Bacteria Population Growth Lesson Plan

science/math connection

Materials

- Calculators
- Bacteria Prediction Guide
- How E. coli Grows Notice /Wonder
- How E. coli Grows (part two)
- E. coli Infections - Reading
- Readworks antibiotics reading - Use Them Wisely
- E. coli Infographic
- Bacteria Growth YouTube video - http://bit.ly/bacteriagrowth

Steps

1) Prediction Guide - 10 min.

a) As students come in, give them the **Bacteria Prediction Guide** to complete before class begins. Students should make their best guesses. By the end of the class, they will be able to confirm if they were correct.

b) After completing on their own, ask students to share their answers with a partner. Which do they agree on?

2) Name Race Warm-up - 10 min.

a) Everyone gets in a circle. The object of the activity is for everyone to say their name in order, as fast as possible, but without interrupting each other. Using an Iphone or other stopwatch, time how quickly we can all say our name. Any predictions on how long it will take? Is everyone ready?

b) Start the stopwatch at the same time as you start the race by saying your name. Hit stop when the last student says their name. How long was that? Listen for guesses. Reveal. How long was it? (14.25 seconds, for example).

c) Do you think we can beat it? Hit Start again. In the second round, don't reset the stopwatch. Reveal it to the group (22.56 seconds, for example). What?! We didn't beat it? "That was faster!" "Wait, you forgot to hit reset." Oh… so, did we beat it? "Yes, 22.56 - 14.25 is about 8.25 seconds!" To everyone else, is that right?

d) Congratulations! Applause for everyone.

3) Notice/Wonder - 15 min.

a) Our lesson today is about a connection between math and science, using bacteria as an example. Has anyone taken the TASC test? Did you notice math on the science test, and science on the math test? It's important to study the connections between different subjects. Today we are going to look at the mathematics of population growth in bacteria.

b) Return to the prediction guide: Read the statements aloud and ask for a show of hands for whether students think each statement is true or false, but don't confirm whether the correct answer. In the course of the lesson, students will find evidence, especially in the E. coli Infographic at the end of the lesson.

c) Notice/Wonder: When we look at different kinds of information today, I'm going to ask you two questions; What you notice and what you wonder? With the first question, I'm asking what you see and what is interesting to you. With the second question, I want to know what questions you have and what you want to know more about.

Draw a T chart on the board (You'll add notes later):

What do you notice?	*What do you wonder?*

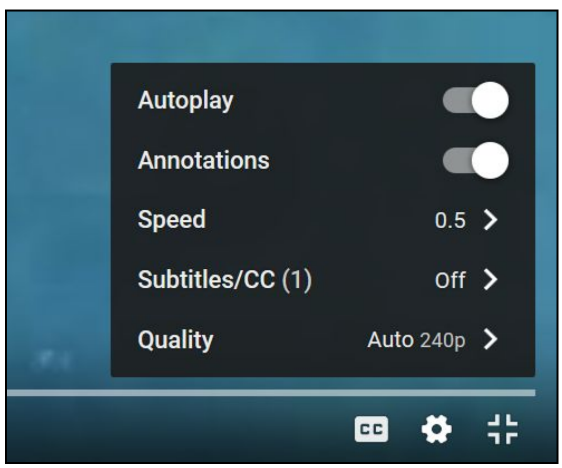
d) I'm going to show you a short video of a bacteria growing.

e) Show video without sound: http://bit.ly/bacteriagrowth

i) What did you notice? What questions do you have? (Share your thoughts with a partner, then discuss as a group. Take notes on what students notice first and then take notes on their questions. Simply write them down. There is no need to answer questions at this point.)

Note: The video is sped up. Students might ask how much. Good question! Write it down.

ii) Would you like to see it again? Let's watch it at a slower speed to see what you notice.



Note: In YouTube, you can change the playback speed by click on the settings icon on the bottom right and choosing different speeds (.25, .5, etc).

f) Hand out **How E. coli Grows** notice/wonder sheet

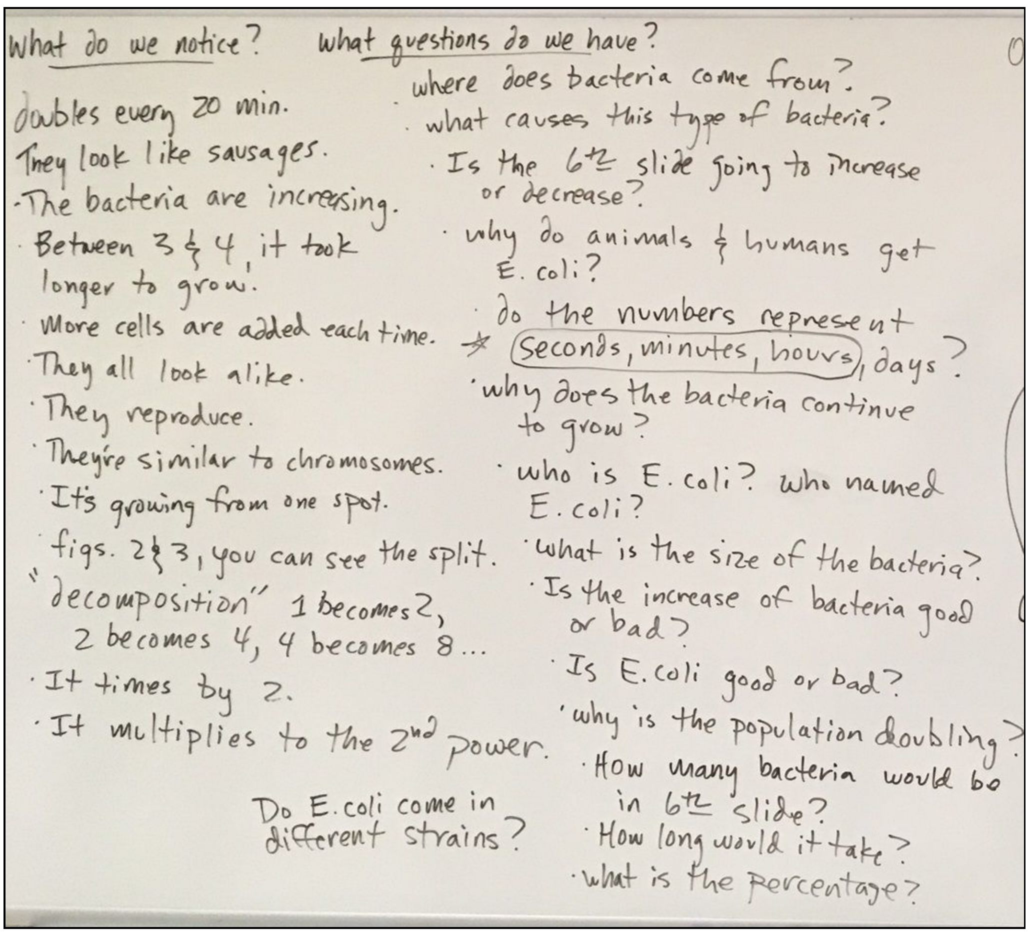
i) Working on your own, look carefully at the handout and take notes on what you notice and what you wonder? Write down at least 2 things you notice and 2 questions you have.

ii) Share what you notice and wonder with a partner. Write down each other's questions. Come up with at least 2 more questions that you didn't have before.

g) Large group

i) Go around the room. One comment from each group. What did you notice? Fill that column up before recording wonderings.

ii) What did you wonder? Take notes. Don't question or comment. Just write down what they say.



Board work from a 2016 class at La Guardia Community College

iii) Things to help students notice before moving on:

- The population grows: 1, 2, 4, 8, 16...

- Population doubles every 20 minutes.
- Bacteria grow by splitting in half. Mitosis is the process by which bacteria reproduce (asexual reproduction).
- The numbers represent time (hours, minutes, seconds).

4) Problem-Solving - 20 min.

a) Individual

i) Hand out **How E. coli Grows (part 2)**. This is also a good time to give out **calculators**. Ask students to work on the first page. Give them a couple minutes to work on their own and then ask them to show their drawings and sentences to a partner.

ii) Talk through the first two questions. Did your drawings look similar? In what way? (They all had 32 bacteria. They were clustered together.) Ask for a few volunteers to share the sentences they wrote to explain how to find the number of bacteria 20 minutes later. The goal of this question is to help students articulate that the population is being multiplied by 2 every 20 minutes. It is helpful to write down all equivalent ways of saying this (doubling, going up by the same amount, adding itself again), but "multiplying by 2" will help students understand exponential growth later. The goal here is for students to articulate this, so give them some time to figure it out.

iii) If the pattern of growth is not clear for all students, you can put the following sentence starter on the board and ask students to complete the sentence in different ways.

Every 20 minutes, the number of bacteria is ___________________________________.

(1) doubling
(2) adding the current population to itself
(3) multiplied by 2*

* All are correct, of course, but we want to emphasize this way of saying it.

iv) Ask students to work on the second page on their own. Set alarm for 5 minutes. When the time is up, if you want to work on your own, please do. If you want to talk with a neighbor, that's fine as well.

b) Small groups

i) Share your ideas with a partner. Work together for 10 min. While students are working independently, draw a table on chart paper or the board to match the worksheet (Leave room on the right side for exponent exploration later):

Time passed	*Number of bacteria*
00:00:00	
00:20:00	
00:40:00	
01:00:00	
01:20:00	
etc.	

ii) If student groups are struggling, give them a support card. If student groups finish quickly, give them a push card.

Note: Push and support cards are questions or situations to give to groups after they have begun working on the task together. The goal of the card is to provide support or extensions without "rescuing students" or having students rely on us as the experts. These cards help multi-level groups work on one problem, so that all students groups are working on same task & math content. When you see a group struggling, you can drop an appropriate support card at their table and move on. The same is true for students who have finished quickly. The push cards give them a related situation to consider.

c) Large group

i) Come back together to talk through the second page. You or the students can use the table for explanation. How many bacteria would there be after 4 hours? How many bacteria would there be after 5 hours?

ii) This is an opportunity for students to talk about the push questions that you handed out during small group work? It's not necessary to get to all these questions. Discuss only the questions that students worked on, possibly in this order (If they haven't already been discussed early in the class):

- *How much time would it take to grow more than a million bacteria?*
- *What shortcuts can you find with a calculator?*
- *How many times has the population doubled when the time is 05:00:00?*
- *How many bacteria would there be after 24 hours?*
- (Don't talk about this question yet.) *How much time has passed when there are 2^9 bacteria? (What is 2^9?)*

5) Exponents & Exponential Growth - 10 min.

a) Return to the table. Say, the population after 20 minutes is 2, right? After 40 minutes, the population is 4 because we multiplied 2 ✕ 2. After 60 minutes, the population is 8, which we could write like 2 ✕ 2 ✕ 2. Add *Multiplying by 2's* column to the table (shown below) and fill in the multiples of 2 so far.

b) Does that continue? How would we write the population after an hour and 20 minutes? 2 ✕ 2 ✕ 2 ✕ 2

c) How about after 2 hours? 2 ✕ 2 ✕ 2 ✕ 2 ✕ 2 ✕ 2 (Wow! How many 2's is that? That's a lot of 2's to write.) And 3 hours? 2 ✕ 2 ✕ 2 ✕ 2 ✕ 2 ✕ 2 ✕ 2 ✕ 2 ✕ 2 (Maybe there's a easier way to write this?)

d) Does anyone know a way mathematicians will write multiplying by 2's many times? (Check for misconceptions) For 2 hours, could I just write 2 ✕ 6? Why or why not? But there are six 2's here! (That would only be 12 bacteria. This is 64 bacteria. It's not 2 + 2 + 2 + 2 + 2 + 2, which is 2 ✕ 6.)

e) Return to the table and add the *Powers of 2* column on the right.

Time Passed	Number of Bacteria	Multiplying by 2's	Powers of 2
00:00:00	1		
00:20:00	2	2	2^1

00:40:00	4	2x2	2^2
01:00:00	8	2x2x2	2^3
…	…	…	…

Completed Table of Bacteria Population Growth

f) Talk about 2^3, for example. What is the small number on top (1,2,3,4…) called? *exponent* (also called *index* or *power*).

g) What is the number on the bottom (in this case, 2) called? base.

h) Can we answer the question, **How many bacteria would there be after 4 hours?** What would it look like in exponents? **5 hours?** How long would it take before there are more than a **million** bacteria?

Note: You or your students may be interested in what equation could be written to determine the population of bacteria after a certain amount of time. A simple expression to represent the number of bacteria could be 2^n, where n represents the number of 20-minute time periods that have passed. For example, after an hour, the population could be represented as 23 or 8 bacteria, since there have been 3 20-minute time periods and 2 ✕ 2 ✕ 2 = 8. A function for the number of bacteria after *n* 20-minute time periods could look like this:

$$f(n) = 2^n$$

In this equation, f(n) **refers** to the number of bacteria after n 20-minute time periods. The term f(n) means the function of n, so you might see a version of this equation with a value for n inserted:

$$f(3) = 2^3$$

$$f(3) = 8$$

Other possible functions for determining the number of bacteria after a certain period of time include the following.

When *n* = hours…

$$f(n) = 2^{3n}$$
$$f(n) = 8^n$$

When *n* = minutes…

$$f(n) = 2^{n/20}$$

Each of these functions will produce the same population of bacteria.

This lesson can be an introduction to exponents. It would be useful to return later to exponential growth and decay as Tim Jones, content expert in math and science, notes:

An important emphasis for TASC, having to do with this topic, is exponential growth versus decay. If the base is less than ONE, then the function models decay. Comparing examples of graphs showing growth and decay may be worth trying with some students.

Also, emphasized, somewhat, is the concept of Percent Increase from exponential expressions like this:

$$P = 6{,}000 \times 1.05^{t}$$

Here "1.05" could represent 105%, or a 5% increase over each time interval (t).

6) Desmos.com (optional) - 15 min.

Note: This graphing activity can also work as an activity on a second day, to come back to the bacteria growth problem. It will be is easier if your students have had some experience reading or making graphs in the past. If this is their first time with graphs, you will need more time to explore the axes, increments, in/out table, etc.

Desmos.com will allow you to plot points to see what the graph would look like. You can go to http://bit.ly/Desmosbacteria2 to work with a graph that is already set up. Add the data the students have calculated. Zoom out to look at the graph of the population.

a) Hand out printed graph http://bit.ly/Desmosbacteria2. Help students orient themselves to the graph.

   i) What is being measured across the bottom? What is being measured vertically?

   ii) What does the first point on the left represent? 1 bacteria after 0 minutes, at the beginning. Which image would this be on the other sheet? The first one.

iii) What does the second point represent? 2 bacteria after 20 minutes. Which image would this be on the other sheet? The second one.

iv) What does the third point represent? 4 bacteria after 40 minutes. Which image would this be on the other sheet? The third one.

v) Say, Draw a point on the graph on the graph to represent the next image. When students are finished, add "8" to the in/out table on the top left. This will place a point at the intersection of 60 minutes (x) and 8 bacteria (y).

x_1	y_1
0	1
20	2
40	4
60	8
80	-----

In/Out table from Desmos.com

b) Ask students to place the rest of their points on the graph. At some point, they will realize that they can't place all of them. Why not? It's growing too quickly. It goes off the page.

c) What is the shape of the graph that we have drawn? What would it look like if we connected the lines? This is an opportunity to talk about the shape of an exponential graph.

d) Any guesses on how many bacteria there would be after 24 hours?

7) TASC Practice - 15 min.

a) Work on your own. Testing conditions. Time students for 3 minutes. This is about how much time they will have on the actual exam.

b) Discuss the problem with your group.

c) Ask representatives to explain the problem.

8) E. coli Infographic & Prediction Guide - 15 min.

a) Hand out **E. coli Infographic** and ask students to use the handout to determine what is true and false on the prediction guide from the beginning of class. They can do this work in pairs/small groups.

9) Return to Video - 5 min.

a) Show the video again, this time with sound, listening to the narration.

b) Ask students, What was that number? Do you want to hear it again? "Five thousand billion billion?" What do you think of that? Some students will probably think it isn't a real number. How would you write it?

Note: Starting with two bacteria and doubling the population every 20 minutes, there would be about 5 thousand billion billion bacteria after 24 hours, assuming there was enough food/space and none had died. This huge number could also be written in these forms:

5,000,000,000,000,000,000,000

5×10^{21}

5 sextillion

This quantity is more than the number of grains of sand in all the beaches on Earth.

10) Exit Ticket - 5 min.

a) Ask students to complete the exit ticket on their own (*What interesting things did you learn about E. coli today? What are some questions you would like to research on your own?*)

b) If time allows, ask for volunteers to share what they wrote before you collect the handouts.

11) Possible Readings for Homework

a) Antibiotics - Use Them Wisely (ReadWorks)

b) E. coli Infections - Reading

Prediction Guide - *E. coli* Bacteria

Consider the following statements and decide which you think are true and which you think are false.

1) _____ T _____ F Individual bacteria can be seen with the naked eye.

2) _____ T _____ F Bacteria grow by splitting in half, in a process called mitosis.

3) _____ T _____ F *E. coli* bacteria live in the guts of animals, but not humans.

4) _____ T _____ F *E. coli* can make you very sick and even cause death.

5) _____ T _____ F Bacteria are used to make insulin for treatment of diabetes.

6) _____ T _____ F 90% of our bodies are made up of E. coli and other microbes.

How E. coli Grows

E. coli (*Escherichia coli*) is the name of a type of bacteria that lives in the digestive tracts of humans and animals. It grows by splitting in half, through a process called mitosis.

What do you notice?	What questions do you have?

How E. coli Grows (part 2)

Imagine yourself working as a scientist. You are growing *E. coli* in a petri dish. Every 20 minutes, you take a photograph through a microscope and then count the number of bacteria at that moment.

1) What do you think the next photograph of bacteria would look like? (Draw them.)

01:40:00

2) Now, imagine 20 minutes have passed after the picture you drew on the left. How would you figure out how many bacteria there are?

Complete the table to the right.

1) How many bacteria would there be after 4 hours?

2) How many bacteria would there be after 5 hours?

Time Passed	*Number of Bacteria*
00:00:00	
00:20:00	
00:40:00	
01:00:00	
01:20:00	
01:40:00	
02:00:00	
02:20:00	

Push and Support Questions

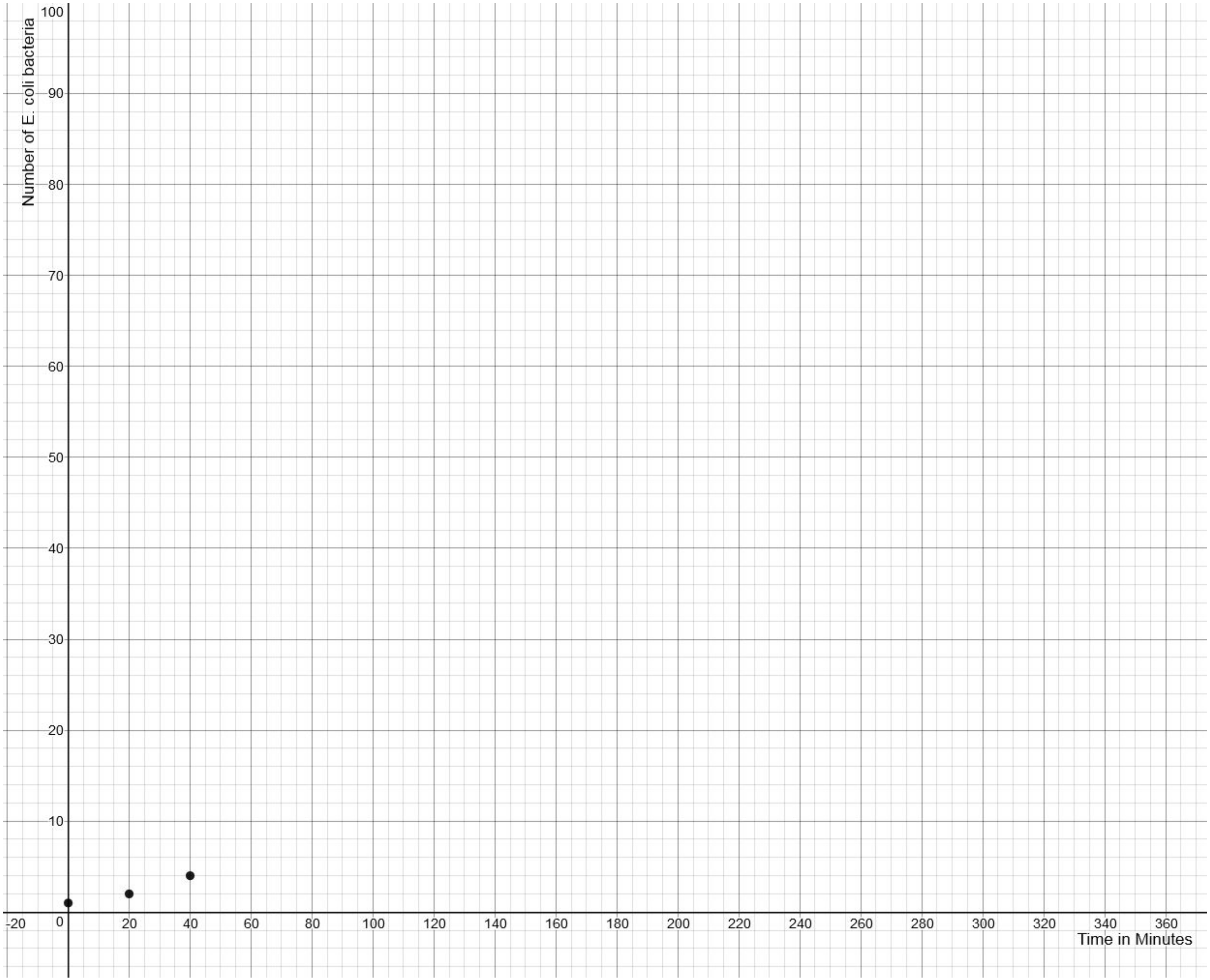
Cut out the strips below before class. Share strips with groups only if they need them to keep working productive.

Support Questions

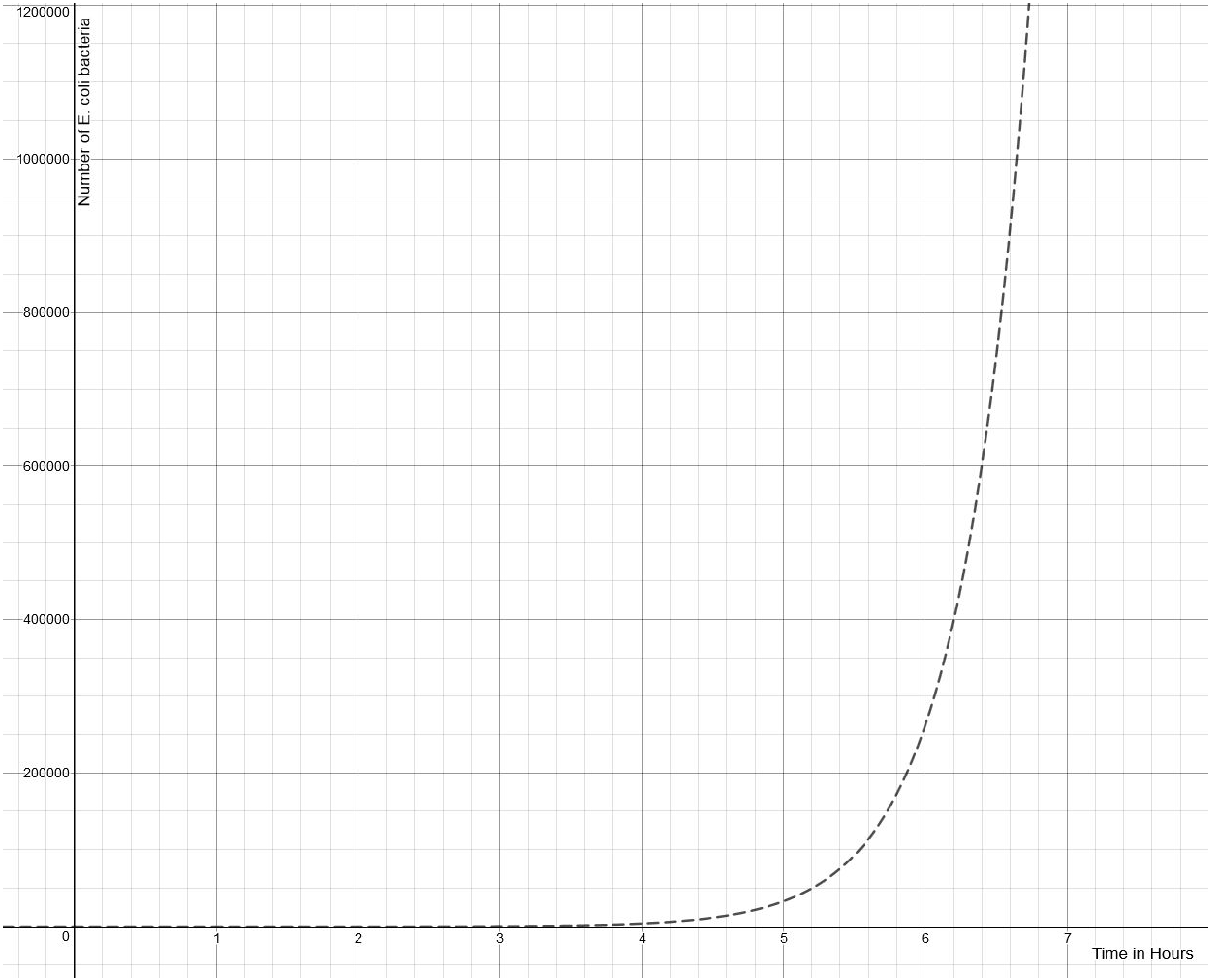
What is the next number in this pattern? 1, 2, 4, 8, 16, 32, ...
What does 01:20:00 mean? How many times has the population doubled?
How much time has gone by when there are 64 bacteria?
How many bacteria would there be after 3 hours?
What shortcuts can you find with a calculator?

Push Questions

How much time would it take to grow more than a million bacteria?
How many times has the population doubled when the time is 05:00:00?
What shortcuts can you find with a calculator?
How many bacteria would there be after 24 hours?
How much time has passed when there are 2^9 bacteria? (What is 2^9?)



Number of E. coli bacteria
100
90
80
70
60
50
40
30
20
10
0
-20
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
Time in Minutes



Number of E. coli bacteria
1200000
1000000
800000
600000
400000
200000
0
1
2
3
4
5
6
7
Time in Hours

TASC Practice Question

The population growth of a colony of E. coli bacteria is shown in the table below.

Hours	**Population)**
0	1
1	8
2	64
3	512
4	4,096
5	32,768

Which of the functions below determines the population of bacteria, *P(t)*, after *t* hours?

A. $P(t) = 8t$

B. $P(t) = t^8$

C. $P(t) = 8^t$

D. $P(t) = 2^t$

Why did you choose this answer?

THE SECRET LIVES OF *E. coli*

Causing illness is only one small part of the story of *E. coli*; its relationship to human health and the food we eat is much more complex. Not all *E. coli* are bad - in fact most are not - and some are even beneficial!

So what IS an *E. coli*?

E. coli is a bacterium; a one-celled organism that is too small to see by the naked eye; it is sometimes referred to as a microorganism or **microbe.** *E. coli's* name came from the name of its discoverer, **Theodor Escherich,** and the fact that it grows in the colon (gut) of humans and animals.

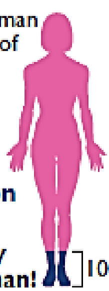
THE GOOD NEIGHBOR

TO KEEP PEOPLE HEALTHY:

- ✓ Protect against invaders
- ✓ Help other good bacteria
- ✓ Soak up toxins

E. coli is a beneficial part of our gut

E. coli is one member of a large community of microbes that live in our intestines. These microbes protect us from pathogens, make vitamins, and help break down food. Our gut provides these microbes with a protected area in which to grow and a supply of food.



- The average human body is made up of 100 trillion cells.
- 90 trillion are *E. coli* and other **microbes**

Only 10 trillion human cells

- **You are only really 10% human!** 10%

THE BAD NEIGHBOR

TO MAKE PEOPLE SICK:

- ✓ Get in gut
- ✓ Stay in gut
- ✓ Produce toxins and irritate gut

It all starts with poop.

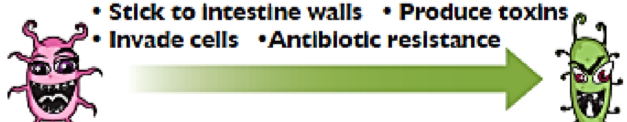
SUMMER 2011: 50 people die and over 4,000 are sickened as a result of an *E. coli* outbreak. Transmission of *E. coli* is mainly from feces to mouth. The source in most contamination events can be traced back to exposure to fecal matter at some point in the food chain!

E. coli can make us sick!

There are many different types of *E. coli*, but the ones that people are most familiar with are those that cause disease. Disease-causing *E. coli* disrupt body functions, resulting in diarrhea. Some can cause permanent damage and sometimes even death.

How do the good guys go bad?

- **Stick to intestine walls**
- **Produce toxins**
- **Invade cells**
- **Antibiotic resistance**

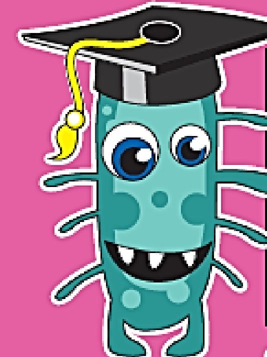


E. coli can exchange genes with other *E. coli* and even other types of bacteria. There are many different genes that, when acquired, could change a harmless *E. coli* into one that makes us sick.

FAQ

There are two ways to protect food from contamination with harmful *E. coli*: ❶ Prevent bacteria (and feces!) from getting into food in the first place or ❷ Treat food products to kill bacteria that have slipped past our precautions.

THE SCIENTIFIC PARTNER



TO HELP PEOPLE UNDERSTAND LIFE:

- ✓ Work in labs
- ✓ Make helpful products
- ✓ Make discoveries

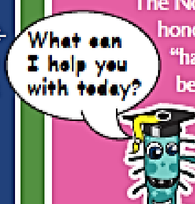
E. coli is a "model organism"

"What is true for *E. coli* is true for the elephant." – Jacques Monod While humans (and elephants!) are made of trillions of cells working together, *E. coli* is composed of a single cell. Biology that would be difficult or unethical to study in humans or animals can be studied more easily in *E. coli*, this is why scientists often refer to *E. coli* as a "model organism".

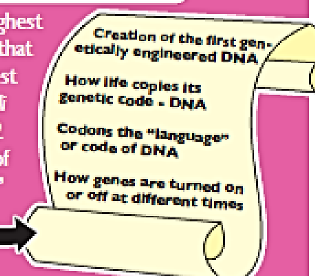
E. coli is a "molecular factory"

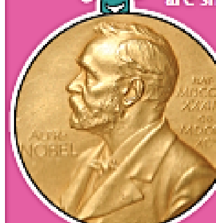
E. coli jump started the biotechnology era because *E. coli's* genetic flexibility allowed microbiologists to use *E. coli* as a factory to produce many biological compounds we use every day. Insulin (for treatment of diabetes) and rennin (for production of cheese) are two examples of this.

E. coli wins record number of Nobel Prizes!



The Nobel Prize is science's highest honor given for discoveries that "have conferred the greatest benefit on mankind." *E. coli* has contributed to 12 Nobel prizes! Some of *E. coli's* "greatest hits" are shown here.





(Nobel Prize!)

FOR THE FREE FULL REPORT VISIT:
http://bit.ly/AAMEcoli

AMERICAN SOCIETY FOR MICROBIOLOGY

Name: ____________________________

After the lesson:

What interesting things did you learn about E. coli today?

What are some questions you would like to research on your own?

Antibiotics: Use Them Wisely

Antibiotics are the best drugs we have to fight deadly bacteria, but the germs are fighting back.

Ah-choo! Carmen has been feeling miserable for the last three days, sneezing and coughing. If she doesn't get well soon, she might miss an important test at school. She might even miss the holiday parties.

Carmen asked her parents to take her to the doctor. She wanted the doctor to give her antibiotics.

Carmen's sister, Silvia, had also been feeling sick, and the doctor gave her antibiotics. Silvia had started feeling better after only a couple of days.

But after the doctor checked Carmen, he said something that she found deeply disappointing. "You don't need antibiotics."

"But you gave them to Silvia, and she's better now," replied Carmen.

"Silvia had strep throat; you have a cold," the doctor said. "Bacteria caused Silvia's strep throat, but your cold is caused by a virus. Some people call antibiotics 'miracle drugs,' but they don't kill all kinds of germs. They kill bacteria, but not viruses."

Carmen learned that antibiotics wouldn't cure her cold. Antibiotics kill the germs that cause many infections. Tuberculosis, ear infections, and some types of pneumonia (a type of lung infection) are just a few. Thanks to these drugs, most people don't die of these diseases today.

What Are Antibiotics?

Some living things, like molds, make substances that can kill bacteria. These substances are called antibiotics. Others are not made by molds. Scientists make them in special laboratories.

Alexander Fleming discovered the first antibiotic in 1928. He was working with the mold Penicillium. Fleming discovered that Penicillium made a substance that killed bacteria.

He called it penicillin. Penicillin kills germs such as *Staphylococcus aureus* (STAFF-uh-low-KAH-kus AW-ree-us). These germs are very dangerous to people. When they get inside the bloodstream, they reproduce, or make many more of themselves, killing the person.

In the 1940s, everyone got very excited about penicillin. Doctors could now cure their patients of bacterial infections that threatened their lives. People all over the world thought that the drug would once and for all get rid of these deadly germs. But time proved everyone wrong. Bacteria are here to stay, and some are even stronger than before.

Take Only As Directed

When the doctor gave Silvia a prescription for penicillin to treat her strep throat, he said very seriously: "You must take all the doses of this antibiotic, one with each meal, until you finish it. This will take 10 days. You have to take all of it to get rid of the germs."

Silvia started taking the antibiotic, but after a few days, she felt better and stopped taking it. She felt fine for a week or so, but then her throat started to hurt again. It got worse than the first time. Her parents took her to the doctor again. The doctor asked Silvia if she had finished all her medicine. She told him she forgot about it when she felt better.

"That's why you got sick again," the doctor said. "Most of the germs that were making your throat hurt were killed easily by a few doses of antibiotics. That's why you felt better after a few days. But some germs are tougher, and you need more doses of the drug to kill them. When you stopped taking the antibiotic, you left the toughest germs alive. These bacteria reproduced, and now you have many of the toughest kind causing your sore throat."

The medicine Silvia took the first time will not kill these tougher germs. They are "resistant" to the drug. The doctor had to kill the bacteria using a different medicine. This time the doctor gave Silvia medicine to take for only five days. Each dose had more medicine in it. And the medicine lasted longer inside her body. Silvia took all her medicine this time. She didn't want to get sick again.

Bacteria Fight Back

Silvia and Carmen wanted to know why germs fight back. The doctor explained that some germs make substances that destroy the drugs before they can reach them. Other bugs can pump the drugs out before they hurt them. Resistance to these drugs allows germs to stay alive and make people sick.

Some germs, such as deadly *Staphylococcus aureus*, are now resistant to some of the medicines. Doctors are afraid that someday many bacteria will fight back many or all of the antibiotics. If this happens, doctors will not be able to cure deadly diseases like tuberculosis or pneumonia.

The Good News

There are ways to help stop bacteria from becoming resistant. Take antibiotics just as the doctor ordered. Take antibiotics only when you have an illness caused by bacteria. Remember, these drugs kill only bacteria and not other germs.

Also, if people take antibiotics when they don't need them, they will kill off the "friendly" bacteria too. The friendly bacteria help keep the bad bugs from growing as quickly. When the good germs die, the bad germs grow faster.

Bacteria are here to stay. But by taking antibiotics responsibly, you can stop them from becoming a deadly enemy.

Name: _______________________________________ Date: _________________________

1. What do antibiotics kill?

A the germs that cause many viruses
B the germs that cause many infections
C the germs that cause colds
D the germs that cause mold

2. The text provides a description of antibiotics and how they work. They text also provides a story about two sisters who become sick. How does the story relate to the description?

A The story contradicts the description.
B The story disproves the description.
C The story supports the description.
D The story weakens the description.

3. The toughest germs are usually killed in the prescription's last doses of an antibiotic. What evidence from the text supports this conclusion?

A Doctors are afraid that someday many bacteria will fight back many or all of the antibiotics. If this happens, doctors will not be able to cure deadly diseases like tuberculosis or pneumonia.
B The doctor said very seriously, "You must take all the doses of this antibiotic, one with each meal, until you finish it. This will take 10 days. You have to take all of it to get rid of the germs."
C The doctor explained that some germs make substances that destroy the drugs before they can reach them. Other bugs can pump the drugs out before they hurt them.
D Silvia started taking the antibiotic, but after a few days, she felt better and stopped taking it. When she stopped taking the antibiotic, she left the toughest germs alive.

4. What might happen if people take antibiotics when they don't need them?

A These people might get a virus.
B These people might get a bacterial infection.
C These people might become resistant to antibiotics.
D These people might get better more quickly.

5. What is the main idea of this text?

A It is important to take antibiotics responsibly.
B Some germs are resistant to antibiotics.
C Viruses cannot be killed with antibiotics.
D Penicillin can cure bacterial infections.

6. Read these sentences from the text.

“Also, if people take antibiotics when they don't need them, they will kill off the ‘friendly’ bacteria too. The friendly bacteria help keep the bad bugs from growing as quickly. When the good germs die, the bad germs grow faster.”

Why does the author use the word "friendly" to describe some bacteria?

A to suggest these bacteria are the same as bad bacteria
B to suggest these bacteria are helpful to bad bacteria
C to suggest these bacteria are bad for your body
D to suggest these bacteria are good for your body

7. Choose the answer that best completes the sentence.

Silvia needed antibiotics because she had an infection caused by bacteria. __________, Carmen did not need antibiotics because she had an infection caused by a virus.

A Previously
B However
C Specifically
D Therefore

8. What explanation did the doctor give Silvia about why she got sick again? Support your answer with evidence from the text.

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9. What could happen if people take antibiotics when they do not need them? Support your answer with evidence from the text.

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10. Why is it important to take antibiotics responsibly? Support your answer with evidence from the text.

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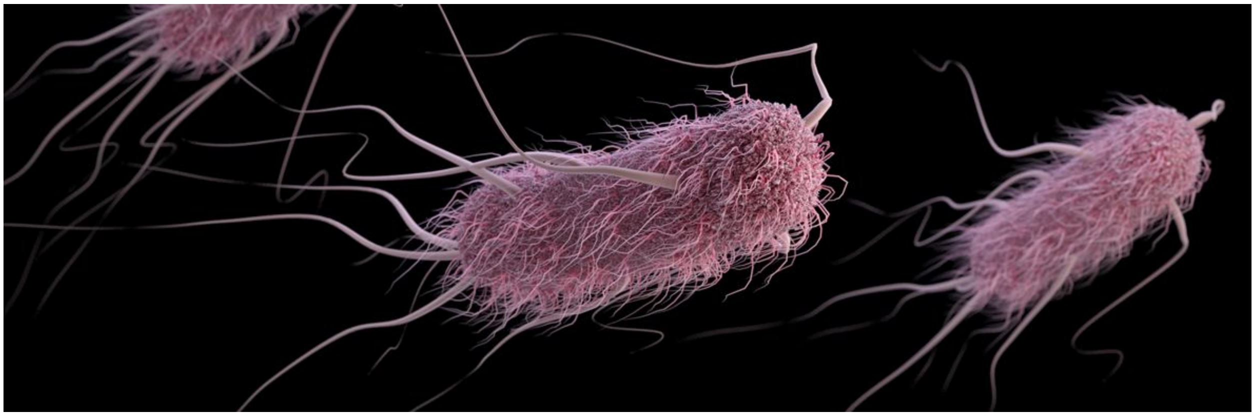

E. coli Infections

What is an E. coli infection?

E. coli (*Escherichia coli*) is the name of a type of bacteria that lives in the digestive tracts of humans and animals.

There are many types of *E. coli*, and most of them are harmless.

However, some types of *E. coli* can make you sick, causing bloody diarrhea, urinary tract infections, and even severe anemia or kidney failure, which can lead to death.

What causes an E. coli intestinal infection?

You can get an *E. coli* infection when come into contact with feces, or stool, of humans or animals, or if you drink water or eat food that has been contaminated by feces.

E. coli in food

E. coli can get into meat during processing. If meat is not cooked properly, bacteria can survive and infect you when you eat the meat. This is the most common way people in the United States become infected with *E. coli*. Any food that has been in contact with raw meat can also become infected.

Other foods that can be infected with *E. coli* include:

- Raw milk or dairy products. Bacteria can spread from a cow's udders to its milk. Check the labels on dairy products to make sure they contain the word "pasteurized." This means the food has been heated to destroy bacteria.

- Raw fruits and vegetables, such as lettuce, alfalfa sprouts, or unpasteurized apple cider or other unpasteurized juices that have come in contact with infected animal feces.

E. coli in water

Human or animal feces infected with *E. coli* sometimes get into lakes, pools, and water supplies. People can become infected when a contaminated city water supply has not been properly treated with chlorine or when people accidentally swallow contaminated water while swimming in a lake, pool, or irrigation canal.

E. coli from person-to-person contact

The bacteria can also spread from one person to another, usually when an infected person does not wash his or her hands well after a bowel movement. *E. coli* can spread from an infected person's hands to other people or to objects.

How do you prevent an E. coli intestinal infection?

Food and water that are infected with *E. coli* germs look and smell normal. But there are some things you can do to prevent infection:

- Cook ground beef to at least 160°F (71°C).
- In the kitchen, wash your hands with hot, soapy water often, especially after you touch raw meat.
- Wash any tools or kitchen surfaces that have touched raw meat.
- Use only pasteurized milk, dairy, and juice products.
- Use only treated, or chlorinated, drinking water.
- When you travel to countries that may have unsafe drinking water, don't use ice or drink tap water. Avoid raw fruits and vegetables, except those with skin that you peel yourself.
- Wash your hands often, and always wash them after you use the bathroom or change diapers.

Adapted from WebMD article
(http://www.webmd.com/a-to-z-guides/tc/e-coli-infection-topic-overview)