Calculating Bacterial Growth

See textbook for more information

$2^{\text{number of generations}}$ x initial number of bacteria = total # of bacteria present after n generations

Example: *Bacillus cereus* divides every 30 minutes. You inoculate a culture with exactly 100 bacterial cells. After 3 hours, how many bacteria are present?

In 3 hours, *B. cereus* will divide 6 times. Therefore, n = 6. $2^6 = 64$ or 2x2x2x2x2x2

100 x 64 = **6,400 cells**

Using the same example, let's say you have determined that your sample contains 6,400 bacterial cells. You know that it incubated 3 hours. How many generations have occurred?

Number of generations = (log $_{\text{cells at end of incubation}}$) - (log $_{\text{cells at beginning of incubation}}$) / 0.301

Therefore, (log 6400) - (log 100) / 0.301 = (3.81 - 2) / 0.301 = **6 generations**

To calculate the generation time for a population: 60 min x hours / number of generations
In this example:

60 min x 3 hours / 6 generations = **30 minutes per generation**

Practice Problems

1. You perform a serial dilution and determine that the original number of cells in your sample was 12, 000. How many bacteria will be present in 12 hours if the generation time is 15 minutes (assume unlimited food and clean environment)?

2. You determine that a coconut cream pie has 3 million (3×10^6) *Staph. aureus* cells in it. You estimate that the food preparer did not wash his hands and probably inoculated the cream with 500 *Staph. aureus*. He also forgot to refrigerate it. 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 8 hours at room temperature?

4. Let's say that flesh eating *Strep. pyogenes* divides every 10 minutes at body temperature. You fall down and scrape your knee and get infected with 5 *Strep. pyogenes* cells. After 4 hours, without medical intervention, how many bacteria will be ravaging your body? Let's say that for every 1 million bacteria, a centimeter of flesh is consumed. After 4 hours, how much tissue would be lost? Are you still alive and would you want to be? (This problem is not fact based.)

Answers

1. number of generations in 12 hours = 4 generations per hour x 12 = 48
   12,000 x 2^{48} = **3.4×10^{18} bacterial cells**

2. log (3×10^6) - log (500) / 0.301 = (6.47 - 2.7) / 0.301 = 12.5 generations

   60 minutes x 6 hours / 12.5 generations = **28.8 minutes per generation**

3. 28.8 minutes per generation, 8 hours x 60 min = 480 minutes total time to grow

   480 / 28.8 = 16.7 generations in 8 hours = n

   therefore: 500 x $2^{16.7}$ = 500 x 1.06 x 10^5 = **5.32×10^7 bacterial cells**

4. 6 generations per hour, 24 generations in 4 hours

   5 x 2^{24} = **8.4×10^7 bacterial cells**

   8.4×10^7 / 1 x 10^6 = 84 million cells

   1 cm of flesh per million = 84 cm of flesh (33.5 inches)

   You would be alive but you would lose the leg. We are assuming the infection does not become systemic.