

Your research team has been flown to a city in West Africa in the midst of a cholera epidemic. *Vibrio cholerae* is a species of bacteria that can spread through poor sanitation.

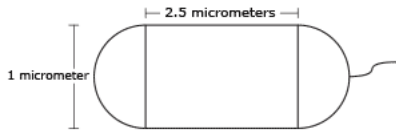
Name:

Tiny Culprits

In this case, there is a widespread lack of toilets. Especially during the rainy season, waste gets into drinking water sources, causing intestinal infections from cholera. The CDC responds to cholera outbreaks across the world with its Global Water, Sanitation, and Hygiene initiative to help improve water quality.

Question 1

Each individual *V. cholerae* is a rod-shaped cell and has a flagellum, which is like a tail. The shape of the cell is a rectangle with 2 half circles at each end. The diagram shows the average dimensions of single bacterium.



What is the perimeter of the figure? Is the perimeter a rational or irrational number? Show or explain how you found the answer.

(The formula for the circumference of a circle is $C = \pi d$, where d is the diameter.)

Question 2

Your research team isolated and measured cross-sections of individual *V. cholerae*. The table shows the perimeter of the cross-sections. Between which two integers does each perimeter lie? Record your answers in the table below.

Cell	Perimeter (micrometers)	Integers
A	$\pi + 3$	<input type="text"/> and <input type="text"/>
B	$0.25\pi + 2$	<input type="text"/> and <input type="text"/>
C	$0.5\pi + 2.5$	<input type="text"/> and <input type="text"/>
D	$0.5\pi + 2$	<input type="text"/> and <input type="text"/>

Question 3

This table shows the perimeter of *V. cholerae* cross-sections.

Perimeter of Cell Cross-Sections

Cell	Perimeter (micrometers)
A	$\pi + 3$
B	$0.25\pi + 2$
C	$0.5\pi + 2.5$
D	$0.5\pi + 2$

Write an A, B, C, D tag to the number line to show the approximate location of each perimeter.



Question 4

This table shows the perimeter of *V. cholerae* cross-sections.

Perimeter of Cell Cross-Sections

Cell	Perimeter (micrometers)
A	$\pi + 3$
B	$0.25\pi + 2$
C	$0.5\pi + 2.5$
D	$0.5\pi + 2$

Is the perimeter of Cell C larger or smaller than $\sqrt{16}$ micrometers? Show or explain how you found the answer.

Question 5

Could a cell have a length of $\sqrt{2}$? Explain why or why not.

Question 6

This table shows the perimeter of *V. cholerae* cross-sections.

Perimeter of Cell Cross-Sections

Cell	Perimeter (micrometers)
A	$\pi + 3$
B	$0.25\pi + 2$
C	$05\pi + 2.5$
D	$0.5\pi + 2$

Which cell has a perimeter closest to $\sqrt[3]{8}$? Show or explain how you found the answer.

Question 7

A scientist estimates that a cell's surface area is $4\frac{4}{27}$ micrometers². What is the decimal expansion of this number? Show or explain how you found the answer.

Question 8

A scientist measures a cell and calculates its surface area to be $3.\overline{36}$ micrometers². What is the surface area expressed as a rational number?

Question 9

By isolating individual bacteria, your team found the mass, in grams, of different cells. The table shows the results.

Mass of Cells (grams)

Cell	Scientific Notation	Standard Form
A	5.6×10^{-11}	
B		0.0000000000461
C	3.8×10^{-10}	
D		0.0000000301

a) Write the mass of Cell A in standard notation.

Explain how you converted scientific notation to standard notation.

b) Write the mass of Cell B in scientific notation.

Explain how you converted scientific notation to standard notation.

c) Write the mass of Cell C in scientific notation.

Explain how you converted scientific notation to standard notation.

d) Write the mass of Cell D in scientific notation.

Explain how you converted scientific notation to standard notation.

Question 10

Mass of Cells (grams)

Cell	Scientific Notation	Standard Form
A	5.6×10^{-11}	
B		0.0000000000461
C	3.8×10^{-10}	
D		0.0000000301

A scientist reports the length of Cell E as 2.7×10^{-1} . He forgot to include the unit of measure for the length of the cell. If Cell E is similar in size to the other cells in the table, is the length measured in micrometers or kilometers? Explain your answer.

Question 11

Mass of Cells (grams)

Cell	Scientific Notation	Standard Form
A	5.6×10^{-11}	
B		0.0000000000461
C	3.8×10^{-10}	
D		0.0000000301

How many times larger is the mass of Cell C compared to Cell A? Show your work.

Question 12

The body length of *V. cholerae* is 2.5 micrometers. A scientist on your team wants to find the volume of bacteria in a small sample of infected water. She starts by measuring the total length, in micrometers, of *V. cholerae* in each sample. Her notes are in exponent expressions that are not simplified.

Cell Length (micrometers)		
Cell	Exponent Expression	Simplified Expression
A	$2.5^3 \cdot 2.5^4$	
B	$(2.5^6)^2$	
C	$\frac{2.5^3}{2.5^2}$	
D	$\frac{2.5^9 \cdot 2.5}{2.5^7}$	

Help her finish the table by simplifying each expression to a term with one exponent. Then, use words to explain the rule for simplifying each expression.

- a) Simplify $2.5^3 \cdot 2.5^4$. Explain the rule for simplifying this type of expression.

- b) Simplify $(2.5^6)^2$. Explain the rule for simplifying this type of expression.

c) Simplify $\frac{2.5^3}{2.5^2}$. Explain the rule for simplifying this type of expression.

d) Simplify $\frac{2.5^9 \cdot 2.5}{2.5^7}$. Explain the rule for simplifying this type of expression.

Question 13

Your team estimates that one *V. cholerae* has a mass of 4.32×10^{-12} grams. If there are 5.6×10^8 bacteria in the 1,500 L tank of lake water, what is the total mass of *V. cholerae* in the tank? Show or explain how you found the answer.

Question 14

Three hours later, your team took another sample of water and estimated that there are now 126,000,000,000 bacteria living in the tank water. The mass of each bacterium is 4.32×10^{-12} grams on average. What is the total mass of bacteria in the tank? Show or explain how you found the answer.

