

Altering Carrying Capacity by Changing Environmental Factors

A Carolina Essentials™ Activity

Student Worksheet



Overview

Escherichia coli is a group of bacteria found in the gut of many animals. Many strains are harmless and part of the normal gut bacteria. Some strains of *E. coli*, however, are known to produce toxins that cause severe abdominal cramps, nausea, vomiting, bloody diarrhea, and a low-grade fever in humans. Symptoms can last 5 to 10 days. Introducing as few as 5 to 10 viable cells into a human can cause symptoms.

Outbreaks of *E. coli* hemorrhagic colitis have occurred across the United States. Some instances are associated with contaminated supplies of ground beef, lettuce, unpasteurized apple cider, and unpasteurized milk. Other instances have occurred when patients went swimming in water contaminated with fecal matter. Several pathogenic strains of *E. coli* are also showing antibiotic resistance.

For this activity, you will assume the role of a microbiologist who has been given the task of investigating two new treatments for pathogenic *E. coli*. The hypothesis is that washing vegetables in the field—immediately upon picking—in a newly designed and formulated detergent can greatly reduce the number of *E. coli* on the vegetables and the length of time they can reproduce.

Research is in the early stage, so there are no human studies yet—just *E. coli* grown on a medium in petri dishes. The medium is formulated for maximum growth of *E. coli*. Your task is to determine the growth medium's carrying capacity for *E. coli* and assess the impact of two treatment detergents added to the media.

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS

Graphing supplies if you are graphing by hand (graph paper, colored pencils, ruler)

Phenomenon



Look carefully at the colonies of *Escherichia coli* in the photo above. What questions could you ask about bacterial growth, colony size, and the carrying capacity of the plate and medium in which the *E. coli* is growing?

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Essential Question

How can mathematical representations be used to identify the carrying capacity of an ecosystem?

Activity Objectives

1. Graph *E. coli* data and determine the carrying capacity for the petri dish ecosystem in which it is growing.
2. Use data to support how two different treatments affected the growth of *E. coli* in petri dishes.

Activity Procedures

These procedures were followed to generate the data below:

1. Inoculate 100 plates of optimal growth medium with 10 *E. coli* bacteria.
2. Record the bacterial growth every 20 minutes for 6 hours.
3. Repeat the procedures for optimal growth medium treated with detergent A.
4. Repeat the procedures for optimal growth medium treated with detergent B.

Average Data for 100 Plates

<i>Escherichia coli</i> bacterial count without treatment		<i>Escherichia coli</i> bacterial count with treatment A		<i>Escherichia coli</i> bacterial count with treatment B	
Time (minutes)	Bacterial Count	Time (minutes)	Bacterial Count	Time (minutes)	Bacterial Count
0	10	0	10	0	10
20	20	20	20	20	20
40	40	40	40	40	40
60	80	60	80	60	80
80	160	80	160	80	160
100	320	100	320	100	320
120	640	120	640	120	640
140	1,280	140	1,280	140	1,280
160	2,560	160	2,560	160	2,560
180	5,120	180	5,120	180	2,560
200	10,240	200	5,120	200	500
220	20,480	220	5,000	220	400
240	40,960	240	4,950	240	300
260	81,920	260	3,100	260	200
280	81,920	280	1,400	280	100
300	81,920	300	1,000	300	50
320	81,920	320	500	320	50
340	81,920	340	500	340	50
360	81,920	360	100	360	50

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Data and Observations

1. Graph the data for the 3 tests. Each graph needs a title, axis labels, and a continuous line.
2. Label the carrying capacity for each *E. coli* system.

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Analysis and Discussion

1. Why was it necessary to test 100 untreated plates?
2. Use the data to explain how treatment detergent A and treatment detergent B affected the *E. coli*/petri dish ecosystem.
3. Assuming that both detergents are safe for humans and animals, which treatment detergent would you recommend for the next stage of testing and why?