# VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

*PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF*

## B. Sc. (HONOURS/ HONOURS WITH RESEARCH)

## MAJOR IN MICROBIOLOGY



## 4-YEAR UNDERGRADUATE PROGRAMME

*(w.e.f. Academic Year 2023-2024)*

***Based on***

**Curriculum & Credit Framework for Undergraduate Programmes**

**(CCFUP), 2023& NEP, 2020**

# VIDYASAGAR UNIVERSITY
## BACHELOR OF SCIENCE (HONOURS/ HONOURS WITH RESEARCH) MAJOR IN MICROBIOLOGY
## (under CCFUP, 2023)

| Level | YR. | SEM | Course Type | Course Code | Course Title | Credit | L-T-P | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CA | ESE | TOTAL |
| B.Sc. (Hons./ Hons. with Research) | 4th | VII | SEMESTER-VII | | | | | | | |
| | | | Major-14 | MCBHMJ14 | T: Biostatistics and Bioinformatics; | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | Major-15 | MCBHMJ15 | T: Recombinant DNA Technology; P: Practical | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | CRM | MCBHCRM | T: Research Methodology and Ethics; P: Practical | 4 | 3-1-0 | 15 | 60 | 75 |
| | | | Major Elective-03 | MCBHDSE 03 | Fundamentals of Genetics, Genomics & Proteomics | 4 | 3-1-0 | 15 | 60 | 75 |
| | | | Minor-07 (Disc.-I) | MCBMIN07 | T: Recombinant DNA Technology; P: Practical *(To be taken by the other Discipline)* | 4 | 3-0-1 | 15 | 60 | 75 |
| | | | | | **Semester-VII Total** | **20** | | | | **375** |

MJ = Major, MI = Minor Course, DSE = Discipline Specific Elective Course, CRM= Compulsory Research Methodology, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

# SEMESTER-VII

## *MAJOR (MJ)*

**MJ-14: Biostatistics and Bioinformatics** **Credits 04 (Full Marks:75)**

**Course Objectives (COBs):**

- Introduce statistical methods and their applications in biological sciences.
- Train students in hypothesis testing, correlation, regression, and data interpretation.
- Familiarize students with bioinformatics databases, sequence analysis, phylogeny, and molecular docking.

**Course Outcomes (COs):**

- Explain descriptive and inferential statistical tools and apply them to biological data.
- Use bioinformatics databases and algorithms (FASTA, BLAST) for sequence analysis.
- Analyze evolutionary relationships and ligand–protein interactions using computational approaches.



*MJ-14T: Biostatistics and Bioinformatics (Theory)* *Credits 03 (45 hrs.)*

**Course Content:**

**Unit 1- Introduction to Biostatistics:** Importance of statistical methods in biological sciences; Concept of sample and population; Variables- discrete and continuous; Frequency distribution and its graphical representation (Histogram, Frequency polygon, Ogive).

**Unit 2 - Descriptive Statistics:** Measures of central tendency (Mean, Median, Mode); Measures of dispersion (Range, Variance, Standard deviation); Coefficient of variation (CV); Standard error of biological data.

**Unit 3- Inferential Statistics:** Concept of hypothesis testing; t-test (paired and unpaired); Chi-square test for goodness- of-fit; Simple correlation (Karl Pearson's method); Linear regression analysis and its applications biological research. **Unit 4 - Introduction to Bioinformatics:** Definition, scope and applications; Interdisciplinary nature; Bioinformatics tools in modern biology

**Unit 5 - Biological Databases:** Nucleotide databases (GenBank, EMBL, DDBJ); Protein databases (UniProt, PDB); Database formats and accession numbers.

**Unit 6 - Sequence Alignment and Comparison:** Pairwise sequence alignment; Multiple

sequence alignment (MSA); Scoring and mutation matrices (PAM and BLOSUM); FASTA and BLAST algorithms andapplications; Database searching strategies

**Unit 7 - Molecular Phylogeny:** Concepts of phylogenetic trees and its construction methods (UPGMA, Neighbor- Joining); Bootstrapping and tree reliability; Evolutionary relationships and cladistics.

**Unit 8 - Ligand-Protein Interaction:** Basics of molecular docking; Drug design and virtual screening; Examples of ligand-binding proteins

*MJ-14P: Biostatistics and Bioinformatics (Practical)* *Credits 01 (30 hrs)*

**Course Outline:**

1. Preparation of graph of experimental data using MS Excel/software.
2. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software.
3. Use of Public Domain Interfaces for downloading different DNA and Protein sequences from authenticated databases (Using NCBI, SWISS-SPROT).
4. Performing BLAST and interpretation of the results.
5. Identification of consensus sequence through multiple sequence alignment.
6. Analysis of regional conservation by MSA, primer designing and restriction site analysis.
7. *In vitro* amplification of DNA by PCR.
8. Construction of phylogenetic tree using multiple sequence alignment.
9. Tertiary structure prediction using homology modelling.

**MJ-15: Recombinant DNA Technology** **Credits 04 (Full Marks:75)**

*MJ-15T:* ***Recombinant DNA Technology*** *(Theory)* *Credits 03 (45 hrs.)*

Course Content:

**UNIT -1 Molecular Cloning- Tools**

Cloning Tools; Applications of Type II restriction enzymes in genetic engineering; Applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases, Cloning Vectors: Definition and Properties, Plasmid vectors: pBR ; Cosmids, BACs, YACs, Use of linkers and adaptors, Genomic and cDNA libraries.

**UNIT -2 Methods in Molecular Cloning and techniques**

Transformation of DNA: Chemical method, Gene delivery: Electroporation, Agrobacterium - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, SDS-PAGE, Southern - and Northern – blotting techniques, DNA microarray analysis, Western blotting, PCR, DNA sequencing.

**UNIT -3: Construction and Screening of Genomic and cDNA libraries**

Steps of Gene cloning: Isolation of genomic DNA and Plasmid DNA, Cutting & Insertion, Introduction of chimera, Screening and selection of transformants.

**UNIT -4: Applications of Recombinant DNA Technology**

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis



**Suggested Readings:**


1. Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA. Clark DP and Pazdernik NJ. (2009)
2. Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K. Primrose SB and Twyman RM. (2006)
3. Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education. Wiley JM, Sherwood LM and Woolverton CJ. (2008).
4. Genomes-3. Garland Science Publishers. Brown TA. (2007).
5. Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K. Primrose SB and Twyman RM. (2008).

*MJ-15P: General Experiments (Practical)* *Credits 01 (30 hrs.)*

**Course Outline:**

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

**Suggested Readings:**


1. Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K. Brown TA. (2010).
2. Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press. Sambrook J and Russell D. (2001).

***COMPULSORY RESEARCH METHODOLOGY (CRM)***

*[for both Hons. and Hons. with Research students]*

# CRM: Research Methodology and Ethics

***CRM (T): Research Methodology and Ethics (Theory)*** ***Credits 03***

**Course Content:**

**Course Objectives (COBs):**

- To provide a foundation in the principles, process, and design of scientific research, including formulation of research problems, hypotheses, and objectives.
- To develop proficiency in literature review, data collection, analysis, and interpretation using appropriate statistical and experimental approaches.
- To inculcate skills in scientific writing, reporting, and adherence to research ethics, ensuring integrity and responsible conduct of research.

**Course Outcomes (COs):**

- Explain the theoretical basis, structure, and methodology of scientific research and distinguish among various research approaches.
- Design and execute research projects through proper problem identification, data handling, statistical analysis, and result interpretation.
- Demonstrate competence in preparing scientific reports and publications while maintaining ethical standards and integrity in research practices.



**Course Content:**

**Unit 1 - Foundation of Research:** Definition, objectives and significance of research; scientific research and theory; conceptual and theoretical models; research process; problem definition; research questions; research design and approaches; role of reasoning in research. **Unit 2 - Review of Literature:** Purpose and significance of literature review; selection and organization of literature; sources and search tools; note-taking and referencing; role of libraries, indexing, abstracting and citation databases. **Unit 3 - Research Formulation and Design:** Selection and formulation of research problems; hypothesis development; measurement and variable identification; types and structure of research design.

**Unit 4 - Experimental Research:** Cause–effect relationships; hypothesis testing; measurement system analysis; error propagation; experimental validity; statistical design of experiments.

**Unit 5 - Data Collection Methods:** Types and sources of data; primary and secondary data; methods of data collection—survey, observation, simulation, and questionnaire techniques.

**Unit 6 - Data Processing and Analysis:** Editing, classification, coding, transcription and tabulation; graphical and numerical data analysis; sampling methods, sample size determination; sampling errors; descriptive and inferential statistics; data interpretation.

**Unit 7 - Research Writing and Reporting:** Structure and format of dissertation and research papers; principles of scientific writing; preparation of abstract, introduction, methodology, results, discussion, and conclusion; tables and illustrations; referencing and citation styles; journal types (Q1–Q4).

**Unit 8 - Research Ethics and Integrity:** Concept and importance of research ethics; intellectual honesty; research misconduct—plagiarism, fabrication, falsification, redundancy; authorship and contributorship; ethical committees andapprovals; biomedical and animal research ethics; data ownership and privacy; environmental ethics.

***MAJOR ELECTIVE (DSE)***

# Major Elective – 03:

# Fundamentals of Genetics, Genomics & Proteomics

## Credits: 4 (Full Marks 75)  Lecture Hours: 60

**MJDSE-03: Fundamentals of Genetics, Genomics & Proteomics  Credits 04 (FM:75)**

*MJDSE-03T: Fundamentals of Genetics, Genomics & Proteomics (Theory)  Credits 04 (60 hrs)*

**Course Content:**

1. **Basic concepts of genetics:** Mendelian Laws (Dominance, Segregation and independent assortment) & Deviation from Mendelian laws. Allele, Multiple allele, Pseudo allele. General concept of allelic interactions, incomplete dominance, co-dominance and epistasis. General concept of Linkage & crossing over, Recombination of genes. **15 L**

2. **Chromosomes:** Structure and organization of eukaryotic chromosome; Euchromatin & heterochromatin. Variations in chromosomal structure (deletion, duplication, inversion & translocation) and number (euploidy, aneuploidy and polyploid- significance). Brief idea on Karyotype and ideogram. **10 L**

3. **Genomics:** General concept of gene, pseudogene, genome and genomics. Basic comparative understanding of DNA virus (Pox virus), RNA virus (HIV), *E.coli* and Human genomes. Application of genomics (forensic science, disease diagnosis and genetic counselling). DNA sequencing methods: Sanger's method, General Idea on Next generation sequencing methods (Pyrosequencing, Illumina and Oxford Nanopore- only Principle). Genome sequencing methods (shotgun & clone-contig method). Genome assembly and annotation- general concept. Human genome project- Brief idea and application. Variable tandem repetitive DNA, Single nucleotide polymorphism (SNP) and DNA barcode- general concept and application. **25 L**

4. **Proteomics:** General concept of Protein, Proteome and proteomics. Principle of 2-D gel electrophoresis. Application of proteomics. General idea on Protein Identification by Peptide mass fingerprinting and Protein engineering (principle and application). **10 L**

**Suggested Reading:**


1. Russell PJ. (2009). i Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings
2. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley India
3. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
4. Primrose SB and Twyman RM (2006) Principles of Gene Manipulation and Genomics, 7th Ed., Blackwell Publishing.
5. Brown TA (2018) Genomes 4th Ed., Garland Science
6. Glick, B.R., Pasternak, J.J., & Patten, C.L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th Ed.).
7. Next-Generation Sequencing Technology: Current Trends and Advancements (2023). Biology 212, 997. https://doi.org/10.3390/biology12070997
8. Sequencing Technologies: The Next Generation – M.L. Metzker, Humana Press, 2nd edition, 2011
9. Deep Learning for Genomics – I. Goodfellow et al., O'Reilly Media, 1st edition, 2022
10. Proteomics: From Protein Sequence to Function Applications – S.R. Pennington and M.J. Dunn, Humana Press, 2nd edition, 2015

## *MINOR (MI)*

**Minor (MI)-07: Recombinant DNA Technology** **Credits 04 (Full Marks:75)**

*Minor (MI)-07T:* ***Recombinant DNA Technology*** *(Theory)* *Credits 03*

**Course Content:**

**UNIT -1 Molecular Cloning- Tools**

Cloning Tools; Applications of Type II restriction enzymes in genetic engineering; Applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases, Cloning Vectors: Definition and Properties, Plasmid vectors: pBR ; Cosmids, BACs, YACs, Use of linkers and adaptors, Genomic and cDNA libraries.

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**UNIT -4: Applications of Recombinant DNA Technology**

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis

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3. Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education. Wiley JM, Sherwood LM and Woolverton CJ. (2008).
4. Genomes-3. Garland Science Publishers. Brown TA. (2007).
5. Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K. Primrose SB and Twyman RM. (2008).

*Minor (MI)-07: General Experiments (Practical)* *Credits 01*

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