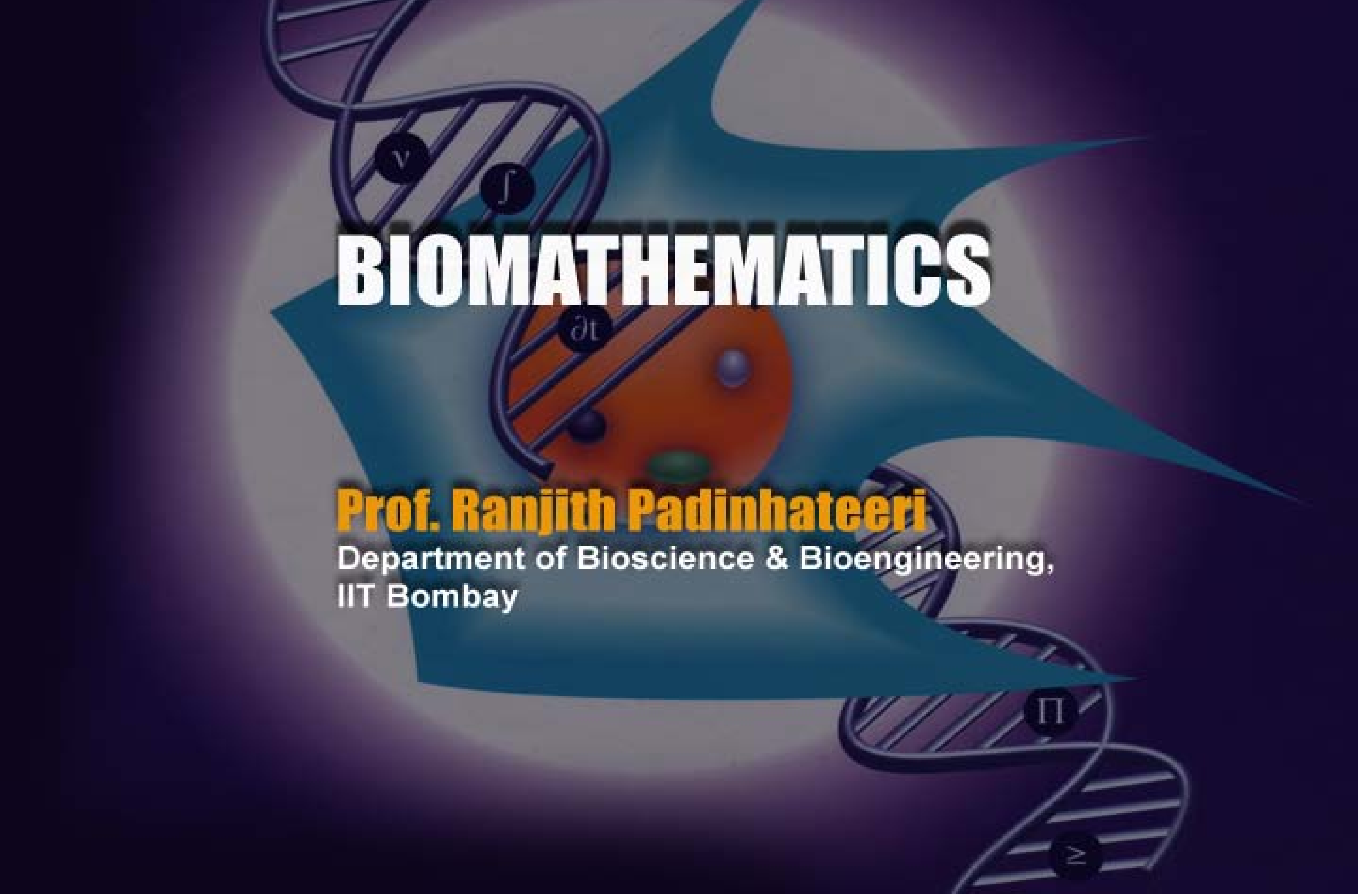

BIOMATHEMATICS
Prof. Ranjith Padinhateeri
Department of Bioscience & Bioengineering,
IIT Bombay

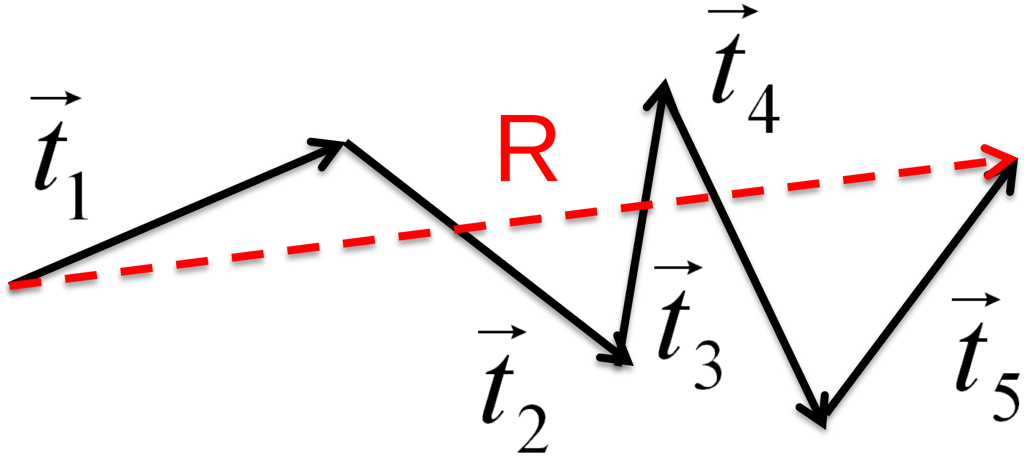
Lecture 25

Statistics

Size of a folded protein: Simplest model

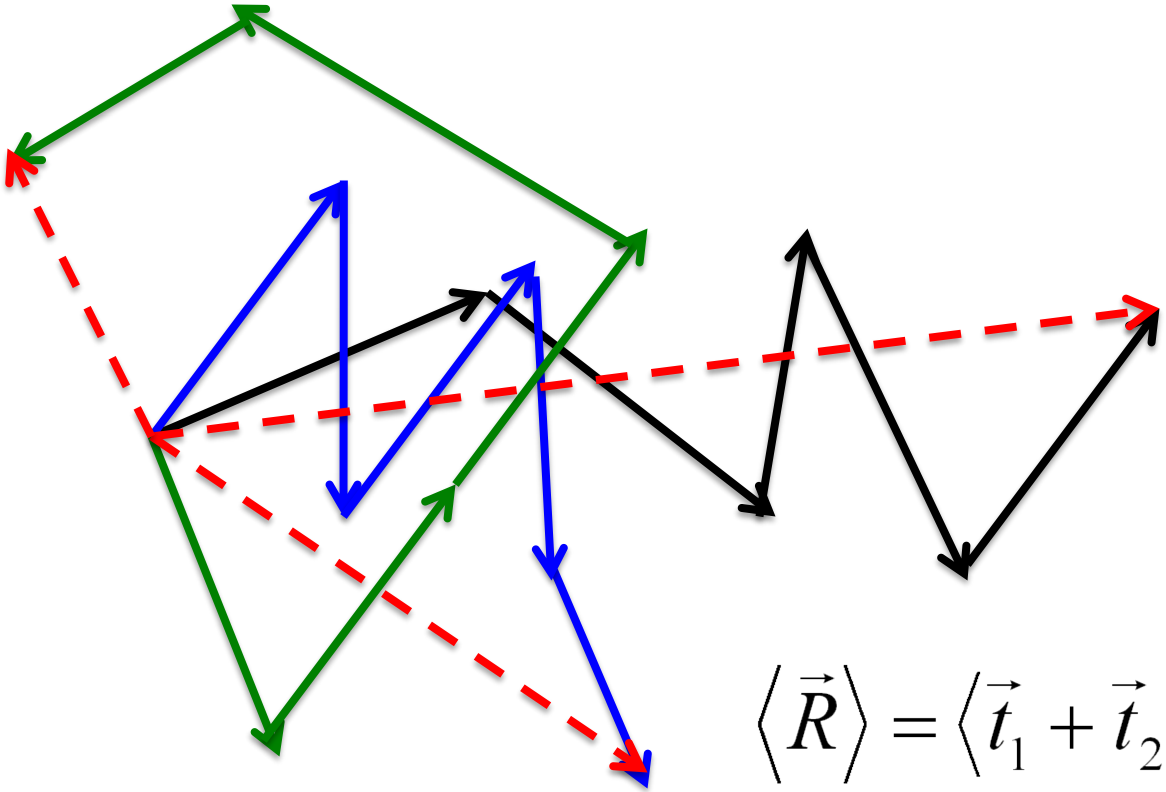
Imagine that a protein of N amino acids has no preferred Orientation (completely flexible)

End-to-end distance



$$\vec{R} = \vec{t}_1 + \vec{t}_2 + \vec{t}_3 + \vec{t}_4 + \vec{t}_5$$

Random orientation



$$\langle \vec{R} \rangle = \langle \vec{t}_1 + \vec{t}_2 + \vec{t}_3 + \vec{t}_4 + \vec{t}_5 \rangle = 0$$

Prof. Ranjith Padinhateeri, Biosciences and Bioengineering, IIT Bombay

End-to-end distance

$$\left\langle \vec{R}^2 \right\rangle = \left\langle \left(\vec{t}_1 + \vec{t}_2 + \vec{t}_3 + \vec{t}_4 + \vec{t}_5 \right)^2 \right\rangle$$

Mean-square average

$$\left\langle \vec{R}^2 \right\rangle = \left\langle \left(\vec{t}_1 + \vec{t}_2 + \vec{t}_3 + \vec{t}_4 + \vec{t}_5 \right)^2 \right\rangle = 5b^2$$

Where b is the length of each monomer/amino acid

Standard deviation

$$\left\langle \vec{R}^2 \right\rangle = \left\langle \left(\vec{t}_1 + \vec{t}_2 + \vec{t}_3 + \vec{t}_4 + \ldots + \vec{t}_N \right)^2 \right\rangle = Nb^2$$

$$\sigma = \sqrt{\left\langle \vec{R}^2 \right\rangle - \left\langle R \right\rangle^2} = b\sqrt{N}$$

Summary

Flexible protein: Average

Flexible protein: Standard deviation

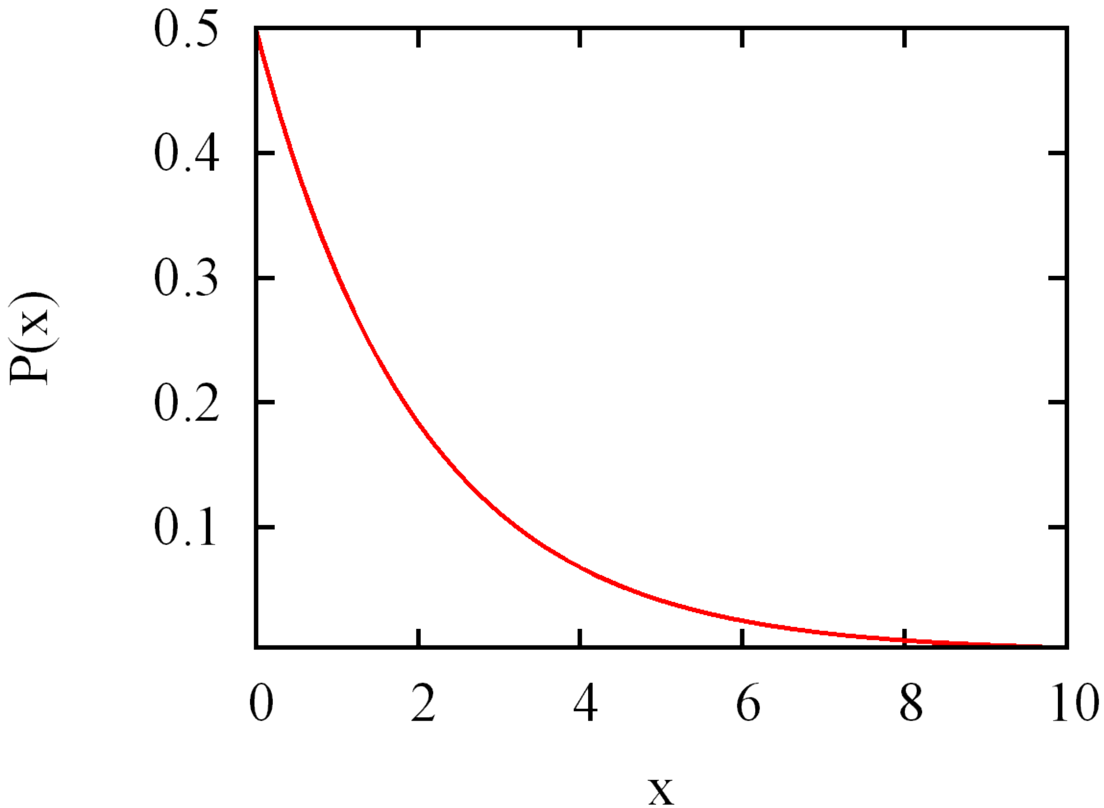
$$\sigma \propto \sqrt{N}$$

Do you know … ?

Microtubules rapidly grow and shrink exhibiting the phenomenon known as dynamic instability. What is the length distribution of microtubules ?

Imagine that proteins bind on to the DNA with a rate k. What is the probability that you have to wait at time ‘dt’ between consecutive binding events ?

Exponential distribution



$$P(x) = A\exp(-kx)$$

Exponential distribution

$$P(x) = A\exp(-kx)$$

How do we find A ?

$$\int_0^{\infty} P(x)dx = \int_0^{\infty} A\exp(-kx)dx = 1$$

Exponential distribution

How do we find A ?

$$\int_0^\infty P(x)dx = \int_0^\infty A\exp(-kx)dx = 1$$

$$\Rightarrow A = k$$

Exponential distribution

$$\langle x \rangle = \int_0^\infty x P(x) dx$$

$$\langle x^2 \rangle = \int_0^\infty x^2 P(x) dx$$

Exponential distribution

$$\langle x \rangle = \int_0^\infty xk\exp(-kx)dx = \frac{1}{k}$$

$$\langle x^2 \rangle = \int_0^\infty x^2 k\exp(-kx)dx = \frac{2}{k^2}$$

$$\sigma = \sqrt{\langle x^2 \rangle - \langle x \rangle^2} = \frac{1}{k}$$

Exponential distribution has standard deviation as big as average