Assignment 1: Dimensions, Units and Order of Magnitude Estimates (bio322)

August 17, 2014

[Total score: 16- individual scores in square brackets]

1. For the following variables provide dimensions and SI units. Please write out (i.e. show) how you arrived at the dimensions [4].

    (a) The permittivity of the space (ϵ_0). Given: The force (f) between like point charges q_1 and q_2 separated by a distance of r is given by Coulomb's law to be

    $$f = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \tag{1}$$

    (b) Viscosity of a medium (η). Given: The Stokes frictional drag coefficient ($\zeta = 2m/\Delta t$) for a sphere of mass m and in time (Δt) is

    $$\zeta = 6\pi\eta r \tag{2}$$

    where r is the sphere radius.

    (c) Concentration (c) of proteins in cells.

    (d) Moles (with reference to molar concentration) of a substance.

2. Estimate the number of proteins in an *E. coli* cell given the cell consists of 70% water and proteins form half the dry mass. Assume an average protein length. Compare your estimate to that measured and discuss deviations or lack of them from accurate measurements, in the context of your assumptions. [4].

3. Estimate the number of water molecules in an *E. coli* cell given the cell consists of 70% water. What is the required flux rate of water to account for the mass doubling of the cell in the period of 20 mins (generation time)? [4].

4. What is the average spacing between two protein molecules of ftsZ (a cytoskeletal protein) in an idealized *E. coli* cell which has an approximate concentration of 1 μM [1]. [4].

References

[1] Rueda,Vicente and Mingorance (2003) Concentration and Assembly of the Division Ring Proteins FtsZ, FtsA, and ZipA during the Escherichia coli Cell Cycle J Bacteriol. 185(11): 3344-3351