

## Syllabus Prescribed for B. Sc. II (Sem. III) Year UG Programme

Title of the Subject:

**Essential Mathematics, Statistics, Bioinformatics and Biophysical Methods**

Programme: **B.Sc. Biotechnology**

**Cos:**

Upon completion of this course successfully, students would be able to

1. Describe several areas of mathematics beyond calculus.
2. Apply laws of probability to concrete problems.
3. Know the various genes and proteins databases
4. Understand concepts in thermodynamics.
5. Understand concepts in radioactivity and chemical nature of solutions.

| Unit     | Content  |
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| Unit I   | <b>Essential Mathematics:</b><br><b>A.</b> Sets: Definition, Subset. Union, Intersection, Venn Diagrams, Complement of a Set, Universal Set. Use of Logarithms in simple problems. Binomial theorem (Without proof) – Simple Examples.<br><b>B.</b> Limits of a function: Concept of limit, Limit of function at a point, Simple algebraic limits.<br><b>C.</b> Derivative/ Differentiation: Derivative of simple algebraic functions; Derivatives of standard Trigonometric & Logarithmic functions; Derivative of Addition and Subtraction of function; Product rule of differentiation.<br><b>D.</b> Integration: Integration as antidifferentiation, Problems involving simple polynomial functions. |
| Unit II  | <b>Introduction to Statistics:</b><br><b>A.</b> Sampling: Types of Sampling; Purposive sampling; Random sampling; Simple sampling & Stratified sampling.<br><b>B.</b> Probability: Random Experiment; Sample space; Event; Probability of an Event; Axioms of probability.<br><b>C.</b> Mean: Calculation of Mean of ungrouped & grouped data; Mode & Median of ungrouped data.<br><b>D.</b> Test of significance; ANOVA.  |
| Unit III | <b>Bioinformatics:</b><br><b>A.</b> Introduction; Historical overview and definition; Goal, Scope, Applications and Limitations of Bioinformatics.<br><b>B.</b> Major databases in bioinformatics; Information retrieval from databases.<br><b>C.</b> Tools for web search.<br><b>D.</b> Primary, Secondary, Composite databases and Structural databases.   |

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| Unit IV | <p><b>General Biophysical Methods:</b></p> <p><b>A.</b> Acids and Bases; Ionization of strong acids and bases; pH and pOH.</p> <p><b>B.</b> Buffers; pH changes in buffers; Buffer capacity; Blood buffers; Henderson – Hasselbalch Equation.</p> <p><b>C.</b> Radioactivity – Nuclear properties; Nuclear forces; Nuclear models (liquid drop and shell model); Radioactive nucleus; Nuclear radiations and their properties - alpha, beta and gamma.</p> <p><b>D.</b> Physical and Biological Half-life; Role of Radioactivity in Biology.</p> |
| Unit V  | <p><b>Thermodynamics:</b></p> <p><b>A.</b> Thermodynamics as applied to biological systems; Laws of thermodynamics.</p> <p><b>B.</b> Enthalpy, Entropy, Free energy, Gibb's free energy (G), Helmholtz free energy (A).</p> <p><b>C.</b> Chemical potential; Half-cell potential; Redox potential.</p> <p><b>D.</b> General idea about structure and bioenergetics of Mitochondria and Chloroplast.</p>  |
| Unit VI | <p><b>Skill Enhancement Module:</b></p> <p><b>A.</b> Sequence retrieval and alignment with bioinformatics tool.</p> <p><b>B.</b> Structure prediction of Protein.</p> <p><b>C.</b> Structure prediction of Gene.</p> <p><b>D.</b> pH measurement of various solutions.</p> <p><b>E.</b> Calculation of Mean, Mode and Median using data.</p>   |

### Course Material/Learning Resources

#### Text books:

1. Fundamentals of Mathematical Statistics-S.C. Gupta and V.K. Kapoor. S. Chand & Co.
2. Discrete Mathematics - B.S. Verma, Vishwa Prakashan.
3. Statistics for Biologists- Campbell R.C. Cambridge University Press, Cambridge.
4. Practical Statistics for Experimental Biologists- Ward Law A.C.
5. Statistical Methods in Biology- Baily N.T.J, English University Press.
6. An Introduction to Biostatistics- P.S.S. Sunderrao & J. Richards, Prentice Hall Pvt. Ltd. India.
7. Biophysics - Cotrell (Eastern Economy Edition)
8. Clinical Biophysics –Principles and Techniques- P. Narayanan (Bhalani Pub. Mumbai)
9. Biophysics – Pattabhi and Gautham (Narosa Publishing House)
10. Instrumentation measurements and analysis – Nakara, Choudhari (Tata McGraw Hill)
11. Handbook of analytical instruments – R.S. Khandpur (Tata Mc Graw Hill)
12. Biophysical Chemistry- Upadhyay, Upadhyay and Nath – (Himalaya Pub. House, Delhi).
13. Methods in Biostatistics- B K Mahajan. Jaypee Brothers, New Delhi.

14. Basic Biostatistics and its application- A K Datta. New Central Book Agency (P) Ltd, Kolkata.
- 15 Elements of Biostatistics – S Prasad. Rastogi Publications, Meerut.
16. Biophysics- G R Chatwal. Himalaya Publishing House.
17. Biophysics – Mohan P Arora. Himalaya Publishing House.
18. Bioinformatics A Beginner's Guide WILEY INDIA PVT LTD
19. Bioinformatics Basics: Applications in Biological Science and Medicine, Second Edition. Robert R. Ruffolo. TAYLOR & FRANCIS GROUP
20. Biochemical Calculations. I H Segel. John Wiley & Sons

**Practicals:**

1. Determination of action spectra of Chlorophyll.
2. Practical based on Chi-square and t- test.
3. Demonstration of Hill's reaction.
4. Retrieval of information from NCBI
5. Retrieval of information from EBI
6. Retrieval of structure file from PDB
7. Preparation of buffers using pH meter
8. Preparation of buffer using Henderson – Hasselbalch equation.

**Learning Outcome:** Student would be able to design and execute experimental procedures.

## Syllabus Prescribed for B. Sc. II (Sem. IV) Year UG Programme

Title of the Subject:

### **Molecular Biology, Genetic Engineering and Microbial Biotechnology**

Programme: **B.Sc. Biotechnology**

#### **Cos:**

Upon completion of this course successfully, students would be able to

1. Understand principal molecular events occur inside prokaryotic and eukaryotic cell.
2. Understand an application of genetic engineering techniques in experimental biology.
3. Understand the role of biotechnology in Medicine, Environment and Industries.
4. Understand principal, working and applications of various laboratory equipment.
5. Understand laboratory scale production of alcohol, amylase, organic acid and antibiotics.

| <b>Unit</b> | <b>Content</b>  |
|-------------|---|
| Unit I      | <b>Molecular Basis of Life:</b><br>Structure of DNA.<br>Replication of DNA in prokaryotes and eukaryotes<br>DNA damage and repair mechanisms.<br>Homologous (Holiday model) and non-homologous (site specific) recombination (transposons)<br>Genetic code  |
| Unit II     | <b>Central theme of Protein Synthesis:</b><br>Transcription and Translation process in prokaryotes and eukaryotes.<br>RNA processing in eukaryotes.<br>Post- translational modification of proteins.<br>Regulation of gene expression in prokaryotes (lac operon) and eukaryotes  |
| Unit III    | <b>Gene Cloning:</b><br>Isolation of genomic and plasmid DNA.<br>DNA manipulating enzymes.<br>Cloning vectors: - Plasmids, bacteriophages, cosmids and phagemids<br>Southern blotting and colony hybridization.<br>Gene library (cDNA and Genomic DNA library)<br>Polymerase Chain Reaction                                   |
| Unit IV     | <b>Microbial Biotechnology (Medicine and Industry):</b><br>Interferon. Insulin, Dextran<br>Recombinant vaccines<br>Recombinant products (Growth hormone, erythropoietin)<br>Types of bioreactors (CSTR, Fluidized bed reactor, UASB)<br>Batch and continuous fermentation<br>Alcohol fermentation<br>Citric acid fermentation |

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| Unit V  | <b>Microbial Biotechnology (Environment):</b><br>Energy from Biomass (Biogas and Biodiesel)<br>Microbial Pesticides and Biofertilizers<br>Microbial Bioremediation<br>Bioleaching<br>Biodegradation of xenobiotic compounds<br>Water Treatment – Aerobic and Anaerobic |
| Unit VI | <b>Skill Enhancement Module:</b><br>Preparation of Biofertilizers (PSB, Azotobacter)<br>Preparation of microbial pesticides (Bt)<br>Agarose gel electrophoresis for Nucleic Acid<br>Laboratory scale production of Penicillin<br>Laboratory scale production amylase   |

### Course Material/Learning Resources

#### Text books:

1. Recombinant DNA: -James. D. Watson, John. Tooze, David.Kutz
2. Introduction to Genetic Engineering: - Nicholas
3. General Microbiology. Vol 1& II.: - Powar & Daginawala
4. Molecular Biology of the Cell: - J. D. Watson, D. Bray
5. The DNA Story: - J. D. Watson
6. Genetic Engineering and its Applications -Joshi P.
7. Gene Transfer and Expression a Laboratory Manual: - Michael Kriegler
8. Concept in Biotechnology: - D. Balasubramaniam
9. Molecular Cloning. - A Laboratory Manual, J. Sambrook, E.F Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York
10. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York, 1988
11. Molecular Biology Lab Fax, TA. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991
12. Molecular Cell Biology (5th Edition) J. Darnell, H. Lodish and D. Baltimore, Scientific American Books, Inc., USA,
13. Gene VI (Xth Edition) Benjamin Lewin, Oxford University Press, U.K
14. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc., New York, 1995
15. Genomes, TS. Brown
16. Environmental Biotechnology. S. V. S. Rana, Rastogi Publications Meerut.
17. Industrial Microbiology by A. H. Patel
18. Industrial Microbiology by Casida.
19. Biotechnology by U. Satyanarayana.
20. Genes: - Pramod Kumar

**Practicals:**

1. Isolation of Genomic DNA
2. To check purity of DNA
3. Plasmid isolation – Mini preparation
4. DNA ligation
5. Competent cell preparation
6. Transformation
7. Restriction digestion of plasmid DNA
8. Laboratory scale production and estimation of ethyl alcohol
9. Isolation of Azotobacter
10. Isolation of Phosphate solubilizing bacteria
11. Determination of Chemical oxygen demand (COD)
12. Determination of Biological oxygen demand (BOD)

**Learning Outcome:** Student would be able to design and execute experimental procedures in Genetic engineering and Microbial Biotechnology.