

**Dr. Babasaheb Ambedkar Marathwada University,
Chhatrapati Sambhajinagar**

Syllabus of Biotechnology for PET- 2024

=====

Section-I (Research Methodology)

- Significance of Research Methodology in Biotechnology. Types of Research: Basic, Applied, and Translational. Research Paradigms: Positivist, interpretivist, and mixed-method approaches in biotechnology research.
- Formulating Research Questions: Defining research objectives, hypotheses, and formulating testable research questions.
- Techniques for conducting comprehensive literature reviews and identifying research gaps. Research Proposal Development and Funding Sources.
- Sampling Techniques and Experimental Design. Data Collection Methods: Surveys, Observations, and Experiments. Quantitative and Qualitative Data Analysis. Statistical Analysis and Software Applications in Biotechnology Research
- Scientific Writing: Research Papers, Reviews, and Reports. Citations and Referencing: Using Citation Styles.
- Effective Oral Communication: Conference Presentations and Seminars. Visual Aids and Graphical Representation of Data. Peer Review Process and Manuscript Submission. Oral Presentation: Strategies for delivering compelling research presentations to diverse audiences.
- Research Ethics: Ethical considerations and responsible conduct of research in biotechnology.
- Human and Animal Subjects: Ethical guidelines for conducting research involving human subjects and animals.
- Problem Identification: Identifying research problems and formulating relevant research questions. Experimental Troubleshooting:
- Developing strategies for addressing challenges and obstacles in Biotechnological experiments.

Section- II (Biotechnology)

- Prokaryotic and eukaryotic cells. Types and classification Microorganisms, Staining Techniques, rRNA sequencing. Microbial diversity, Bacterial genetics, Microbial growth and sporulation.
- Classification, Nomenclature, General Properties, Morphology, and Ultra Structure of Viruses. Cultivation, Purification & Enumeration of Viruses, Virioids & Prions. Bacteriophage,
- Biomolecules: Structure, function and significance. Metabolic engineering approaches to enhance energy production and biomolecule synthesis.
- Role of biomolecules in the development of biopharmaceutical products. Small interfering RNA (siRNA) and microRNA (miRNA) in gene silencing. Harnessing photosynthesis for sustainable bioenergy production
- Mendel's experiments and laws. Patterns of inheritance: Extensions of Mendelian genetics, chromosomes linkage, recombination, and gene mapping. Mutation and its types. mitosis and meiosis. Sex determination and sex-linked inheritance. Genetic disorders related to chromosomal abnormalities. Hardy-Weinberg equilibrium and factors affecting genetic equilibrium. Microevolution: Natural selection, genetic drift, gene flow, and mutation. Macroevolution: Speciation and patterns of evolution.
- Realtime PCR, quantitative PCR, and allele-specific PCR for genetic testing. DNA Sequencing techniques, Recombinant Protein Therapeutics: Expression systems, protein purification, and applications in biopharmaceuticals. Gene Therapy: Viral and nonviral vector-mediated gene delivery. Biomarker :Identification and validation of biomarkers for disease diagnosis and prognosis.
- Cellular totipotency, Micropropagation, Somaclonal Variation, Somatic embryogenesis and synthetic seed production Plant organ culture, *Agrobacterium* mediated plant transformation, Analysis and application of transgenic
- Bioinformatics and its interdisciplinary nature. Biological databases and data types in genomics, proteomics, and metabolomics. Next-generation sequencing technologies and data analysis pipelines. Ethical and legal considerations in bioinformatics.
- Biopharmaceuticals and their significance in modern medicine, Biosimilars and Biobetters.
- Immune system, Components of the immune system: Innate and adaptive immunity, , Antigens, Immunogens, T lymphocytes, B lymphocytes, Antibody structure, B cell receptor (BCR) and T cell receptor (TCR): Structure and signalling, Major Histocompatibility Complex (MHC). Agglutination, Immunoprecipitation, ELISA, Western blotting, and flow cytometry,

- Enzymes: classification, Mechanisms of enzyme action, active site and energetic of enzyme substrate complex formation; specificity of enzyme action;
- Kinetics of single substrate reactions; estimation of Michelis –Menten parameters, multi-substrate reactions - mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation, enzyme immobilization.
- DNA Repair Systems,DNA Replication and Recombination DNA Transcription and Translation in pro and eukaryotes,
- Intellectual Property rights, types, and importance in biotechnology.
- Cell structure and function., Cell membrane, organelles, and their roles in cellular processes, Cellular communication, and signal transduction pathways. Cell cycle regulation and checkpoints. Mitosis and meiosis: Mechanisms and significance. Cell proliferation and cell death (apoptosis). Cell fate determination and differentiation. Introduction to stem cells and their properties. Embryonic development and the role of stem cells. Tissue regeneration and adult stem cells
- Genetic and environmental factors contributing to developmental disorders. Mechanisms underlying congenital malformations and potential therapeutic interventions.
- Genomics and its significance in biology.
- Animal biotechnology and its applications,Ethical considerations and societal implications of animal biotechnology, Regulations and guidelines governing animal biotechnology research,In vitro fertilization (IVF) and embryo transfer techniques,Techniques for generating transgenic animals, Methods for identifying and selecting transgenic animals, Principles and techniques of animal cloning,Genome editing technologies (e.g., CRISPR/Cas9) and their applications in animals.
- Biochemical Engineering Bioprocess engineering: Definition and scope, Mass and energy balances in bioprocesses, Case studies and examples of mass and energy balances, Different modes of operation of reactors, Screening and Isolation of microorganisms, Strain improvement of the selected organisms, special example of strain improvement program (penicillin production).
- Designing of fermentation media for lab scale experiments to industrial process; inoculum development and production; inoculum development strategies and procedure; storage of cultures for repeated fermentations,Design of a basic fermenter
- Regulation of gene expression: operon concept- *lac*, *trp*, *ara*, *gal*, Factors and elements involved regulation, DNA binding motifs, Epigenetic gene regulation, Restriction Endonucleases: their properties and specificities, applicability, plasmids; pBR322 and pUC19,Artificial chromosome vectors (YACs; BACs, Expression vectors, Mammalian expression and viral vectors; Baculovirus and Adeno virus vectors.

- rDNA Technology, **Genome mapping tools**: RFLP, AFLP, EST, SSR, SNP, *GISH*, *FISH*, **Gene silencing technologies**, Bt Cotton, Genetic engineering of plants for viruses, herbicide tolerance. GMO, debate over GM crops, metabolic engineering, Protein engineering: - AAT, Subtilisin, streptokinase,
- Column Chromatography techniques Electrophoretic techniques, Flow cytometry, Light and electron microscopic techniques, Ultraviolet and visible light spectroscopy, CD, ORD, IR and Raman's spectroscopy. Molecular structure determination by NMR and MS.
- Entrepreneurship and its relevance in biotechnology. Current trends and prospects in the global and Indian biotech industries. Key sectors within biotechnology, global and Indian regulatory requirements in biotechnology.
- Microbial Products for Human Health and Consumption: Antibiotics, Recombinant products: Chymosin, Fermented foods and Alcoholic beverages, Biofertilizers, Biohydrogen Production: Microbial electrolysis system, Electricigens and Microbial Fuel Cell,
- Recalcitrant/ xenobiotic compounds, Concept and consequences of biomagnification, Microbiology of degradation of xenobiotics in the environment, ecological considerations, biomagnification and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its environmental impact assessment and ethical issues.
- Microbiology of wastewater and solid waste treatment: - physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Anaerobic processes: Anaerobic digestion,
- Biotransformation- Introduction, types of reactions involved, procedures and applications with respect to steroids, antibiotics and pesticides transformations,
- Bioaccumulation of heavy metal ions from industrial effluents, Bioleaching of metals, Acid Mine Drainage
- Structure and organization of animal cell. Equipments and materials for animal cell culture technology. Primary and established cell line cultures. balanced salt solutions and simple growth medium. tissue disaggregation, maintenance of cell culture, criteria for subculture and propagation, Measurement of viability,
- The Impact of Biotechnology on the Drug Development Process. Working and applications of biosensors in Pharmaceutical Industries.
- Hybridoma technology- Monoclonal antibodies Production, Purification and Applications. Phage display technology.
- Therapeutic proteins: Classification based on pharmacological action.
- Emerging clinical diagnostics: Microarrays, FACS, Lab-on-a-Chip approach for molecular diagnosis, Introduction to SELDI-TOF and diagnostic proteomics. Nano-diagnostics.
- Gene therapy: *Ex vivo*, *In vivo*, *In-situ* gene therapy, Strategies of gene therapy- gene replacement/ augmentation, gene correction, gene editing, gene regulation and silencing.
- Viral vectors: Adenoviruses, Adeno associated virus, Herpes Simplex virus,

- Non-viral vectors: Liposomes, Receptor mediated gene transfer, Gene gun.
- Gene therapy for genetic diseases: Familial Hypercholesterolemia, Cystic Fibrosis.
- Nano medicine.