Problem Set 1: Molecular and Cellular Scales

1. How many end-on cells will give diameter of human hair?
2. What is the fold relation between DNA and *E. coli* diameters?
3. What is the volume occupied by the genomic DNA in *E. coli*? How does it compare with the volume of the whole *E. coli* cell? What is the percent volume occupied by the genomic DNA relative to the cell volume?
4. 20% protein component of cell is ribosomal. Assume all ribosomal protein bound to the ribosome. What is the number of ribosomes in an *E. coli* cell? Mass of single Ribosome ~ 2.5 MDa. Ribosome contains 1/3 protein, 2/3 RNA.
5. Ribosome diameter ~ 20 nm. What is the total volume of a single ribosome? What is the percent volume occupied by ribosomes relative to cell volume?
6. Shape of cell gives surface area. What is the N_{lipid} molecules in a typical *E. coli* cell? The area per lipid is ~ 0.5 nm^2.
7. 70% of the cell mass is water in *E. coli*. What is the number of water molecules in *E. coli*?
8. For inorganic ions, consider the Potassium ion (K^+). It has an average concentration in E. coli cells of [K] ~ 100 mM. What is the number of K+ ions in a single *E. coli* cell?