Should Food Have Bacteria?

Middle School, Life Science

Task Overview

In this task, students will develop an explanation for how one organism's population growth in an ecosystem may cause the population growth of other organisms in the same ecosystem to decrease. First, students will explore ecosystems in food composed of living bacteria and determine which bacteria are safe and which can be harmful if present in food. Next, students investigate how the presence of safe bacteria, such as *lactobacillus*, can prevent harmful bacteria from forming on food.

Background Information

Food can be thought of as an ecosystem. Bacteria, of many types, are the primary living organisms interacting in food ecosystems. Some food bacteria are safe for humans to eat while others are harmful. When bacteria eat food, they release waste products that can be neutral, beneficial, or harmful. Harmful bacteria, for example, produce toxic waste products, which make us sick when they enter our digestive system.

One bacteria that is safe for humans to consume is *lactobacillus.* When *lactobacillus* feeds on sugars in food, it produces lactic acid and carbon dioxide through a process called lacto-fermentation. Lactic acid and carbon dioxide reduce the pH and available oxygen in food ecosystems to the point that harmful bacteria (that spoil food and make people sick) have a hard time growing in the ecosystem. *Lactobacillus* can continue to survive in the low pH (acidic) and low oxygen food ecosystems it helps create. Therefore, humans are able to use the unique characteristics of *lactobacillus* to help keep harmful bacteria out of food without any negative impacts to our digestive systems. Sometimes humans even add *lactobacillus* starters to food to encourage growth. This makes the food ecosystem unfavorable for other harmful bacteria to grow and can increase the shelf life of food.

Next Generation Science Standards

Three-Dimensional Claim

Construct and support an argument using empirical evidence and cause and effect relationships

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to predict how the population growth of one organism affects the population of another organism in the ecosystem due to access to oxygen and PH.

This task is intended to elicit student learning of the following **NGSS elements** for each of the three dimensions:

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems (MS)

- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction

Science and Engineering Practices

Analyzing and Interpreting Data (MS)

- Analyze and interpret data to provide evidence for phenomena.

Engaging in Argument from Evidence (MS)

- Construct, ~~use, and/or present~~ an ~~oral and~~ written argument supported by empirical evidence and scientific reasoning to support or refute an explanation ~~or a model~~ for a phenomenon ~~or a solution to a problem.~~

Crosscutting Concepts

Cause and Effect (MS)

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Suggestions for Use

This task is intended to be used for formative assessment purposes — to identify students' strengths and needs with the above dimensions in order to provide feedback to students and guide shifts in instruction.

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Assumptions

Students should have engaged with instructional experiences that ask them to analyze and interpret various types of data (e.g., charts and bar graphs) to identify cause and effect relationships among populations of organisms in an ecosystem. Students should also have an understanding of how populations with similar food, water, oxygen, or other resource requirements may compete for resources in an ecosystem, affecting the growth and reproduction of populations. It is not necessary for students to understand the process of fermentation for this task.

Materials Needed

- Should Food Have Bacteria? Student Task

Assessment Guidance

Introduction

Certain types of bacteria are known to make humans sick, including through food. For centuries, humans have tried to find safe and effective ways to preserve food, so it won't spoil. Is all bacteria harmful or can some bacteria be used to prevent food spoiling?

Prompt 1

In this task, you will be looking at food ecosystems. Typically, when we talk about ecosystems, we picture outdoor environments where plants and animals interact with nonliving components like rocks, water, and sunlight. However, ecosystems also exist within food! This is primarily due to the presence of various types of living bacteria. In Figure 1 below, you can see the ecosystem within yogurt (the zoom in circle).

Figure 1. Ecosystem in Yogurt

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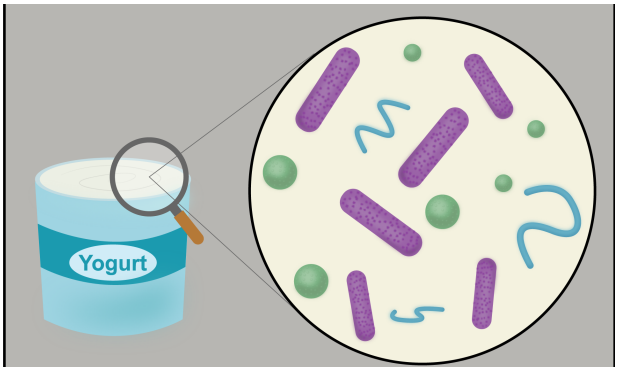


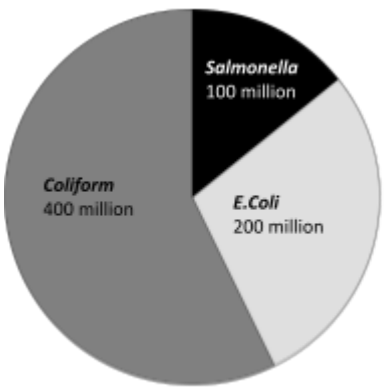
Describe what you see in the circle. What do you think these shapes represent?

Prompt 1 is not assessed and is used as a scaffold to support student learning.

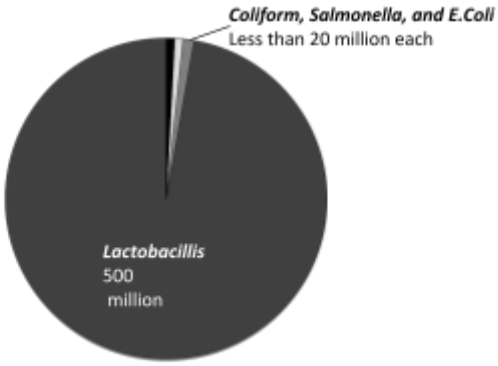
Prompt 2

Investigate two yogurt food ecosystems that contain different bacteria to figure out which bacteria are harmful. The data in Chart 1 below represents populations of different bacteria in two different food ecosystems.

Chart 1. Number of Each Bacteria Present in Food Ecosystem A and B



Food Ecosystem A



Food Ecosystem B

a. Use Chart 1 to describe how the bacteria are different in Food Ecosystem A and B.

Prompt 2a is not assessed and is used as a scaffold to support data analysis.

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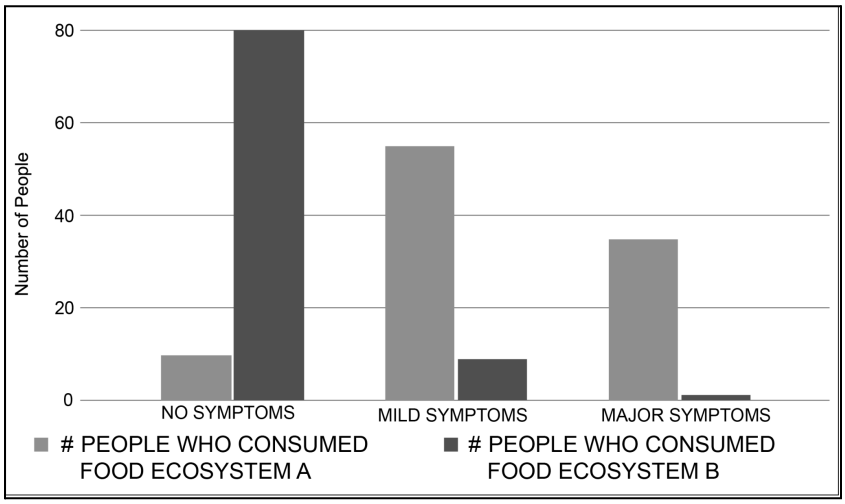
A group of people consumed Food Ecosystem A and a different group of people consumed food Ecosystem B. Look at Chart 2 below to see the severity of negative symptoms people experienced after eating each food.

Chart 2. Digestive Symptoms From Consuming Food Ecosystem A and B



b. Use Chart 2 to describe how the symptoms were different for people who ate Food from Ecosystem A and B.

Prompt 2b is not assessed and is used as a scaffold to support data analysis.

c. Which bacteria seems to be the least harmful? Use data from the charts to support your claim.

Prompt 2c is not assessed and is used as a scaffold to better understand the phenomenon and gather data to use as evidence in 3-dimensional prompts later in the task.

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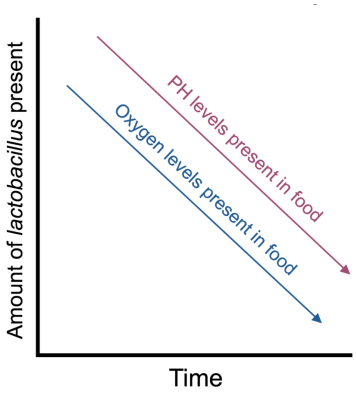
Prompt 3

Now that you know which bacteria is not harmful, let's investigate whether this bacteria can also prevent harmful bacteria from forming in food. Look at Chart 3 below to see how this bacteria affects the food ecosystem.

Chart 3. How *Lactobacillus* Affects the Food Ecosystem



a. Use Chart 3 to describe two ways *lactobacillus* affects the food ecosystem.

Many bacteria require certain pH and oxygen levels in their food ecosystem to survive, as shown in Chart 4 and Chart 5 below.

Chart 4. Preferred Oxygen Level for Each Bacteria	**Chart 5. Preferred pH Level for Each Bacteria**

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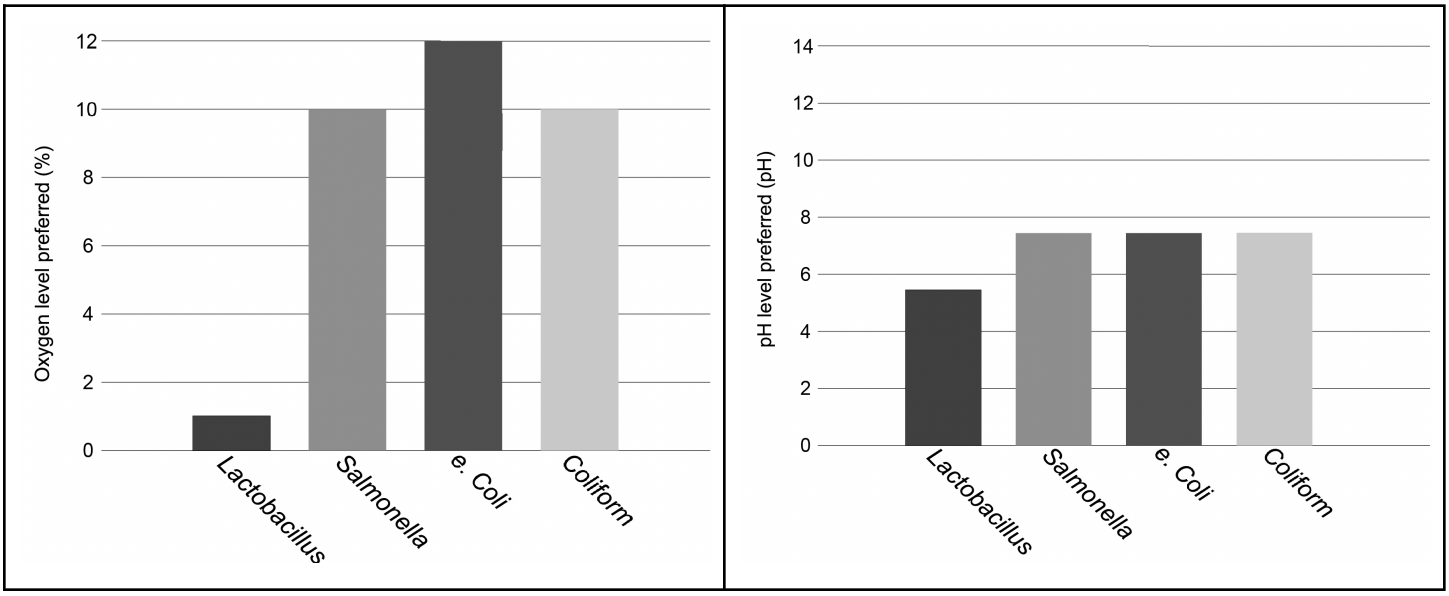

b. Use Charts 4 and 5 to describe the differences in the oxygen and pH levels that each bacteria prefers.

c. If *lactobacillus* is in the food ecosystem, how does it affect the ability of other bacteria to survive (ie. Coliform, e. Coli, Salmonella)?

Prompt 3 Performance Outcome:
Analyze and interpret data to predict how the growth of populations can be constrained due to access to oxygen and PH.

SEP	Analyze and interpret data to provide evidence for phenomena
DCI	In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction

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CCC	Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Prompt 3C Rubric			
	Emerging	**Developing**	**Proficient**
Sample Student Response	a. they go down. b. There is more bacteria on one side. They will help them survive.	a. ph and oxygen levels decrease. b. Other bacteria like much higher levels of oxygen than lactobacillus. c. They probably won't survive because they like more oxygen.	a. As lactobacillus increases, ph and oxygen levels decrease. b. The other bacteria prefer much higher levels of oxygen and slightly higher pH levels. c. If the population of lactobacillus is in the food ecosystem, it would make it harder for the other bacteria to survive because they prefer lots of oxygen and higher pH levels.
Look-Fors	Describes **inaccurate and/or general** observations from the data **AND/OR** Makes **an inaccurate or irrelevant** claim for how *lactobacillus* affects the survival of other bacteria using **little to no** reasoning.	Describes **relevant and partial** observations from the data **AND** Makes an **accurate** claim for how *lactobacillus* affects the survival of other bacteria using **partial or general** reasoning about the conditions bacteria need for survival.	Describes **relevant and complete** observations from the data **AND** Makes an **accurate** claim for how *lactobacillus* affects the survival of other bacteria using **sufficient** reasoning about the conditions bacteria need for survival.

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Prompt 4

Make a claim: should humans add *lactobacillus* to foods, such as yogurt or cheese, to prevent other bacteria from spoiling food? Include the following in your argument:

- ☐ A claim for whether to use *lactobacillus* to prevent other bacteria from spoiling food
- ☐ How *lactobacillus* impacts the environment and availability of resources for other bacteria (*supported with specific evidence from charts)*
- ☐ How and why l*actobacillus* might impact the populations of other bacteria within an ecosystem (*supported with specific evidence from charts)*

Prompt 4 Performance Outcome:

Construct and support an argument using empirical evidence and cause and effect relationships to predict how the population growth of one organism affects the population of another organism in the ecosystem due to access to oxygen and PH.

SEP	Construct a written argument supported by empirical evidence and scientific reasoning to support an explanation for a phenomenon.
DCI	In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction
CCC	Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Prompt 4 Rubric

	Emerging	Developing	Proficient
Sample Student Response	No, because bacteria is really bad for you and we shouldn't eat bacteria.	Lactobacillus should be added to food to prevent food spoiling because it decreases the oxygen and pH levels in a food	Lactobacillus should be added to food because Chart 2 showed us it was less harmful than other bacteria and it reduces pH

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		ecosystem and decreases the presence of other harmful bacteria.	and oxygen levels (Chart 3) which other harmful bacteria don't survive well with (Chart 4 and 5). This means the bad bacteria can't grow when lactobacillus is present.
Look-Fors	Makes **an inaccurate or irrelevant** claim for whether humans should add lactobacillus to food to prevent bacteria from spoiling food **AND/OR** Provides **little to no** evidence from the data **and/or** reasoning.	Makes an **accurate** claim for whether humans should add lactobacillus to food to prevent bacteria from spoiling food **AND** Provides **some relevant** evidence from the data **and/or general** reasoning about how the growth of populations can be affected by access to oxygen and pH.	Makes an **accurate** claim for whether humans should add lactobacillus to food to prevent bacteria from spoiling food **AND** Provides **relevant and complete** evidence from the data **and sufficient cause and effect** reasoning about how the growth of populations can be affected by access to oxygen and pH.

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