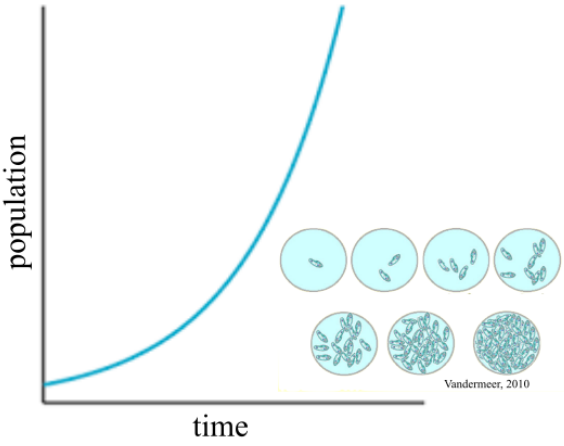
The Exponential Curve:
Explosive Growth through Replication

- All living things **reproduce** (make children).
- **Cell division**: the splitting of one cell or microorganism into two
- When the number of something keeps doubling, we call this **exponential growth**. The more cells you have, the more new cells they make. Exponentially growing populations grow faster and faster.
- Exponential growth allows tiny microbes to take over huge regions if they have enough food to keep dividing and they aren't killed off.

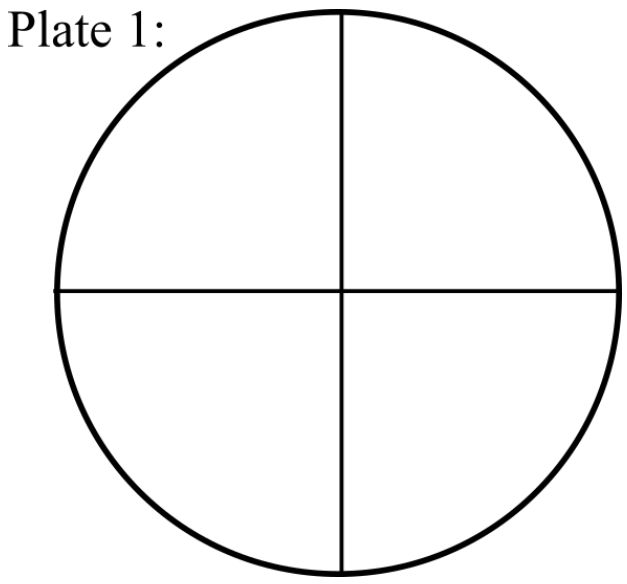


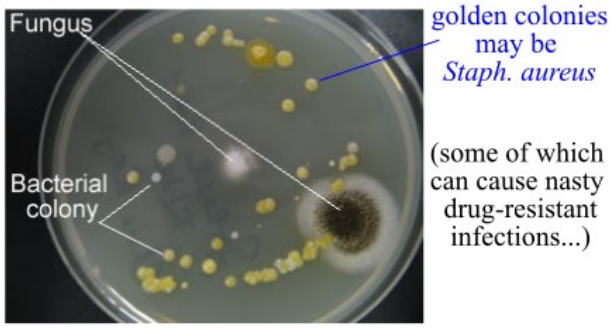
Part 1: Bacterial Colonies

Look over the agar plates you infected last week.

1. Start with Plate 1 (sampling different surfaces). Write what you see in each section.

Dots? Spots? Smears? Nothing? Fuzzy threads? What color?
If you have a few spots, estimate how many there are.



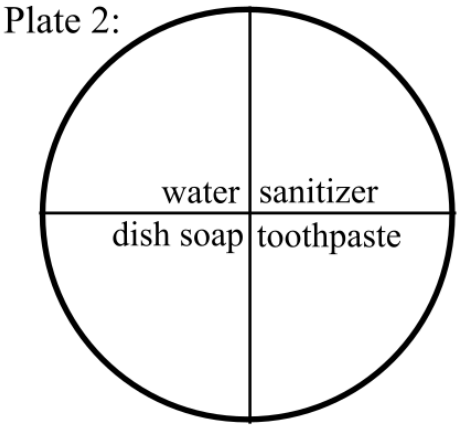


If you see tiny individual dots, what do you think those are?
single bacteria colonies of many bacteria pieces of a larger microorganism

- If you see fuzzy or hairy-looking blobs, these are most likely **mold**. Molds are a type of fungus (relative of mushrooms). Fungi form long thread-like cells called **hyphae** that combine into branched networks called **mycelia**.
- If you see tiny individual spots, they are colonies of identical (**clonal**) bacteria. Each spot started from a single bacterium that reproduced over and over again.
- If you see smears, these might be dense mats of bacteria formed from many colonies fusing together. Can you see single colonies on the edges of the smear?

Compare to your hypotheses from last time:
The sample from which surface grew the most bacteria? _____
The sample from which surface grew the least bacteria? _____

2. Now look at Plate 2 (where you tested hygiene products).



Write what you see in each section:

Compare to your hypothesis from last time:
Which substance had the least bacterial growth around it?
_____

Discuss:
- When and why would you want to use hand sanitizer?
- Why do we use toothpaste when we brush our teeth?

Part 2: Exponential Growth

In this activity, we will use cheerios to represent individual bacteria as they replicate.

1. Place 1 cheerio in the bowl. In every **generation**, each cheerio will turn into 2 cheerios.

Make guess: How many generations do you think it would take for the entire bowl to be full of cheerios?

_____

2. After the first generation, your 1 cheerio doubles. Now you should have 2 cheerios in your bowl.
3. Start plotting the number of cheerios versus the generation number on the graph provided.

Discuss: on the vertical axis of your plot, how many cheerios does each tiny square represent?

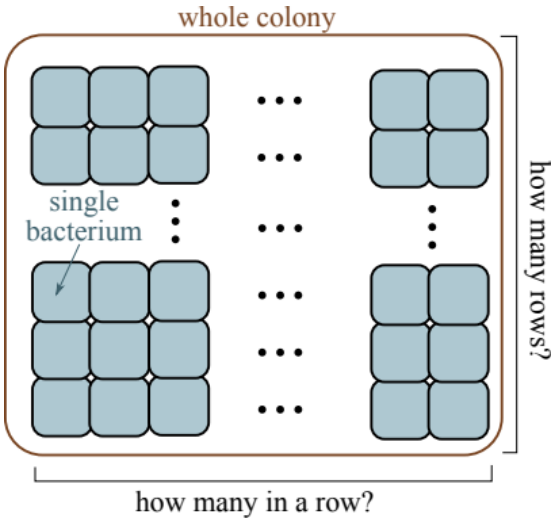
4. Double the number of cheerios in the bowl again for the 2nd generation and plot the number on your graph. Keep doubling for the 3rd, 4th, and 5th generation. Connect the dots as you plot.

5. To save the trouble of counting more cheerios, we will use a balance scale to keep doubling. Place the spare bowl on the other side of the scale and measure out an equal mass of cheerios (enough to make the scale balance). Pour them all into your original bowl.
Use math to figure: How many cheerios must you have in the 6th generation? _____
Plot the number on your graph.

6. Keep using the scale to double the number of cheerios for more generations until the entire bowl is full. Plot the estimated numbers on your graph. You can round each number as you go. For example 128 cheerios can be rounded to about 100 cheerios.

How many generations did it take to fill the whole bowl? _____

7. A single bacterium is tiny – just 1 **micrometer** long.
It takes 1000 bacteria laid out end-to-end to stretch across 1 millimeter.
Can you estimate how many bacteria are in one of the bacterial colonies (spots) on your agar plate?
Width of spot: _____ mm
Number of bacteria in each row: _____ mm
Number in whole spot: _____
(Pretend the spot is a square and each of the bacteria are little squares laid out in rows. Assume only 1 layer thick.)



Exponential growth (doubling over and over again) let a single tiny bacterium grow into a large enough colony for you to see. Bacteria can divide every few hours, so over the week they had time for many generations of doubling.

Discuss:

- Where else might you see the shape of an exponential growth curve (growing faster and faster)? When is exponential growth dangerous?
- Given how fast an exponential growth curve rises, why haven't bacteria completely taken over the world? What can stop exponential growth?