Please turn in your assignment on **March 21st at the beginning of class**. I will take off
two points for each day it is late, including turning it in at the *end* of class.

Calculating Bacterial Growth

By knowing three simple formulae, problems related to calculating the number of
bacteria growing during the logarithmic phase can easily be solved. Use the formula
explanations and the worked examples here to help solve the homework problems below.

The number of bacteria cells in the log phase of growth can be determined by;

$$X = X_0 * 2^k \qquad\qquad (1)$$

where:
$X = $ = total # of bacteria present after k generations;
$X_0 = $ initial number of bacteria;
$k = $ number of generations (or doublings)

Example: *Bacillus cereus* divides every 30 minutes. You inoculate a culture with exactly
100 bacterial cells. After 3 hours, how many bacteria are present if you assume all log-
phase growth?

       Answer: In 3 hours, *B. cereus* will divide 6 times.

               Therefore, k = 6.
               $X = X_0 * 2^k$
               $X = 100 * 2^6$
               $X = 6400$ cells

Let's say that you didn't know how many generations resulted in the bacteria growth
calculated above, but you did know the number of cells present at the beginning and end
of the logarithmic growth (100 and 6400 cells, respectively). How do we calculate the
number of generations that occurred?

In this situation (when you know the starting and final numbers of cells, but do not know
k), use;

$$k = [(\log x) - (\log x_0)] / 0.301 \qquad (2)$$

where:
k = number of generations (or doublings);
X = cells at the end of incubation;
X_0 = cells at beginning of incubation

Therefore,

$k = [(\log 6400) - (\log 100)] / 0.301$
$k = (3.81 - 2) / 0.301$
$k = 6$ generations…just like we calculated for use in formula (1) above.

Sometimes we want to know how much time it takes for a generation to occur. The generation time for a population can be calculated by dividing the number of minutes of logarithmic growth (t), by k.

In this example:

$t = 60$ min x 3 hours
$t = 180$ min

$$\text{generation time} = t / k \qquad (3)$$

where;
t = total logarithmic growth time (minutes);
k = number of generations

Therefore,

generation time = 180 min / 6 generations
generation time = 30 min per generation

Use the formulae and examples above to solve these problems.

1. A worker at a deli neglects to wash his hands before preparing potato salad. He mistakenly contaminates the salad with 12,000 *Salmonella* cells. How many bacteria will be present in 12 hours if the generation time is 15 minutes (assume unlimited growth)?

2. You determine that a coconut cream pie contains 3 million (3×10^6) *Staphylococcus aureus* cells. You assume that the food preparer did not wash his hands and probably inoculated the cream with 500 *S. aureus*. If the pie was made 6 hours ago, how many generations have occurred? How long is each generation?

3. Using the generation time from Problem 2, how many bacteria would be present after eight hours at room temperature?

4. *Streptococcus pyogenes* are often referred to as "flesh eating bacteria" (it's true, look it up). It can divide every 40 minutes at body temperature. Assume that you fall down and scrape your knee and get infected with five *S. pyogenes* cells. You think nothing of this minor accident, and avoid seeking medical attention.

    i)   After 24 hours, how many bacteria will be infecting your body?

    ii) Let's say that for every one million bacteria, a cubic millimeter of flesh is consumed in a day. After 24 hours, how much tissue (in cubic mm) would be lost?