INTRODUCTORY MATHEMATICAL METHODS FOR BIOLOGISTS

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PRE-REQUISITES : Core

INTENDED AUDIENCE : Students, PhD scholars, teachers, industry

COURSE OUTLINE :
It is an introductory mathematics course for biology students with the aim of training them to do quantitative analysis of biological systems. Students will be trained on how to use the language of mathematics to describe biological processes, how to write down simple mathematical equations for various phenomena occurring in biology.

ABOUT INSTRUCTOR :
Prof.Ranjith Padinhateeri completed his MSc and PhD in Physics from IIT Madras. During PhD he studied statistical mechanics of DNA. After PhD he did post-doctoral research in University of Illinois Chicago, USA, Northwestern University. Evanston, USA, and Institute Curie, Paris, France. He does his research in the broad area of biological physics. Prof.Ranjith Padinhateeri does theoretical studies to understand various biological phenomena using a variety of tools from physics, including equilibrium and non-equilibrium statistical mechanics, polymer physics, and soft-matter theory. He tackled research problems using a combination of computational and analytical methods. His Specific areas of interest include Nucleosome dynamics, Chromatin assembly, DNA mechanics and self-assembly of proteins

COURSE PLAN :

Week 1 : Introduction, Graphs and Functions

Lecture 1 : Introduction
Lecture 2 : Graphs and Functions
Lecture 3 : Equations as Graphs
Lecture 4 : Exponential and Periodic Functions
Lecture 5 : Logarithmic and Other Functions

Week 2 : Functions and its Derivatives, Computing Derivatives of Curves

Lecture 6 : Images as 2D/3D Functions
Lecture 7 : Functions and its Derivatives
Lecture 8 : Computing Derivatives of Curves
Lecture 9 : Rules for Calculating Derivatives
Lecture 10 : Understanding Derivatives

Week 3 : Plotting Curves , Numerical Calculation of Derivatives, Partial Derivatives

Lecture 11 : Curvature and Second Derivative
Lecture 12 : Plotting Curves
Lecture 13 : Numerical Calculation of Derivatives
Lecture 14 : Function,Derivatives and Series Expansion
Lecture 15 : L'Hopital's Rule and Partial Derivatives

Week 4 : Integration and their Graphical Understanding

Lecture 16 : Integration
Lecture 17 : Integration:Rules
Lecture 18 : Graphical Understanding
Lecture 19 : Integration:More Examples
Lecture 20 : Integration: Product of Two Functions

Week 5 : Vectors : Position and Movement in 2D, Cell Symmetry : Use of Polar Coordinates

Lecture 21 : Exponential growth and Decay
Lecture 22 : Scalars and Vectors
Lecture 23 : Vectors:Position and Movement in 2D
Lecture 24 : Cell Symmetry:Use of Polar Coordinates
Lecture 25 : Gradient.Forces and Flows :Part I

Week 6 : Gradient, Forces and Flows , Understanding Diffusion

Lecture 26 : Gradient.Forces and Flows :Part II
Lecture 27 : Understanding Diffusion
Lecture 28 : Diffusion Constant and Einstein Relation 1905
Lecture 29 : Diffusion Equation
Lecture 30 : Diffusion vs.Active Transport

Week 7 : Introduction to Fourier series , Fourier Transform and Statistics

Lecture 31 : Nernst Equation
Lecture 32 : Fourier Series : Part I
Lecture 33 : Fourier Series : Part II
Lecture 34 : Fourier Transform
Lecture 35 : Introduction to Statistics

Week 8 : Basics of bio-statistics

Lecture 36 : Mean,Standard deviation and Distribution
Lecture 37 : Frequency Distribution and Probability Distribution
Lecture 38 : Binomial Distribution
Lecture 39 : Normal Distribution
Lecture 40 : Hypothesis Testing and Mathematical Modeling