Lecture 1

Estimate the size of the E.coli
Model the shape cylinder +sphere

V= 4/3 π r^3 + π x h x r^2

V= 4/3 X 3.14 x 0.5^3 + 3.14 x 1 x 0.5^2 = 1.3 um^3

In the textbook it estimates that the E.coli is like a cylinder and it is not right. The shape of cell is more like a dumbbell shape, a cylinder connects two half spheres.

Area of the E.coli is (4π r^2) + 2π r h = 4 x 3.14 x $(½)^2$ + 2 x 3.14 x ½ x 1 = 3+ 3 = 6 um^2

1.3 um^3 = 1.3 femtoliter

The density of water is 1 ml/gr then roughly the weight of the cell is about

1 ml 1gr
$1.3x10^{-12}$ml (=1.3fl) 1.3pg of cell

Genome (DNA) size,

N^{genome} = $5x10^6$ basepair

1basepai = 0.34 nm length than Length of genome = 0.34 x (5×10^6) = 1.7 mm
Cylinder model

 = 1 basepair

$V_{basepair}$ = h x π x r^2 = 0.34 x 3.14 x 1 nm^2 = 1 nm^3 /basepair

V of genome is (1 nm^3 / basepair) x $5x10^6$ bp = 5 $x10^{-3}$ um^3

What is the consequence?
Length of DNA > Length of E.coli,
Volume of DNA < Volume of E.coli

Lets calculate the how many proteins inside the cells:

Proteins is the major structural units in cells organize and regulates a lot of functions inside cells from cell division to energy production inside cells and changes in protein concentration in cells are associated with a lot of different diseases.

Lets calculate the how many proteins inside the cells:

After you dry the e.coli it as found that dry mass is forming the 30 % of the whole e.coli then

1.3 pg x 30% = 0.39 pg of mass
We also know roughly 15 % of is the protein then 0.2 pg of total protein exist in each e.coli.

The question is how many copies of the proteins are present inside the cells.
Lets see how crowded is the cells,

1 protein = 300 amino acids, amino acids come together and form the protein.

1 mono acids = 100 Da = $1.6 +10^{-22}$ gr
If there 300 amino acids each protein has a mass of $5x10^{-20}$ gr

Number of proteins = total protein mass / mass per protein = $20x10^{-14}$ gr / ($5x10^{-20}$ gr/protein) = $4x10^{6}$ protein molecules in each E.coli.

This is 4 million proteins in 1.3 um^{-3} or 1 to 2 micron E.coli cells

1/3,a membrane protein than $1.3x10^{6}$ membrane protein
2/3, a cytoplasmic protein. $2.7x10^{6}$ is present in cytoplasm.

Now lets calculate the number of ribosomes in E.coli.

10% of proteins are in ribosome complex

N ribosome = 0.1 x 20 X 10^{-14} gr / 8000 amino acid x 1 amino acid / 1.6 10^{-22} gr =

20000 copies of ribose exist in each E.coli.

We can even estimate total volume in E.coli is occupied by the ribosome where the proteins are produced.

The diameter of ribosomes is about 20 nm

Lets assume that ribosome has a structure of sphere the volume is $4/3\ \pi\ r\text{^}3 = 3200\ nm^3$

It is about 3200 nm^3 x 20000 ribosome = 65 x 10^6 nm^3 = this is the total volume occupied by all ribosomes.

6.5 x 10^7 nm^3 / 1.3 x 10^9 nm^3 = 5 % of the E.coli is occupied by the ribosome molecules.

Now lets look at the lipid molecules inside the E.coli the question is how many E.coli molecules exist on the surface of E.coli. There is inner and outer membrane in E.coli and each has 2 membranes so total of 4 membrane are present. Suppose that half the molecules in the membrane is lipid.

N lipid = 4 x 0.5 of the membrane is lipid x $Area_{E.coli}$ / $Area_{lipid}$ =

4 x 0.5 x 6x10 ^{9} nm^2 / 0.5 nm^2 = 2x10^7 lipid molecules in E.coli.

Draw the quantitative picture of the E.coli.