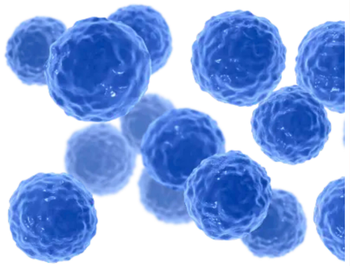
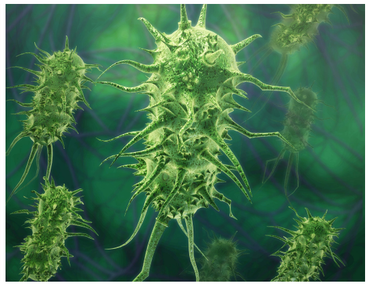
NASA SPOTLITE

Science for students by students

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?



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NASA eClips™

National Institute of Aerospace

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

What are NASA Spotlites?

NASA Spotlites are 90-120 second student-produced video segments that address common science misconceptions as determined by reputable assessment sources such as the National Assessment of Educational Progress (NAEP), National Science Foundation (NSF) Factual Knowledge Questions, and the Misconceptions-Oriented Standards-based Assessment Resources for Teachers (MOSART).

NASA Spotlites are designed to increase scientific literacy in a standards-based classroom. By producing Spotlite videos, students gain production experience, as well as deepen their understanding of science content. Approved NASA Spotlites can be found at the NASA eClips website: https://nasaeclips.arc.nasa.gov/

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5E Lesson Model

NASA eClips™ Guides use the 5E constructivist model developed by Biological Sciences Curriculum Study. Constructivism is an educational philosophy that promotes student-centered learning where students build their own understanding of new ideas. The 5E instructional model consists of five stages for teaching and learning: Engage, Explore, Explain, Extend (or Elaborate), and Evaluate.

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NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Lesson Overview

Science Misconceptions

All bacteria are harmful.
Bacteria are only found in dirty or unsanitary environments.

Standards

Next Generation Science Standards
MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells.
MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

Objective

As a result of watching Spotlite videos, learning the vocabulary collaboratively, and exploring how bacteria grow, students will explain where bacteria can be found, and describe the potential positive and negative roles bacteria play in our lives.

Materials

Assessment
Per student:
- copy of pretest and posttest
- Frayer Model Graphic for Vocabulary Development

Per classroom:
- chart paper for posting final vocabulary definitions

Per small group:
- copy of a digital Frayer Model (alternatively, this can be printed)

Explore
For each group of students:
- 3 Petri dishes with lids filled with tryptic soy agar
  - Beef broth and powdered gelatin can be used in place of agar
- 3 cotton-tipped swabs
- hand sanitizer (antibacterial gel)
- sink with liquid hand soap in a pump container
- paper towels
- probiotic yogurt drink and plain yogurt
- milk
- water
- 3ml disposable plastic transfer pipettes
- microscope 100x or more magnification
- microscope slides

Safety

- Review digital citizenship before students use online resources.
- Make sure students wear safety goggles to protect their eyes.
- Use caution when using microscopes and slides.
- Keep the Petri dishes away from students until the time of data analysis. No student, at any time, should touch the agar, gelatin or the bacteria.
- Seal the Petri dishes with clear tape once they have been swabbed.
- When the activity is complete and pictures have been taken of all samples, immediately discard the sealed Petri dishes in a trash container that is inaccessible to students.

Target Vocabulary

active cultures
bacteria
colony
eukaryotic
fermentation
fission
microbes
prokaryotic
sanitary
transmit

Time Frame

Between two and five 45-minute class periods:
Day 1 - Engage and Explore*
*Optional data collection over a week or more
Day 2 - Explain and Elaborate/Extend
Day 3 - Evaluate

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Background Information

Bacteria are the simplest and the oldest one-celled organisms that can be seen with a light microscope. While there is a great variety of bacteria, most do not need much to thrive and can live just about anywhere -- like on the ground or in water. Different strains of bacteria have adapted to survive in very harsh climates, such as high altitudes, deep in the ocean, and at very cold or hot temperatures. Those that are adapted to survive in extreme environments are called extremophiles.

While people generally think that bacteria are bad for us, most bacteria are good. For example, bacteria in the soil cause dead animals and plants to decay and make the soil rich for new plants. However, if bacteria not normally found in the human body enter the body, they may begin to multiply rapidly and cause an illness.

Bacteria can grow very quickly. On average, bacteria can double the size of their population every 20 minutes, with each bacterium splitting into two identical copies of the parent. That means that one bacterium splits into two bacteria, these two split into four, these four split into eight, and so on. If reproduction occurs every 20 minutes, it does not take long before there are lots of bacteria.

Bacteria produce important proteins through biosynthesis, a process by which cells, such as bacteria, put together simple molecules to make more complex ones. Scientists, called biochemists, study exactly how bacteria produce proteins, and bioengineers change the bacteria so that they could produce the kind of proteins that we need, for example, proteins used in developing medications.

Engineers also add bacteria to biofuel to create useable energy and remove waste from fermentation by-products while generating electricity. Scientists and engineers are also modifying different types of bacteria to act as clean-up agents for oil spills: the bacteria are able to break down oil compounds to simplify the removal from the water.

Adapted from: Bacteria are Everywhere
https://www.teachengineering.org/activities/view/nyu_bacteria_activity1

The most common types of bacteria are distinguished by their shape and the structure of their cell wall.

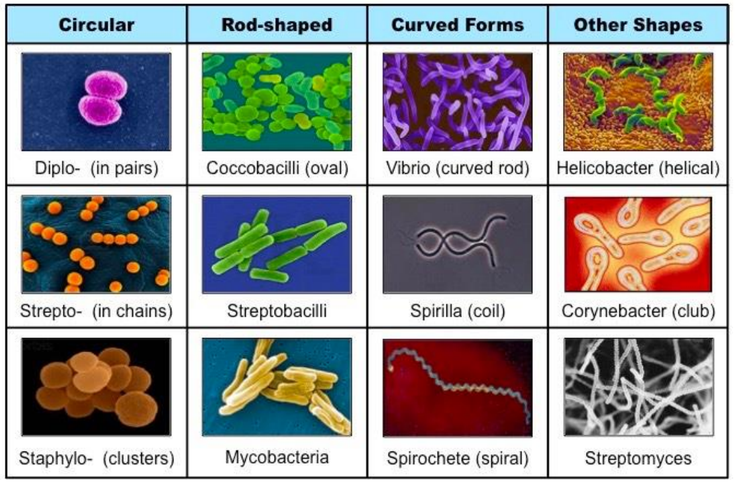


Image Credit:
https://ib.bioninja.com.au/viewing-cells/

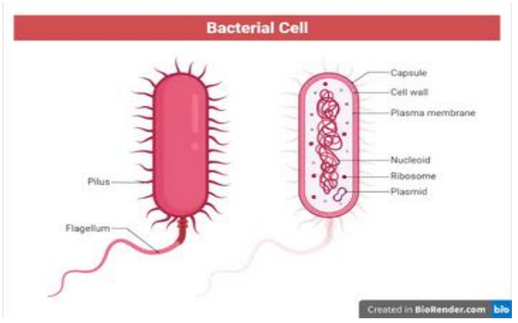


Image Credit:
https://www.biorender.com/

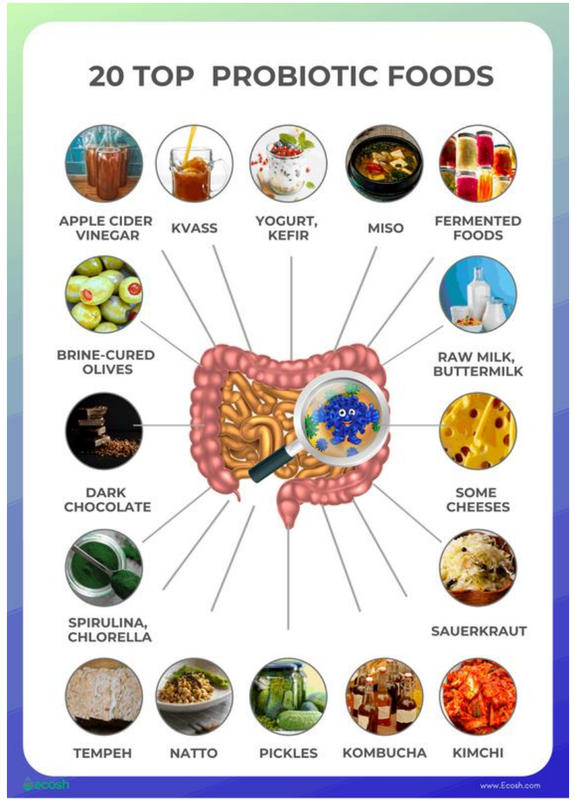


Image Credit:
https://ecosh.com/probiotics-40-health-benefits-of-probiotics-and-20-top-probiotic-foods/

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Engage

Pre-assessment

Probe for students' prior knowledge using the pre-assessment

1. Pretest items are located **at this link.**
2. Essential questions
3. Discussion questions

Essential Question(s)

Where can you find bacteria?
What role do bacteria play in the environment and/or with people?

True or False?

All bacteria are harmful.

👍 👎

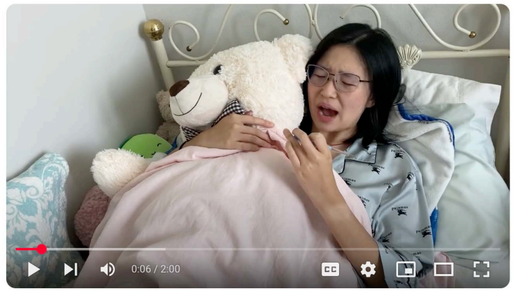
Today's Lesson

In today's lesson you will learn that some bacteria are beneficial, while others can be harmful. As a result of watching Spotlite videos, learning the vocabulary collaboratively, and exploring how bacteria grow, you will be able to explain where bacteria can be found and describe the positive and negative roles they play in our lives.

NASA Spotlite Videos

Watch these video clips about bacteria. As you watch, identify a misconception about whether all bacteria are harmful

NASA Spotlite: Bacteria, Friend or Foe?
Link - https://youtu.be/ptHblVCcwXk



NASA Spotlite: The Spread of Diseases
Link - https://youtu.be/gmfWXZ2RxVw

Class Discussion

- How do bacteria play a significant role in our world, either positive or negative?
- How do bacteria reproduce, and why is it important to understand this process?
- How might the study of bacteria help us prepare for future space exploration, including missions to Mars or beyond?

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

Activities

Microorganisms like bacteria are all around us and we can study how quickly they grow. Complete some activities to explore where and how bacteria grow.

Activity 1 - Handy Bacteria

Study three different conditions under which bacteria are found and compare the growth of the individual bacteria from each source: 1) an unwashed hand, 2) a hand washed with soap and water, and 3) a hand sanitized with antibacterial gel.

Image Credit: Canva.com

1. Label the lids for each Petri dish containing agar. Label one Petri dish “washed,” one “unwashed,” and one “sanitized.” (You can create your own agar. Directions are in the references and resources section.)
2. Rub a clean cotton swab on the unwashed hand.
3. Then gently rub the cotton swab sample from the unwashed hand back and forth on the agar in the Petri dish labeled “unwashed.” Tape the lid on the dish.
4. Rub a clean cotton swab on the washed hand.
5. Then gently rub the cotton swab sample from the washed hand back and forth on the agar in the Petri dish labeled “washed.” Tape the lid on the dish.
6. Rub a clean cotton swab on the hand sanitized with antibacterial gel.
7. Then gently rub the cotton swab sample from the sanitized hand back and forth on the agar in the Petri dish labeled “sanitized.” Tape the lid on the dish.
8. Place the Petri dishes in well-ventilated warm area -- between 22 ºC (72 ºF) and 37 ºC (99 ºF), in the dark. Petri dishes need to be placed upside down (i.e. lid on the bottom) to avoid condensation. Record observations every day for 5 to 10 days.

Write a description of the bacterial culture.	Sketch the bacterial culture. Use colored pencils when appropriate.
Date: Time: Temperature: Shape and color: Other:	Sample Name:

- **Be sure to wear eye and skin protection as needed.**
- As soon as the plates have been streaked and the Petri dish lid replaced, apply two pieces of tape to keep the lids connected; however any closure should not be made air-tight.
- No student, at any time, should touch the agar or the bacteria. When taking pictures, take pictures through the Petri dish.
- When the activity is complete and pictures have been taken of all samples, immediately discard the Petri dishes in a trash container that is securely away from the student population.

Alternate Virtual Lab Activity

Use this interactive created by Michigan State University to learn about the streak plate method for identifying bacteria.

https://learn.chm.msu.edu/vibl/content/streakplate.html

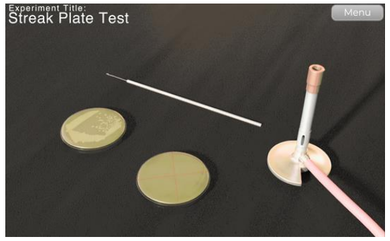


Image Credit: https://learn.chm.msu.edu/

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

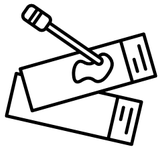
Activities

Microorganisms like bacteria are all around us and we can study how quickly they grow. Complete some activities to explore where and how bacteria grow.

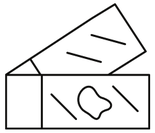
Activity 2 - Good Bacteria

Observe live bacteria in a probiotic yogurt drink.

1. Prepare the Microscope:
   - Ensure microscopes are clean and functioning properly.
   - Set the microscope to the lowest magnification (usually 40x) to start.
2. Prepare the Milk Slide:
   - Use a dropper to place a small drop of milk onto the center of a clean slide.
   - Carefully place a cover slip over the milk. If there are air bubbles, gently press the cover to remove them.
   - Wipe off any excess milk from the edges with a paper towel.



3. Prepare the Yogurt Slide:
   - Stir the yogurt sample to ensure it's well-mixed.
   - Use a dropper to place a small amount of yogurt onto a clean slide. You may dilute the yogurt slightly with distilled water if it's too thick.
   - Place a cover slip over the yogurt sample, ensuring no air bubbles.



4. Microscope Observation at 40x Magnification:
   - Have students place the milk slide under the microscope.
   - Start at 40x magnification and allow them to adjust the focus.
   - Ask students to observe the milk sample and take notes. They should look for the general structure and any small particles.
   - Next, have them switch to the yogurt slide under 40x magnification.
   - Encourage them to compare the appearance of yogurt with milk. The yogurt may appear more textured and could show clusters of bacteria (though not clearly defined yet).

5. Microscope Observation at 100x Magnification:
   - Switch to 100x magnification.
   - Ask students to refocus on the milk slide. At this higher magnification, they might observe fat globules or small particles more clearly.
   - Now, switch to the yogurt slide at 100x. Here, students may begin to see bacterial cells (like lactobacilli) in the yogurt, which appear as small rod-shaped or spherical structures.
   - Encourage them to compare what they see between the two slides. The yogurt should have far more visible bacterial cells than the milk, which will mostly show fat globules or proteins.

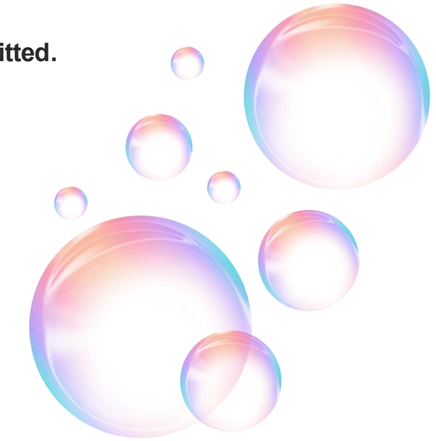
- **Be sure to wear eye and skin protection as needed.**
- Use caution when using microscopes and slides.
- No student, at any time, should touch the agar or the bacteria. When taking pictures, take pictures through the Petri dish.
- When the activity is complete and pictures have been taken of all samples, immediately discard the Petri dishes in a trash container that is securely away from the student population.

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

Activities

Use this activity to teach learners about how diseases can spread or be transmitted.



Activity 3 - Bubble Sickness Game

Play the Bubble Sickness game to teach about indirect disease transmission.

1. Explain to students that today they will be playing a game to see how easily infectious diseases, like the common cold or flu, can spread through a classroom.
2. Define the bubbles as "germs" from a sneeze or cough, helping students visualize how sickness can spread through droplets.
3. Tell students that if a bubble lands on them, they become "sick."
4. Have students spread out and move freely around the room, mimicking real-world interactions.
5. The teacher blows bubbles into the room while students move. The goal is for the bubbles to land on as many students as possible. Move around to simulate how sneezes or coughs can travel unpredictably in different directions.
6. After 30 seconds, ask students to freeze. At this point, any student who was touched by a bubble is now “sick.”
7. Have the "sick" students move to one side of the room, while the “healthy” students (who weren’t touched by a bubble) move to the other side.

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

During the “explain” of a 5E lesson, the teacher clarifies key ideas, introduces formal terminology, and helps students connect their experiences to scientific principles. Here is some suggested language for helping learners understand the concepts in each activity.

Activity 1 - Handy Bacteria

Students studied bacterial growth under these three different conditions: unwashed hand, hand washed with soap and water, and hand disinfected with hand sanitizer.
It can take about 20 minutes for bacterial populations to double in size.
The optimal temperature for growth of most types of bacteria is 37 ºC (98.6 ºF).

- "Earlier, we observed bacteria growth from different types of hand hygiene. Now, let's talk about why we got the results we did. Bacteria need certain conditions to grow, like water, nutrients, and air. When we don’t wash our hands, bacteria have everything they need to thrive. But when we wash with soap or use hand sanitizer, we remove or kill the bacteria, which stops them from growing."
- "Remember when you saw fewer bacteria after washing with soap and water? That’s because soap helps lift dirt and oils, which carry bacteria, off your skin. How did the hand sanitizer plate look? That worked by killing bacteria directly."
- "What we’ve been talking about are conditions that promote or inhibit bacterial growth. When we removed bacteria with soap, we interrupted the environment they needed to survive. The antibacterial gel used disinfectants, chemicals that kill bacteria by breaking down their cell walls."
- "Some of you noticed that even after washing, there were still a few bacteria left. That’s normal. No method is 100% effective, but washing with soap and water is one of the best ways to reduce the spread of germs."

Encourage further discussion with these questions.

- Does anyone have any questions about how bacteria grow or why hand washing helps?
- What do you think would happen if you just rinsed your hands with water without using soap?

Activity 2 - Helpful Bacteria

Observe live bacteria in a probiotic yogurt drink.

In turning milk into yogurt, the bacteria Streptococcus thermophilus ferments the milk.
Fermentation is a process in which a substance is broken down into a simpler chemical, typically in the absence of oxygen.

- "In our activity, you observed the live bacteria in the probiotic yogurt drink. These bacteria are called probiotics. They are actually helpful to your body, particularly for your digestive system. So even though some bacteria can cause illness, others—like these—are good for you. Did you notice anything specific about the bacteria you saw?"
- "The type of bacteria in the yogurt, such as Lactobacillus and Bifidobacterium, are examples of beneficial bacteria. We call them probiotics because they help maintain a healthy balance in our gut, which is part of our digestive system. Your gut is home to trillions of bacteria, and many of them play a role in breaking down food and producing vitamins."
- "Probiotic bacteria work by helping your body digest certain foods that your stomach might not be able to break down on its own. They also help crowd out harmful bacteria, making it harder for bad bacteria to make you sick. So, they keep your gut healthy by balancing the microorganisms that live there."
- "Some of you might be thinking, ‘Aren’t all bacteria bad?’ Actually, only a small percentage of bacteria cause diseases. Most bacteria in our environment are either harmless or helpful. In fact, your body needs certain bacteria to stay healthy, and probiotic foods like yogurt are one way to get them."
- "In fact, probiotic foods add additional helpful bacteria to the millions of bacteria that already live in your body, mostly in the intestines. These bacteria are called your “microbiome”. The balance of bacteria in your microbiome is important for keeping your immune system strong and your body functioning properly."

Encourage further discussion with these questions.

- How are bacteria beneficial to humans?
- Why do you think foods like yogurt and fermented foods contain these types of bacteria?
- Can you think of other ways bacteria are helpful?

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Explain

During the “explain” of a 5E lesson, the teacher clarifies key ideas, introduces formal terminology, and helps students connect their experiences to scientific principles. Here is some suggested language for helping learners understand the concepts in each activity..

Activity 3 - Play the Bubble Sickness game to learn about indirect disease transmission.

Activity source - https://www.nationalgeographic.org/lesson/theres-outbreak/print/

Infectious diseases can spread through contact, particularly airborne droplets (like those from sneezing or coughing).

- “The bubbles represent germs in the air. A sneeze or a cough spreads germs quickly, even without direct contact.”
- “It can be very easy for some sicknesses to spread. Like being close to one another in crowded spaces (like schools, buses, or malls).”

Bubbles Represent Airborne Germs: In the game, the bubbles symbolize tiny droplets carrying germs, which can easily spread through the air via sneezes or coughs.

The Unpredictability of Spread: Just as in real life, not everyone gets sick immediately, but contact with airborne particles increases the chance of infection.

Visualizing Infection: By seeing who gets "infected" by the bubbles, you can visualize how quickly germs can spread in a group setting.

Healthy vs. Sick Groups: Comparing "healthy" and "sick" students helps demonstrate how diseases can spread to some people but not others, depending on exposure.

Encourage further discussion with these questions.

- Why did some students get sick and others didn’t?
- How does this apply to real situations, like a flu outbreak at school?
- What can we do to prevent getting sick?
- Why do doctors recommend staying home when sick?

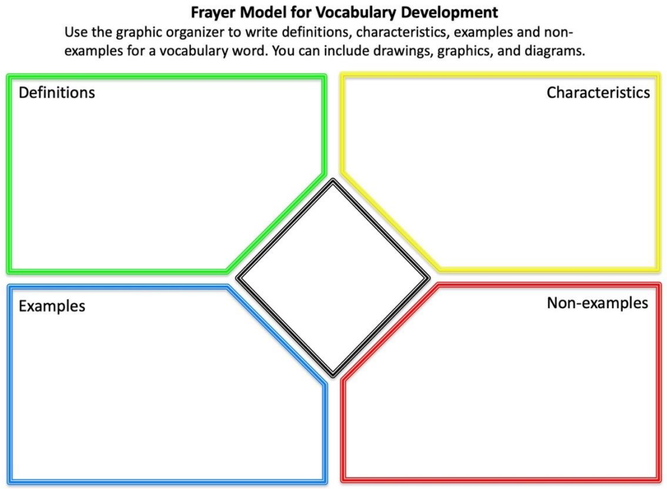
NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

Vocabulary Development

It’s almost impossible to learn science concepts without also learning vocabulary words. Vocabulary words help people discuss science concepts, so they’re important. However, knowing vocabulary words is not the same as understanding science concepts. This section is designed to help your students do more than memorize definitions as they connect the vocabulary to the science concepts that they have explored.

1. Place the term "temperature" in the center of the graphic organizer. (Link to a fillable Frayer Model) Facilitate a discussion with students exploring why this word is key vocabulary to this study.
2. Ask students to brainstorm ***characteristics*** of "temperature" and add responses to the area with the corresponding heading on the graphic organizer.
3. Ask students to continue their exploration as they research the topic using a variety of resources, including their textbook and notes.
4. Next, ask students to add ***examples*** and ***non-examples*** in the Frayer Model. Emphasize the higher-level thinking skill of comparing and contrasting. How are the examples alike/different than the non-examples?
5. Using the information provided, ask students to develop their own ***definition*** of the term "temperature" that is clear and concise.
6. After completing the example together, assign a new vocabulary word to each group of students to work on collaboratively. The group will complete the Frayer Model graphic organizer using their assigned word.
7. Groups will share their Frayer Models and lead discussions to check for understanding of each vocabulary word. Refer to definitions in the Explain section. (Link to Definitions)
8. Compile and post final definitions so all students have access for later reference.



NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Evaluate

Post-Assessment

Check students' understanding with these activities.

1. Identify misconception
2. Discussion questions
3. Vocabulary Review
4. Posttest items are **located here.**

Identify Misconception

What is a common misconception people have about bacteria? How can you correct this misconception?

Discussion Question(s)

Where can you find bacteria?
What role do bacteria play in the environment and/or with people?

NASA Spotlite Videos

Re-watch the video clips about bacteria. How did your explorations of the topic confront the misconceptions presented in the videos?

Vocabulary Review

Use the new vocabulary you have learned to answer these questions.

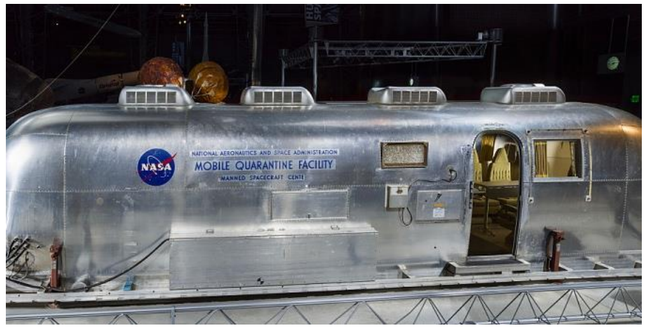
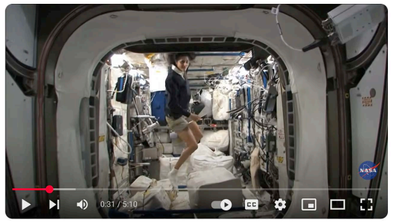
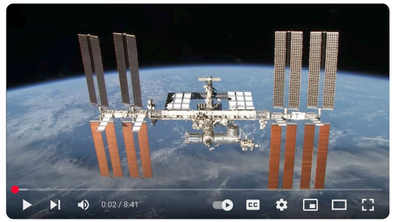


Image credit: NASA

1. Before traveling into space astronauts are quarantined or kept away from other people for a week. Why do you think this protocol is part of the process?



https://youtu.be/tBVUTFPate0



https://youtu.be/ntYP7cRozhk

International Space Station Tour
https://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html

2. Where on the International Space Station would you expect more microbes to be found? Where would you expect to find the least amount of microbes?

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Evaluate

Pretest & Posttest -- Answer Key

1. Which of the following is true about bacteria?
a) All bacteria are harmful.
b) Bacteria are always visible to the naked eye.
c) Bacteria are not found in our bodies.
d) Bacteria can have various shapes, sizes, and functions. ***

2. Which of the following is NOT a characteristic used to describe different bacterial species?
a) Shape
b) Color
c) Size
d) Movement ***

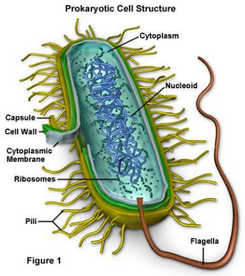
3. Which of the following is a true statement?
a) Bacteria only grow in darkness.
b) Hand sanitizer does not kill 100 % of bacteria on your hands. ***
c) It takes about 20 minutes for a bacteria population to double in size.
d) Bacteria are only found in unsanitary environments.

4. Which genus of bacteria is responsible for turning milk into yogurt and cheese?
a) Lactobacillus ***
b) Escherichia
c) Salmonella
d) Clostridium

5. How do bacteria primarily spread among humans?
a) Through the air
b) By touching contaminated surfaces ***
c) Through drinking water
d) All of the above

6. In which of the following locations would you most likely find extremophiles?
a) Your kitchen
b) A garden
c) A volcano's hot spring ***
d) A library

7. What is the main purpose of the bacterial cell wall?
a) Energy production
b) Protection and structural support ***
c) Reproduction
d) Photosynthesis



8. Where can bacteria be found in the environment?
a) Only in soil
b) Only in water
c) Virtually everywhere on Earth ***
d) Only in the air

9. Where do bacteria live in your body?
a) Only on the skin
b) Only in the intestines
c) Only in the mouth
d) **All of the above *****

10. Where do some bacteria, like those involved in sewage treatment, thrive and help break down organic matter?
a) In freshwater lakes ***
b) In the stratosphere
c) In the vacuum of space

11. What is the term to describe organisms like bacteria that can survive in harsh environments?
a) Fish
b) Mammals
c) Plants
d) Extremophiles *****

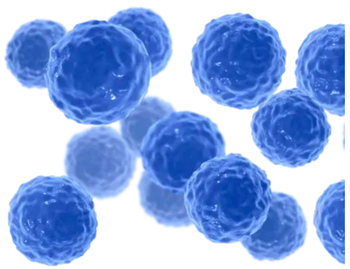
12. Where can you commonly find bacteria that produce yogurt and sourdough bread?
a) On Mars
b) In the depths of the ocean
c) In dairy products and fermented foods ***
d) On the surface of the Moon

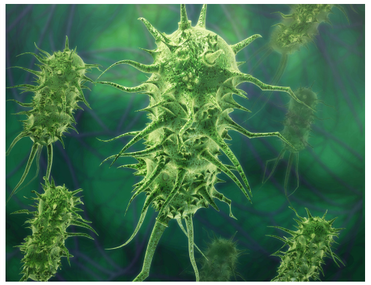
NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Engage


True or False?

All bacteria are harmful.



NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Engage

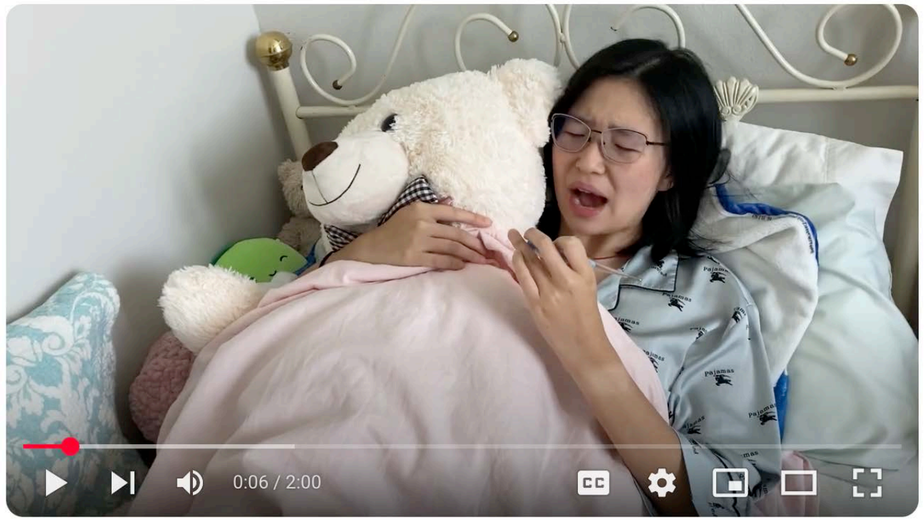
Today's Lesson

In today's lesson you will learn that some bacteria are beneficial, while others can be harmful. As a result of watching Spotlite videos, learning the vocabulary collaboratively, and exploring how bacteria grow, you will be able to explain where bacteria can be found and describe the positive and negative roles they play in our lives.

NASA Spotlite Videos

Watch these video clips about bacteria. As you watch, identify a misconception about whether all bacteria are harmful.

NASA Spotlite: Bacteria, Friend or Foe?
Link - https://youtu.be/ptHblVCcwXk



NASA Spotlite: The Spread of Diseases
Link - https://youtu.be/gmfWXZ2RxVw

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Engage

Class Discussion

- How do bacteria play a significant role in our world, either positive or negative?
- How do bacteria reproduce, and why is it important to understand this process?
- How might the study of bacteria help us prepare for future space exploration, including missions to Mars or beyond?

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

Activities

Microorganisms like bacteria are all around us and we can study how quickly they grow. Complete some activities to explore where and how bacteria grow.

- **Be sure to wear eye and skin protection as needed.**
- Use caution when using microscopes and slides.
- As soon as the plates have been streaked and the Petri dish lid replaced, apply two pieces of tape to keep the lids connected; however any closure should not be made air-tight so air can still circulate freely inside the plate.
- No student, at any time, should touch the agar or the bacteria. When taking pictures, take pictures through the Petri dish.
- When the activity is complete and pictures have been taken of all samples, immediately discard the Petri dishes in a trash container that is securely away from the student population.

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

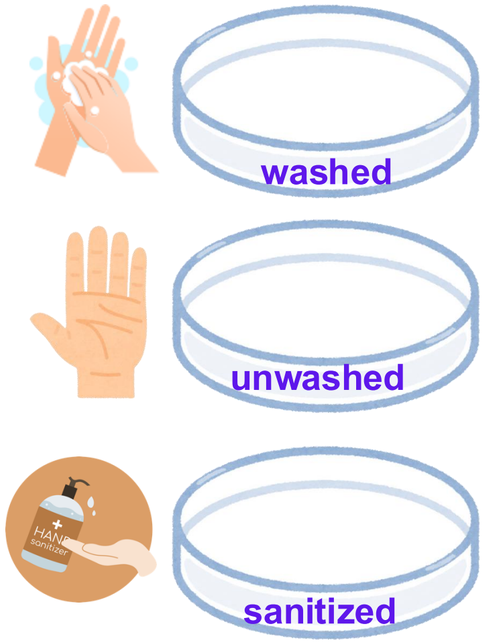
Explore

Activities

Microorganisms like bacteria are all around us and we can study how quickly they grow. Complete some activities to explore where and how bacteria grow.

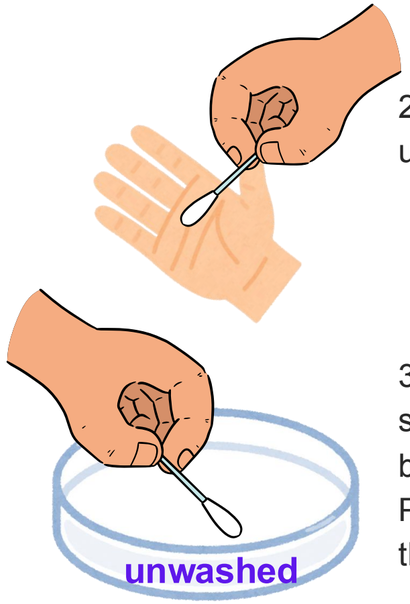
Activity 1 - Handy Bacteria

Study three different conditions under which bacteria are found and compare the growth of the individual bacteria from each source: 1) an unwashed hand, 2) a hand washed with soap and water, and 3) a hand sanitized with antibacterial gel.



1. Label the lids for each Petri dish containing agar. Label one Petri dish “washed,” one “unwashed,” and one “sanitized.”

(You can create your own agar. Directions are in the references and resources section.)



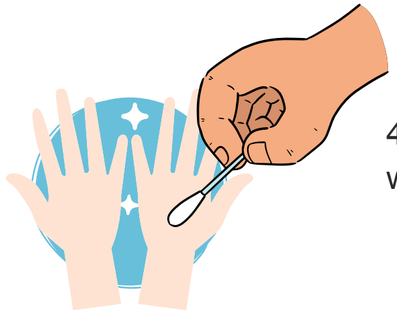
2. Rub a clean cotton swab on the unwashed hand.

3. Then gently rub the cotton swab sample from the unwashed hand back and forth on the agar in the Petri dish labeled “unwashed.” Tape the lid on the dish.

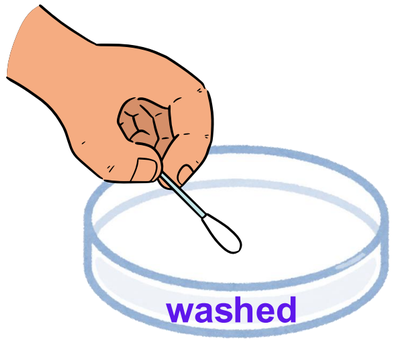
NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

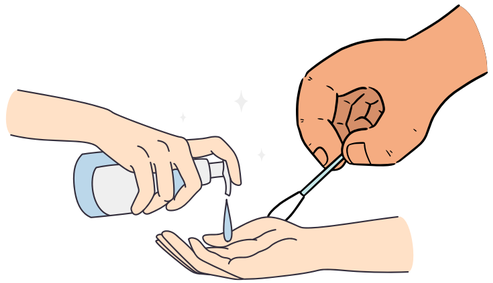
Activity 1 - Handy Bacteria (Continued)



4. Rub a clean cotton swab on the washed hand.



5. Then gently rub the cotton swab sample from the washed hand back and forth on the agar in the Petri dish labeled “washed.” Tape the lid on the dish.



6. Rub a clean cotton swab on the hand sanitized with antibacterial gel.

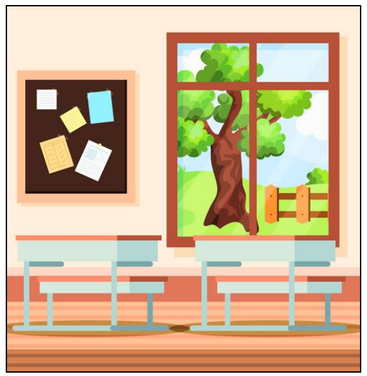
7. Then gently rub the cotton swab sample from the sanitized hand back and forth on the agar in the Petri dish labeled “sanitized.” Tape the lid on the dish.

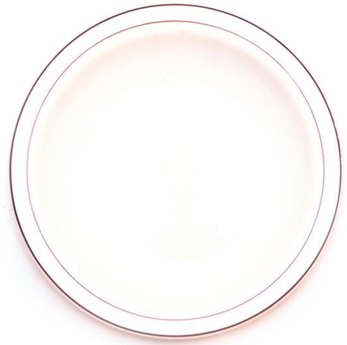
NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

Activity 1 - Handy Bacteria (Continued)

8. Place the Petri dishes in a well-ventilated warm area -- between 22 ºC (72 ºF) and 37 ºC (99 ºF), in the dark. Petri dishes need to be placed upside down (i.e. lid on the bottom) to avoid condensation. Make and record observations every day for 5 to 10 days.

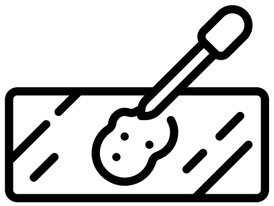


Write a description of the bacterial culture.	Sketch the bacterial culture. Use colored pencils when appropriate.
Date: Time: Temperature: Shape and color: Other:	Sample Name: 

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

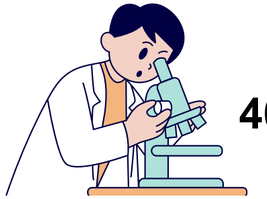
Explore

Continue to explore where and how bacteria grow.
Activity 2 - Good Bacteria
Observe live bacteria in a probiotic yogurt drink.



1. Place about 1 ml of probiotic yogurt drink on a microscope slide with a drop of water. Cover with a cover slip.

2. Place the prepared slide on the microscope, and adjust the magnification to 40x. Record observations.



40 X

3. Adjust the magnification to 100x. Record observations.

100 X

Write a description of what is viewed at each magnification.	Sketch the bacterial culture. Use colored pencils when appropriate.
Magnification: Description:	
Magnification: Description:	
Magnification: Description:	

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

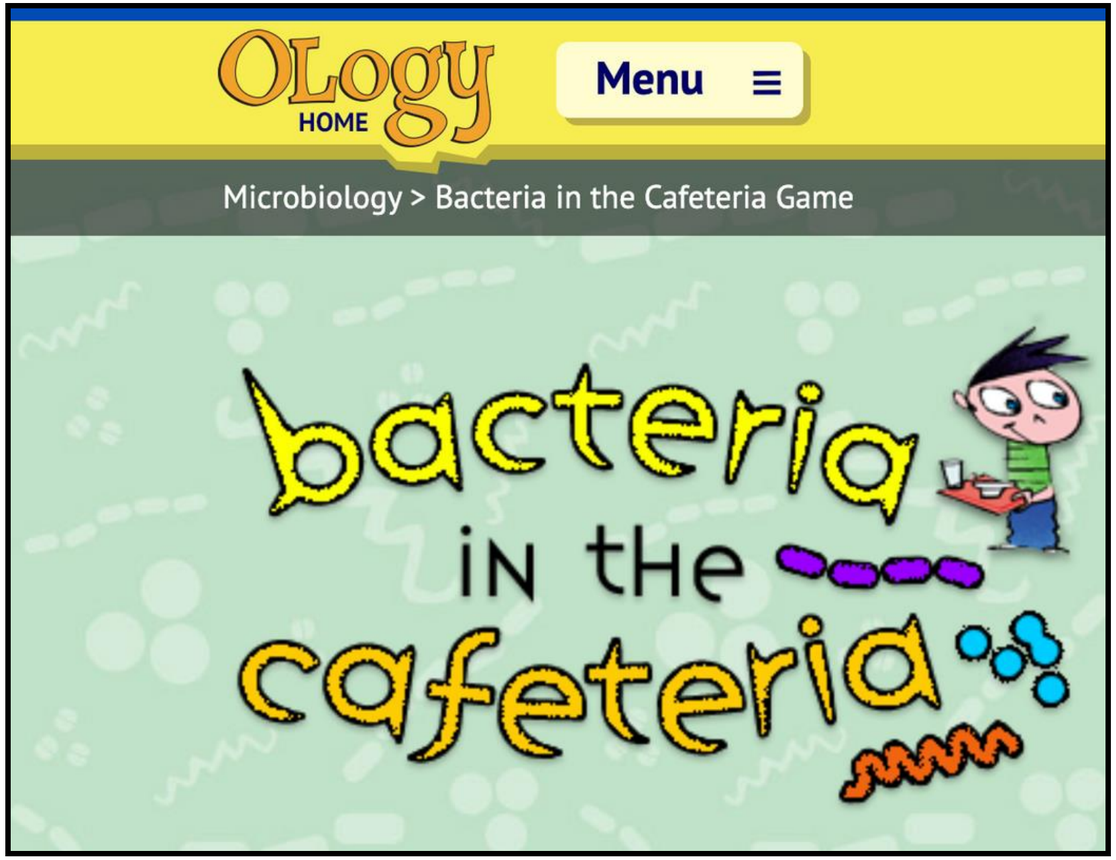
Explore

Activities

Continue to explore where and how bacteria grow.

Alternate Virtual Activity

Use this interactive game created by the American Museum of Natural History to learn about the different kinds of microbes and where they can be found.



https://www.amnh.org/explore/ology/microbiology/bacteria-in-the-cafeteria-game

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

Continue to explore where and how bacteria grow.

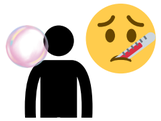
Activity 3 - Play the Bubble Sickness game to learn about indirect disease transmission.

Activity source - https://www.nationalgeographic.org/lesson/theres-outbreak/print/

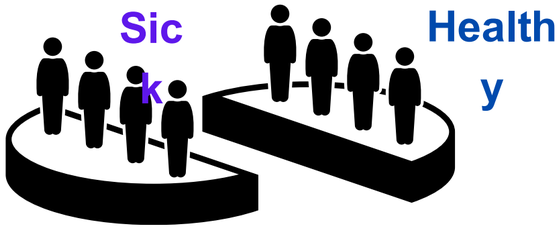
Your teacher is sick with “Bubble Sickness.” The teacher promises not to touch anyone as long as they are sick with “Bubble Sickness.” However, if one of the bubbles lands on someone, that person becomes “sick.”

1. When the teacher says “go,” wander around the room.

As you wander, the teacher will blow bubbles in your direction. 

If a bubble lands on someone, that person becomes “sick.” 

2. When you hear the teacher say “stop,” if you are “sick,” stand on one side of the room reserved for sick students. The healthy students stand on the other side of the room.



3. Write down your observations.
What can the bubbles represent?
What do you expect would happen if you continued playing the game?

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explore

Continue to explore where and how bacteria grow.

Activity 4 - Play the High Five game to learn about direct contact disease transmission.

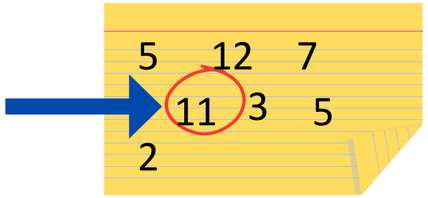
Activity source - https://www.nationalgeographic.org/lesson/theres-outbreak/print/

1. You are assigned a number.
   1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 or 12.
2. You need an index card and a pencil or pen.
3. When the teacher says go, walk through the room.

4. When you encounter another student, give the student a high five and write the student's number down on your index card.
5. Do this until the time is up. Return to your seats.

6. Have someone roll a set of two dice. Anyone who was assigned that number was infected with the "High Five" sickness.
7. Look at your card. Anyone who has that rolled number on their card has now been infected.

infected number



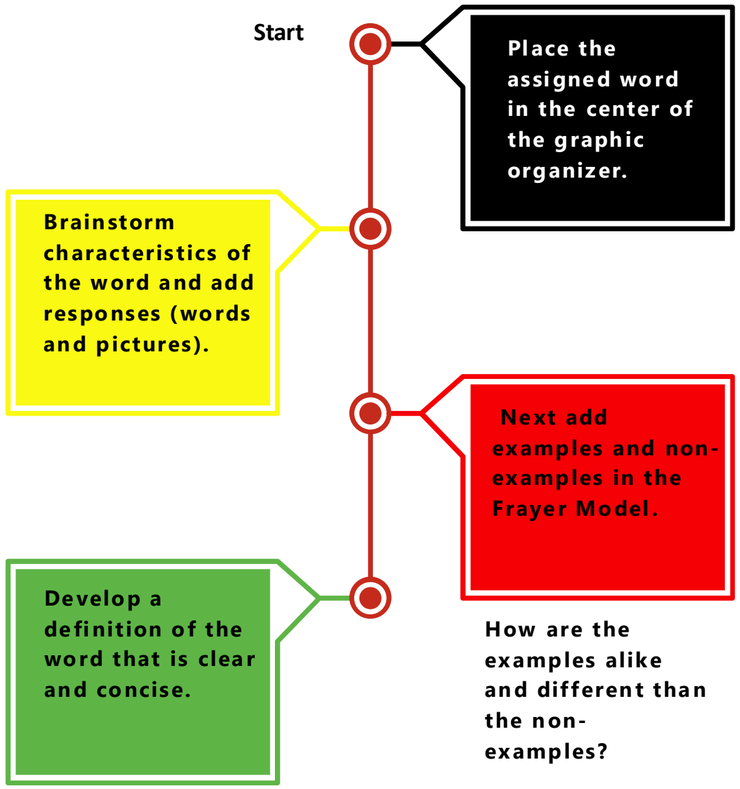
8. Write down your observations.
   What did you learn about how diseases can be transmitted?

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

Vocabulary Development

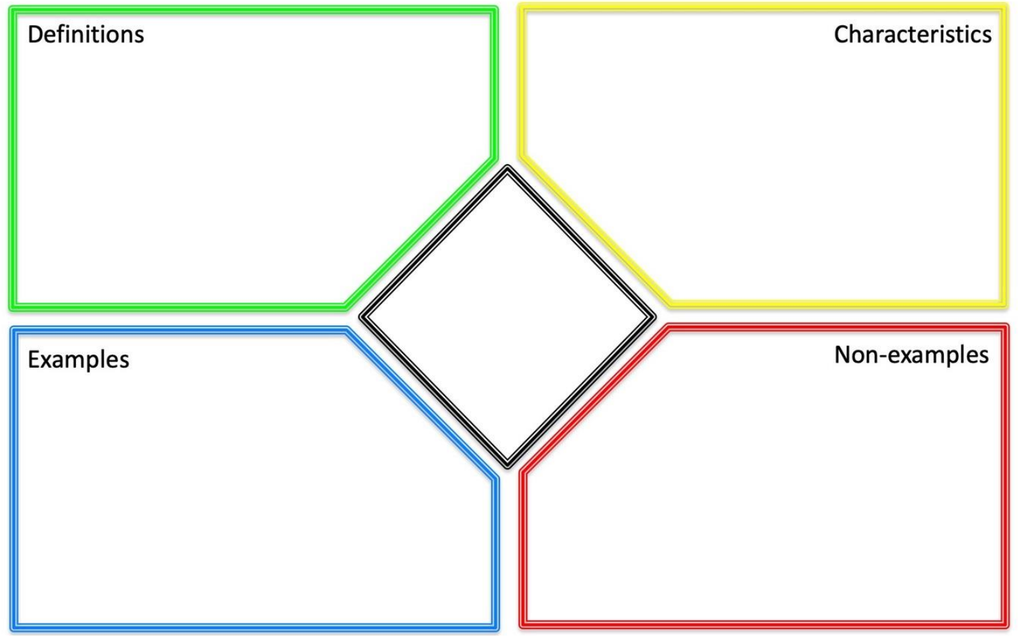
It's almost impossible to learn science concepts without also learning vocabulary words. Vocabulary words help people discuss science concepts.



Complete a Frayer Model with your group using your assigned word and fill in the graphic organizer. We will share some as a class.

Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



NASA Spotlite Interactive Lesson: Does Land Cover Matter?

Explain

Vocabulary Development

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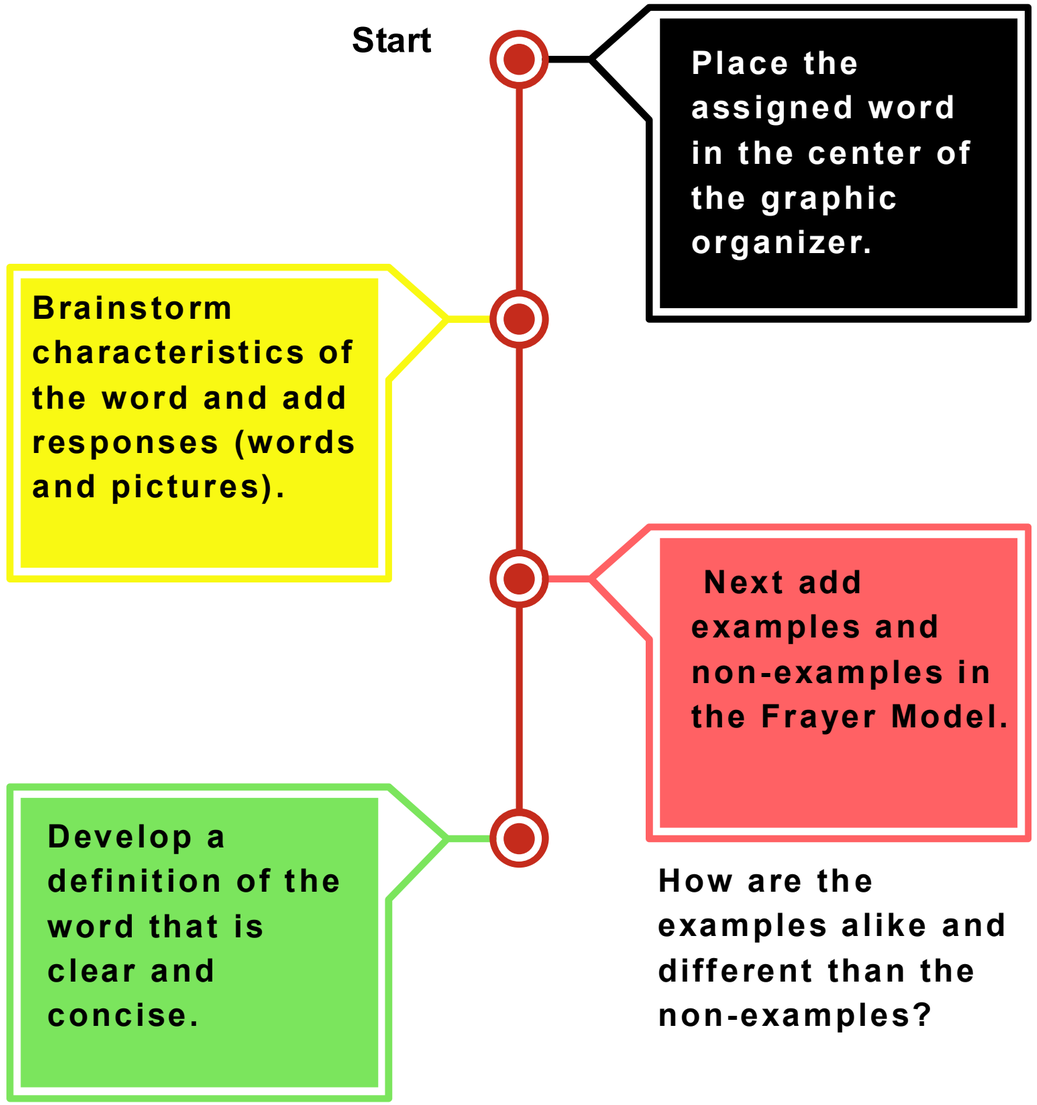

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

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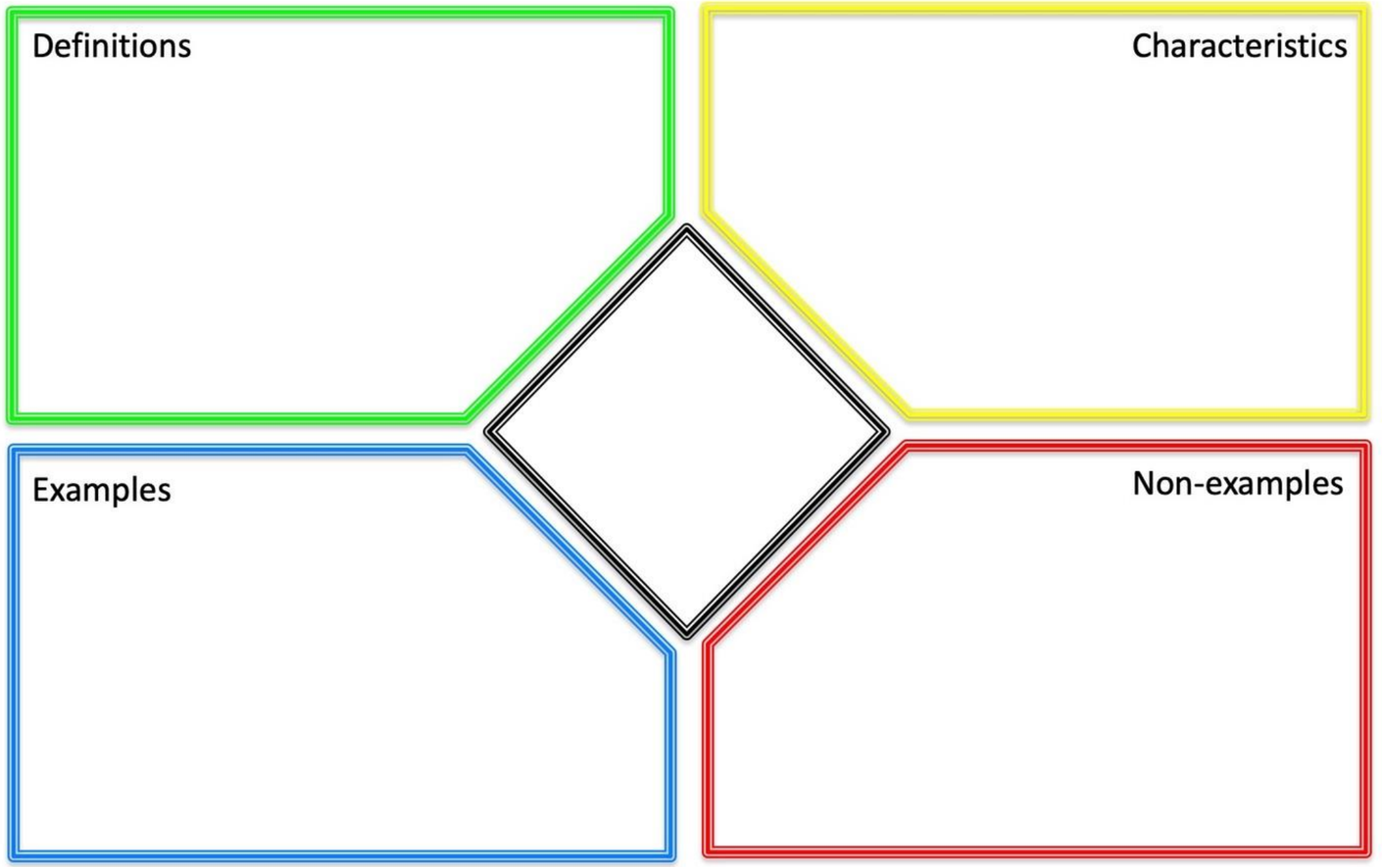


NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

Vocabulary Words

active cultures: also called a live culture; a colony of living microorganisms (e.g. bacteria), growing within a substance such as yogurt

bacteria: plural form of bacterium; any of a group of single-celled microorganisms that live in soil, water, organic matter, or the bodies of plants and animals and are important because of their chemical effects and as a cause of disease

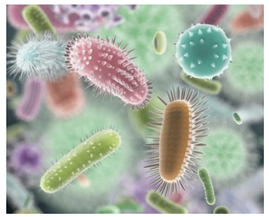


Image credit: Canva

colony: a visible cluster of bacteria

Image credit: Canva

eukaryotic: a cell that has a nucleus

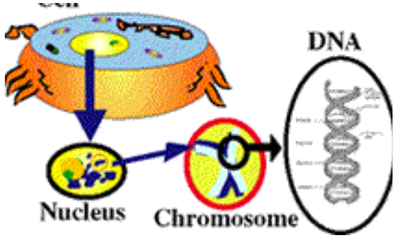


Image credit: https://www.smorescience.com/

fermentation: a food-based reaction caused by the action of enzymes that breaks compounds into simpler substances; used for food preservation and preparation

Image credit: NASA

fission: one cell divides into two, which is how bacteria reproduce

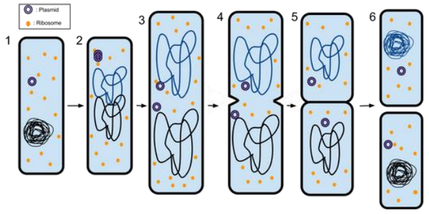


Image credit: https://simple.wikipedia.org/wiki/Binary_fission

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

Vocabulary Words

Microbes: tiny living things that are found all around us and are too small to be seen by the naked eye. They live in water, soil, and in the air. The human body is home to millions of these microbes, also called microorganisms.

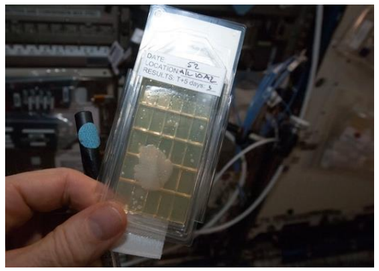


Image credit: NASA

pathogen: disease-carrying agents that can pass from one individual to another, both in humans and animals

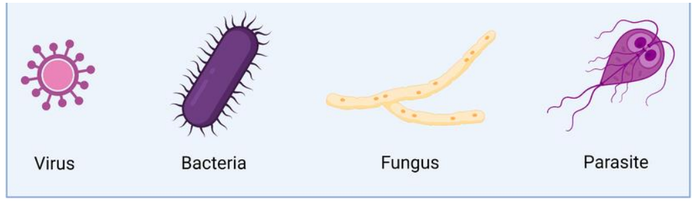


Image credit: https://www.smorescience.com/

prokaryotic: a cell that lacks a nucleus; bacteria are prokaryotic

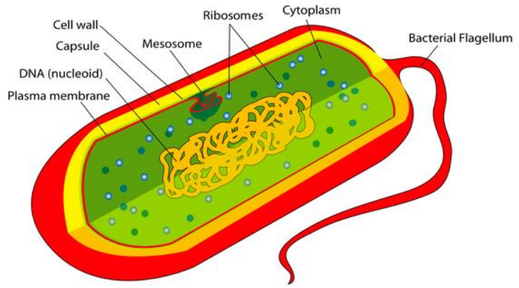


Image credit: https://simple.wikipedia.org/wiki/Prokaryote

sanitary: free from direct and/or bacteria; healthy and clean

Image credit: Canva

transmit: something is spread or passed from one person or thing to another

Image credit: https://minnesota.agclassroom.org/matrix/lesson/791/

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

Bacteria Cell

Bacterial cell walls are important and have quite a few functions. They help bacteria maintain their shape and keep them from bursting. They control molecules going in and out of the cell. Scientists can use the thickness of the cell wall to identify and categorize different types of bacteria.

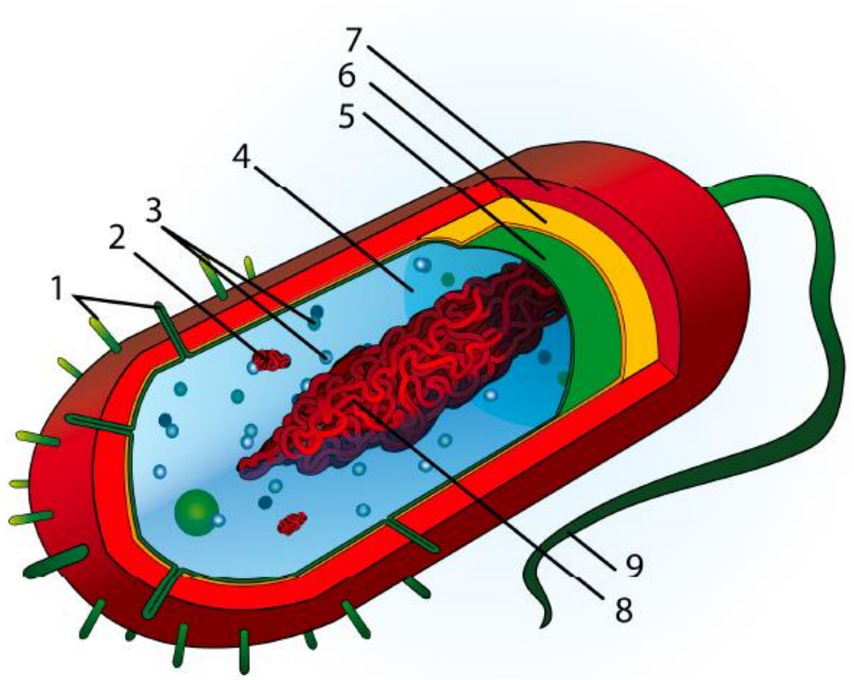


Image Credit: Wikimedia Commons

1. Pili - hair-like structures that help bacteria attach to surfaces and other bacteria
2. Plasmids - genetic material (DNA)
3. Ribosomes - structures that make proteins
4. Cytoplasm - a gel-like material in which the ribosomes and genetic material are suspended
5. Cytoplasmic Membrane - a thin layer of phospholipids and proteins that controls the movement of nutrients in and out of the cell
6. Cell Wall - a rigid wall that gives the cell its structure and protects the plasma membrane
7. Capsule - a third layer that helps prevent the bacteria from drying out or being engulfed by larger microorganisms (only present in some types of bacteria)
8. Nucleoid - a mass of genetic material (DNA)
9. Flagellum - a structure that helps the bacterium move around and sense its environment

Source:
https://letstalkscience.ca/educational-resources/backgrounders/introduction-bacteria

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

Microbiology 101: Where People Go, Microbes Follow

Read the article and watch the video about how NASA studies microbes on the International Space Station.

Wherever there are humans, there are microbes, too. Bacteria and fungi live all around us, in our homes, offices, industrial areas, the outdoors – even in space. People literally could not live without these tiny organisms, many of which are beneficial.

The trick is limiting the number of potentially harmful ones, particularly in a contained environment such as a spacecraft. From the launch of the very first module of the **International Space Station**, NASA has monitored its microbial community.

Because the station is an enclosed system, the only way that microbes get there is hitching a ride on the contents of resupply spacecraft from Earth and on arriving astronauts. The NASA Johnson Space Center **Microbiology Laboratory** puts a lot of effort into knowing which microbes ride along.

"We can't sterilize everything we send into space and don't want to, but we do a lot to limit potential pathogens from making their way to the station," says NASA microbiologist Sarah Wallace, Ph.D. "At launch, the cargo, food, vehicles, and crew members each have their own microbiome or suite of microbes. When everything gets to the station, these microbiomes become part of the space station microbiome."

Link to full article - https://www.nasa.gov/mission_pages/station/research/news/microbiology-101-space-station-microbes-research-iss

NASA ScienceCasts: Station Science 101 - Monitoring Microbes for Astronaut Health
Link to video - https://youtu.be/_K-oS6sJDoY?si=3zpKQNSUDFtXL8gY

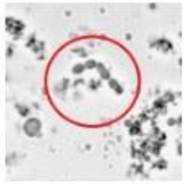
NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Explain

Yogurt - The Chemistry Behind its Fermentation

There are two bacteria used in yogurt production

How yogurt bacteria positively interact

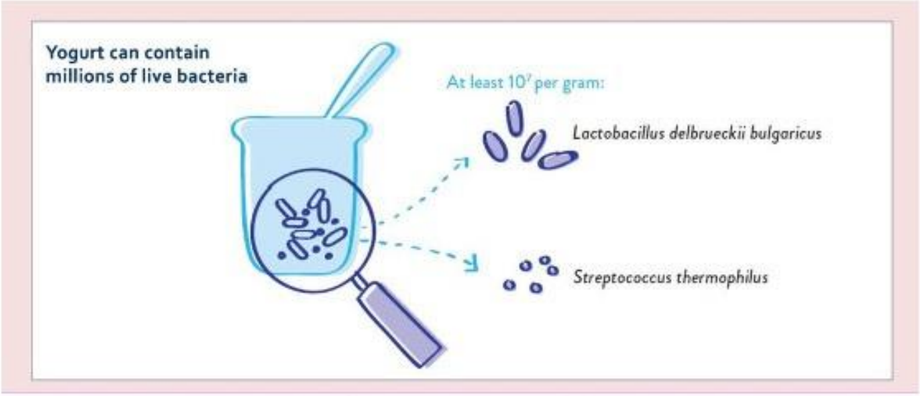


Streptococcus thermophilus (S. thermophilus) – Grows first in a a neutral, high-oxygen environment like milk. This helps to create conditions that allow L. bulgaricus to develop.

Image Credit: Wikimedia Commons

Lactobacillus delbrueckii bulgaricus (L. bulgaricus) – Breaks some of the proteins in milk down into amino acids. This makes it easier for S. thermophilus to collect the nutrients to keep growing.

Image Credit: Wikimedia Commons



Source: "**Yogurt for Health: 10 evidence-based conclusions** to mark the 5th anniversary of the Yogurt In Nutrition Initiative" - June 2018

www.yogurtinnutrition.com
@YogurtNutrition

Image Credit: CC BY-NC

Getting the right consistency

Both bacterial strains transform the lactose of milk into lactic acid. The proteins found in milk called caseins clump together and form a thicker substance: yogurt!

Image Credit: CC BY-NC

Stopping the fermentation process: lower the temperature

Lower temperatures slow the growth of the two bacteria and prevent yogurt from becoming more acidic.

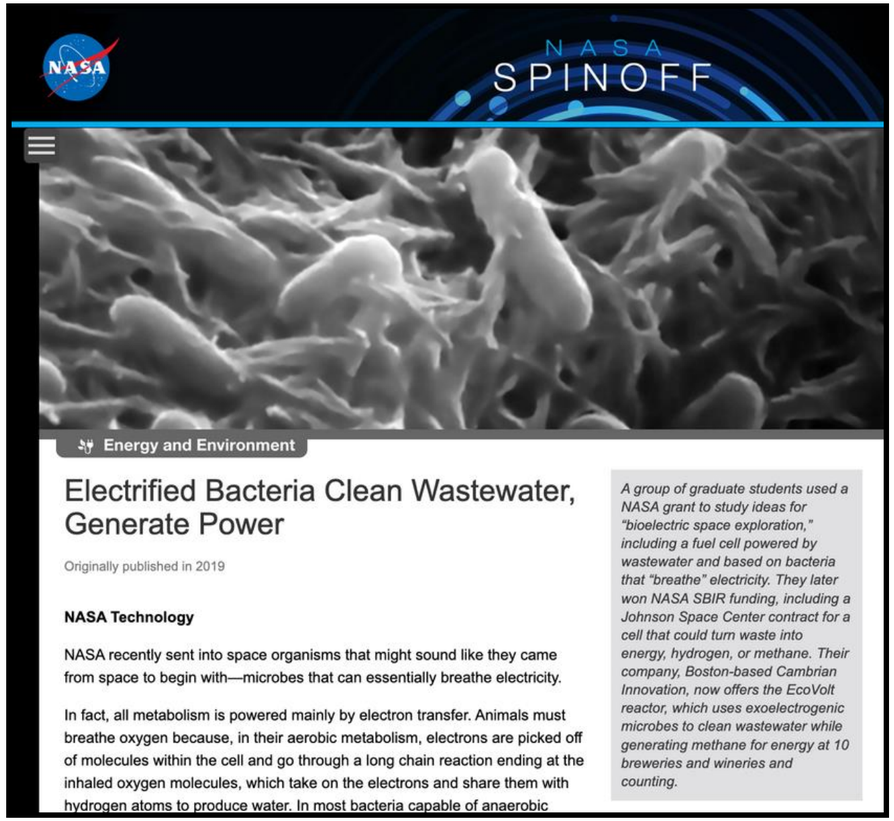
Source: Food Unfolded, https://www.yogurtinnutrition.com/ Yogurt in Nutrition Initiative for Sustainable and Balanced Diets

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

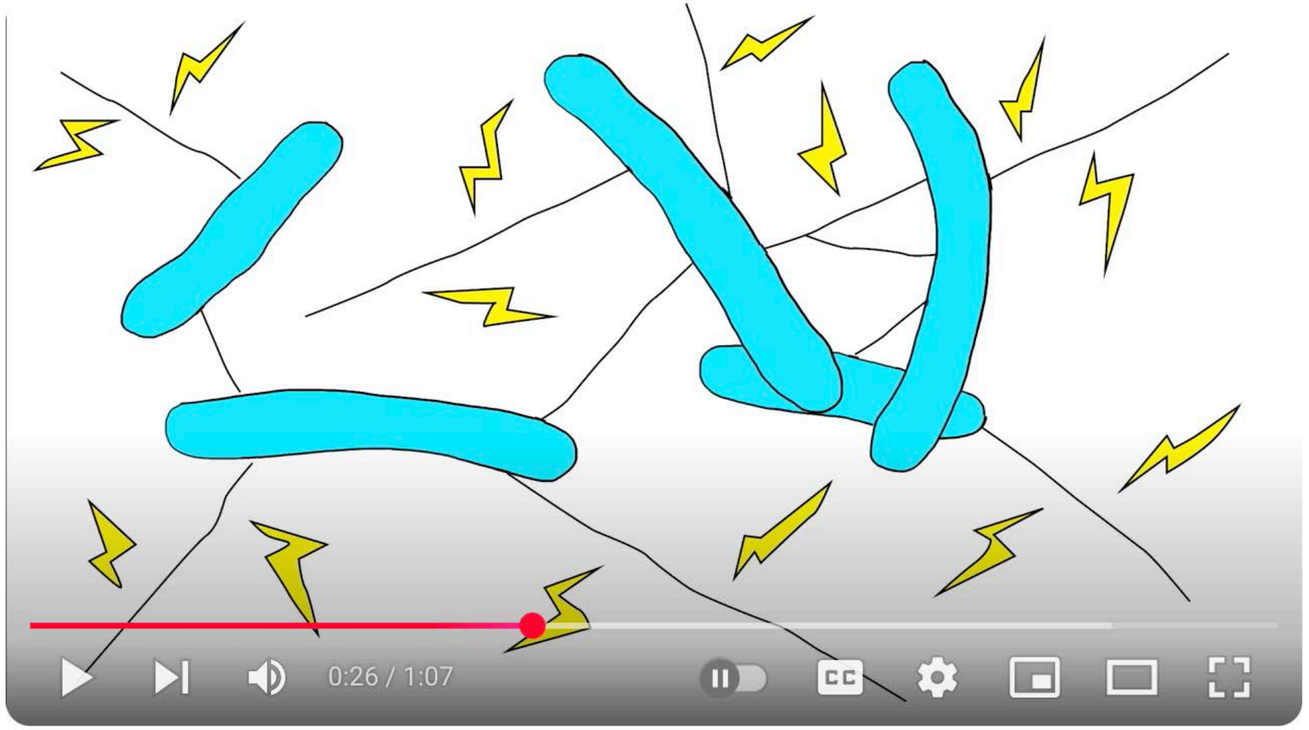
Extend

NASA Connection

Read the article and watch the video to learn about the beneficial uses for bacteria.



https://spinoff.nasa.gov/Spinoff2019/ee_1.html



How Bacteria That Make Electricity Could Help Us Colonize Mars https://youtu.be/KhsCg7pmv0o?feature=shared

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

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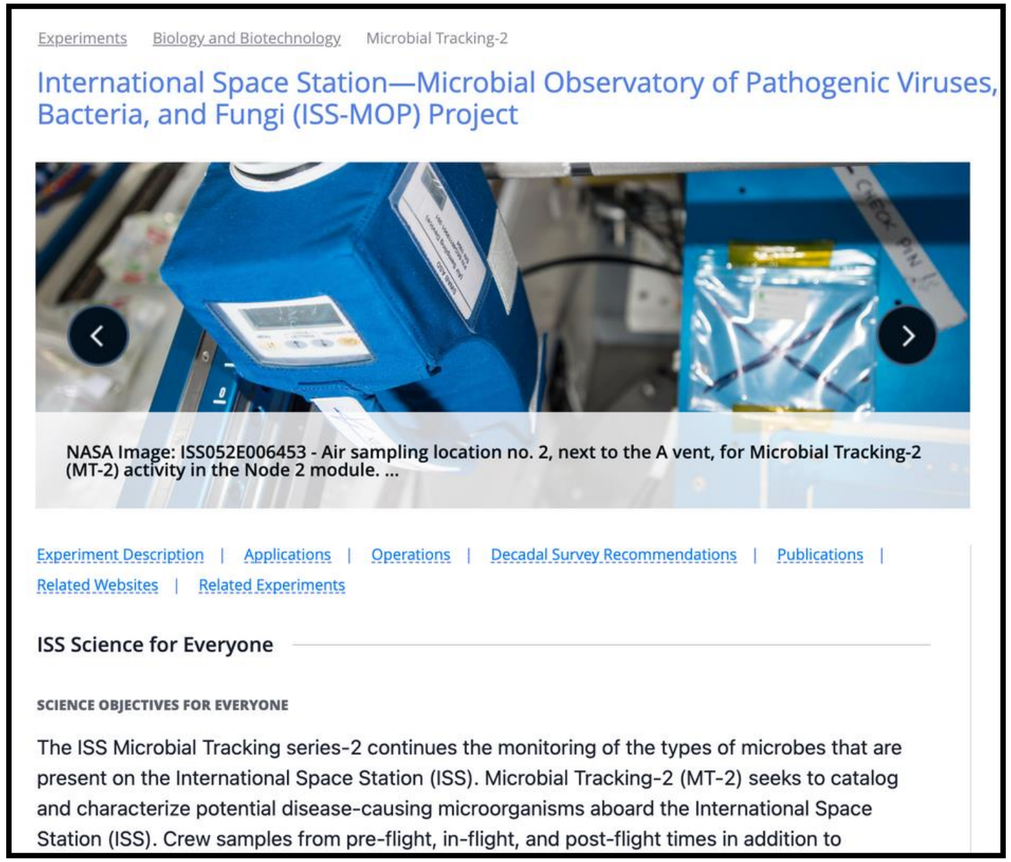


https://www.nasa.gov/mission_pages/station/research/experiments/explorer/Investigation.html#id=1663

Our World: What is an Extremophile?
https://youtu.be/DVox3i1pcpQ?feature=shared

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Extend

NASA Connection

Watch the videos to extend your knowledge of cells and to learn about Dr. Egle Cekanaviciute, a space biologist.

Real World: Small Systems Count - Cells in Space
https://youtu.be/15Z9zuWlMLA?feature=shared

Ask SME: Space Biologist - Egle Cekanaviciute
https://youtu.be/EIcrmcgCeQg

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Evaluate

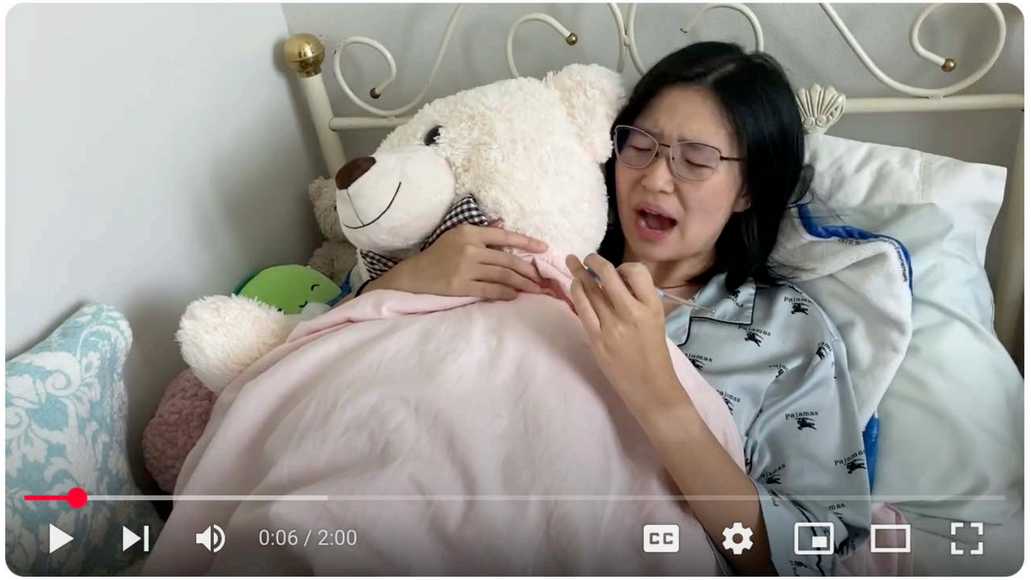
Identify Misconception

What is a common misconception people have about bacteria? How can you correct this misconception?

NASA Spotlite Videos

Re-watch the clips about bacteria.

NASA Spotlite: Bacteria, Friend or Foe?
Link - https://youtu.be/ptHblVCcwXk



NASA Spotlite: The Spread of Diseases
Link - https://youtu.be/gmfWXZ2RxVw

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Evaluate

Vocabulary Review

Use the new vocabulary to answer these questions.

International Space Station Tour - https://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html

1. Before traveling into space astronauts are quarantined or kept away from other people for a week. Why do you think this protocol is part of the process?

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

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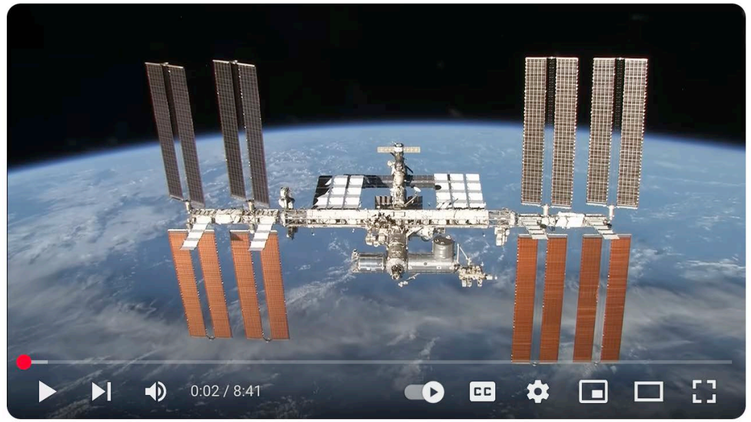
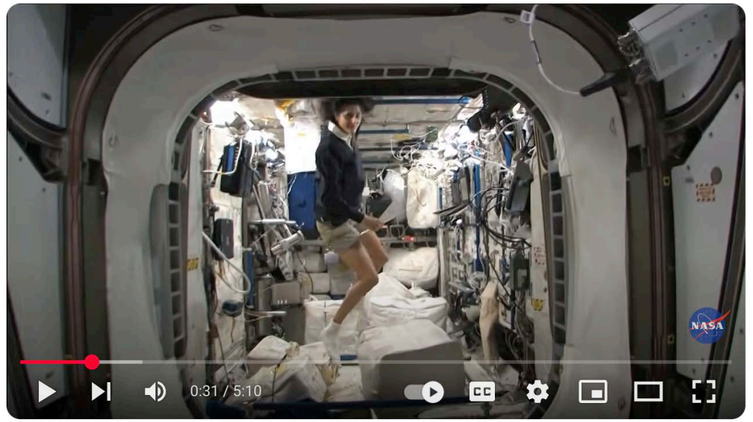
Vocabulary Review

Use the new vocabulary to answer these questions.



Station Tour: Harmony, Tranquility, Unity
https://youtu.be/tBVUTFPate0



Station Tour: Destiny, Columbus, Kibo
https://youtu.be/ntYP7cRozhk

2. Where on the International Space Station would you expect more microbes to be found? Where would you expect the least amount of microbes?

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

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Pretest & Posttest

1. Which of the following statements is true about bacteria?
a) All bacteria are harmful.
b) Bacteria are always visible to the naked eye.
c) Bacteria are not found in our bodies.
d) Bacteria can have various shapes, sizes, and functions.

2. Which of the following is NOT a characteristic used to describe different bacterial species?
a) Shape
b) Color
c) Size
d) Movement

3. Which of the following is a true statement?
a) Bacteria only grow in darkness.
b) Hand sanitizer does not kill 100 % of bacteria on your hands.
c) It takes about 20 minutes for a bacteria population to double in size.
d) Bacteria are only found in unsanitary environments.

4. Which genus of bacteria is responsible for turning milk into yogurt and cheese?
a) Lactobacillus
b) Escherichia
c) Salmonella
d) Clostridium

5. How do bacteria primarily spread among humans?
a) Through the air
b) By touching contaminated surfaces
c) Through drinking water
d) All of the above

6. In which of the following locations would you most likely find extremophiles?
a) Your kitchen
b) A garden
c) A volcano's hot spring
d) A library

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Evaluate

Pretest & Posttest

7. What is the main purpose of the bacterial cell wall?
a) Energy production
b) Protection and structural support
c) Reproduction
d) Photosynthesis

8. Where can bacteria be found in the environment?
a) Only in soil
b) Only in water
c) Virtually everywhere on Earth
d) Only in the air

9. Where do bacteria live in your body?
a) Only on the skin
b) Only in the intestines
c) Only in the mouth
d) All of the above

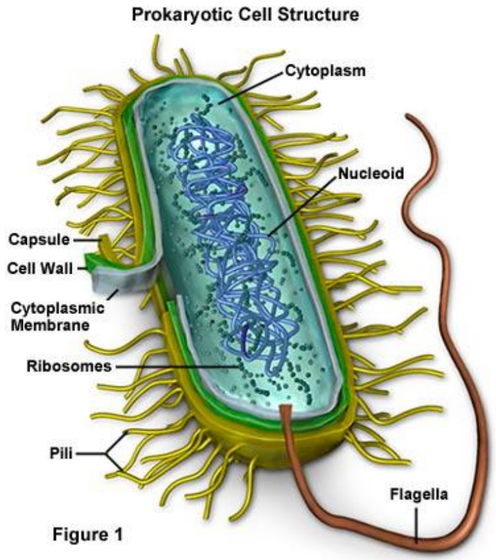


Figure 1

10. Where do some bacteria, like those involved in sewage treatment, thrive and help break down organic matter?
a) In freshwater lakes
b) In the stratosphere
c) In the vacuum of space

11. What is the term to describe organisms like bacteria that can survive in harsh environments?
a) Fish
b) Mammals
c) Plants
d) Extremophiles

12. Where can you commonly find bacteria that produce yogurt and sourdough bread?
a) On Mars
b) In the depths of the ocean
c) In dairy products and fermented foods
d) On the surface of the Moon

NASA Spotlite Interactive Lesson: Bacteria, Friend or Foe?

Engage | Explore | Explain | Extend | Evaluate

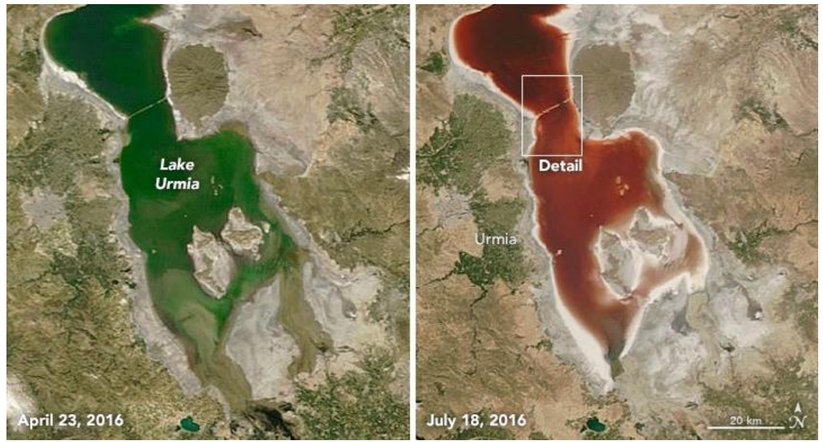


Image Credit: Landsat Image Gallery
https://landsat.visibleearth.nasa.gov/view.php?id=88395

Like the Aral Sea, Iran's salty Lake Urmia has shrunk rapidly during the past few decades. As it grows smaller, the lake grows saltier. And as it grows saltier, microscopic organisms are periodically turning the water striking shades of red and orange.

References and Resources :

Bacteria Are Everywhere! Teach Engineering
https://www.teachengineering.org/activities/view/nyu_bacteria_activity1

Bacteria in the Cafeteria. American Museum of Natural History
https://www.amnh.org/explore/ology/microbiology/bacteria-in-the-cafeteria-game

Cell Size and Scale. Learn Genetics
https://learn.genetics.utah.edu/content/cells/scale/

Inside a Cell. Learn Genetics
https://learn.genetics.utah.edu/content/cells/insideacell20/

Introduction to Bacteria. Let's Talk Science
https://letstalkscience.ca/educational-resources/backgrounders/introduction-bacteria

PROBIOTICS – 40 Health Benefits of Probiotics and 20 Top Probiotic Foods
https://ecosh.com/probiotics-40-health-benefits-of-probiotics-and-20-top-probiotic-foods/

The Gram Stain. Virtual Interactive Bacteriology Laboratory. Michigan State University
https://learn.chm.msu.edu/vibl/content/streakplate.html

There's an Outbreak! National Geographic.
https://www.nationalgeographic.org/lesson/theres-outbreak/print/

Yogurt Cultutres. Science Buddies
https://www.sciencebuddies.org/science-fair-projects/project-ideas/MicroBio_p010/microbiology/yogurt-cultures

Yogurt- The chemistry behind its fermentation. Yogurt in Nutrition Initiative for Sustainable and Balanced Diets
https://www.yogurtinnutrition.com/

NASA eClips

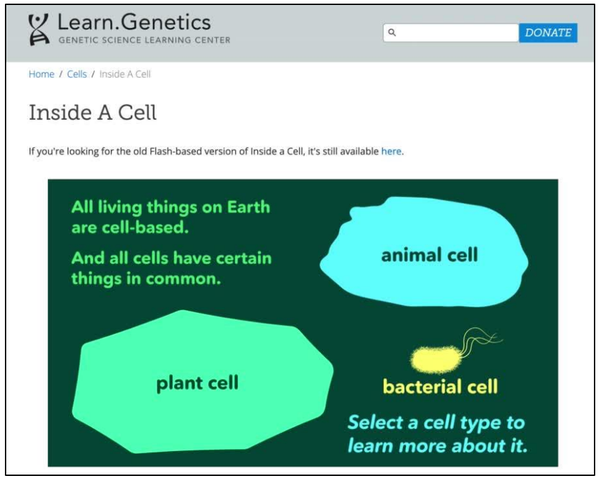
National Institute of Aerospace

Agar Alternative

In place of agar, use beef broth or bouillon and gelatin. Here are directions to create the gelatin mix.

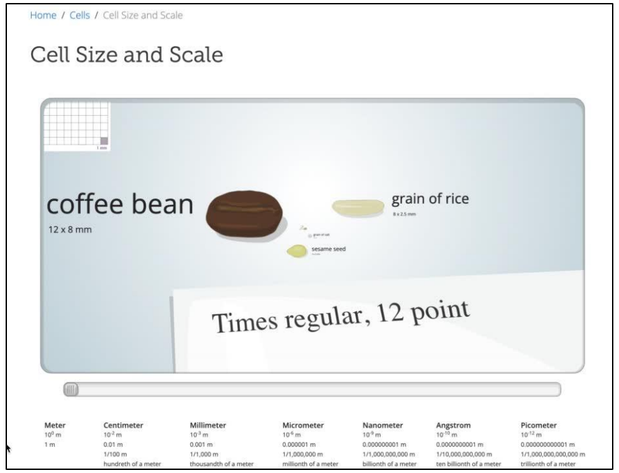
1. Add 4 cups of cold water to a saucepan.
2. Mix in 4 packets of powdered gelatin.
3. Mix in 4 beef bouillon cubes.
4. Mix in 4 teaspoons of sugar.
5. Bring slowly to a boil, stirring frequently.
6. Turn off heat, let cool for 5 minutes.

See parts of a cell with this interactive from the University of Utah.



https://learn.genetics.utah.edu/content/cells/insideacell20/

Compare the sizes of cells to other objects using this interactive from the University of Utah.



https://learn.genetics.utah.edu/content/cells/scale/