

Altering Carrying Capacity by Changing Environmental Factors

A Carolina Essentials™ Activity



Overview

In this scenario-based activity, students use bacterial growth data to identify the carrying capacity of an “ideal” growing medium and determine how different treatments affect the growth and carrying capacity of the medium. Students must graph data, identify the carrying capacity of the system, and explain how the treatments affected bacterial growth. Graphing may be completed by hand or digitally (depending on skill level).

Life Science
Grades: 9–12

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?

Student responses will vary. Have students share some of the questions they recorded.

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.

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TIME REQUIREMENTS



PREP | **ACTIVITY**
15 min | 30–45 min

Teacher Prep: 15 min
Student Activity: 30–45 min

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS

Student activity pages

TEACHER PREPARATION AND DISPOSAL

Copy or upload the student pages for the activity. No disposal is required.

HELPFUL LINKS

[Evolution and Antibacterial Resistance](#)

REFERENCE KITS

[Evolution in Real Time: Bacteria and Antibiotic Resistance](#)

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Next Generation Science Standards* (NGSS)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking <ul style="list-style-type: none">• Use mathematical and/or computational representations of phenomena or design solutions to support explanations.	LS2.A: Interdependent Relationships in Ecosystems <ul style="list-style-type: none">• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.	Scale, Proportion, and Quantity <ul style="list-style-type: none">• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Student Procedure

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.

Teacher Preparation and Tips

You may wish to review graphing techniques, with the computer or by hand, with students.

*A good pre-activity assignment is to ask students to research *E. coli* food contamination news articles that have impacted their area.*

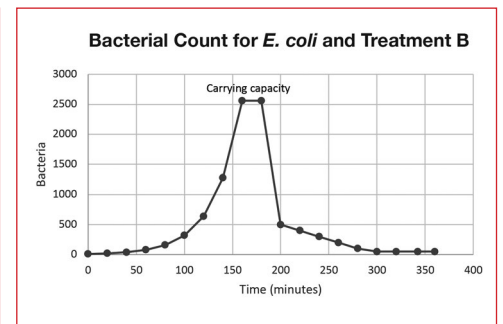
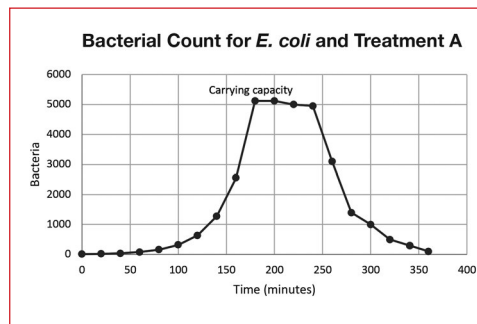
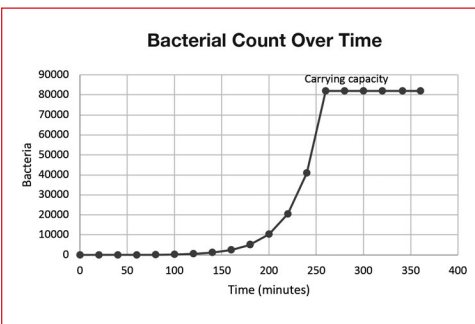
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Average Data for 100 Plates

<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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Analysis and Discussion

1. Why was it necessary to test 100 untreated plates?

The untreated plates are a control for the research project. Optimal growth media or growing environments of the control plates allow for the establishment of the carrying capacity of the medium under the best bacterial growing conditions. The treated growth medium can then be compared to the control to determine if the treatments of the growth medium changed the time to reach carrying capacity and the amount of E. coli at the carrying capacity.

2. Use the data to explain how treatment detergent A and treatment detergent B affected the E. coli/petri dish ecosystem.

Treatment A decreased the amount of time the E. coli was maintaining carrying capacity individuals, and carrying capacity was achieved at about 180 minutes. The number of cells at carrying capacity also decreased to about 5,000 cells. Treatment detergent A decreased maximum growth and the time it took to reach maximum growth. Treatment detergent B had even a shorter time at carrying capacity (about 20 minutes), and the number of cells at carrying capacity dropped to about 2,600. Carrying capacity was achieved at about 160 minutes, which is another decrease. Detergent B showed additional impedance in E. coli growth.

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?

Both detergents showed a decrease in the amount of cell growth and a lower number of cells at carrying capacity. Detergent B had larger decreases than detergent A, and cell growth peaked earlier with detergent B. Since this product is designed to be used in the field as leafy vegetables are picked, I would recommend further research on detergent B. The next research step could be to test the detergent on the vegetables with E. coli bacteria present. Researchers will also need to determine how the detergent affects the vegetable itself (color, freshness, odor, etc.).

TEACHER NOTES

References

Mayo Clinic. 2019. "E. Coli - Symptoms and causes"
<https://www.mayoclinic.org/diseases-conditions/e-coli/symptoms-causes/syc-20372058>

University of Nebraska-Lincoln. 2019. "Escherichia coli O157:H7 (E Coli)"
<https://food.unl.edu/escherichinia-coli-o157h7-e-coli>

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