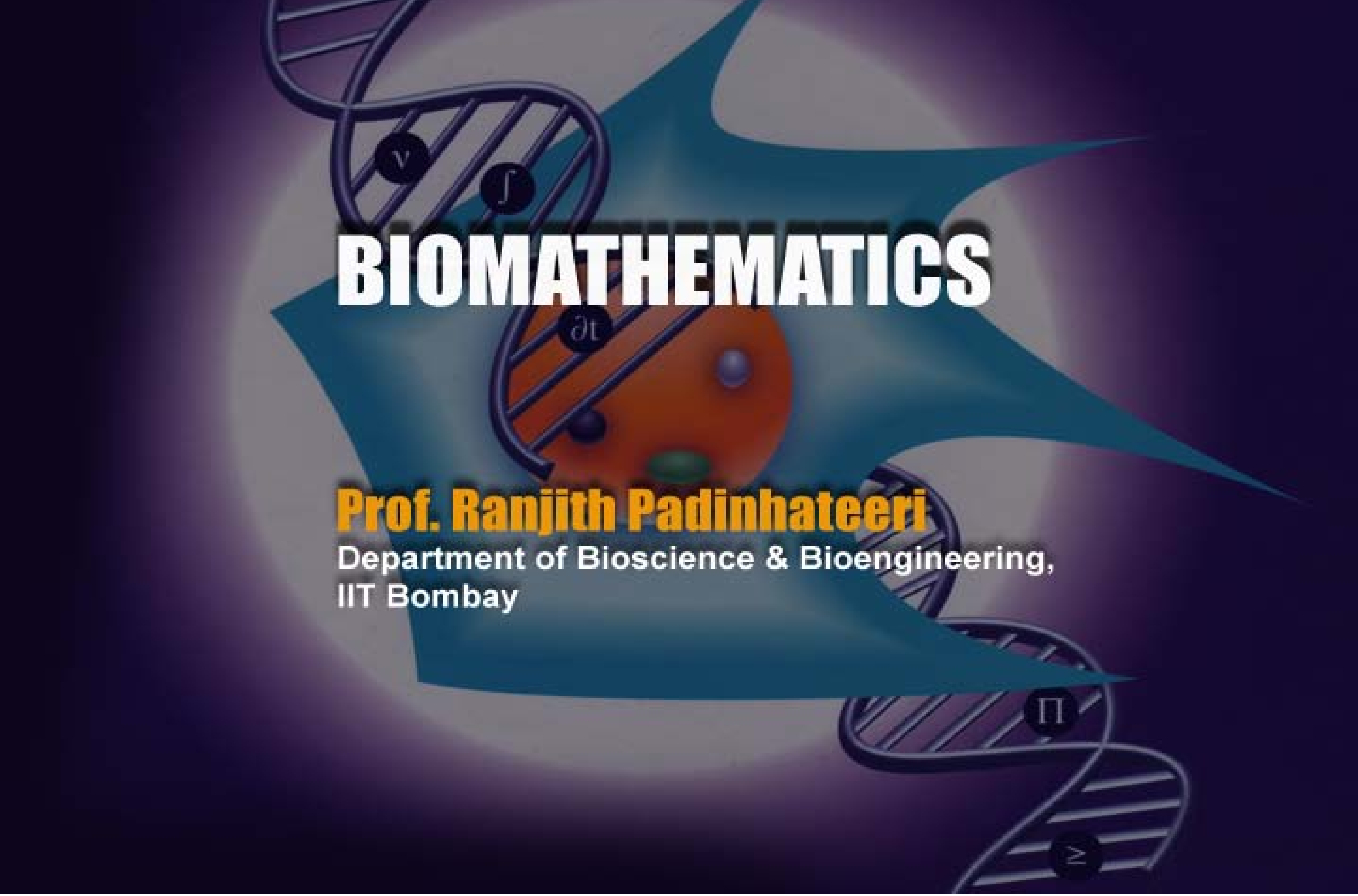

BIOMATHEMATICS

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Lecture 26

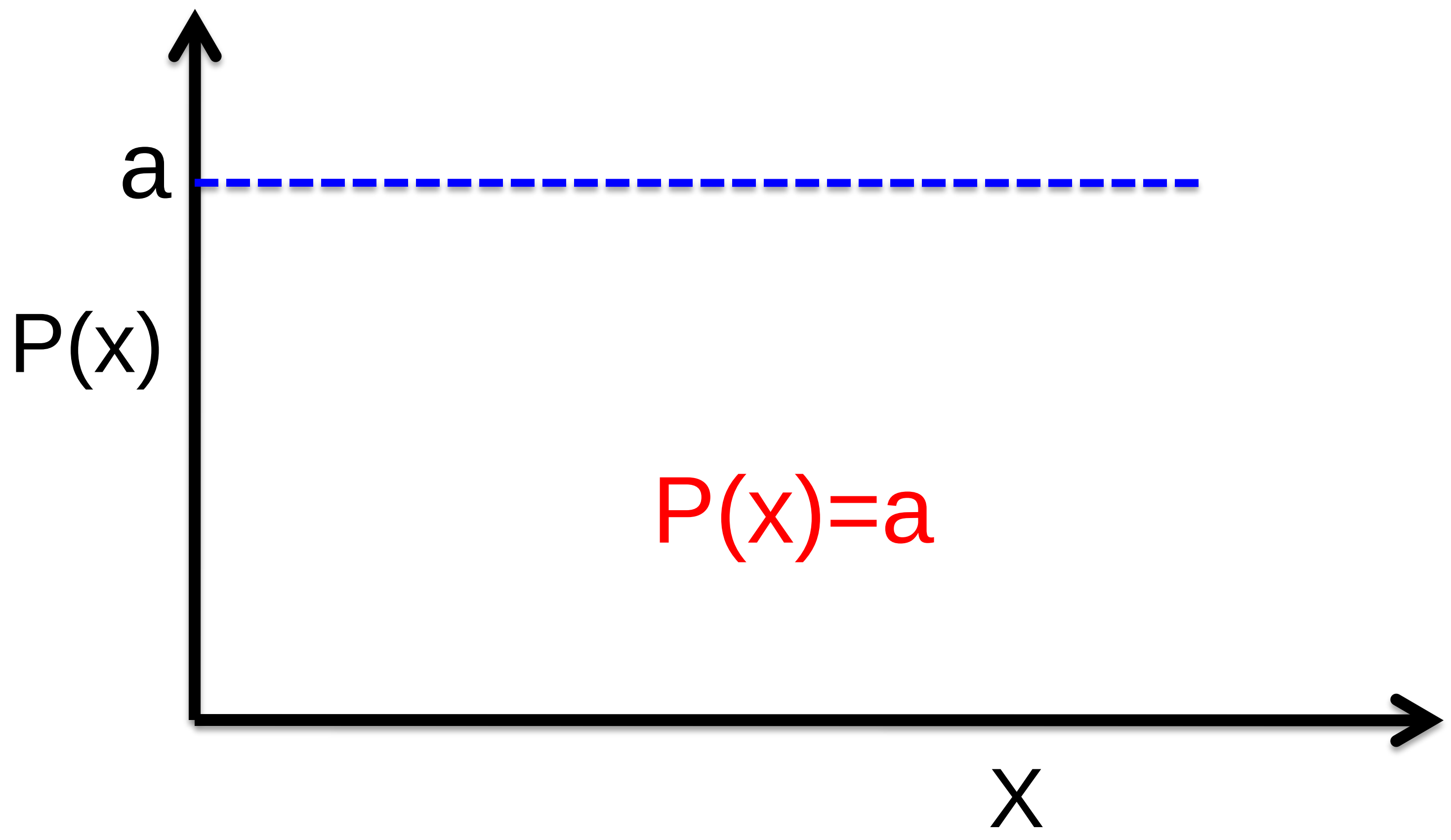
Statistics

Uniform distribution

Uniform distribution

- Events that are equally likely
  - Results from tossing a coin
  - Results from throwing a die
  - N bp random sequence

Uniform distribution



Uniform distribution

- Probability of getting both heads in two tossings

Poisson distribution

- Distribution of random events
  - Mutations
  - Randomly falling mangoes !

Mutations

You have many copies of a DNA each of length L.

Let 4 be the average number of mutations per copy.

How likely that you will find a DNA with exactly 3 mutations ?

Probability distribution of mutations

Probability that you will find a DNA with 3 mutations, if the average number of mutations is 4

$$P = \frac{4^3 \exp(-4)}{3!}$$

Probability distribution of mutations

Probability that you will find a DNA with exactly r mutations, if the average number of mutations is m

$$P(r,m) = \frac{m^r \exp(-m)}{r!}$$

Probability of getting 10 mangoes

You are sitting near a mango tree.
Imagine, on an average, 6 mangoes fall down every hour; How likely that you will get exactly 10 mangoes in an hour ?

$$P(10,6) = \frac{6^{10} \exp(-6)}{10!}$$

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Probability of getting at least 10 mangoes

On an average, 6 mangoes fall down every hour; How likely that you will get 10 or more mangoes in an hour ?

$$P = \sum_{r=10}^{r=\infty} \frac{6^r \exp(-6)}{r!}$$

Probability distribution of mutations

Probability that you will find a DNA with at least 2 mutations, if the average number of mutations is 3

$$P = \sum_{r=2}^{r=\infty} \frac{3^r \exp(-3)}{r!}$$

Mutation and Cancer:

Knudson's study

Dr. Alfred Knudson's had data of many patients having Retinoblastoma

Using simple ideas from statistics, he made many interesting inferences about cancer and mutations

Knudson's study of Retinoblastoma

Knudson asked: If 95% of the patience have Retinoblastoma (at least 1 tumor),
what should be the average number of tumors ?

Knudson's study of cancer

Probability that you will find a patient with exactly r tumors, if the average number of tumors is m

$$P(r,m)=\frac{m^r \exp(-m)}{r!}$$

Probability of finding a patient with cancer

Probability that you will find a patient with at least 1 tumor, if the average number of tumors is m

$$P = \sum_{r=1}^{r=\infty} \frac{m^r \exp(-m)}{r!} = 0.95$$

He found that this is true only when m=3

Average number of tumors

If 95% of the patients have cancer, it means that there has to be, on an average, three tumors per person

Unilateral vs bilateral

If only one eye has tumor, it is unilateral

If both eyes have tumors, it is bilateral

Retinoblastoma in the left eye

What is the probability of finding Retinoblastoma in the left eye ?

Retinoblastoma in the left eye

What is the probability of finding Retinoblastoma in the left eye ?

Ans = 1/2

Two tumors in the left eye

If one has a total of 2 tumors, what is the probability that both of that will be in the left eye ?

Two tumors in the left eye

If one has a total of 2 tumors, what is the probability that both of that will be in the left eye ?

Ans: (1/2)*(1/2)

Two tumors in the left eye

If one has a total of r tumors, what is the probability that all of that will be in the left eye ?

Ans: $(1/2)^r$

Unilateral retinoblastoma

Probability of finding r tumors in the left eye : $(1/2)^r$

Probability of finding r tumors in the right eye : $(1/2)^r$

Unilateral retinoblastoma

Probability of finding r tumors in the left eye : $(1/2)^r$

Probability of finding r tumors in the right eye : $(1/2)^r$

Probability of finding r tumors in either of the eyes (unilateral) : $2*(1/2)^r$

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Using this Knudson calculated the fraction of people having unilateral retinoblastoma, and compared with his data, and again found that average number of tumors is 3

Summary

Uniform distribution

Poisson distribution