# MASTER OF SCIENCE (BIOINFORMATICS AND GENOMICS)

## SEMESTER 1

## BTMSC 501 – BIOCHEMISTRY (3 CREDITS)

***Course Objective:***

To build a strong foundation in biochemical principles, macromolecular structure-function relationships, enzymology, and metabolism essential for bioinformatics and genomics applications.

***Learning Outcomes:***

- Explain chemical foundations of biological systems.
- Analyze protein structure, folding, and function.
- Interpret enzyme kinetics and metabolic regulation.
- Apply biochemical concepts to molecular biology research.

### UNIT I: CHEMICAL BASIS OF LIFE

This unit introduces the origin of life and the chemical foundation underlying biological systems. Topics include the Miller-Urey experiment and abiotic formation of amino acid oligomers. Students will study the composition of living matter, properties of water and its role in life, pH, buffers (including blood and gastric pH), ionization, and hydrophobic interactions. The unit further explores biomolecular hierarchy and emergent properties of macromolecules in aqueous systems.

### UNIT II: PROTEIN STRUCTURE

Covers amino acid structures, peptide bonds, covalent structure of proteins, and determination of primary to quaternary structures. Includes Ramachandran plot analysis, protein evolution, molecular pathways of protein degradation, and structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, and chymotrypsin. The unit introduces protein purification techniques and characterization tools. Also includes principles of protein folding—Anfinsen's dogma, Levinthal paradox, folding pathways, molten globule state, molecular chaperones, folding diseases, and basic molecular dynamics simulations.

### UNIT III: ENZYME KINETICS

This unit focuses on enzyme catalysis, catalytic principles, Michaelis-Menten kinetics, enzyme efficiency, activation, inhibition, covalent modification, and isozymes. Case studies include catalytic antibodies, carbonic anhydrase, proteases, and nucleoside monophosphate kinase. Regulation mechanisms like zymogens and allosteric modulation (e.g., hemoglobin) are also covered.

### UNIT IV: GLYCOBIOLOGY

Students are introduced to the chemistry and function of sugars: mono-, di-, and polysaccharides (e.g., glycogen, amylose, cellulose). Glycosylation patterns in glycoproteins and glycolipids are explored alongside lipid structure and classification, including membrane and storage lipids and lipoproteins.

### UNIT V: STRUCTURE AND FUNCTIONS OF DNA & RNA AND LIPIDS

Details nucleic acid structures—nucleosides, nucleotides, DNA/RNA comparison, double-helix formation, and the evolution of DNA as the genetic material. Lipid self-assembly into micelles and bilayers, membrane protein integration and function, and active/passive transport mechanisms are also discussed.

### UNIT VI: BIOENERGETICS

Covers fundamental bioenergetic principles including free energy, reaction coupling, redox balance, oxidation of carbon fuels, and metabolic motifs. Describes oxidative phosphorylation, ATP synthase mechanism, mitochondrial shuttles, photosynthesis pathways (Calvin cycle, light reactions), and regulatory mechanisms. Also includes hormone action (epinephrine, insulin), glycogen metabolism, and the integration of central metabolism.

### UNIT VII: ROLE OF VITAMINS & COFACTORS IN METABOLISM

Explores vitamin-derived cofactors in metabolic reactions and enzyme activity. Discusses regulation of metabolism via nutrient sensing and signaling networks (e.g., TOR, autophagy). Starvation responses and hormonal regulation (insulin, glucagon) are contextualized in relation to carbohydrate and nitrogen metabolism.

### SUGGESTED READINGS:


1. Stryer, L. (2015). *Biochemistry*, 8th ed.
2. Lehninger, A. L. (2012). *Principles of Biochemistry*, 6th ed.
3. Voet & Voet (2016). *Biochemistry*, 5th ed.
4. Dobson, C. M. (2003). *Nature*, 426, 884–890.
5. Richards, F. M. (1991). *Scientific American*, 264(1), 54–63.


## BTMSC 503 – CELL AND MOLECULAR BIOLOGY (3 CREDITS)

***Course Objective:***

To understand cellular architecture, molecular mechanisms of genetic regulation, cell signaling, and transformation processes at the molecular level.

***Learning Outcomes:***

- Describe cellular organization and genome dynamics.
- Interpret molecular mechanisms of DNA replication, repair, and transcription.
- Analyze signaling pathways and cell cycle regulation.
- Apply experimental techniques to study cellular functions.

### UNIT I: DYNAMIC ORGANIZATION OF CELL

This unit introduces cell architecture and chemistry, emphasizing compartmentalization, membrane structure, and organelles such as ER, Golgi, lysosomes, mitochondria, chloroplasts, and cytoskeleton. Also covers nucleus and nucleolus structure and chromosome organization.

### UNIT II: CHROMATIN STRUCTURE AND DYNAMICS

Focuses on chromatin and DNA-protein interactions. Includes DNA polymerase structure, DNA replication, repair, recombination, epigenetic modifications, transcription control, transcription factors, and post-transcriptional regulation including RNA splicing, export, degradation, and miRNA/siRNA pathways.

### UNIT III: CELLULAR SIGNALING, TRANSPORT AND TRAFFICKING

Covers mechanisms of nuclear and organelle transport, vesicle-mediated trafficking, and transport across mitochondrial and chloroplast membranes.

### UNIT IV: CELLULAR PROCESSES

Discusses cell cycle, mitosis, meiosis, stem cell differentiation, cell-ECM and cell-cell interactions, signal transduction, motility, and modes of cell death including apoptosis.

### UNIT V: MANIPULATING AND STUDYING CELLS

Introduces techniques for cell isolation, culture, microscopy, and basic methods for studying DNA, RNA, and protein.

### UNIT VI: GENOME INSTABILITY AND CELL TRANSFORMATION

Explores mutagenesis, proto-oncogenes, tumor suppressor genes, mutagens, transposons, and mechanisms of tumor suppression and activation. Emphasizes oncogene-driven transcriptional regulation.

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### SUGGESTED READINGS:


1. Alberts et al. (2008). *Molecular Biology of the Cell*, 5th ed.
2. Lodish et al. (2016). *Molecular Cell Biology*, 8th ed.
3. Lewin's Genes XI (2014)
4. Cooper & Hausman (2013)
5. Becker's World of the Cell (2012)
6. Watson, J. D. (2008). *Molecular Biology of the Gene*


## BTMSC 505 – PLANT AND ANIMAL BIOTECHNOLOGY (3 CREDITS)

***Course Objective:***

To introduce biotechnological methods in plant and animal systems for genetic manipulation, reproductive technologies, and molecular diagnostics.

***Learning Outcomes:***

- Implement plant and animal tissue culture techniques.
- Apply gene transfer methods in genetic engineering.
- Analyze molecular marker applications for trait improvement.
- Understand transgenesis and molecular pharming applications.

## UNIT I: PLANT TISSUE CULTURE AND ANIMAL CELL CULTURE

Covers the history and principles of plant tissue culture including totipotency, callus and cell suspension cultures, somatic embryogenesis, media formulation, sterilization techniques, micropropagation, somaclonal variation, androgenesis, germplasm conservation, cryopreservation, and synthetic seed production. Animal cell culture section includes media types, primary and continuous cell lines, organ culture, and applications in virology, pharmacology, and toxicity testing.

## UNIT II: PLANT GENETIC MANIPULATION

Introduces Agrobacterium-mediated gene transfer, Ti and Ri plasmids, T-DNA transfer, binary and cointegrate vectors. Direct gene transfer methods include PEG-mediated transformation, electroporation, and particle bombardment. Also includes selectable markers, chloroplast transformation, marker-free systems, and advanced approaches like cisgenesis, intragenesis, and genome editing. Application in molecular pharming is also discussed.

## UNIT III: ANIMAL REPRODUCTIVE BIOTECHNOLOGY AND VACCINOLOGY

Explains animal gamete structure, cryopreservation, artificial insemination, superovulation, in vitro fertilization, embryo culture and transfer. Introduces transgenesis, cloning for conservation, vaccine types (live, killed, subunit), and recombinant vaccine strategies.

## UNIT IV: PLANT AND ANIMAL GENOMICS

Overview of genome structure, classification, genomics technologies (DNA/RNA/protein/metabolite/phenotype level), genome databases, and functional assignment by forward and reverse genetics.

## UNIT V: MOLECULAR MAPPING AND MARKER-ASSISTED SELECTION

Focuses on molecular markers: RFLP, RAPD, SSR, AFLP, SNPs, and their application in DNA fingerprinting, QTL mapping, marker-assisted selection for biotic/abiotic stress resistance, animal disease resistance, and detection of food adulteration using DNA-based diagnostics.

## SUGGESTED READINGS:


1. Chawla, H. S. (2000). Introduction to Plant Biotechnology
2. Slater et al. (2008). Plant Biotechnology
3. Glick & Pasternak (2010). Molecular Biotechnology

4. Brown, T. A. (2006). Gene Cloning and DNA Analysis
5. Primrose & Twyman (2006). Principles of Gene Manipulation and Genomics
6. Gordon, I. (2005). Reproductive Techniques in Farm Animals
7. Levine, M. M. (2004). New Generation Vaccines

## BTMSC 509 GENETICS

***Course Objective:***

To develop an understanding of classical and molecular genetics principles, population genetics, and chromosomal variations relevant to genomics.

***Learning Outcomes:***

- Apply Mendelian principles to genetic inheritance studies.
- Explain extranuclear inheritance and genetic disorders.
- Analyze chromosomal aberrations and their consequences.
- Perform basic calculations in population genetics.

### UNIT 1 MENDELIAN PRINCIPLES AND CHROMOSOME THEORY OF INHERITANCE:

Mendel's laws of inheritance, Codominance, incomplete dominance, Genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism. The chromosome theory of heredity, Sex chromosomes, Sexlinkage, sex limited and sex influenced characters Mendelian principles in human genetics, Pedigree analysis, genetic disorders and Inborn errors of metabolism, The discovery of linkage, Linkage of genes on X chromosomes,Linkage maps and linkage mapping, Linkage disequilibrium, Calculating recombinant frequencies from selfed dihybrids. Haploid mapping (2 point & 3 point cross), Diploidmapping (Tetrad analysis).

### UNIT 2 THE EXTRANUCLEAR GENOME AND INHERITANCE:

The concept of extranuclear genome in higher plants and animals. Extranuclear inheritance (mitochondrial, chloroplast), Kappa particles in Paramecium, Sigma factor in Drosophila, Cytoplamic Male Sterility (CMS) in crop plants and its applications in plantbreeding.

### UNIT 3 CHROMOSOMAL VARIATION IN NUMBER & STRUCTURE –

Euploidy, Non-disjunction & Aneuploidy, Aneuploid in plants and Humans, Polyploidy in Plants and Animals and its applications, Chromosomal Mosaics, Deletion,Duplication, Inversion, Translocation, Transposable Genetic Elements.

### UNIT 4 POPULATION GENETICS:,

Hardy Weinberg law; Migration; Gene flow and Genetic drift.

### SUGGESTED READINGS:

1. Principles of Genetics, E J Gardner, John Wiley & Sons Inc.
2. Principles of Genetics, D.P. Snustad & M.J. Simmons, John Wiley and Sons Inc.

## BTMSC531 BIOINFORMATICS CREDITS: 3 (45 LECTURES)

***Course Objective:***

To introduce bioinformatics tools, databases, sequence alignment techniques, phylogenetic analysis, gene prediction, and structure modeling.

***Learning Outcomes:***

- Retrieve and analyze biological data from databases.
- Perform pairwise and multiple sequence alignments.
- Construct phylogenetic trees and interpret evolutionary relationships.
- Predict gene structures and model protein 3D structures.

### UNIT 1: INTRODUCTION TO BIOINFORMATICS & BIOLOGICAL DATABASES:

Major Bioinformatics Resources; Biological databases:- Sequence databases- Nucleotidesequence database, Protein sequence databases, Protein Family Databases, Structural databases,Repositories for high throughput genomic sequences: EST, etc.; Enzymes and metabolic pathways databases, Literature databases.

### UNIT 2: SEQUENCE COMPARISON AND ALIGNMENT TECHNIQUES:

Pairwise sequence alignments: basic concepts of sequence alignment: local and global alignments, Dot Plot & Dynamic programming (Needleman and Wunsch, Smith and Waterman algorithms) for pairwise

alignments, gap penalties, Scoring Matrices; use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results

### UNIT 3: MULTIPLE SEQUENCE ALIGNMENTS (MSA) AND PHYLOGENETIC ANALYSIS:

Basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.) & interpretation of results, concept of dendrogram and its interpretation.

Phylogenetic analysis: Concepts in taxonomy & phylogeny; Definition and description of

phylogenetic trees and various types of trees Evolutionary Change in Nucleotide Sequences, Rates and patterns of nucleotide substitution, Types of Trees, Methods for Phylogenetic estimation: Maximum parsimony, Distance Matrix Methods and Maximum Likelihood Methods, Validation methods.

### UNIT 4: 3D- STRUCTURE PREDICTION:

Fundamentals of the methods for 3D structure prediction,

Homology/comparative Modeling.

### UNIT 5: GENE FINDING TOOLS:

Basic concept of tools for Gene Finding

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TEXT BOOKS/REFERENCES:

1. Introduction to Bioinformatics by Arthur C. Lesk
2. Introduction to Bioinformatics by T.Attawood and D. Parry-Smith
3. David W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring harbor
4. •Malcolm Campbell, Laurie J. Heyer. Discovering Genomics, Proteomics, & Bioinformatics. 2003. Cold Spring Harbor Laboratory Press. 0805347224.
5. •Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.

## MA415 BIOSTATISTICS

***Course Objective:***

To impart fundamental statistical concepts and methods essential for analyzing biological and genomics data.

***Learning Outcomes:***

- Apply descriptive and inferential statistical techniques.
- Perform correlation, regression, and time series analyses.
- Understand probability distributions relevant to biological data.
- Conduct hypothesis testing and ANOVA.

### UNIT I DESCRIPTIVE STATISTICS:

Application of statistics in managerial decision-making, Collection of data, Tabulation and graphic presentation of data, Measures of Central tendency (Mean, Median and Mode),Measuring the variation in Data, Standard Deviation, Population Variance, Sample Variance, Significance of Standard Deviation; Percentiles, Quartiles, Skewness. Distribution of sample means, standard error and confidence interval.

### UNIT II

Correlation and Regression: Correlation: Meaning and uses, Methods of correlation, Regression: Meaning and uses, Regression equations, Time series: Concepts, Components of time series, Measurement of trend. Scatter plot, multiple regressions.

### UNIT III

Probability: Permutation and combination, Sample space and events, probability concepts, addition theorem, multiplication theorem, Conditional probability.

### UNIT IV

Probability Distributions: Discrete Random Variables, Continuous Random Variables, Expected Value, Variance, Introduction to one way and two-way analysis of variance; Data transformations. Binomial Distribution, Poisson distribution, Normal Distribution.

### REFERENCE BOOKS

1. Wayne W. Daniel, Biostatistics : Basic Concepts and Methodology for the Health Sciences, 9th edition,Wiley India Pvt Ltd, 2008
2. Sheldon Ross, A First Course in Probability, 9th Edition, , 2014.

3. Edward Batschelet, Introduction to Mathematics for Life Scientists, 3rd Edition, Springer-Verlag, 1992.
4. S.P. Gordon and F.S. Gordon, Contemporary Statistics:A Computer Approach, McGraw-Hill PublishingCompany, New York, 1994.

## BTMSC 525 DATABASE AND COMPUTER PROGRAMMING

***Course Objective:***

To teach database design, management, and programming skills (Python) necessary for biological data analysis and bioinformatics applications.

***Learning Outcomes:***

- Design and manage relational databases using MySQL.
- Develop Python scripts for bioinformatics workflows.
- Apply object-oriented programming and file handling in biological data analysis.
- Integrate database querying with Python programs.

### UNIT I

Introduction to Databases and Transactions: What is database system, purpose of database system, data types, relational databases, database architecture, transaction management.

### UNIT 2

Database Design ,ER-Diagram and Unified Modeling Language: Database design and ER Model:overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design.

### UNIT III INTRODUCTION TO PYTHON PROGRAMING:

Python Programing, history of Python Programing, features of Python Programing, why to learn Python Programing, and application of Python Programing. Installation of Python and Visual Studio Code (VSCode).

### UNIT IV

String object basics, String methods, Splitting and Joining Strings, String format functions, list object basics, list methods, List as stack and Queues, List comprehensions. Variables and Data Types: Variable, declaration of variable, variable assignment, data types in Python, checking Data type, Data types Conversion, Python programs for Variables and Data Types.

### UNIT V

PYTHON IDENTIFIERS, KEYWORDS, READING INPUT, OUTPUT FORMATTING: Identifier, Keywords, Reading Input, Taking multiple inputs from user, Output Formatting, Python end parameter.

## UNIT VI

TUPLES, SET, DICTIONARIES & FUNCTIONS: Tuples, Sets, Dictionary Object basics, Dictionary Object methods, Dictionary View Objects. Functions basics, Parameter passing, Iterators, Generator functions, Lambda functions, Map, Reduce, filter functions.

## UNIT VII

Operators in Python: Operators and types of operators- Arithmetic Operators, Relational Operators, Assignment Operators, Logical Operators, Membership Operators, Identity Operator, Bitwise Operators and Python programs for all types of operators.

## UNIT VIII

**Decision Making**: Introduction to Decision making, Types of decision-making statements, Introduction, syntax, flowchart and programs for, if statement, if…else statement, elif statement

## UNIT IX

LOOPS*:* Introduction to loops, Types of loops- (a) for loop, (b) while loop, ( c) infinite loop,(d) nested loop; Break, continue and pass statement, and Python programs for all types of loops.

## UNIT X

OOPS CONCEPTS & WORKING WITH FILES OOPS: basic concepts, Creating classes and Objects, Inheritance, Multiple Inheritance, Working with files, Reading and writing files, Buffered read and write, Other File methods.

## RECOMMENDED TEXTBOOKS AND REFERENCES:


1. PYTHON FOR BIOINFORMATICS SECOND EDITION CHAPMAN & HALL/CRC Mathematical and Computational Biology Series.
2. Head First Python 2e: A Brain-Friendly Guide Paperback – Illustrated, 16 by Paul Barry, Oreilly
3. Python: The Complete Reference Paperback – 20 March 2018 by Martin C. Brown (Author), TMH Publication
4. Let Us Python by Yashavant Kanetkar , 1 January 2019, BPB publication
5. Python Programming, A modular approach, First Edition, By Pearson Publication by Taneja Sheetal and Kumar Naveen , 26 September 2017.


# BTMSC 537 – BIOINFORMATICS LAB

***Course Objective:***

To provide hands-on training in bioinformatics tools for sequence retrieval, alignment, gene prediction, structure modeling, and scripting.

***Learning Outcomes:***

- Retrieve biological sequences and perform alignments.
- Construct phylogenetic trees using MSA tools.
- Predict protein structures and annotate functional domains.
- Script basic bioinformatics analyses using Biopython.

**Practical**

1. Retrieval of nucleotide and protein sequences from NCBI, EMBL, and UniProt databases
2. Pairwise sequence alignment using Needleman-Wunsch and Smith-Waterman algorithms (online tools)
3. Multiple sequence alignment using Clustal Omega or MUSCLE and phylogenetic tree construction
4. ORF prediction and gene annotation using ORF Finder and BLASTX
5. Homology modeling of protein 3D structure using SWISS-MODEL
6. Visualization of protein structures using PyMOL or Chimera
7. Functional domain analysis using Pfam and InterProScan
8. Use of genome browsers (UCSC/Ensembl) for gene structure analysis
9. Prediction of subcellular localization and signal peptides
10. Scripting basic sequence analysis tasks using Biopython (e.g., GC content, translation, motif search)

## BTMSC 541 – DATABASE AND COMPUTER PROGRAMMING LAB

***Course Objective:***

To practice database creation, SQL querying, and Python programming for biological data processing and visualization.

***Learning Outcomes:***

- Create ER diagrams and implement relational schemas.
- Develop Python scripts for biological data handling.
- Parse and analyze FASTA files programmatically.
- Connect Python applications with MySQL databases.

**Practical**

1. Designing Entity-Relationship (ER) diagrams and converting to relational schema
2. Creation of MySQL database, tables, and execution of basic SQL queries
3. Writing Python scripts for sequence input/output, counting nucleotide/protein frequencies
4. Using Python loops and conditionals for FASTA file parsing
5. Implementation of string and list operations for biological data handling
6. Writing functions for codon-to-amino acid translation

7. Accessing NCBI using Biopython's Entrez module
8. Creating data visualization plots (bar, line, scatter) using matplotlib/seaborn
9. Mini-project: Python-based DNA/RNA sequence analyzer with GUI using tkinter
10. Connecting Python script to MySQL database for sequence storage and retrieval

## BTMSC 517 – PLANT AND ANIMAL BIOTECHNOLOGY LAB

***Course Objective:***

To develop practical skills in plant and animal biotechnology techniques including tissue culture, transformation, and molecular analysis.

***Learning Outcomes:***

- Conduct plant tissue culture and micropropagation experiments.
- Perform Agrobacterium-mediated genetic transformation.
- Isolate genomic DNA and analyze by PCR and gel electrophoresis.
- Maintain and assess animal cell cultures.

**Practical**

1. Surface sterilization and inoculation of explants for callus induction
2. Preparation of Murashige and Skoog (MS) media with different hormones
3. Micropropagation via shoot multiplication and rooting
4. Somatic embryogenesis and synthetic seed preparation
5. Agrobacterium-mediated transformation of model plant (e.g., tobacco leaf discs)
6. Genomic DNA isolation from plant tissues and PCR-based verification
7. SDS-PAGE analysis of plant-expressed recombinant proteins
8. Animal cell line thawing, subculturing, and cryopreservation
9. MTT assay for cell viability and drug toxicity
10. Chromosomal DNA isolation from cultured mammalian cells and gel electrophoresis

## SEMESTER 2

## BTMSC508 COURSE TITLE: GENOMICS AND PROTEOMICS CREDITS: 2

***Course Objective:***

To impart knowledge of genome organization, mapping, sequencing technologies, comparative genomics, and proteomics approaches.

***Learning Outcomes:***

- Describe genome and proteome structures in prokaryotes and eukaryotes.
- Analyze genome mapping and sequencing strategies.
- Apply comparative genomics for evolutionary studies.
- Interpret proteomic techniques and functional genomics data.

### UNIT I: BASICS OF GENOMICS AND PROTEOMICS

Overview of genome organization in prokaryotes and eukaryotes. Includes extra-chromosomal elements such as bacterial plasmids, mitochondrial and chloroplast DNA. Introduces the central dogma extension to systems biology integrating proteome, transcriptome, and metabolome.

### UNIT II: GENOME MAPPING

Covers principles and methods for genetic and physical mapping. Topics include gene markers, linkage analysis, cytogenetic techniques, FISH, somatic cell hybridization, radiation hybrid mapping, in situ hybridization, and comparative gene mapping.

### UNIT III: GENOME SEQUENCING PROJECTS

Introduces major sequencing efforts like the Human Genome Project and comparative genome sequencing across microbes, plants, and animals. Students learn to retrieve and interpret genome data from public databases.

### UNIT IV: COMPARATIVE GENOMICS

Discusses applications of molecular markers like 16S rRNA typing and SNPs for taxonomy and evolutionary studies. Introduces comparative genomics in understanding species evolution, pathogen

surveillance, and drug target discovery. Explains determination of gene location within genome sequences.

### UNIT V: PROTEOMICS

Covers proteomics approaches and technologies including 2D-PAGE, isoelectric focusing, MALDI-TOF, yeast two-hybrid systems, and protein databases. Describes strategies and challenges in proteomics, protein separation techniques, and mass spectrometry.

### UNIT VI: FUNCTIONAL GENOMICS AND PROTEOMICS

Explores transcriptomics and genome-wide expression profiling for gene function annotation. Includes contig assembly, chromosome walking, reverse and forward genetics, protein-protein and protein-DNA interactions, protein chips, and functional proteomics. Covers biomedical and clinical applications of proteomics and introduces metabolomics, lipidomics, metagenomics, and systems biology.

### RECOMMENDED TEXTBOOKS AND REFERENCES:


1. Primrose, S. B., Twyman, R. M. (2006). *Principles of Gene Manipulation and Genomics*. Blackwell Publishing.
2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology*. Humana Press.
3. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. Benjamin Cummings.


## BTMSC 510 – MOLECULAR DIAGNOSTICS (2 CREDITS)

***Course Objective:***

To introduce molecular biology techniques for diagnosing genetic and infectious diseases, focusing on genomics and metabolomics approaches.

***Learning Outcomes:***

- Apply molecular methods for disease diagnosis.
- Analyze genomic and metabolomic biomarkers.
- Understand molecular basis of inherited and somatic diseases.
- Evaluate quality assurance frameworks in diagnostics.

### UNIT I: GENOME BIOLOGY IN HEALTH AND DISEASE –

chromosomal structure and DNA, RNA, and protein roles in disease biology. Emphasis on DNA polymorphism, clinical variability, and pharmacogenomics.

### UNIT II: GENOME: RESOLUTION, DETECTION & ANALYSIS –

Includes advanced diagnostic techniques: ARMS-PCR, multiplex PCR, real-time PCR, ISH, FISH, RFLP, DHPLC, DGGE, SSCP, DNA sequencing (Sanger and NGS), and microarrays. Introduces platforms like SAGE and ESTs for gene expression analysis.

### UNIT III: DIAGNOSTIC METABOLOMICS

Covers the use of metabolite profiling using LC-MS and NMR for biomarker discovery in clinical fluids and tissues associated with metabolic disorders.

### UNIT IV: DETECTION AND IDENTITY OF MICROBIAL DISEASES

Molecular methods for identifying non-culturable pathogens and antimicrobial resistance genes. Focus on 16S rRNA typing and molecular diagnostics in microbiology.

### UNIT V: DETECTION OF INHERITED DISEASES –

Case studies include Fragile X Syndrome and von-Hippel Lindau disease. Highlights use of triplet repeat analysis and identification of inherited cancer syndromes.

### UNIT VI: MOLECULAR ONCOLOGY

Discusses detection of somatic mutations via NGS, predictive cancer biomarkers, matched therapy, and pharmacogenomic profiling for colorectal, breast, and lung cancers.

### UNIT VII: QUALITY ASSURANCE AND CONTROL

Introduces regulatory and quality assurance frameworks for clinical molecular diagnostics, including test validation and reporting.

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### SUGGESTED READINGS:


1. Campbell & Heyer (2006). Discovering Genomics, Proteomics, and Bioinformatics
2. Brooker, R. J. (2009). Genetics: Analysis & Principles
3. Glick et al. (2010). Molecular Biotechnology
4. Coleman & Tsongalis (2010). Molecular Diagnostics


## BTMSC 512 – RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS (2 CREDITS)

***Course Objective:***

To equip students with research design principles and scientific communication skills for effective dissemination of research outcomes.

***Learning Outcomes:***

- Formulate research questions and design experiments.
- Maintain scientific records and interpret results critically.
- Develop skills for scientific writing and oral presentation.
- Understand research ethics and publication standards.

## UNIT I: HISTORY OF SCIENCE AND SCIENCE METHODOLOGIES

Covers development of empirical science, deductive and inductive reasoning, experimental design, control groups, reductionist vs holistic biology, and descriptive science.

## UNIT II: PREPARATION FOR RESEARCH

Guides students in choosing a research mentor, identifying a question, and maintaining accurate lab records.

## UNIT III: PROCESS OF COMMUNICATION

Focuses on effective communication skills: goal setting, feedback, listening, interpreting non-verbal cues, cross-cultural communication, and oral presentation techniques.

## UNIT IV: SCIENTIFIC COMMUNICATION

Provides instruction on technical writing, plagiarism avoidance, structure of scientific papers (IMRAD), poster preparation, email etiquette, peer-review process, and ethics in publishing.

### SUGGESTED READINGS:


1. Valiela, I. (2001). *Doing Science*
2. National Academies (2009). *On Being a Scientist*
3. Gopen & Smith (1990). *The Science of Scientific Writing*, *American Scientist*
4. Mohan & Singh (2010). *Speaking English Effectively*


# BTMSC516 COMPUTATIONAL BIOLOGY CREDITS: 2

***Course Objective:***

To provide practical exposure to computational tools for genome analysis, NGS data handling, and structure-based drug discovery.

***Learning Outcomes:***

- Analyze gene expression data using R and Linux environments.

- Handle NGS data formats and perform variant analysis.
- Predict gene functions and annotate genomes.
- Perform molecular docking and validate drug targets.

## UNIT 1: INTRODUCTION TO COMPUTER PROGRAMMING LANGUAGES

Introduction to Unix/ Linux operating system and basic commands. R statistical package installation and configuration, GUI for R: R-commander, R-studio, Analysis of gene expression using R.

## UNIT 2: GENOME ANALYSIS:

Biological databases, Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Human genome project, Genomics and crop improvement.

## UNIT 3: HANDLING OF NGS DATA:

Overview of different NGS data formats, Sequencing machine to raw sequence, Initial QC (e.g. Phred Score), Alignment, Post alignment processing, Depth and Coverage, Variant Calling, Annotation, data visualization.

## UNIT 4: STRUCTURE-BASED DRUG DEVELOPMENT:

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Analysis of docking results and validation with known information. **(8 Lectures)**

## TEXT BOOKS/REFERENCES:


1. Jonathan Pevsner. **(**2015). **Bioinformatics and Functional Genomics**.
2. Mount DW. (2001). **Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.**
3. Arthur C. Lesk. **Introduction to Bioinformatics.**
4. Baxevanis, A.D. and Francis Ouellette, B.F. (2004) **Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.** Second Edition, Wiley.
5. Malcolm Campbell, Laurie J. Heyer. (2003). **Discovering Genomics, Proteomics, & Bioinformatics.** Cold Spring Harbor Laboratory Press. 0805347224.
6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press
7. Mathur K Sunil. (2010). **Statistical Bioinformatics with R.** Elsevier.
8. Internet and shared latest online Material.


# BTMSC 518 – DRUG DISCOVERY AND DEVELOPMENT CREDITS: 2

***Course Objective:***

To provide an overview of the drug discovery pipeline, computational drug design, preclinical testing, and regulatory aspects.

***Learning Outcomes:***

- Explain stages of drug discovery and target identification.
- Apply computational methods for drug design and screening.
- Analyze pharmacokinetic and pharmacodynamic profiles.
- Understand clinical trial phases and regulatory frameworks.

## UNIT I: DRUG DISCOVERY PIPELINE

This unit covers the stages of drug discovery—target identification and validation, assay development, lead compound identification, and optimization. Emphasis is placed on the role of genomics and proteomics in target discovery and disease modeling.

## UNIT II: COMPUTATIONAL DRUG DESIGN

Students will learn structure-based and ligand-based drug design principles including molecular docking, pharmacophore modeling, virtual screening, and QSAR. Tools like AutoDock, PyMOL, and SwissADME will be introduced.

## UNIT III: PRECLINICAL TESTING AND PHARMACOLOGY

Covers ADMET properties, bioavailability, toxicity testing, and pharmacokinetics/pharmacodynamics (PK/PD). Students understand the significance of animal models and biomarkers in assessing drug efficacy and safety.

## UNIT IV: TRANSLATIONAL AND REGULATORY ASPECTS

Discusses IND and NDA processes, phases of clinical trials, ethical considerations, ICMR and CDSCO guidelines, and regulatory approval mechanisms in India and globally. Includes recent success stories of drug repurposing and personalized medicine.

## SUGGESTED READINGS:


1. Hughes, J. P., Rees, S. S., Kalindjian, S. B., & Philpott, K. L. (2011). *Principles of early drug discovery*. British Journal of Pharmacology.
2. Krogsgaard-Larsen, P., Liljefors, T., & Madsen, U. (2016). *Textbook of Drug Design and Discovery*. CRC Press.
3. Glick, B. R., & Pasternak, J. J. (2010). *Molecular Biotechnology* (4th ed.). ASM Press.
4. Rang, H. P., Dale, M. M. et al. (2015). *Rang and Dale's Pharmacology* (8th ed.). Elsevier.
5. Leach, A. R. (2001). *Molecular Modelling: Principles and Applications*. Pearson Education.

## BTMSC542 MICROBIAL DIVERSITY AND METAGENOMICS CREDITS: 2

***Course Objective:***

To explore microbial diversity, metagenomics strategies, and in silico tools for microbial community analysis and functional discovery.

***Learning Outcomes:***

- Characterize microbial communities using molecular techniques.
- Apply NGS-based approaches in metagenomics.
- Use bioinformatics tools for metagenome analysis.
- Understand applications in antimicrobial screening and microbiome studies.

### UNIT I INTRODUCTION TO MICROBES THEIR GENETICS AND GENOMICS:

Prokaryotic cell structure, Microbial nutrition, transport metabolism, the measure of growth, microbial genetics and genomics. Introduction to Viruses, Algae, Fungi and protozoa

### UNIT II MICROBIAL DIVERSITY:

Different types of bacteria based on nutrition, environment halophiles, psychrophiles, barophiles etc. Microbial evolution, taxonomy, phenetic and phylogenetic classification, phylogeny, microbial ecology, Archaebacteria

### UNIT III INTRODUCTION TO METAGENOMICS:

Sequence and function-based metagenomics, metagenomics in microbial diversity, molecular markers, Molecular techniques for characterization of microbial communities e.g., PCR, DGGE, ARDRA, rRNA operon, the repetitive sequence for bacterial identification. Next Generation Sequencing in metagenomics, GT metagenomics, SARST metagenomics, transcriptomics,

### UNIT IV IN SILICO TOOLS FOR METAGENOME ANALYSIS:

(1) Functional Metagenome dataset (DNASTAR, ORF FINDER, BLAST etc), (2) Sequenced Metagenome dataset (FASTQC, FASTQP, METAQC), (3) 16S rRNA gene datasets (QIIME, MEGAN, MOTHUR etc), (4) Whole genome datasets(MGRAST, SEED, METAPATH), Geochip, Phylochip. Metagenomics in the screening of novel antimicrobials, Antibiotic resistome, Human Gut Microbiota, Soil microbiome etc

### SUGGESTED READING:


1. Microbiology by Prescott, Harley and kleins
2. Microbial biotechnology by Alexander Frazier
3. Handbook of Molecular Microbial ecology I Metagenomics and complementary approaches by Frans J de Bruijn

4. Handbook of Molecular Microbial ecology II Metagenomics and complementary approaches by Frans J de Bruijn
5. Minning of microbial wealth and metagenomics By Kalia, Purohit, Rahi Springer
6. Metagenomics: Application of Genomics to Uncultured Microorganisms Jo Handelsman. Microbiology and mol biology reviews 2004.
7. Screening for novel enzymes from metagenome and SIGEX, as a way to improve it Jiae Yun and Sangryeol Ryu. Microbial cell factories 2005
8. Metagenomic analysis and interpretation, NR Chauhan. https://doi.org/10.1016/B978-0-12-816548-5.00010-1

# SEMESTER 3

## BTMSC 621 – BIOMEDICAL GENOMICS CREDITS: 3

***Course Objective:***

To study human genome organization, genomic variations, disease genomics, and applications of genomics in personalized medicine.

***Learning Outcomes:***

- Interpret human genomic architecture and variations.
- Analyze genomic basis of monogenic and complex diseases.
- Perform GWAS and analyze biobank datasets.
- Apply genomics in clinical diagnostics and therapeutic strategies.

### UNIT I: HUMAN GENOME ORGANIZATION AND VARIATION

This unit introduces the structure of the human genome, highlighting euchromatin, heterochromatin, repetitive DNA elements, gene density, and regulatory elements. It covers different types of genomic variation including single nucleotide polymorphisms (SNPs), insertions/deletions (indels), copy number variations (CNVs), and structural variants. Students will explore public resources like the Human Genome Project, ENCODE, 1000 Genomes Project, and gnomAD to understand population-specific genomic diversity and allele frequencies.

### UNIT II: GENETIC BASIS OF HUMAN DISEASES

Students will examine the genomic underpinnings of monogenic and complex diseases with case studies on cystic fibrosis, Huntington's disease, and breast cancer (BRCA1/2). The unit emphasizes disease gene identification approaches including linkage analysis, candidate gene studies, and positional cloning. It also covers chromosomal aberrations, aneuploidies, and pathogenic structural variants detected through array CGH and whole genome sequencing.

### UNIT III: GENOME-WIDE ASSOCIATION STUDIES (GWAS)

This unit focuses on the principles and design of GWAS, including sample selection, genotyping technologies, quality control, and statistical analysis. Students will learn to interpret Manhattan plots and explore concepts such as minor allele frequency (MAF), linkage disequilibrium (LD), population stratification, and imputation. Applications of GWAS in identifying disease susceptibility loci and traits in large biobank data are discussed.

### UNIT IV: CLINICAL GENOMICS AND PHARMACOGENOMICS

Students will study how genomic data is used in clinical diagnostics and therapy selection. Topics include somatic mutation profiling in cancers, pharmacogenomic markers (e.g., CYP2C9, TPMT), gene panels, and matched therapy using NGS. The unit discusses implementation of genomic medicine in oncology, cardiology, and rare disease diagnosis, alongside bioethical and regulatory aspects.

## UNIT V: TRANSLATIONAL GENOMICS AND FUTURE DIRECTIONS

This unit explores integrative omics approaches such as transcriptomics, epigenomics, and proteogenomics in disease biology. Students will study case examples from The Cancer Genome Atlas (TCGA), Human Cell Atlas, and precision medicine initiatives. Emphasis is placed on personalized health prediction, electronic health record integration, and future trends in single-cell and spatial genomics.

### SUGGESTED READINGS:


1. Strachan, T., & Read, A. (2018). *Human Molecular Genetics* (5th ed.). Garland Science.
2. Brown, T. A. (2020). *Genomes* (5th ed.). Oxford University Press.
3. Ginsburg, G. S., & Willard, H. F. (2009). *Genomic and Personalized Medicine*. Academic Press.
4. Collins, F. S., & Varmus, H. (2015). *A New Initiative on Precision Medicine*. New England Journal of Medicine.
5. Manolio, T. A. et al. (2009). *Finding the missing heritability of complex diseases*. Nature, 461(7265), 747–753.


# BTM.SC. 522 POPULATION DIVERSITY, DISEASES AND HEALTH

***Course Objective:***

To understand population genetics, human diversity, GWAS applications, and their impact on human health and disease.

***Learning Outcomes:***

- Describe models of human evolution and population structure.
- Analyze genetic markers and their applications.
- Understand GWAS methodology and interpretation.
- Correlate genetic diversity with disease susceptibility.

## UNIT 1: POPULATION DIVERSITY

Introduction to population diversity, human evolution, models of human origin, parallel evolution: RAO, WGE, hybridized assimilation, Admixture, genetic drift/variance, neutral and adaptive genetics processes, admixture, founder effect, bottleneck effect, gene flow, LD, independent assortment, hardy weinberg principle

## UNIT 2: GENETIC MARKERS

PCR, SSCP, SNP genotyping - allelic discrimination (mass spec based, fluorescence, allele specific primers ; hybridization based, ligation based, enzymatic cleavage , MALDI TOF, FRET, PYROSEQUENCING, Retrotransposons - SINE and LINES, microsatellites, STR, haplotype, genotype, RFLP, diplotype, coalscent modelling, neutral and adaptive genetics, GENECHIP, SNPLEX

## UNIT 3: GENOME WIDE ASSOCIATION STUDIES

Introduction to Genome Wide Association Studies (GWAS), Manhattan Plot SNP, MAF, tools like PLINK, databases etc, SNP databases, Genotyping, Common Disease Common Variant Hypothesis, QTL, Data Imputation, HapMap, Quality check

### UNIT 4: GWAS AND HUMAN HEALTH

Importance and Significance of GWAS: Genetic diversity and disease related case studies, Human genetics and malaria resistance, malaria life cycle, Human HIV genetics, COVID 19, Microbial GWAS, Pathogen adaptation

### SUGGESTED READINGS


1. Any Genetics Book
2. Population genetics and human health in the genomic era. Review
3. Genome-wide association studies of COVID-19: Connecting the dots. Review
4. Genomes, Populations and Diseases: Ethnic Genomics and Personalized Medicine
5. Genome- wide association studies. Nature Reviews, Methods and Primers
6. Human genetics and malaria resistance (2020)
7. HIV-1 and human genetic variation (Nature Reviews. Genetics, 2021
8. Minding the gap in HIV host genetics: opportunities and challenges Human genetics 2020
9. SNP Genotyping:Technologies and Biomedical Applications. Annual Review, 2007
10. Current Affairs of Microbial Genome-Wide Association Studies: Approaches, Bottlenecks and
11. Analytical Pitfalls


## BTMSC 623 – AGRICULTURAL GENOMICS CREDITS: 3

***Course Objective:***

To explore genome organization, functional genomics, molecular breeding, and microbiome applications in agriculture and livestock.

***Learning Outcomes:***

- Analyze plant and animal genomes for trait discovery.
- Apply QTL mapping and genomic selection in breeding.
- Integrate functional genomics tools for crop improvement.
- Study soil and gut microbiomes for agricultural sustainability.

### UNIT I: GENOME ARCHITECTURE OF PLANTS AND LIVESTOCK

This unit introduces nuclear, chloroplast, and mitochondrial genome organization in crop plants and domesticated animals. Topics include repetitive DNA, transposable elements, gene families, and pan-genome concepts. Students learn about model crop genomes (e.g., rice, maize, Arabidopsis) and major livestock genomes (e.g., cattle, chicken).

## UNIT II: FUNCTIONAL GENOMICS AND TRAIT DISCOVERY

The unit covers transcriptomics, epigenomics, and gene expression profiling tools such as RNA-seq, methylome analysis, and translatomics for trait discovery. Functional annotation using reverse genetics, RNAi, TILLING, and CRISPR-Cas9 based genome editing strategies are explored for dissecting gene function in stress, yield, and nutritional traits.

## UNIT III: MOLECULAR MAPPING AND QTL ANALYSIS

Students will learn about molecular marker systems (RFLP, SSR, SNPs), genetic linkage and physical maps, and quantitative trait loci (QTL) mapping. The unit includes marker-assisted selection, QTL pyramiding, and genomic selection. High-throughput genotyping and genome-wide prediction models are discussed for crop and livestock improvement.

## UNIT IV: GENOMICS FOR CROP AND ANIMAL IMPROVEMENT

Focuses on applications of genomics in breeding for disease resistance, abiotic stress tolerance, nutritional quality, and productivity. Includes case studies on transgenic rice, Bt cotton, genome-edited tomatoes, and genomic selection in dairy cattle. Emphasis on integration of genomic selection with traditional breeding and regulatory considerations for genome-edited crops.

## UNIT V: METAGENOMICS AND MICROBIOME IN AGRICULTURE

This unit introduces the role of soil and plant microbiomes in sustainable agriculture. Students learn about metagenomic approaches to study rhizosphere and gut microbiota using 16S rRNA sequencing and shotgun metagenomics. Applications in plant growth promotion, nutrient mobilization, pathogen suppression, and livestock health are discussed.

### SUGGESTED READINGS:


1. Varshney, R. K., Tuberosa, R. (2013). *Translational Genomics for Crop Breeding*. Wiley-Blackwell.
2. Gupta, P. K. (2018). *Molecular Biology and Genetic Engineering*. Rastogi Publications.
3. Raghunathan, G. (2014). *Agricultural Biotechnology*. Dominant Publishers.
4. Collard, B. C., & Mackill, D. J. (2008). *Marker-assisted selection: An approach for precision plant breeding in the twenty-first century*. Phil. Trans. R. Soc. B.
5. Xu, Y. (2010). *Molecular Plant Breeding*. CAB International.


# BTMSC 627 – CONTEMPORARY GENOMICS RESEARCH CREDITS: 2

***Course Objective:***

To introduce students to advances in sequencing, genome editing, systems genomics, and ethical considerations in genomics research.

***Learning Outcomes:***

- Analyze latest sequencing and genome editing technologies.
- Integrate multi-omics data for systems-level understanding.

- Critically evaluate ethical and policy issues in genomics.
- Review and interpret primary genomics research articles.

## UNIT I: ADVANCES IN SEQUENCING TECHNOLOGIES

Students explore the evolution of sequencing technologies from Sanger to third-generation platforms such as PacBio and Oxford Nanopore. Emphasis is placed on read length, accuracy, cost, and applications. Includes case examples from de novo assemblies and long-read transcriptomics.

## UNIT II: CRISPR AND GENOME ENGINEERING

Covers advances in genome editing tools including base editors, prime editing, and epigenome editors. Applications in disease modeling, gene therapy, and crop improvement are discussed. Students will critically review primary research articles in plant and mammalian systems.

## UNIT III: MULTI-OMICS INTEGRATION AND SYSTEMS GENOMICS

Focuses on the integration of genomics, transcriptomics, epigenomics, proteomics, and metabolomics in disease and developmental biology. Includes tools and pipelines for systems-level analysis and case studies on cancer, host-pathogen interaction, and environmental genomics.

## UNIT IV: GENOMIC DATA ETHICS AND POLICY

This unit discusses data sharing policies, genomic privacy, informed consent in biobanks, ethical dilemmas in genome editing, and societal implications. Students will debate current policy reports and position papers.

### SUGGESTED READINGS:


1. Mardis, E. R. (2017). *DNA sequencing technologies: 2006–2016*. Nature Protocols, 12(2), 365–368.
2. Shendure, J., & Ji, H. (2008). *Next-generation DNA sequencing*. Nature Biotechnology, 26(10), 1135–1145.
3. Zhang, F., Wen, Y., & Guo, X. (2014). *CRISPR/Cas9 for genome editing: progress, implications and challenges*. Human Molecular Genetics.
4. Nature Reviews Genetics – *Featured Reviews on Single-cell, Multi-omics, and Epigenomics*.
5. Church, G. M. et al. (2015). *The Personal Genome Project*. Molecular Systems Biology.


# BTMSC 609 COURSE TITLE: INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS CREDITS: 2

## UNIT I: INTRODUCTION TO IPR

Covers different types of intellectual property: patents, trademarks, copyrights, industrial designs, geographical indications, and traditional knowledge. Includes relevance of IPRs to biotechnology, international protection frameworks (WIPO, WTO, TRIPS), and concepts such as "prior art," invention disclosure, and use of patent databases (USPTO, EPO, India).

## UNIT II: PATENTING

Indian Patent Act 1970 and its amendments. WIPO Treaties, Budapest Treaty, Patent Cooperation Treaty (PCT).Procedures for filing patent applications, patent types, NBA forms, provisional and complete specifications. Patent infringement, commercialization, licensing (outright sale, royalty-based), and benefit-sharing. Institutional policies on patenting by researchers. Financial support mechanisms and publication of patents (India, Europe, US).

## UNIT III: BIOSAFETY

Introduces biosafety principles and history, types of biological safety cabinets, biosafety levels (BSL-1 to BSL-4), and containment for infectious agents. Includes: Definitions of GMOs & LMOs, Risk assessment protocols for transgenic crops, RNAi-based, and genome-edited products, Concepts of "familiarity" and "substantial equivalence", Environmental, food, and feed safety evaluation procedures

## UNIT IV: NATIONAL AND INTERNATIONAL REGULATIONS

Cartagena Protocol, OECD documents, Codex Alimentarius. Indian regulations: EPA Act, RCGM, GEAC, IBSC, BRAI Bill. Guidelines for rDNA experiments, biosafety field trials, SOPs, state-level protocols. GM food labeling and FSSAI regulations

## UNIT V: BIOETHICS

Covers ethical conflicts in biology: Interference with nature, confidentiality, consent, euthanasia, ART, prenatal diagnosis. Gene therapy, transplantation ethics. Research ethics: cloning, stem cells, human/animal experiments, GE food. Topics include benefit-sharing, environmental protection, biodiversity, biopiracy, and rights of future generations.

## RECOMMENDED TEXTBOOKS AND REFERENCES:


i. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill.
ii. National IPR Policy, DIPP, Ministry of Commerce, GoI
iii. Complete Reference to IPR Laws (2007), Snow White Publication
iv. Kuhse, H. (2010). Bioethics: An Anthology. Blackwell
v. Karen F. Greif & Jon F. Merz. Current Controversies in the Biological Sciences, MIT Press

vi. World Trade Organization: www.wto.org
vii. World Intellectual Property Organization: www.wipo.int
viii. National Biodiversity Authority: www.nbaindia.org
ix. Recombinant DNA Safety Guidelines (1990), DBT, GoI
x. Wolt et al. (2009). Transgenic Research, 19(3), 425–436.
xi. Craig et al. (2008). Euphytica, 164(3), 853–880.

## BT211 COURSE TITLE: ECOLOGY AND ENVIRONMENT CREDITS: 3

***Course Objective:***

The objective of this course is to provide students with an understanding of ecological principles and environmental challenges, focusing on the integration of bioinformatics and genomics in environmental analysis and sustainability. Students will explore key ecological concepts and learn to apply molecular biology techniques for addressing environmental issues.

***Learning Outcomes:***

- Understand the basic principles of ecology, ecosystem functioning, and biodiversity.
- Analyze environmental challenges, such as climate change and pollution, using genomics tools.
- Apply bioinformatics approaches to study environmental DNA (eDNA) and its implications for conservation.
- Evaluate environmental policies and propose sustainable solutions using interdisciplinary knowledge.

### UNIT I: INTRODUCTION TO ECOLOGY

Provides an overview of ecosystem structure and function. Covers energy flow, food chains, food webs, trophic levels, and ecological pyramids. Discusses the concept of productivity and ecosystem classification (aquatic and terrestrial).

### UNIT II: BIOGEOCHEMICAL CYCLES

Explains the carbon, nitrogen, phosphorus, sulfur, and hydrological cycles. Emphasizes microbial roles in nutrient cycling and human-induced disruptions.

### UNIT III: BIODIVERSITY AND CONSERVATION

Defines biodiversity, levels (genetic, species, ecosystem), and values. Covers hotspots, threats to biodiversity (habitat loss, invasive species), and conservation strategies (in-situ and ex-situ). Introduces biodiversity databases and role of molecular markers in conservation.

### UNIT IV: ENVIRONMENTAL POLLUTION AND CONTROL

Details air, water, and soil pollution sources, effects, and mitigation. Describes bioremediation, phytoremediation, and wastewater treatment (primary to tertiary). Discusses microbial applications in pollution control.

### UNIT V: GLOBAL ENVIRONMENTAL ISSUES

Focuses on climate change, ozone depletion, acid rain, and desertification. Introduces concepts like carbon footprint, carbon credits, and international protocols (Kyoto, Paris Agreement).

### UNIT VI: ENVIRONMENTAL BIOTECHNOLOGY

Explores biosensors for pollutant detection, genetically modified organisms (GMOs) for remediation, and ecological risk assessment. Includes case studies on microbial consortia and bioaugmentation.

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RECOMMENDED TEXTBOOKS AND REFERENCES:


1. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology*. Thomson Brooks/Cole.
2. Dash, M. C. (2004). *Fundamentals of Ecology*. Tata McGraw-Hill.
3. Sharma, P. D. (2005). *Ecology and Environment*. Rastogi Publications.
4. Cunningham, W. P., & Saigo, B. W. (2007). *Environmental Science: A Global Concern*. McGraw-Hill.
5. Pepper, I. L., Gerba, C. P., & Brusseau, M. L. (2011). *Environmental and Pollution Science*. Academic Press.


## BTMSc 619 Dissertation I credits 4

***Course Objective:***

To develop independent research skills including experimental design, data collection, analysis, and preliminary interpretation.

***Learning Outcomes:***

- Design and plan a research project under supervision.
- Execute experiments and troubleshoot techniques.
- Analyze and interpret preliminary research data.
- Present initial research findings in a scientific manner.

## SEMESTER 4

## BTMSC 602 DISSERTATION II CREDITS 24

***Course Objective:***

To carry out full-fledged research culminating in data analysis, thesis writing, and defense, integrating multidisciplinary knowledge.

***Learning Outcomes:***

- Perform comprehensive experiments independently.
- Critically analyze and interpret complex datasets.
- Write a scientific dissertation adhering to academic standards.
- Defend research outcomes through oral and written presentations.