Cell Biology by the Numbers – Exercise 4

Durations and rates

Solve the exercises below.

Give specific references to where you got each number you use and notice the number of significant digits used (reminder: http://book.bionumbers.org/rigorous-rules-for-sloppy-calculations/).

Think how to break each question into components and then find the numbers and calculate the answer, while specifying your assumptions and steps.

1. From "Cell Biology by the Numbers" textbook Chapter 4, read one vignette- preferably one that is related to your research topic or that you have previous knowledge of. Write a few sentences on what you learned from it, how you suggest to make it better and anything insightful you have to add. Bonus will be given to new insights and most useful suggestions.

2. Estimate how long it takes a ribosome to make another copy of itself. Consider only the protein portion of the ribosome, and assume the molecular weight of the ribosome is about 10^6 Da.

   (*Hint: remember that pool size = rate × turnover time, see Ron's explanation if interested*)

3. In wild conditions, cells experience conditions which are starkly different from conditions at which they are grown in the lab. Consequently, the characteristics of cells in the wild differ quite significantly than what we consider as "normal". In the ocean, for example, one of the most numerous bacteria, *Pelagibacter ubique*, has an average volume of ≈0.04 μm^3 (Zhao et al., AEM, 2017), which is about 25-fold lower than our rule of thumb $1\mu m^3$ for *E. coli*. The average doubling time of *P. ubique* is about 30 hours (BNID 105462), more than an order of magnitude slower than lab-grown bacteria.

   a) What is the minimal number of ribosomes required to synthesize the entire protein mass of a *P. ubique* cell in a doubling time of 30 hours (the combined mass of the cell which is composed of protein)? Assume ribosomes work as fast as they do in *E. coli*.

   b) Using cryo-ET, researchers have measured ≈500 ribosomes in *P. ubique* (Zhao et al., AEM, 2017). How does this number compare to your calculation? Calculate the average polymerization rate of a ribosome in *P. ubique*.

   c) If there is an order of magnitude difference in the results, suggest explanations.