8MdhIVDkZGpXSUnYU-BLH87nP4e9ZGyyasHI85jTkNcaAulaEALw_wcB

- Agar (preferably premade) https://www.sciencecompany.com/Nutrient-Agar-Ready-To-Pour-Kit-P16211
- Permanent marker for each student

Perishable or disposable materials:

- latex gloves for every student
- safety glasses for every student
- lab coat for every student
- Petri Dishes- (9) petri dishes for each pair of students (Can be purchased with premade agar) https://a.co/d/0dvrUUUG
- L spreaders (one for each petri dish used) https://a.co/d/6AsIb7p
- (3)15ml falcon tube for each pair of students

https://a.co/d/7GTfm0V

- 1.5 ul eppendorf tubes (9) for each pair of students

https://a.co/d/4E49uvl

- Sterile Cotton swabs to collect samples

https://a.co/d/6bkfAZK

- Objects to swab such as fruits/vegetables
- (9) ziplock bags for each pair of students petri dishes

Safety

Ensure that students understand and adhere to safe laboratory practices when performing any activity in the classroom or lab. Demonstrate the protocol for correctly using the instruments and materials necessary to complete the activities, and emphasize the importance of proper usage. Use personal protective equipment such as safety glasses or goggles, gloves, and labcoats when appropriate. Model proper laboratory safety practices for your students and require them to adhere to all laboratory safety rules. Students are not to touch their mouth or eyes when implementing the experiment. Petri dishes containing bacteria should be placed and kept in ziplock bags.

Day 1

Teacher Preparation

Medium Preparation (If premade LB agar petri dishes were not purchased)

- **Preparation LB broth**
- Weigh 25 g of LB powder in an autoclavable 1000 ml bottle and adjust the volume up to 1000 ml of deionized water and place a magnetic bar inside the bottle..
- then place the bottle on a magnetic stirrer to homogenize.
- Sterilize the medium by autoclaving at autoclaving 15 mins at 121°C.
- carefully place the medium on the safety chamber to cool.
- It can be stored in the refrigerator until needed

Preparation LB Agar

- Weigh 25 g of LB powder and 15 g of agar into an autoclavable 1000 ml bottle.
- Adjust the volume up to 1000 ml of distilled water.
- Then place the bottle on a magnetic stirrer to homogenize.
- Sterilize the medium by autoclaving at 15 mins at 121°C.
- Carefully place the medium on the safety chamber and allow it to get to room temperature.
- Then carefully and gently pour the medium on the petri dish and allow the medium to solidify.
- Once the medium is solidified, flip the plates upside down.
- It can be stored in the non food used refrigerator until needed

Microwave- for warming solidified agar mixture for 1 to 3 minutes to completely dissolve the agar. Just like gelatin, agar needs heat for 1-3 minutes to properly dissolve gel, but gels are 25 degrees celsius. Be sure to watch while in the microwave for every 10-15 seconds.

CAUTION: Adult supervision is required to boil water. If you are using a microwave oven to boil the mixture, be careful not to let it boil over. The mixture should be clear with no particles floating in it after boiling. **Be sure to use an oven mitt to remove agar from the microwave or hotplate.**

Day 1: Pipetting the Rainbow

Supplies:

- (1) 10 ul and 100 ul pipette for each student
- box of 20- 200 ml pipette tips for each pair of students
- (4) 1.5 ul eppendorf tubes for each pair of students
- 1.5 ul eppendorf, tube of 15 drops of red food coloring
- 1.5 ul eppendorf, 15 drops of orange food coloring
- 1.5 ul eppendorf, 15 drops of yellow food coloring
- 1.5 ul eppendorf, 15 drops of green food coloring
- Pipetting the Rainbow activity sheet for each student Pipette_the_Rainbow_.docx.pdf
- Paper towels for any spills

- small basket for each pair with plastic bag for students to place used tips in

ALL materials should be placed on desks prior to lesson. Pair up students prior to beginning lesson and give each student a Pipette Rainbow activity sheet (see link below), Food coloring 1.5 ul eppendorf tubes (red, orange, yellow,green for each pair to share, 10 ul and 100 ul pipette for partner to share and tips for the pipettes, as well as a disposable bag for tips to be placed in.

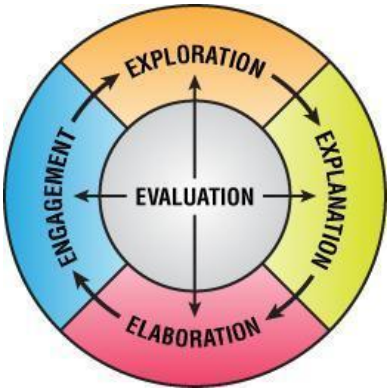
(Day 1 of 3 45 minutes) Give each student gloves, lab coat and safety glasses

Engage:

Activating Prior Knowledge

- Let's think about bacteria. Turn to your partner and name one thing that might have bacteria. How do you know that the item/object you named has bacteria?.
- Choose a couple of students to share examples of bacteria.
- Use the KWL chart to write down what students already know about bacteria.Bacteria KWL Chart
- Ask students what are some questions that they have about bacteria.
- Ask students if they know what microorganisms or microbes are? Give students a chance to respond.

Guiding the lesson using the 5E Learning Cycle



Engage (10 minutes)

1. Tell the students that there are five main types of microbes/microorganisms:Viruses, Bacteria, Archaea, Fungi, and Protists. The focus for our lesson will be analyzing bacteria.

2. Students will watch ***Science with the Amoeba Sisters*** video on bacteria. Bacteria (Updated)

3. After video review vocabulary (antibiotics,bacteria,colonized,colonies, contaminated, decomposers,DNA, ecosystem,microbes,microorganisms, and reproduction) Then, explain to students that they will be using pipettes to extract bacteria. Next, explain the importance of holding the pipette correctly and not turning the dial past or beyond the measurements of the pipettes or the pipette will break. Also, explain that the pipette is not a toy to play around with.

Vocabulary:
• **antibiotics** – medicines treat infections by killing bacteria or stopping them from growing and multiplying.
• **bacteria** – tiny, single-celled organisms that get nutrients from their environments.
• **colonized** – to create a habitat or territory
• **colonies** – group of organisms
• **contaminated** – to make impure or unsuitable by contact or mixture with something unclean, bad, etc.
• **decomposers** – an organism that breaks down dead or decaying organisms, such as plants or animals
• **DNA** – (deoxyribonucleic acid) a molecule that contains the genetic code for all living organisms
• **ecosystem** – a geographic area where living and nonliving things interact with each other to form a community of life:
• **microbes/microorganisms** – living things that are too small to be seen with the naked eye. Can only be seen with a microscope.
• **reproduction**– a biological process that allows organisms to create more organisms like themselves

Explain (3 minutes)

Today we will Pipette a Rainbow. You will practice pipetting using food coloring to create a rainbow. When you use each color, be sure to change out your tips by disposing each tip into your trash bag. (Be sure to model placing tip on pipette and disposing tip)

Explore (15 minutes)

.First model for students how to hold the pipette.
- Then explain that there is a first level and a second level. Have students pick up their pipette so they can feel the stopping point of the first level and then the second level Explain that the different levels are friction because it is the rubbing of the two things to cause the object to stop. Explain that the first stopping point will suck up the liquid. Let students practice stopping on the first level. Then explain that the second level will be what releases the liquid. Students should practice stopping on the second level.

- Share Student video on Pipetting the Rainbow Pipette the Rainbow: Student Demonstration

- Give students time to pipette their rainbow.

Questions to ask:
- Explain the dos and don'ts of pipetting?
- Why is it important to change the tips when switching 1.5 ul eppendorf tubes or liquids?
- How many droplets did the color red require? Green ? Yellow? Orange?
- What was the volume of the pipette for red? Green? Yellow? Orange?

Differentiation

- Students at or above grade level can be given a task card explaining the directions for pipetting the colors independently.
- Students below or close to grade level should follow along with the teacher as direct instructions are given.
- Show student video of pipetting the rainbow Pipette the Rainbow: Student Demonstration

Elaborate (Expected timing 5 minutes)
- Turn to your partner. Discuss what you learned about bacteria today.
- Call on some students to share.
- Have students write in their writing journal about what they learned about bacteria, or pipetting during the lesson. Were there any challenges that you had to overcome when pipetting? What do you hope to learn from this lesson?

Day 2

Day two: For each pair of students (3)15ul falcon tube for each pair of students, labeled with the name of the item swabbed. (9) Premade petri dishes, tube racks to place tubes in, gloves, lab coats, and safety glasses.

Engage (Day 2 of 4 Time: 10 minutes)

- Tell the students that there are five main microbes. Call on a student to name at least one of the main microorganisms until all 5 have been identified. Our focus is bacteria.

- Let's review some things that you have learned so far about bacteria. Use the KWL chart to write down **what I learned** on the KWL chart.
- Students will watch a Amoeba Sisters Youtube video. (OLD VIDEO) Bacteria: The Good, The Bad, The Kinda Gross
- **Turn to your partner-** Partner A tells partner B one thing you learned from the previous lesson. Then partner B tells partner A to share what they learned. Call on a couple of students to share what they learned from the previous lesson.
- After the video,review vocabulary

Vocabulary:

• **antibiotics** – medicines treat infections by killing bacteria or stopping them from growing and multiplying.
• **bacteria** – tiny, single-celled organisms that get nutrients from their environments.
• **colonized** – to create a habitat or territory
• **colonies** – group of organisms
• **contaminated** – to make impure or unsuitable by contact or mixture with something unclean, bad, etc.
• **decomposers** – an organism that breaks down dead or decaying organisms, such as plants or animals
• **DNA** – (deoxyribonucleic acid) a molecule that contains the genetic code for all living organisms
• **ecosystem** – a geographic area where living and nonliving things interact with each other to form a community of life:
• **microbes/microorganisms** – living things that are too small to be seen with the naked eye. Can only be seen with a microscope.
• **reproduction**– a biological process that allows organisms to create more organisms like themselves

Day 2 Explain (5 minutes)

Then, explain to students that today they go on a bacteria scavenger hunt. They will find areas to swab for bacteria (different fruits or objects around the school or classroom) today using sterile Q Tips. Each pair of partners have **(1) pipette**, **(3) 15 ml falcon tubes** with Q tip and buffer solution already placed in the tube,**1.5 ul eppendorf tubes (9) for each pair of students, (9) L spreaders** and **(9) Premade petri dishes.** With your partner label each of the tubes(ex. tube -1 apple, tube -2 carrots, tube -3 strawberries) It is VERY important that you don't put your fingers in your mouth. Explain the classroom expectations for working with a partner and each partner having a job for swabbing, bacteria, pipetting,spreading, and labeling. Remind students that they will change their pipette tips each time they are pipetting.

Day 2 Explore (30 minutes)

1. Have students with their partner take turns using the Q tip to swab bacteria from the different items around the classroom or school. (door handles, drain of a sink, window sill, anywhere that there may be dust).
2. When students have completed they will vortex each of their 15 ml tubes.

***Let 15 ml tubes sit until next day if time doesn't permit to continue**

Otherwise follow these directions

1. Give each pair of students (9)1.5 ul eppendorf tubes, 9 premade petri dishes, 9 spreaders, and permanent marker.
2. Students should label each eppendorf tube (-1,-2,-3,-4,-5)
3. Next pipette 900 ul (or 100 ul 9 times if using 10 -100 ul pipette) of broth and place into each tube (Buffer can be substituted in place of broth)
4. Then put 100 ml of bacteria from area #1 tube and place into -1 eppendorf tube. Then vortex -1 eppendorf tube.
5. Next, take 100 ul from -1 eppendorf tube and place into -2 eppendorf tube and then vortex -2 eppendorf tube.

(change tip) Then take -2 eppendorf tube and place 100 ul into -3 eppendorf tube and vortex -3 eppendorf tube **(change tip)**. Take -3 eppendorf tube and place 100 ul of -3 into -4 eppendorf tube **(change tip)**. Vortex -4 eppendorf tube, then take 100 ul of -4 eppendorf tube and put into -5 eppendorf tube. Vortex -5 eppendorf tube.

6. Students should take the petri dishes and separate into 3 groups. Label each set for example sink -1, sink,-2, sink -3, then continue to label the next set with the name of item swabbed and area-1,area-2,area-3, then label the third set with the name of the item swabbed and area -1,area-2,area-3. (Partners can share this job of labeling)
7. Be sure to separate sets
8. Then mix/vortex area -1 and put 100 ul of -1 into the petri dish -1 that is labeled for that swabbed area. Vortex -2 and then pipette 100 ul of area -2 into the petri dish labeled for that area -2. Vortex -3 and then pipette 100 ul of area -3 into the petri dish labeled for that area -3.
9. Use an L spreader to spread bacteria in the petri dish. Throw away the spreader and use another L spreader to spread -2, then throw away the spreader and get another spreader to spread -3.
10. Repeat directions 8 and 9 for the next two groups of petri dishes of the items that were swabbed.
11. Place one petri dish into each ziplock bag
12. Let petri dishes sit for at least 15 minutes and then place in an incubator or at room temperature. Let sit until the next day. **(DO NOT OPEN the ZIPLOCK BAGS !!!!)**

Evaluate (5 minutes)

Questions to ask to assure that the stated learning objectives were met?

1. Describe bacteria.
2. Explain the difference between good bacteria and bad bacteria.
3. Explain how antibiotics contribute to the increase or decrease of bacteria.
4. Identify the five main microbes/microorganisms.
5. Classify the different bacteria and where they can be found in the ecosystem.

Day 3

Day three: Place petri dishes belonging to each pair of students in their work area.

Day 3 Explain (5 minutes)

Today you will analyze the bacteria in each group of petri dishes and count the number of colonies found in each petri dish. Before we begin I want to share with you a bacteria and virus video. As you watch the video and listen to the difference between bacteria and viruses. Be ready to compare and contrast bacteria and viruses.

Day 3 Engage (15 minutes)

- Turn to your partner and share a time that you were sick. How or what did you do to make yourself feel better?

Share Generation Genius video,
https://www.generationgenius.com/videolessons/bacteria-and-viruses-video-for-kids/

Questions to ask after watching the video:

1. How do you know the difference between living and nonliving things?
2. What are some examples of common ways that bacteria and viruses are spread?
3. Why don't doctors give patients antibiotics for viral infections?
4. Where is bacteria found?
5. How are bacteria and viruses alike? Different?

Explain:

- Today you will examine and analyze bacteria in each petri dish. Model or show students how to create a data chart on paper or using their technology.
- As you analyze the bacteria in each petri dish, you will circle with your permanent marker any colonies that you find. **(DO NOT OPEN the ZIPLOCK BAGS!!!!)**
- Then I want you to examine the different groups. Compare and contrast -1 to -2, and to -3. What do you observe?
- After observing, I want you to document your data and create a graph of your findings using Apple Numbers on your iPad (students can also use Excel or draw a graph).

Day 3 Explore (30 minutes)

- Students will work with their partner to analyze the bacteria in the petri dishes and compare and contrast their findings. They will document their results in their science notebook or on their ipad. (See resources for data table)
- Students will use their technology device to create a graph of their findings

- Students will write in their journal if their prediction on day one was correct on which item would have the most and least bacteria and why the item has the most/least bacteria.

Day 3 Evaluate (20 minutes)

Assessment:

Partners will share their graph and results with the class.

Questions to ask to assure that the stated learning objectives were met?

6. Describe bacteria.
7. How did you analyze the bacteria?
8. Explain how you were able to identify which item had the most bacteria.
9. Explain why you think item number __ had more bacteria.
10. Explain why you think item number __ had less bacteria.

Day 4

Day 4 Explain (3 minutes)

Today you will recall all the information that you learned about bacteria. Then you are going to take what you have learned and create a model that provides evidence of your learning. You can decide how you want to present your evidence of learning.

Day 4 Engage (10 minutes)

- Review KWL chart with students and continue to fill in the **What did I learn column**.
- Create a chart of different ideas that students can use to show evidence of their learning. Ex. Google Slides, Apple Keynote, diagrams, skit, animation, create a video, drawings and illustrations, etc.
- Share rubric for grading the project.

Day 4 Explore (45 minutes)

- Students will explore ways to communicate and explain bacteria.
- Students will decide on what information they want to present.
- Students will work on their individual bacteria project.

Students will:

- Identify good and bad bacteria.
- Identify the different microbes/microorganisms.
- Compare and Contrast the amount of bacteria found on everyday items.
- Explain and model why skin is important for protection and for our body to remain healthy.

Day 4 Evaluate

- **Reflection-** Reflect on your knowledge of how bacteria grows. How could you help reduce bacterial growth and make better choices when it comes to handling food and touching objects?
- **Bacteria Project- Students will be evaluated on their individual projects after completion of the project.**

Required Resources:

- **Amoeba Sisters** Video Bacteria (Updated)
- **Amoeba Sisters**(OLD VIDEO) Bacteria: The Good, The Bad, The Kinda Gross
- **Generation Genius** video, https://www.generationgenius.com/videolessons/bacteria-and-viruses-video-for-kids/
- Pipetting the Rainbow Pipette_the_Rainbow_.docx.pdf
- Pipette The Rainbow Teacher Instructions Video **https://youtu.be/s1XTydD9yzA?si=TuPJVB-75CBcCfxu**
- Pipette The Rainbow Teacher Instructions Video Pipette the Rainbow: Student Demonstration

Sources:

Amoeba Sisters, *Bacteria*, YouTube, 07/15/24, https://youtu.be/ORB866QSGv8?si=NhtGBAnqftptBII7

Amoeba Sisters, *Bacteria, The Good,The Bad, The Kinda Gross,* YouTube, 07/15/24

Course Hero, *Pipette the Rainbow*, 07/15/24 https://www.coursehero.com/plans/?utm_source=google&utm_medium=cpc&utm_campaign=branded_trademark_ext_US&utm_term=stu&gad_source=1&gclid=Cj0KCQjwkdO0BhDxARIsANkNcrd5CimzhZJBeYvY0kuev2tJ3pcaVcSP01UxaK7EOAzEF8VDipsTsHEaAuCEEALw_wcB

Generation Genius, *Bacteria and Viruses*, 07/16/24 https://www.generationgenius.com/videolessons/bacteria-and-viruses-video-for-kids/

MagicSchool AI, Rubric Generator, 07/16/24 https://app.magicschool.ai/tools

Appendices:

- Pipetting the Rainbow

Pipette_the_Rainbow_.docx.pdf

- **Bacteria, The Good and the Bad** Project Rubric

Bacteria project Rubric

- **Bacteria, The Good and the Bad** Google Slides

Bacteria, The Good and the Bad Slide.pptx

- Bacteria Counting Data Sheet

Bacteria Swabbing Data Sheet

- Bacteria KWL Chart

  Bacteria KWL Chart