Title: Mathematical and Numerical Methods for Biologists [2-1-0-6]

Content :

Functions: Idea of functions using examples from Biology. E.g., concentration of proteins as a function of time. Periodic functions. Functions as graphs. Sketching simple functions: Exponential, Gaussian, Logarithm, etc
Image as a 2D function.

Differentiation: Introduction of change in concentration, change in size, etc., as derivatives. Slope and derivative. Derivatives of simple functions. Examples from biology. Techniques of differentiation. Numerically computing derivatives. Partial derivatives. Taylor series.

Plotting functions: Identifying maxima and minima and using them to sketch any function. Using software to plot functions. Finding out the roots of an equation. Newton-Raphson method.

Integration: Integration as the area under a curve. Definite integrals as the limit of a sum. Numerically finding integrals. Integrating simple expressions. Use of Integration techniques in biology.

Differential Equations: Ordinary/partial differential equations: Applications in biology. Calculus of growth and decay processes. Rate equations, Diffusion, Solving differential equations numerically.

Vectors and matrices, Coordinate systems: Scalars and vectors. Matrices. Spherical polar coordinates, Cylindrical coordinates. Use of these coordinate systems to describe structure of biomolecules and other examples from biology.

Descriptive statistics and Data display: Measurement scales. Continuous and discrete data; Summarizing data set: Histograms, Pie Charts, other ways of representing data. Mean, mode, median, variance, standard deviation, Errors, fitting a function to experimental data, linear regression with examples.

Distributions: Quantities typically measured in experiments as random variables. Binomial distribution, Poisson distribution, Normal distribution, Exponential distribution, etc.

Basic idea of hypothesis testing: Basic introduction to z-test, t-test. Numerically computing z and t values (using software like excel).

Texts / References:

1. *Mathematics for Biological Scientists, M. Aitken, B. Broadhursts, S. Haldky, Garland Science (2009) Introduction to Mathematics for Life Scientists, E. Batschelet, Springer Verlag, 3rd edition (2003)*
2. *Calculus for Life Sciences, R. De Sapio, W. H. Freeman and Co. (1976)*
3. *Random Walks in Biology, H. C. Berg, Princeton university press (1993)*
4. *Martin Bland: An Introduction to Medical Statistics, Oxford University Press, 1987.*