Problem Set N^{o} 1
Bacterial Growth

General directives: When doing your calculations, do not round off your intermediate numbers. Only round off the final answer. You will need to submit your answers through Blackboard. Your answers must be submitted to one significant figure after the decimal. For example, 2.0, 2.0 X 10^3, 0.02, or 0.002. The deadline for the submission will be announced in class and on Blackboard. It is strongly recommended that you submit your answers using the web browser Firefox.

Consider the following information to answer questions 1-5: A growth medium is inoculated to obtain 10,000 cells/mL. After three hours a viable count determined that there were 500,000 cells/mL.

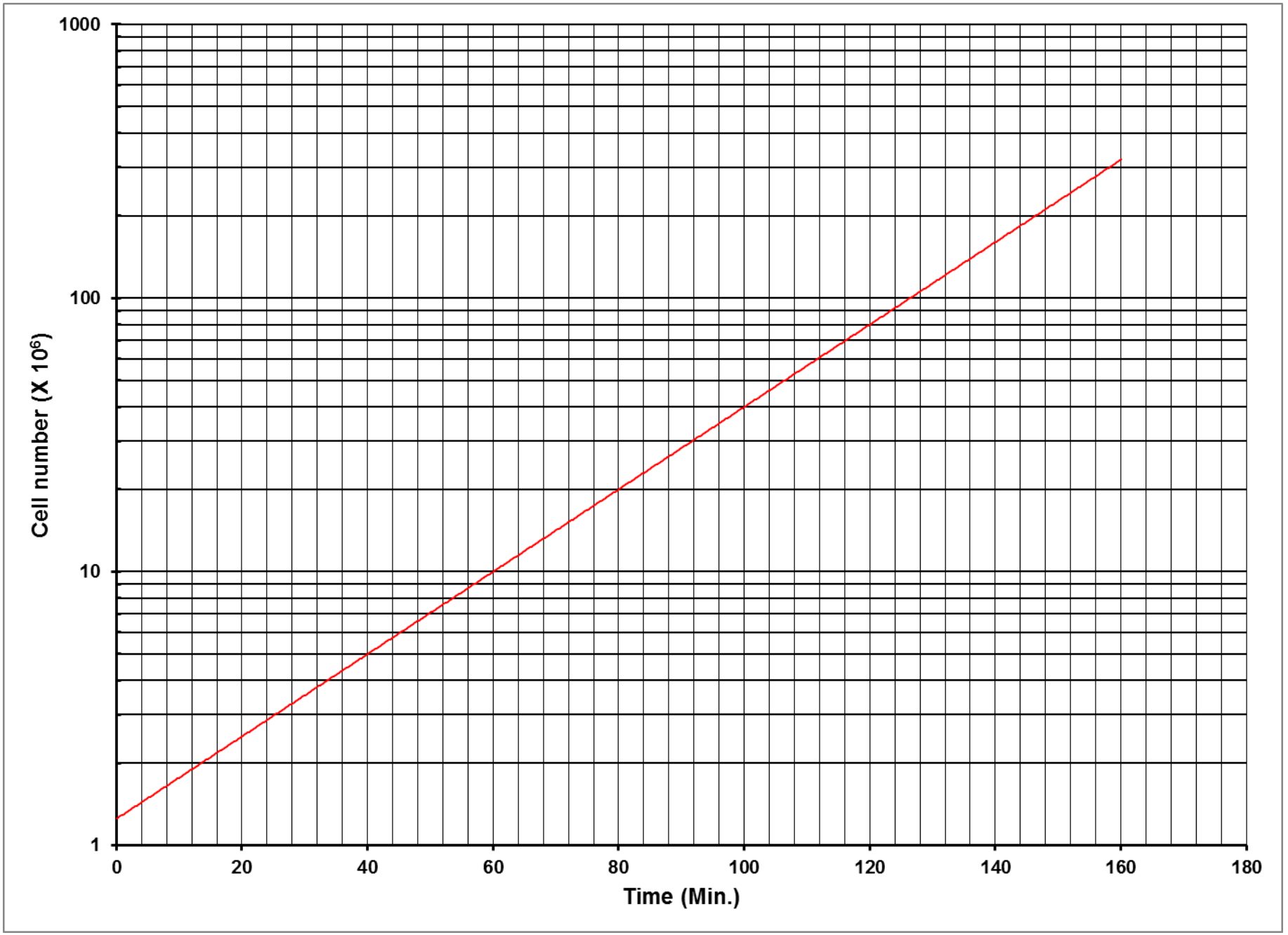
1. How many times did the population double during the three hour time span?
2. How many cells will there be after 24 hours of unlimited growth?
3. What is the generation time of the bacteria? (Give your answer in minutes)
4. After 6 hours of growth, a sample of the culture is diluted by a factor of 10^5. How many CFUs are expected for a plating of 0.1 mL from this dilution? (Assume that one CFU = 1 cell)
5. A direct count was done on a sample of the culture taken after 2 hours of growth. The sample was applied to a hemacytometer slide whose counting chamber had the following dimensions: 2mm X 2mm X 0.1mm. Given that the counting chamber had 40 squares, what is the average number of cells you would expect in one square?
6. A bacterium has a generation time of 3 hours. With how many bacteria should a culture be inoculated to obtain 81,920 bacteria after 42 hours?
7. A bacterium has a doubling time of 1.5 hours. How long would it take for an initial population of 6 cells to reach a density of 12,288 bacteria?

8. The presence and growth of bacteria in food products causes a need for a “best before date” of some products (such as milk) so that shoppers will buy the product and consume it before the number of bacteria grows too large and the product goes bad. When milk is stored in a fridge at 4^{o}C, the average growth rate of the bacteria is 0.00019 cells/minute. Assuming an initial bacterial load of 500 cells and a critical threshold of 56570 cells, for how many days can the milk be stored and consumed before it goes bad?
9. At room temperature, the generation time of bacteria in milk is about 10 times shorter than that at 4^{o}C. Given this information, for how many days can the milk be stored at room temperature before it goes bad?
10. Five E*. coli* cells are introduced in a medium containing 2 carbon sources; glucose and lactose. The generation times with glucose and lactose are 15 and 20 minutes, respectively. Initially, only glucose is used as a carbon source until it is exhausted after one hour of growth. How many cells would you have after 3 hours of growth?

Refer to the graph on the next page to answer the following questions

11. How many cells are observed after 124 minutes of growth?
12. What is the generation time of this culture?
13. How many times did the culture double over the time span illustrated by the line?
14. Assume that the culture will reach stationary phase after 300 minutes of growth and initiate the death phase after 400 minutes of growth. What cell number would you expect after 375 minutes of growth?
15. The optical density of the culture after 42 minutes of growth was 0.25. At what time would you expect the culture to reach an optical density of 1.0?
16. The optical density of the culture after 42 minutes of growth was 0.25. What is the expected optical density after 124 minutes of growth?
17. A viable count of this culture, which represents Neisseria meningococcus, was done after 100 minutes of growth. How many CFUs are expected?

18. How many cells were initially inoculated in the culture medium at time zero?
19. At 92 minutes, the cells were transferred to a new medium in which the growth rate (μ) was two times lower. What is the expected number of cells after 60 minutes of growth following the transfer?
20. By what factor did the population size increase between 40 and 120 minutes?


1000
100
10
1
Cell number (X 10⁶)
0
20
40
60
80
100
120
140
160
180
Time (Min.)