LS2103-Introduction to Biophysics
Tutorial-1

29th August 2024

Problem 1

The mass of water within the "hydration layer" of thickness d surrounding a near-spherical organelle of radius $R = 50\ nm$ is estimated to be $1.6 \times 10^{-17}\ g$. The "hydration layer" is estimated to be 2 water molecules thick; the density of water is $1.0\ g\ cm^{-3}$

a Estimate the diameter of a water molecule in Angstroms. From this information.

b The exact diameter of a water molecule is $2.8\ \mathring{A}$. Why do you think your estimate possibly varies from this answer?

Problem 1: Solution

Given an organelle with

Problem 2

Find the dependence of the Time Period (τ) on a spring's characteristic parameters using dimensional analysis.

$$F = -kx$$
$$E = \frac{1}{2}kx^2 \tag{1}$$

Problem 3

The human genome contains approximately 3.4×10^9 base pairs. Based on the length scales shown in the figure, estimate the *maximum* capacity of DNA as a data storage medium and make a rough comparison to the max. capacity of modern electronic data storage.

Note:

1 3 base pairs code for an Amino Acid.

2 An Intel $10nm$ chip has 10^9 *transistors* mm^{-2}

3 Assume 1 transistor can store 1 information bit.

Problem 3

0.34 nm

2 nm
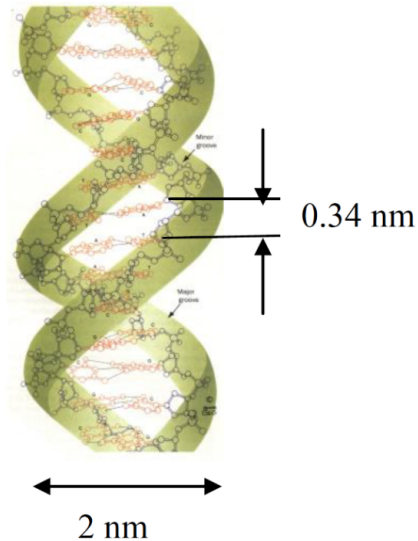
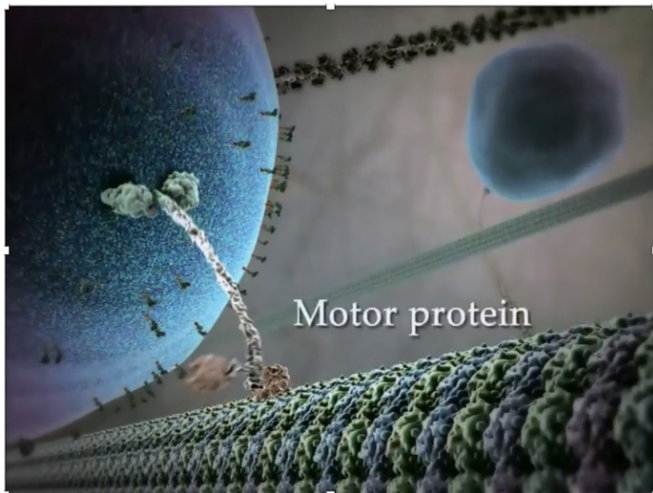# Problem 4: Kinesin on a Microtubule

Figure: Reference: Harvard Visions (Inner Life of a Cell)

Problem 4: Kinesin on a Microtubule

For a Kinesin Motor, assume

1. Each step is 8nm in length
2. For each step 1 ATP is required

What is the magnitude of the force applied, assuming there is no dissipative loss? Take the energy released from the hydrolysis of one ATP molecule is 7.3 $kcal/mol$