Math

HANDS ON

FOOD SAFETY

A program of the GMA Science and Education Foundation

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Acknowledgments

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The lessons and activities in this unit were created or adapted by Dr. Jennifer Richards, Assistant Professor, Department of Agricultural Leadership, Education, and Communications, The University of Tennessee.

Endorsements

Sponsorships

MATHEMATICS

Summary of Activities:

Setting the Stage

Carousel Activity

Summarizing the Results

Understanding Scale

Bacterial Growth Demonstration

Application of Knowledge

Is it Safe to Eat?

Student Reflection

Analyzing Bacterial Growth Data

Analyzing Data Self-Assessment

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Day	Mathematics GA 7th Grade Standards	
Day 1	MGSE7.RP.2	Recognize and represent proportional relationships between quantities.
	MGSE7.RP.3	Use proportional relationships to solve multistep ration and percent problems.
Day 2	MGSE7.G.1	Draw, construct, and describe geometrical figures and describe the relationships between them. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
	MGSE7.RP	Analyze proportional relationships and use them to solve real-world and mathematical problems.
Day 3	MGSE7.RP.2a	Decide whether two quantities are in a proportional relationship, e.g. by testing for equivalent rations in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.
	MGSE7.RP.2b	Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.
Day 4	MGSE7.NS.2	Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.
	MGSE7.NS.3	Solve real-world and mathematical problems involving the four operations with rational numbers.
	MGSE7.EE.4	Solve real-life and mathematical problems using numerical and algebraic expressions and equations. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about quantities.
Days 5 and 6	MGSE7.NS.3	Solve real-world and mathematical problems involving the four operations with rational numbers
	MGSE7.EE.3	Solve real-life and mathematical problems using numerical and algebraic expressions and equations. Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations as strategies to calculate with numbers in any form; convert between forms as appropriate; assess the reasonableness of answers using mental computation and estimation strategies.
	MGSE7.SP.3	Draw informal comparative inferences about two populations. Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.
	MGSE7.SP.4	Draw informal comparative inferences about two populations. Use measures of center and measure of variability for numerical data from random samples to draw informal comparative inferences about two populations.

Robert Gagne's Nine Events of Effective Instruction-Math

Stage of Instruction	Event	Description	Math Activity
Pre-Instruction	Gaining Attention	Stimulates readiness to learn and participate. Stimuli like surprises or questions are typically used for this event.	Setting the Stage
	Informing learners of the objectives	Generates expectancy by helping them understand what they will be learning	Inform learners of the objectives
	Stimulating recall of prior learning	Relating new information to something they already know or have experienced helps learners make sense of the lesson	Carousel Activity Graphing Data
Instruction	Presenting the stimulus	New information is presented. Strategies like providing examples or presenting vocabulary should be used to present the lesson content to provide more effective instruction	Understanding Scale
	Providing learning guidance	Helps facilitate the process of long-term information storage	Bacterial Growth Demonstration
	Eliciting performance	Requires the learner to practice the new skill or behavior. The repetition further increases the likelihood of retention of the new information	Application of Knowledge
Post-Instruction	Providing feedback	Assess and further facilitate learning. Typically, activities designed for feedback are for comprehension, not scoring	Is it Safe to Eat?
	Assessing performance	To evaluate the effectiveness of the instructional events, you must test to see if the expected learning outcomes have been achieved	Student Reflection
	Enhancing retention and transfer	Helps learners develop expertise by internalizing the new information. Methods for helping learners internalize are paraphrasing, generating examples, creating concept maps or outlines, and repetition	Analyzing Bacterial Growth Data

Unit Activities:	Setting the Stage, Objectives, Carousel Survey, Graph Data	*Learning Objectives:*	Students will be able to: 1. Develop and organize a simple data set generated from a class survey. 2. Use relationships to calculate percent.
Materials:	Carousel prompts, calculators (optional)		
		Content Standards:	MGSE7.RP.2 MGSE7.RP.3

Activities:

Setting the Stage (8 minutes)

Purpose: To capture attention and prepare students to learn and participate.

Learner Level: All

- Write the following question on the board or overhead: **Describe what we mean when we say a human grows.**
    - Ask students to write down their response to the question. Allow 3-5 minutes for students to do so.
    - Allow students to share their responses with the class.
    - Pose questions for discussion:
        - How much have you grown over the last year?
        - What makes a human grow?
        - What has to happen for any organism to grow? (cell division)

Inform the Learner of the Objectives (2 minutes)

Purpose: To help students understand what they are responsible for learning.

- Tell students: **This week we are going to study the difference in the growth of humans and the growth of bacteria. Our first activity is going to determine how likely bacteria is to grow in your kitchen at home.**

Activities:
Carousel Activity
(30 minutes)

Purpose: To familiarize students with new words, activate prior knowledge, and provide a guide to the concepts they will learn in this lesson.

Learner Level: All

- Before beginning this activity, copy each question from the **Carousel Activity**.
- Post each page in a different place around the room.
- Divide students into 10 groups and send each group to a different page.
- Give students 1-2 minutes to read the question on their page and then tally their response in the appropriate box in the answer grid.
- Rotate student groups to a new page every 2-3 minutes until each group has answered every question.
- Discuss each question with the class, noting the various answers. Discuss the best answer choice(s) for each question.

Percent of Change Data
(20 minutes)

Learner Level: All

- Assign each group of students one of the question pages from the Carousel Activity above.
- Each group should use the data (student responses tallied) from their assigned questions to compute the percent of students who selected each response.
- When groups are finished, each group will discuss their findings with the rest of the class.
- Encourage students to make observations and identify questions indicating an area needing improvement (due to low numbers of correct responses).

1. I clean the area where I make food and snacks before and after making food and snacks.
   a. Never
   b. Sometimes
   c. Usually
   d. Always

A	**B**
C	**D**

2. The last time there was cookie dough in my home, the dough was:
   a. Made with raw eggs, and I sampled some of it
   b. Made with raw eggs and refrigerated, then I sampled some of it
   c. Store-bought, and I sampled some of it
   d. Not sampled until baked

A	**B**
C	**D**

3. Meat, poultry, and fish products are defrosted in my home by:
   a. Setting them on the counter
   b. Placing them in the refrigerator
   c. Microwaving
   d. I don't know

A	**B**
C	**D**

4. I know the types of foods that put me at a higher risk for getting food poisoning.
   a. Strongly disagree
   b. Disagree
   c. Agree
   d. Strongly agree

A	**B**
C	**D**

5. When cooking meat I use a thermometer to check the temperature and doneness of the meat.
   a. Never
   b. Sometimes
   c. Usually
   d. Always

A	**B**
C	**D**

6. The temperature of the refrigerator in my home is:

a. 50 degrees Fahrenheit
b. 40 degrees Fahrenheit
c. 20 degrees Fahrenheit
d. I don't know; I've never measured it

A	**B**
C	**D**

7. I can positively impact the safety of my food by keeping cooked foods at room temperature for longer than 2 hours.
   a. Strongly disagree
   b. Disagree
   c. Agree
   d. Strongly agree

A	**B**
C	**D**

8. I feel that it is an adult's responsibility to keep my food safe when handling food.
   a. Strongly disagree
   b. Disagree
   c. Agree
   d. Strongly agree

A	**B**
C	**D**

9. If a cutting board is used in my home to cut raw foods and it is going to be used to chop another food, the board is:

a. Reused as is
b. Wiped with a damp cloth
c. Washed with soap and hot water
d. Washed with soap and hot water and then sanitized

A	**B**
C	**D**

10. I wash my hands before and after preparing snacks and meals
    a. Never
    b. Rarely
    c. Sometimes
    d. Always

A	B
C	D

Carousel Prompts

1. I clean the area where I make food and snacks before and after making food and snacks.
   a. Never
   b. Sometimes
   c. Usually
   d. Always

2. The last time there was cookie dough in my home, the dough was:
   a. Made with raw eggs, and I sample some of it
   b. Made with raw eggs and refrigerated, then I sampled some of it
   c. Store-bought, and I sampled some of it
   d. Not sampled until baked

3. Meat, poultry, and fish products are defrosted in my home by:
   a. Setting them on the counter
   b. Placing them in the refrigerator
   c. Microwaving
   d. I don't know

4. I know the types of foods that put me at a higher risk for getting food poisoning.
   a. Strongly disagree
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5. When cooking meat I use a thermometer to check the temperature and doneness of the meat.
   a. Never
   b. Sometimes
   c. Usually
   d. Always

6. The temperature of the refrigerator in my home is:
   a. 50 degrees Fahrenheit
   b. 40 F
   c. 20 F
   d. I don't know; I've never measured it

7. I can positively impact the safety of my food by keeping cooked foods at room temperature for longer than 2 hours.
   a. Strongly disagree
   b. Disagree
   c. Agree
   d. Strongly agree

Carousel Prompts

8. I feel that it is an adult's responsibility to keep my food safe when handling food.
    a. Strongly disagree
    b. Disagree
    c. Agree
    d. Strongly agree

9. If a cutting board is used in my home to cut raw foods and it is going to be used to chop another food, the board is:
    a. Reused as is
    b. Wiped with a damp cloth
    c. Washed with soap and hot water
    d. Washed with soap and hot water and then sanitized

10. I wash my hands before and after preparing snacks and meals
    a. Never
    b. Rarely
    c. Sometimes
    d. Always

Carousel Explanations

1. **I clean the area where I make food and snacks before and after making food and snacks.**
    a. Never
    b. Sometimes
    c. Usually
    d. Always
        - The kitchen is one of the most dangerous places in the house because of the infectious bacteria that are sometimes found in raw foods.
        - Germs are easily spread to other people in the kitchen because food is prepared here.
        - Dirt and germs live on tables, countertops, and other places in the kitchen where food is prepared.

2. **The last time there was cookie dough in my home, the dough was:**
    a. Make with raw eggs, and I sampled some of it
    b. Make with raw eggs and refrigerated, then I sampled some of it
    c. Store-bought, and I sampled some of it
    d. Not sampled until I ate the baked cookies
        - Eating raw cookie dough may put you at risk for infection with *Salmonella enteritidis*, a bacterium that can be inside eggshells.
        - Refrigerating will <u>not</u> kill the bacteria.
        - Other foods containing raw eggs, such as homemade ice cream, cake batter, mayonnaise, and eggnog, carry a *Salmonella* risk, too.
        - Their commercial counterparts are usually made with pasteurized eggs; that is, eggs that have been heated sufficiently to kill bacteria. However, there is still a risk to consuming the commercial cookie dough products without baking them.

3. **Meat, poultry, and fish products are defrosted in my home by:**
    a. Setting them on the counter
    b. Placing them in the refrigerator
    c. Microwaving
    d. I don't know
        - Gradual defrosting overnight in the refrigerator is best because it helps maintain quality
        - Using the microwave oven or putting the packaging in a water-tight plastic bag submerged in cold water and changing the water every 30 minutes are also safe ways to defrost.
        - Do <u>not</u> thaw meat, poultry, and fish products on the counter or in the sink without cold water; bacteria can multiply rapidly at room temperature.
        - Marinate food in the refrigerator, not on the counter. Discard the marinade after use because it contains raw juices, which may harbor bacteria.

4. **I know the types of foods that put me at a higher risk for getting food poisoning.**
    a. Strongly disagree
    b. Disagree
    c. Agree
    d. Strongly agree
        - *Salmonella:* Raw meats, poultry, eggs, dairy products
        - *E. coli* O157:H7: Ground beef, fruits, vegetables, raw milk
        - *Listeria*: Deli meats, hot dogs, soft cheese, imported seafood products
        - *Campylobacter jejuni*: Raw poultry, meat, and unpasteurized milk
        - *Staphylococcus aureus*: Meats, poultry, egg products, mayonnaise based products

5. **When cooking meat I use a thermometer to check the temperature and doneness of the meat.**
    a. Never
    b. Sometimes
    c. Usually
    d. Always
        - Using a digital or dial food thermometer is important.
        - Cooking by color is misleading.
        - Some ground meat may prematurely brown before a safe internal temperature has been reached.

6. **The temperature of the refrigerator in my home is:**
    a. 50 degrees Fahrenheit
    b. 40 F
    c. 20 F
    d. I don't know; I've never measured it
        - Refrigerators should stay at 40°F or less because it slows the growth of most bacteria.
        - The temperature won't kill the bacteria, but it will keep them from multiplying, and the fewer there are, the less likely you are to get sick.
        - According to surveys, in many households, the refrigerator temperature is above 50 F.
        - Measure the temperature with a thermometer and, if need, adjust the refrigerator's temperature control dial.

7. **I can positively impact the safety of my food by keeping cooked foods at room temperature for longer than 2 hours.**
    a. Strongly disagree
    b. Disagree
    c. Agree
    d. Strongly agree
        - Refrigerator or freeze leftovers within 2 hours or sooner to prevent harmful bacteria from multiplying.
        - Cold temperatures keep most harmful bacteria from growing and multiplying.
        - Bacteria grow most rapidly at unsafe temperatures between 40°F – 140°F.

8. **I feel that it is an adult's responsibility to keep my food safe when handling food.**
    a. Strongly disagree
    b. Disagree
    c. Agree
    d. Strongly agree
        - We have an individual responsibility for the food that we eat.
        - Taking actions such as washing hands, storing foods properly, cooking foods properly, and being aware of the foods that cause foodborne illness outbreaks will help in preventing a foodborne illness.

9. **If a cutting board is used to cut raw foods and it is going to be used to chop another food, the board is:**
    a. Reused as is
    b. Wipes with a damp cloth
    c. Washed with soap and hot water
    d. Washed with soap and hot water and then sanitized
        - Use smooth cutting boards of hard maple or plastic and free of cracks and crevices.
        - Wash cutting boards with hot water, soap, and a scrub brush to remove food particles. Then sanitize the boards by putting them through the automatic dishwasher or rinsing them in a solution of 1 teaspoon of chlorine bleach in 1 quart of water.
        - Always wash and sanitize cutting boards after using them for raw foods and before using them for ready-to-eat foods.

10. **I wash my hands before and after preparing snacks and meals**
    a. Never
    b. Rarely
    c. Sometimes
    d. Always
        - The most important thing that you can do to keep from getting sick is to wash your hands.
        - Frequently washing hands allows you to wash away germs that could have been picked up from other people, contaminated surfaces, or from animals and animal waste.

Unit Activities:	Review, Understanding Scale	*Learning Objectives:*	Students will be able to: 1. Apply use of scale to create 3-D scale models of a 6-sided die. 2. Recognize the impact of magnifying an object by 4x, 10x, and 40x.
Instructional Events:	Present the stimulus		
Materials:	Rulers, calculators, dice, construction paper, tape		
Student Handouts:	*Understanding Scale* Worksheet	*Content Standards:*	MGSE7.G.1 MGSE7.RP

Activities:

Review
(5 minutes)

Daily Review Question: **Yesterday we took surveys to determine how safe your kitchen is and graphed the results. Did any of you suggest changes to your parents last night during dinner? Today we are going to learn about scale and try to get an idea of how big a bacterium is.**

Understanding Scale
(50 minutes)

- Ask students: In science class you are conducting an experiment to grow bacteria. How big is a bacterium?
- Allow students to guess.
- Explain to students that bacteria are microscopic, which means they can only be seen using a microscope.
- Tell students that later in the week they will use a microscope to look at bacteria. The microscope will allow them to see the bacteria at 4x, 10x, and 40x its actual size.
- To demonstrate this scale, have students complete the Understanding Scale worksheet.
- Optional: Allow students to go outside and, using a measuring stick, mark off their heights at 4x, 10x, and 40x.

Activities:
Understanding Scale (continued)

- Students should construct a die at actual size (1x), 4x, and 10x.
    a) Have students measure a standard six-sided die (1.5cm).
    b) Using a ruler and construction paper, have students measure out six 1.5cm squares. Students should cut out the squares and construct a die. This die represents the actual size or 1x.
    c) Have students determine the dimensions of a 4x die (1.5cm x 4 = 6cm).
    d) Using a ruler and construction paper, have students measure out six 6cm squares. Students should then cut out each square and construct a die. This die represents the actual size of 4x.
    e) Have students determine the dimensions of a 10x die (1.5cm x 10 = 15cm).
    f) Using a ruler and construction paper, have students measure out six 15cm squares. Students should then cut out each square and construct a die. This die represents the actual size or 10x.
    g) While students are constructing their dice, draw examples of 1x, 4x, 10x, and 40x (60cm) squares on the board for students to use as a comparison.
- Explain to students that when they look at their bacteria in the microscope these are the powers of magnification they will use.
- Encourage students to draw connections between the actual sizes of the die versus the 40x.

Unit Activities:	Review, Understanding Bacterial Growth, Bacterial Growth Demonstration	*Learning Objectives:*	Students will be able to: 1. Recognize bacterial growth as an example of exponential growth. 2. Use given formulas to calculate the growth of bacteria over a given time period.
Instructional Events:	Present the Stimulus, Provide Learner Guidance		
Materials:	Modeling Clay *Understanding Scale* handout	*Content Standards:*	MGSE7.RP.2a MGSE7.RP.2b

Activities:

Review (5 minutes)

Daily Review Question: **Yesterday we learned about the size of bacteria. What surprised you the most about what you learned yesterday? Today we are going to continue learning about scale and the size of bacteria.**

Understanding Bacterial Growth (15 minutes)

Learner Level: Average – High

- Display the following definition on the board: **Bacterial growth means an orderly increase in the number of bacteria.**
- Have students compare and contrast bacterial growth with growth in animals and plants.
    - Allow students to brainstorm ideas and record these differences in a Venn Diagram.
        - Differences include: rates of growth, animals and plants grow in size instead of number.
        - Similarities include: growth is a result of cell division.
- Lead a discussion on students' ideas.

Learner Level: Low-Average

- Distribute a copy of **Understanding Bacterial Growth** to each student.
- Lead students through completing each section.
- Ask students to share ideas from the Venn diagram with the class.

Bacterial Growth Demonstration (15minutes)

Purpose: To facilitate the transfer of new knowledge to long-term retention by providing a concrete demonstration of an abstract concept.

Learner Level: All

- Give each student a golf-ball sized piece of clay that represents a single bacterium.
- Every 30 seconds, have each student divide his/her "bacteria": first two, then four, then eight, then 16, then 32 to demonstrate bacterial growth.
- After students have finished dividing their "bacteria", each student will transfer their growth data onto a table showing the exponential growth curve. Students will then determine if the bacterial growth rate occurred at a proportional or non-proportional rate of growth per second.
    - Ex.

Time	# Bacteria
0	1
30	2
60	4

- Next, students will determine the number of bacterial cells that would be present after x number of seconds. (Ex. How many bacterial cells would be present after 360 seconds?)

Unit Activities:	Review, Application of Knowledge, Is it Safe to Eat?	*Learning Objectives:*	Students will be able to: 1. Calculate the growth of bacteria over a given time period. 2. Solve problems involving unit rates.
Instructional Events:	Elicit Performance, Provide Feedback		
Student Handouts:	*Applying Bacterial Growth Rates* Worksheet *Is it Safe To Eat?* Worksheet	*Content Standards:*	MGSE7.NS.2 MGSE7.NS.3 MGSE7.EE.4

Activities:

Review (5 minutes)

Daily Review Question: **Yesterday we learned that bacteria grow by multiplying. How is that different from how humans grow? Today you are going to solve some problems to determine if foods in certain situations are safe to eat.**

Application of Knowledge (20 minutes)

Purpose: To allow the learner to practice the new knowledge. The repetition further increases the likelihood of retention of the new information.

Learner Level: All

- Give each student a copy of **Applying Bacterial Growth Rates.**
- Explain that bacteria, including strains that make us sick like *E. coli*, can divide as often as every 20 minutes under optimal conditions.
- If it takes 128 cells of *E. coli* to make you sick, and the cells can divide as often as every 20 minutes, then how long would it take for one cell to grow enough to make you sick?
- Ask students to calculate how many bacteria there would be after three hours and four hours at this fission rate.
- Then, have students graph an exponential multiplication rate with a specified time period and rate at which that number doubles, and then doubles again and again.
    - Example: If an organism doubles every twenty minutes, how much time must pass for there to be over one million cells? (6 hours, 40 minutes)

Activities:

Is it Safe to Eat? (20 minutes)

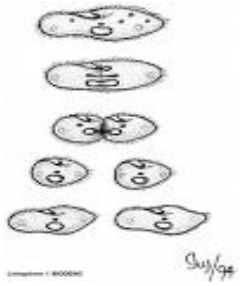
Purpose: To assess and facilitate further student learning.

Learner Level: All

- Give each student a copy of **Is it Safe to Eat?**
- Walk students through the example problem and then let students complete the remaining problems.
- It is important to remind students that these are only examples and should not be used as a guide for whether food is safe.
- Encourage students to share individual stories regarding food safety.
- Remind students that in real life they would not know the number of pathogenic cells contaminating their food.

Teacher's Copy

Applying Bacterial Growth Rates



1. Under the best conditions, bacteria can divide every **20** minutes.

Tracking Bacterial Growth:

Use the chart below to track the growth of a single *E. coli* bacterium cell over several hours. Assume the cell has a generation time of 20 minutes. This means that every 20 minutes the cells divide, causing the amount of cells to double.

# of Divisions	Time Elapsed in Minutes	# of Cells
0	0	1
1	20	2
2	40	4
3	60	8
4	80	16
5	100	32
6	120	64
7	140	128
8	160	256
9	180	512

2. One *E. coli* cell could multiply up to **8** cells in just 1 hour.

3. How many *E. coli* cells would there be after 2 hours? **64**

4. How many *E. coli* cells would there be after 3 hours? **512**

5. If it takes 128 cells of *E. coli* to make you sick, and the cells can divide as often as every 20 minutes, then how long would it take for one cell to grow enough to make you sick?

140 minutes

Teacher's Copy

Tracking Bacterial Growth:

Shigella (a type of bacteria) has a generation time of 40 minutes. Use the chart below to track the growth over several hours. Assume there are 4 cells present at start time.

# of Divisions	Time Elapsed in Minutes	# of Cells
0	0	4
1	40	8
2	80	16
3	120	32
4	160	64
5	200	128
6	240	256
7	280	512

6. How many *Shigella* cells would there be after 2 hours? **32**

7. How many *Shigella* cells would there be after 4 hours? **256**

8. In optimal conditions, how many times would *Shigella* cells divide in 2 hours?

Important information	
Total Time:	2 hrs
Generation Time:	40 min

Step 1: Convert the Total Time from hours to minutes

2 hrs = **120** min

Step 2: Divide Total Time by Generation Time

120 min / 40 min = **3**

9. In optimal conditions, how many times would *Shigella* cells divide in 6 hours?

Important information	
Total Time:	360 min
Generation Time:	40 min

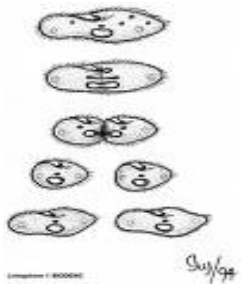
9 cell divisions

10. In optimal conditions, how many times would *Shigella* cells divide in 8 hours?

Important information	
Total Time:	480 min
Generation Time:	40 min

12 cell divisions

Applying Growth Rates



1. Under the best conditions, bacteria can divide every _____ minutes.

Tracking Bacterial Growth:

Use the chart below to track the growth of a single *E. coli* bacterium cell over several hours. Assume the cell has a generation time of 20 minutes. This means that every 20 minutes the cells divide, causing the amount of cells to double.

# of Divisions	Time Elapsed in Minutes	# of Cells
0	0	1
1	20	
2	40	
3	60	

2. One *E. coli* cell could multiply up to _____ cells in just 1 hour.

3. How many *E. coli* cells would there be after 2 hours? _____

4. How many *E. coli* cells would there be after 3 hours? _____

5. If it takes 128 cells of *E. coli* to make you sick, and the cells can divide as often as every 20 minutes, then how long would it take for one cell to grow enough to make you sick?

_____

Tracking Bacterial Growth:

Shigella (a type of bacteria) has a generation time of 40 minutes. Use the chart below to track the growth over several hours. Assume there are 4 cells present at start time.

# of Divisions	Time Elapsed in Minutes	# of Cells
0	0	4
1	40	
2	80	

6. How many *Shigella* cells would there be after 2 hours? _____

7. How many *Shigella* cells would there be after 4 hours? _____

8. In optimal conditions, how many times would *Shigella* cells divide in 2 hours?

Important information	
Total Time:	2 hrs
Generation Time:	40 min

Step 1: Convert the Total Time from hours to minutes

2 hrs = _____ min

Step 2: Divide Total Time by Generation Time

_____ min / _____ min = _____

9. In optimal conditions, how many times would *Shigella* cells divide in 6 hours?

Important information	
Total Time:	_____
Generation Time:	_____

10. In optimal conditions, how many times would *Shigella* cells divide in 8 hours?

Important information	
Total Time:	_____
Generation Time:	_____

Instructor Copy

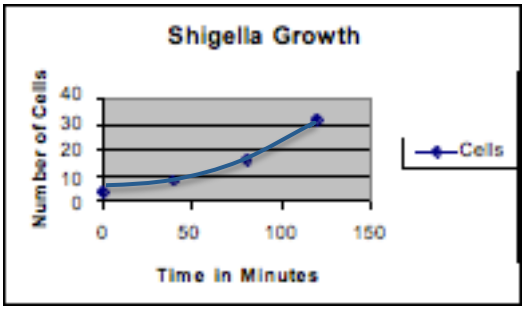
Is it Safe to Eat?

Part I Directions: For each of the scenarios, using the information provided, complete the table and determine if the food is safe to eat.

Example: *Shigella* has a generation time of 40 minutes and an infectious dose of 10 cells. Mom's tuna salad was infected with 4 cells of *Shigella* and has been sitting on the dining room table for 2 hours. Is it safe to eat?

Important Information		Bacteria type:	*Shigella*
Total Time:	2 hours	Infectious dose:	10 cells
Generation Time:	40 minutes	# of cells at start:	4 cells

# of Times Cells Divide	Time Elapsed in Minutes	Number of Cells
0	0	4
1	40	8
2	80	16
3	120	32



No, the tuna salad is not safe to eat after 2 hours of sitting on the table.

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1. *E. coli O157:H7* has a generation time of 20 minutes and can make you sick with as few as 10 cells. Judy likes to eat her hamburgers medium rare. If her hamburger was contaminated with 2 *E. coli* O157:H7 cells that were not killed during cooking and she waited 20 minutes to eat the hamburger, is it safe to eat?

Important Information		Bacteria type:	*E. coli O157:H7*
Total Time:	20 minutes	Infectious dose:	10 cells
Generation Time:	20 minutes	# of cells at start:	2 cells

# of Times Cells Divide	Time Elapsed in Minutes	Number of Cells
0	0	2
1	20	4

Is it safe to eat?

Yes, the hamburger is safe to eat after waiting 20 minutes to eat the hamburger.

2. Under ideal conditions, *Salmonella* has a generation time of 30 minutes and an infectious dose of 15-20 cells. Aunt Susie's homemade Ranch salad dressing has been sitting on the picnic table for 2.5 hours. If the dressing started out infected with 3 *Salmonella* cells, is it safe to eat now?

Important Information		Bacteria type:	*Salmonella*
Total Time:	2.5 hours	Infectious dose:	15-20 cells
Generation Time:	30 minutes	# of cells at start:	3 cells

# of Times Cells Divide	Time Elapsed in Minutes	Number of Cells
0	0	3
1	30	6
2	60	12
3	90	24
4	120	48
5	150	96

Is it safe to eat?

No, the Ranch salad dressing is not safe to eat after sitting on the picnic table for 2.5 hours or 150 minutes.

3. Using the information provided, write your own food safety scenario. Then, complete the table and to determine if the food is safe to eat.

Important Information		Bacteria type:	*Campylobacter jejuni*
Total Time:	3 hours	Infectious dose:	400-500 cells
Generation Time:	90 minutes	# of cells at start:	150 cells

Scenario:

Is it safe to eat?

No, it is not safe to eat.

Part II Directions: Now, rather than using a table, use the formula for exponential growth to determine if the food is safe to eat. Show your work. Then create a line graph for each scenario illustrating the exponential growth curve.

4. *E. coli* O157:H7 has a generation time of 20 minutes and can make you sick with as few as 10 cells. If Judy's hamburger was contaminated with 2 *E. coli* O157:H7 cells that were not killed during cooking, determine if it is safe to eat in each of the following situations.

Important Information		Formula:	$y = a(1 + b)^x$	
Total Time:		# of cells at start	a	**2 cells**
Generation Time:	**20 minutes**	Growth Rate	b	**100% or 1**
Infectious dose:	**10 cells**	# of times cells divide	x	

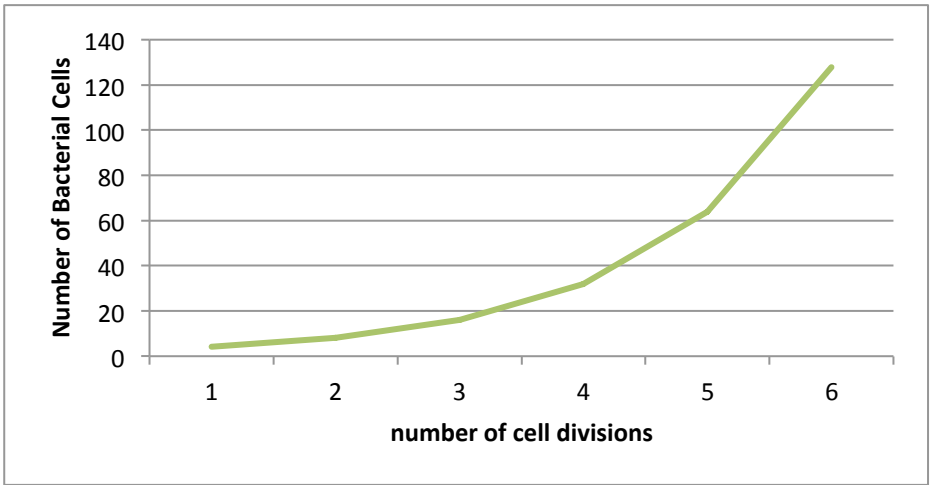
a. How many *E. coli* cells would be present (y) if she waited 40 minutes to eat the hamburger? Is it safe to eat?

Solution: If the total time is 40 minutes, then the cells divide 2 times, so $y = 2\ (1 + 1)^2 = 8$ cells. This is less than the infections dose of 10 cells. Yes, it is safe to eat.

b. How many *E. coli* cells would be present (y) if she waited 1 hour to eat the hamburger? Is it safe to eat?

Solution: If the total time is 60 minutes, then the cells divide 3 times, so $y = 2\ (1 + 1)^3 = 16$ cells. This is more than the infectious does of 10 cells. No, it is not safe to eat.

c. Create a graph of the exponential growth curve where the number of times the cells divide is along the x-axis and the total number of bacterial cells is along the y-axis.



Challenge: How many *E. coli* cells would be presented (y) if she waited 3 hours to eat the hamburger?

$y = 2(1 + 1)^9 = 1024$ cells

5. Under ideal conditions, *Salmonella* has a generation time of 30 minutes and an infectious dose of 15-20 cells. If the dressing started out infected with 3 *Salmonella* cells, determine if it is safe to eat in each of the following situations.

Important Information		Formula:	$y = a(1 + b)^x$	
Total Time:		# of cells at start	a	**2 cells**
Generation Time:	**30 minutes**	Growth Rate	b	**100% or 1**
Infectious dose:	**15-20 cells**	# of times cells divide	x	

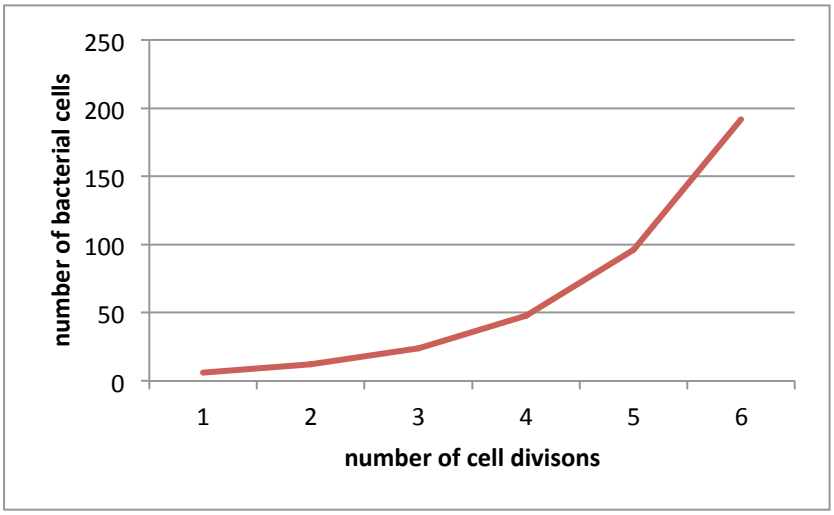
a. How many *Salmonella* cells would be present (y) if the homemade salad dressing had been sitting on the picnic table for 1 hour? Is it safe to eat?

Solution: If the total time is 60 minutes, then the cells divide 2 times, so $y = 3(1+1)^2 = 12$ cells. This is less than the infectious dose of 15-20 cells. Yes, it is safe to eat.

b. How many *Salmonella* cells would be present (y) if the homemade salad dressing had been sitting on the picnic table for 3 hours? Is it safe to eat?

Solution: If the total time is 90 minutes, then the cells divide 3 times, so $y = 3(1+1)^3 = 192$ cells. This is more than the infectious dose of 15-20 cells. No it is not safe to eat.

c. Create a graph of the exponential growth curve where the number of times the cells divide is along the x-axis and the total number of bacterial cells is along the y-axis.



CHALLENGE: How many *Salmonella* cells would be present (y) if the homemade salad dressing had been sitting on the picnic table for 6.5 hours?

$$y = 3(1 + 1)^{13} = 24{,}576 \text{ cells}$$

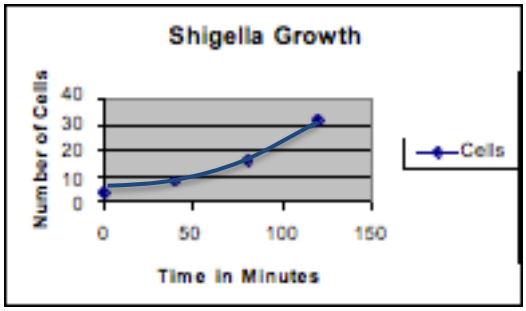
Is it Safe to Eat?

Part I Directions: For each of the scenarios, using the information provided, complete the table and determine if the food is safe to eat.

Example: *Shigella* has a generation time of 40 minutes and an infectious dose of 10 cells. Mom's tuna salad was infected with 4 cells of *Shigella* and has been sitting on the dining room table for 2 hours. Is it safe to eat?

Important Information		Bacteria type:	*Shigella*
Total Time:	2 hours	Infectious dose:	10 cells
Generation Time:	40 minutes	# of cells at start:	4 cells

# of Times Cells Divide	Time Elapsed in Minutes	Number of Cells
0	0	4
1	40	8
2	80	16
3	120	32



No, the tuna salad is not safe to eat after 2 hours of sitting on the table.

---

1. *E. coli* O157:H7 has a generation time of 20 minutes and can make you sick with as few as 10 cells. Judy likes to eat her hamburgers medium rare. If her hamburger was contaminated with 2 *E. coli* O157:H7 cells that were not killed during cooking and she waited 20 minutes to eat the hamburger, is it safe to eat?

Important Information		Bacteria type:	
Total Time:		Infectious dose:	
Generation Time:		# of cells at start:	

# of Times Cells Divide	Time Elapsed in Minutes	Number of Cells

Is it safe to eat?

_____

_____

_____

2. Under ideal conditions, *Salmonella* has a generation time of 30 minutes and an infectious dose of 15-20 cells. Aunt Susie's homemade Ranch salad dressing has been sitting on the picnic table for 2.5 hours. If the dressing started out infected with 3 *Salmonella* cells, is it safe to eat now?

Important Information		Bacteria type:	
Total Time:		Infectious dose:	
Generation Time:		# of cells at start:	

# of Times Cells Divide	Time Elapsed in Minutes	Number of Cells

Is it safe to eat?

_____

_____

_____

determine if the food is safe to eat.

3. Using the information provided, write your own food safety scenario. Then, complete the table and to

Important Information		Bacteria type:	*Campylobacter jejuni*
Total Time:	3 hours	Infectious dose:	400-500 cells
Generation Time:	90 minutes	# of cells at start:	150 cells

Scenario:

Is it safe to eat?

_____

_____

_____

Part II Directions: Now, rather than using a table, use the formula for exponential growth to determine if the food is safe to eat. Show your work. Then create a line graph for each scenario illustrating the exponential growth curve.

4. *E. coli* O157:H7 has a generation time of 20 minutes and can make you sick with as few as 10 cells. If Judy's hamburger was contaminated with 2 *E. coli* O157:H7 cells that were not killed during cooking, determine if it is safe to eat in each of the following situations.

Important Information		Formula:	$y = a(1 + b)^x$	
Total Time:	_____	# of cells at start	a	_____
Generation Time:	_____	Growth Rate	b	_____
Infectious dose:	_____	# of times cells divide	x	_____

   a. How many *E. coli* cells would be present (y) if she waited 40 minutes to eat the hamburger? Is it safe to eat?

   b. How many *E. coli* cells would be present (y) if she waited 1 hour to eat the hamburger? Is it safe to eat?

   c. Create a graph of the exponential growth curve where the number of times the cells divide is along the x-axis and the total number of bacterial cells is along the y-axis.

Challenge: How many *E. coli* cells would be presented (y) if she waited 3 hours to eat the hamburger?

5. Under ideal conditions, *Salmonella* has a generation time of 30 minutes and an infectious dose of 15-20 cells. If the dressing started out infected with 3 *Salmonella* cells, determine if it is safe to eat in each of the following situations.

Important Information		Formula:	$y = a(1 + b)^x$	
Total Time:	_____	# of cells at start	a	_____
Generation Time:	_____	Growth Rate	b	_____
Infectious dose:	_____	# of times cells divide	x	_____

a. How many *Salmonella* cells would be present (y) if the homemade salad dressing had been sitting on the picnic table for 1 hour? Is it safe to eat?

b. How many *Salmonella* cells would be present (y) if the homemade salad dressing had been sitting on the picnic table for 3 hours? Is it safe to eat?

c. Create a graph of the exponential growth curve where the number of times the cells divide is along the x-axis and the total number of bacterial cells is along the y-axis.

CHALLENGE: How many *Salmonella* cells would be present (y) if the homemade salad dressing had been sitting on the picnic table for 6.5 hours?

Unit Activities:	Review, Student Reflection, Analyzing Data	*Learning Objectives:*	Students will be able to: 1. Use mean, median, mode and range to analyze a data set. 2. Use statistical analysis to compare treatments in a data set. 3. Create graphical representations of data.
Instructional Events:	Assessing Performance, Enhance Retention & Transfer		
Materials:	Construction Paper		
Student Handouts:	*Analyzing Data* worksheet	*Content Standards:*	MGSE7.NS.3 MGSE7.EE.3 MGSE7.SP.3 MGSE7.SP.4

Activities:

Review (5 minutes)

Daily Review Question: **Yesterday you solved some problems to determine if foods in certain situations are safe to eat. Today we are going to analyze the results of your bacterial growth labs from science class. What predictions do you have as to which treatment was the most effective in getting rid of bacteria?**

Student Reflection (15-20 minutes)

Purpose: To determine if students are successfully meeting the learning objectives for this lesson.

Learner Level: All

- Ask students to reflect on the math concepts they've learned so far (bacterial growth and scale).
- Allow students to work in pairs and provide each pair with a piece of construction paper.
- Each pair should write one "really good" word problem or discussion question regarding the material they have learned so far this week.
- Post each pairs' question on the board and, as a class, try to answer each question correctly.

Analyzing Bacterial Growth Data (30 minutes)

Purpose: To allow students to develop expertise with the new information and create a construct for transferring knowledge to long-term retention.

Learner Level: All

- Using the raw data collected in the science follow-up lab, have students complete the **Analyzing Data** worksheet individually. Modifications for lower level students include: completing the exercise as a group and reducing the number of problems.
- Once students have finished, have them complete the **Analyzing Data Self-Assessment.**

Unit Activities:	Review, Analyzing Data, Self-Assessment	*Learning Objectives:*	Students will be able to: 1. Use mean, median, mode and range to analyze a data set. 2. Use statistical analysis to compare treatments in a data set. 3. Create graphical representations of data.
Instructional Events:	Enhance Retention & Transfer		
Student Handouts:	*Analyzing Data* Worksheet *Analyzing Data Self-Assessment*	*Content Standards:*	MGSE7.NS.3 MGSE7.EE.3 MGSE7.SP.3 MGSE7.SP.4

Activities:

Review (5 minutes)

Daily Review Question: **Yesterday we began analyzing the results of the bacterial growth labs from science class. What trends did you see as you analyzed this data? Today we are going to finish our analysis.**

Analyzing Data (30 minutes)

Purpose: To allow students to develop expertise with the new information and create a construct for transferring knowledge to long-term retention.

Learner Level: All

- Using the raw data collected in the science follow-up lab, have students complete the **Analyzing Data** worksheet individually.
- Once students have finished, have them complete the **Analyzing Data Self-Assessment.**
- Modifications for lower level students include: completing the exercise as a group and reducing the number of problems.

Self-Assessment (5 minutes)

- Students should complete the **Analyzing Data Self-Assessment.**

Analyzing Data Self-Assessment

0	2	4	6	8	10	You complete each task for questions 1-5.
0	1	2	3	4	5	All of your graphs are labeled correctly, have a title, and use regular intervals.
0	1	2	3	4	5	Your responses to questions are thoughtful and accurate.
0	1	2	3	4	5	Your work represents your best effort, is neat, and easy to read.

TOTAL: /25 points

Analyzing Data Self-Assessment

0	2	4	6	8	10	You complete each task for questions 1-5.
0	1	2	3	4	5	All of your graphs are labeled correctly, have a title, and use regular intervals.
0	1	2	3	4	5	Your responses to questions are thoughtful and accurate.
0	1	2	3	4	5	Your work represents your best effort, is neat, and easy to read.

TOTAL: /25 points

Analyzing Data Self-Assessment

0	2	4	6	8	10	You complete each task for questions 1-5.
0	1	2	3	4	5	All of your graphs are labeled correctly, have a title, and use regular intervals.
0	1	2	3	4	5	Your responses to questions are thoughtful and accurate.
0	1	2	3	4	5	Your work represents your best effort, is neat, and easy to read.

TOTAL: /25 points