Academic Council dated 15th July, 2023 as per Item Number: 1.03

DOMBIVLI SHIKSHAN PRASARAK MANDAL'S,

K.V. PENDHARKAR COLLEGE OF ARTS, SCIENCE AND COMMERCE, (AUTONOMOUS) DOMBIVLI (EAST), DIST. THANE

(Affiliated to University of Mumbai)

Faculty of Science

DEPARTMENT OF BIOTECHNOLOGY

(Programme: Masters of Science, M.Sc.)

SYLLABUS FOR

M.Sc. – Biotechnology (Semester I and II) NEP-2020

Choice Based Credit System (CBCS)

(With effect from the Academic Year: 2023-2024)

Ms. Sandeeptha Rathindran
BoS Chairperson

Prof. (Dr.) K. R. Jagdeo
I/C Principal

M.Sc. Biotechnology Course Structure

Semester – I						
Sr. No.	**Course Code**	**Course Title**	**Category**	**Teaching hours/ week**	**Total Marks**	**Credits**
1.	BT23101MM	Cell Biology	Major Mandatory 1	4	100	4
2.	BT23102MM	Biochemistry	Major Mandatory 2	4	100	4
3.	BT23103MM	(Practical of Cell Biology & Emerging techniques)	Major Mandatory 3	16	100	3
	BT23104MM	(Practical of Biochemistry & Emerging techniques)			100	3
4.	BT23105ME	Emerging Techniques in Biotechnology	Major Elective	4	100	4
5.	BT23106RM	Research Methodology	RM	4	100	4

Semester –II						
Sr. No.	**Course Code**	**Course Title**	**Category**	**Teaching hours/ week**	**Total Marks**	**Credits**
1.	BT23201MM	Immunology	Major Mandatory 1	4	100	4
2.	BT23202MM	Plant & Animal Biotechnology	Major Mandatory 2	4	100	4
3.	BT23203MM	Practical Paper 1 (Practical of Immunology & Bioprocess Engineering)	Major Mandatory 3	16	100	3
	BT23204MM	Practical Paper 2 (Practical of Plant & Animal Biotechnology)			100	3
4.	BT23205ME	Bioprocess Engineering & Technology	Major Elective	4	100	4
5.	BT23206OJ	On Job Training/Field project	OJT/FP	4	100	4

Semester –I

Course code	Course Title	Category	Credit	Number of lectures
BT23101MM	**CELL BIOLOGY**	**Major Mandatory 1**	**4**	

Course Objectives: To acquaint the students with knowledge of internal organization of cell, its signaling mechanism & genome instability in cell.

Course Outcomes: By the end of the course the student will be able to:

- Outline structural organization of the cell.
- Describe cellular machineries with respect to gene expression and regulation.
- Explain molecular mechanism of cellular signaling
- Summarize how intracellular vesicles mediate membrane trafficking.
- Describe the role of checkpoints, cyclins, Cdks in cell cycle control systems.
- Discuss the causes of genomic instability and mechanism of cell transformation.
- Distinguish between mechanisms of tumor suppressing genes & oncogenes.

Unit	Topics	
Unit I Dynamics and organization of cell	Internal organization of the cell - cell membranes and cell organelle; dynamics of DNA and mechanisms based on central dogma; chromatin control: gene transcription and silencing by chromatin Writers,- Readers and –Erasers; replication, transcription and translation machineries mitochondrial genetic code translation product cleavage, modification and activation.	15
Unit II Cellular signaling, transport and trafficking	Cellular signaling Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior. Cell signaling- intercellular communications- nerve impulses, neurotransmitters; agonist and antagonist reactions.	15
Unit III Cellular processes manipulations	Cell cycle machinery, cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell- ECM and cell-cell interactions; cell motility and migration; cell death: different modes of cell death and their regulation. Observing cells under a microscope, analyzing and manipulating0 DNA, RNA and proteins.	15
Unit IV Genome instability and cell transformation	Mutations, physical, chemical and biological mutagens; types of mutations; Epigenetic mutations intra- genic and intergenic suppression; transpositions- role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.	15

Learner's space: Advanced toolbox of cell cycle tag construct (Applied strategies for cell cycle tag methodology).

References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). Molecular Biology of the Cell. New York: Garland Science.
2. Lodish, H. F. (2000). Molecular Cell Biology. New York: W.H. Freeman.
3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.
4. Cooper, G. M., & Hausman, R. E. (2009). The Cell: a Molecular Approach. Washington: ASM; Sunderland.
5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston: Benjamin Cummings.
6. Watson, J. D. (1987). Molecular Biology of the Gene (7th ed.). Menlo Park, CA: Benjamin/Cummings.
7. Ernst J M Helmreich The Biochemistry cell signaling. Oxford University Press (Indian Edition).

Course code	Course Title	Category	Credit	Number of lectures
BT23102MM	**BIOCHEMISTRY**	**Major Mandatory 2**	**4**	

Course Objectives: To acquaint the students with the knowledge of various biomolecules, their significance & performance based tests through biological samples.

Course Outcomes: By the end of the course the student will be able to:

- Elaborate the structure & function of complex carbohydrates.
- Obtain clarity on membrane dynamics & structural integrity.
- Discuss the concept of protein folding & related diseases.
- Outline different nucleic acid binding proteins & related inborn errors.
- Differentiate between the integrated central metabolic pathways & their energetics.

Units	Topic	
Unit-I Glycobiology & Membrane Biochemistry	Glycosylation of Biomolecules - Synthesis N-linked, O- linked, and GPI linked glycoproteins and role of glycosylation. Lipid aggregates: micelles, bilayers and liposomes- structure, types, preparation, characterization, and therapeutic applications of liposomes. Glycobiology in Biotechnology and Medicine Composition and Architecture of membrane: structural lipids in membranes, membrane-bound proteins - structure, properties, and function. Membrane Dynamics: lipid movements, lipase, FRAP, Lipid raft, Membrane fusion. Solubilisation of the membrane by using different detergents.	15
Unit- II Protein Folding	Denaturation and Renaturation of proteins; Denaturants and their mode of action; Anfinsen's classical experiment; Folding curves and transitions; Types of protein folding and intermediates; Models of protein folding; Assisted protein folding (Chaperones); misfolding and diseases. Protein degradation: Ubiquitin-proteasome pathway and lysosomal proteolysis.	15
Unit- III Biochemistry of Nucleic acids	Forces stabilizing nucleic acid structures, triple helix. Super helix topology- linking number, Twist and writhing number, measurement of supercoiling and Topoisomerases. Nucleic acid binding protein – Leucine Zipper, Zinc fingers, OB fold, Beta Barrel, Helix-turn- helix, Helix-loop-helix. Biosynthesis of nucleic acids and inborn errors of nucleic acid Metabolism. Methodologies for detection: Gel retardation assay, Yeast 2 Hybrid Method advantages and limitations, yeast split-hybrid and reverse two-hybrid systems, Co-Immunoprecipitation (Co-IP+) and Far- Western Blot Analysis.	15
Unit- IV Bioenergetics and regulation of metabolism	Biosynthesis of Amino acids; phenylalanine, tyrosine, threonine and methionine. Bioenergetics- coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism. Integration of central metabolism; entry/ exit of various biomolecules from central pathways, principles of metabolic regulation. Strategies of energy metabolism in different organs. Metabolic Homeostasis: Regulation of Appetite, Energy Expenditure, and Body Weight. Metabolic Adaptation: Starve– Feed Cycles, insulin signaling and Diabetes Mellitus, target of rapamycin (TOR).	15

Learner's space: Inter-relationship between metabolic pathways of biomolecules with respect to metabolic & genetic disorders.

References:

1. Stryer, L. (2015). *Biochemistry*. (8th edition) New York: Freeman.
2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th edition). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th edition). Hoboken, NJ: J. Wiley & Sons.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008).
5. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
6. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014).
7. *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
8. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM; Sunderland.
9. Laouini et.al. Preparation, Characterization and Applications of Liposomes: State of the Art. journal of Colloid Science and Biotechnology Vol. 1, 147–168, 2012
10. Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9

Course code	Course Title	Category	Credit	Number of lectures
BT23103MM	**PRACTICAL PAPER 1 (Practical of Cell Biology & Emerging techniques)**	**Major Mandatory 3**	**3**	

1. Testing of Cell permeability- osmotic fragility
2. Isolation of cell organelle by differential centrifugation techniques from plant / animal sources
3. Isolation of mitochondrial DNA
4. Isolation of chloroplast DNA
5. Study of Cell motility(bacteria, algae, cyanobacteria, protozoans,)
6. Study of Cell death /apoptosis studies using flow-cytometry demonstration
7. Isolation and identification of mutagens of plant origin (demonstration/ video).
8. Isolation and assay of glycogen from liver and skeletal muscles of bird/mammal.
9. Microscopy types Confocal, Fluorescence, STORM – demonstrations/videos and pictures – Write up
10. Photo album of chromosomal abnormalities in normal and disease condition numerical detected by using different probes – centromeric, locus specific, telomeric Structural - Translocations and fusion genes Detection of inversions and interstitial deletions by SKY CGH for a disease or cancer
11. Demonstration/ video of 2D PAGE
12. Demonstration of Affinity chromatography.

BT23104MM	**PRACTICAL PAPER 2 (Practical of Biochemistry and Emerging techniques)**	**Major Mandatory 3**	**3**	

1. Preparation of Acetate and Phosphate buffers using the Henderson-Hassel Bach equation.
2. Determination of an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. Protein gel staining techniques: silver staining, Activity staining: LDH, glycoprotein staining
4. Viscosity studies of proteins.
5. Identification of sugars in fruit juices using thin layer chromatography.
6. Isolation of starch from potato and its estimation by anthrone method.
7. Extraction of pigments from biological sources – plants and/or microorganisms and study of their absorption spectrum in visible light.
8. Determination of the concentration and quality of protein/NA by using UV spectrophotometry. (UsingCase Studies).
9. Interaction studies of protein-drug or protein-ligand using UV-spectroscopy technique under different conditions (pH, concentration, temperature).

Course code	Course Title	Category	Credit	Number of lectures
BT23105ME	**EMERGING TECHNIQUES IN BIOTECHNOLOGY**	**Major Elective**	**4**	

Course Objectives: To acquaint the students with different emerging techniques in biotechnology.

Course Outcomes: By the end of the course the student will be able to:

- Elucidate construction and application of various tools, arrays & assays of gene expression.
- Explain the techniques & principles involved in various next generation sequencing methods of genomics.
- Perform the separation and identification of proteins using tools of proteomics.
- Analyze different aspects of advanced Cytogenetic techniques and its applications.
- Summarize concepts of different types of advanced microscopy.

Unit	Topics	
Unit I **Genomics**	Gene expression by SAGE and Microarrays- Construction of microarrays – genomic arrays, cDNA arrays and oligo arrays and its applications, NGS platforms, high and low read sequences Study of protein-DNA interactions-electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation Introduction to pharmacogenetics and pharmacogenomics.	15
Unit II **Proteomics**	**Proteomics;** ***Separation and Identification of Proteins*** 2D- PAGE, isoelectric focusing, Edman reaction Protein tryptic digestion and peptide mass fingerprinting mass spectrometry, MALDI-TOF ***Protein Expression Profiling***; Protein Microarrays/ Protein chips: Types and applications **Gel-based quantitative proteomics:** DIGE (Difference in Gel Electrophoresis); **Gel-free based quantitative proteomic:** Surface Plasmon resonance, MS based used with stable-isotope tagging, ***In vivo labelling***-SILAC, ***Invitro labelling***- ICAT: Clinical and biomedical applications of proteomics, Introduction to metabolomics, lipidomics, metagenomics and systems biology.	15
Unit III Molecular cytogenetics	Introduction to CRISPR CAS, Introduction to chromosomal abnormalities, Advanced Cytogenetic techniques and applications - FISH, M-FISH, SKY, CGH, Microarrays principle, and methodology. Molecular Approaches for Delineating, Marker Chromosomes, Prenatal Diagnosis of Common Aneuploidies, Preimplantation FISH Diagnosis of Aneuploidies, Molecular Cytogenetics in Reproductive Pathology Interphase FISH Studies of Chronic Myeloid Leukemia, FISH Detection of HER2 Amplification in Breast Cancer, Chromogenic In Situ Hybridization and FISH in Pathology.	15

Unit IV **Advanced Microscopy**	Confocal microscopy. Advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; Beyond the Diffraction Limit: Stimulated Emission Depletion (STED) Super-Resolution Summary, Super- Resolution Imaging with Stochastic Optical Reconstruction Microscopy(STORM) and Photoactivated Localization Microscopy (PALM).	15

Learner's Space: Artificial Intelligence & Machine Learning in Biotech industry.

References:

1. Campbell, I. D. (2012). *Biophysical Techniques*. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). *Methods in Molecular Biophysics: Structure, Dynamics, Function*. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). P*hysical Biology of the Cell*. New York: Garland Science.
4. Huang, B., Bates, M., & Zhuang, X. (2009). *Super-Resolution Fluorescence Microscopy.* Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
5. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). *Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems.* Science, 353(6299). doi:10.1126/science.aad5147.
6. Lander, E. (2016). *The Heroes of CRISPR.* Cell, 164(1-2), 18-28. doi:10.1016/j. cell.2015.12.041.
7. Ledford, H. (2016). *The Unsung Heroes of CRISPR*. Nature, 535(7612), 342-344. doi:10.1038/535342a.
8. *Molecular Imaging* Theranostics, 4(4), 386-398. doi:10.7150/thno.8006 Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.
9. Molecular biology of the cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 5th ed. 2008
10. Methods in Molecular Biology, Vol. 204: Molecular Cytogenetics: Protocols and Applications, Edited by: Y. S. Fan © Humana Press Inc., Totowa, NJ 2001
11. Genome 3 TA Brown
12. Molecular Biotechnology – Principles and applications of recombinant technology, Glick 4th edition 2010
13. Microarray and Microplates: Applications in biomedical sciences Shu Ye, Ian Day, 2003, Bios Scientific Ltd, oxford.
14. Human Molecular Genetics. Tom Strachan and Andrew Read, 2004, 3rd Edition, Garland Science.
15. Introduction to human molecular genetics. Jack Pasternak, 2005, 2nd Edition, Wiley publication.
16. Microarray bioinformatics by Dov Sketel , Cambridge university press 2003

Course code	Course Title	Category	Credit	Number of lectures
BT23106RM	**RESEARCH METHODOLOGY**	**RM**	**4**	

Course Objectives: To acquaint the students with guidelines for good research and publication ethics.

Course Outcomes: By the end of the course the student will be able to:

- Analyze the need of literature, experimental data, and supporting information in realm of research publication.
- Elucidate components of research & its steps, types& errors.
- Practice good-research and publication ethics.
- Exercise originality by avoiding plagiarism/falsification.

Unit	Topics	
Unit I Introduction to Research Methodology	Resources or search engines available for gathering information and literature in related area, Critical review of available literature, Problem Identification Formulation (finding research gaps).	15
Unit II Research Concepts and Data Collection	Definition of Research, Qualities of Researcher, Components of Research Problem, Various Steps in Scientific Research, Types of Research; Hypotheses Research Purposes - Research Design – Survey Research. Sources of Data: Primary Data, Secondary Data; Procedure. Questionnaire - Sampling Merits and Demerits - Experiments - Kinds - Procedure; Control Observation - Merits - Demerits - Kinds – Procedure. Research conditions: repeatability and reproducibility, bias, measurement and source of error: Type-I Error - Type-II Error, experimental controls, Association versus causality	15
Unit III Crafting Scientific publication	Types of publications - their purpose and readers, Choosing Appropriate Journal/Publisher - available tools, Steps in drafting reports, editing and evaluation of final draft, evaluating the final draft; Good Research Report, observation and research report., Component of an articles: Introduction, M&M, Results, Discussion, and Conclusion. Brevity in scientific writing, Authors guidelines in scientific publications, Language polishing, Citation style and editor, uniformity.	15
Unit IV Research, publication, and ethics	Scientific conduct and misconduct, fabrication, falsification, duplicate-publication, Plagiarism and self-plagiarism, Erratum, Retraction, Authorship and issues, statement of authors contribution, Corresponding authors role and responsibility, Need for Acknowledgement, Conflict of interest, Plagiarism, COPE guidelines, Publication models - subscription vs. open access, Authors right, Editorial process and publication life-cycle.	15

Learner's space: RM in Agriculture, Pharmacy & Entrepreneurship etc., Exploring online softwares for data analysis.

Reference books:

1. Research Methodology- Methods and Techniques, C.R. Kothari 2004
2. Research Methodology in medical and biological sciences, Laake P, Benestad H.B, Olsen B.R. 2007
3. Research Methods for Biosciences, Holmes, Moody & Dine, Oxford University Press

Semester II

Course code	Course Title	Category	Credit	Number of lectures
BT23201MM	**IMMUNOLOGY**	**Major Mandatory 1**	**4**	

Course Objectives: To acquaint the students with details of clinical immunology, immunotechniques and Autoimmunity.

Course Outcomes: By the end of the course the student will be able to:

- Summarize the concept of tumor immunology & immunodeficiency.
- Elucidate role of MHC in antigen presentation & HLA typing.
- Outline the mechanism of cytotoxicity and apoptosis.
- Explain the concept of autoimmunity mechanism & related genetic diseases.
- Demonstrate skills in execution of immunotechnique in disease diagnosis.

Unit	Topics	
Unit - I **Clinical Immunology**	Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; tumor immunology, Cancer immunotherapy; Immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.	15
Unit – II **Immunogenetics**	Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex and CAR-T cell therapy.	15
Unit III **Antigen antibody Interactions**	Precipitation, agglutination and complement mediated immune reaction; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; biosensor assays for assessing ligand – receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays.	15
Unit IV **Autoimmunity and Transplantation**	Genetic studies of autoimmunity; Autoimmune mechanism and types, altered antigens, Systemic Lupus Erythematosus, Grave's disease, Rheumatoid arthritis, Myasthenia Gravis, Multiple sclerosis, GvH Animal models of autoimmunity Immunologic basis of graft rejection, clinical manifestation of graft rejection, clinical transplantation.	15

Learners Space: Explore upcoming techniques used in advanced immunology.

References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York:
2. W.H. Freeman.
3. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology.

London: Gower Medical Pub.
4. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
5. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.
6. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press.
7. Parham, P. (2005). The Immune System. New York: Garland Science
8. An introduction to Immunology C V Rao Narosa Publishing house
9. Immunology essential and fundamental, Second edition S Pathak & U Palan Parveen Publishing House
10. Text Book of Medical Biochemistry, Praful Godkar. Bahalani Publishers
11. Immunology, An introduction, fourth edition. Ian R Tizard Thomson
12. Immunology, sixth Ed Roitt, Brostoff, Male Mosby, An imprint of Elsevier science Ltd
13. Medical Microbiology, Anantnarayan

Course code	Course Title	Category	Credit	Number of lectures
BT23202MM	**PLANT AND ANIMAL BIOTECHNOLOGY**	**Major Mandatory 2**	**4**	

Course Objectives: To acquaint the students with concepts and techniques of PTC & ATC.

Course Outcomes: By the end of the course the student will be able to:

- Enlist various components of PTC media & its role.
- Describe different types of PTC techniques.
- Elaborate on applications of PTC.
- Comment on ATC growth media, its preparation & various cell-cultures.
- Discuss the application of animal tissue culture.
- Outline the concept of in-vitro fertilization techniques & its significance.
- Elaborate on different types of vaccines & its production.

Unit	Topic	
Unit I Plant tissue culture	Plant tissue culture: historical perspective; totipotency. Plant cell culture media preparation and plant growth regulators - nutrients and plant hormones; sterilization techniques, Plant tissue culture types and applications - seed culture, organ culture, meristem culture, somatic embryogenesis, organogenesis,	15
Unit II Plant Tissue Culture Applications	Genetic engineering: *Agrobacterium*-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid. Genetic transformation - *Agrobacterium*-mediated gene delivery. Molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds. Plant cell cultures for secondary metabolite production, Germplasm conservation and cryopreservation.	15
Unit III Animal Tissue Culture	Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology.	15
Unit IV Animal reproductive biotechnology and Vaccinology	**Animal reproductive biotechnology:** structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; superovulation, embryo recovery and *in vitro* fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; animal cloning - basic concept, cloning for conservation for conservation endangered species **Vaccinology:** history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines	15

Learner's space: Commercial laboratory setup for PTC & ATC.

References

1. Biology of plant metabolomics, Robert Hall, Annual Plant Reviews, 43, Chichester, West Sussex; Ames, Iowa : Wiley-Blackwell, 2011
2. Plant Biotechnology. Umesha, S. (2013).

3. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
4. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Publishers.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
7. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
8. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.
9. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.
10. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
11. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
12. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: An Introduction to Genetic Engineering. Oxford: Oxford University Press.
13. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants, Wiley 2002.

Course code	Course Title	Category	Credit	Number of lectures
BT23203MM	**PRACTICAL PAPER 1 (Practical of Immunology & Bioprocess Engineering)**	**Major Mandatory 3**	**3**	

1. Perform Dot blot assays.
2. *In-vitro* demonstration of phagocytosis and calculating phagocytic index.
3. Detection of rheumatoid factor (RF) using Latex bead agglutination / precipitation test.
4. Separation of lymphocytes on Ficoll Histopaque and viability count.
5. Visit to a blood bank and preparation of report.
6. Western blotting-Demonstration
7. Study of antigen-antibody interaction by Mancini technique.
8. Lab scale production of enzyme and estimate its purity.
9. Immobilization of an organism / enzyme and detect the conversion of substrate to product.
10. Production of Microbial pigment and its extraction.
11. Demonstration of media optimization by Placket Burman test- demonstration
12. Analytical techniques like HPLC, FPLC, GC, GC-MS *etc.* for measurement of amounts of products/substrates.
13. Quality Assurance in the food industry.

BT23204MM	**PRACTICAL PAPER 2 (Practical of Plant & Animal Tissue Culture)**	**Major Mandatory 3**	**3**	

1. Preparation of culture media with various supplements for plant tissue culture.
2. Preparation of explants of plant species for inoculation under aseptic conditions.
3. Culturing of *Agrobacterium tumefaciens* and attempt transformation of any dicot species.
4. Check the efficiency of seed sterilization by physical & chemical methods.
5. Establishment of callus culture from explant.
6. Preparation of Synthetic seeds.
7. Establishment of cell suspension cultures for secondary metabolite production.
8. Determination of cell count of an animal tissue and check their viability.
9. Preparation of culture media with various supplements for animal tissue culture.
10. Preparation of TAB vaccine and sterility testing.
11. Study of monolayer formation and passaging.
12. Study of animal cell/ tissue preservation techniques.
13. Observation of normal and transformed cell lines
14. Perform Toxicology MTT Assay of environmental pollutants in cultured cells

Course code	Course Title	Category	Credit	Number of lectures
BT23205ME	**BIOPROCESS ENGINEERING AND TECHNOLOGY**	**Major Elective**	**4**	

Course Objectives: To inform the students with concepts of bioprocess technology and its applications.
Course Outcomes: By the end of the course the student will be able to:

1. Explain the effect of process parameters on fermentation, measurement and control and study bioprocess economics.
2. Discuss different fermentation processes and systems with cell disruption methods.
3. Outline the use of enzymes in the food industry.
4. Enlist the role of microbes in the mechanism of enzyme function and reactions in food processes.

Unit	Topic	
Unit I **Basic principles of biochemical engineering**	**Sources of Microorganisms Used in Biotechnology**- Literature search and culture collection supply, Isolation de novo of organisms producing metabolites of economic importance. **Strain Improvement**- Selection from naturally occurring variants, Manipulation of the genome of industrial organisms in strain improvement **Bioreactor design and analysis** Media formulation and optimization methods; sterilization of bioreactors aeration and agitation in bioreactors KLa value (factors affecting and methods of determination), heat transfer in bioprocess measurement and control of bioprocess parameters. **Bioprocess economics**	15
Unit II **Fermentation systems and downstream processing**	**Principles of Microbial Growth** Batch Fermentation, Fed-Batch Fermentation Continuous Fermentation **Maximizing the Efficiency of the Fermentation Process** High-Density Cell Cultures, Increasing Plasmid Stability, Quiescent *E. coli* Cells, Protein Secretion and Reducing Acetate **Bioreactors** **Typical Large-Scale Fermentation Systems** Two-Stage Fermentation in Tandem Airlift Reactors, Two- Stage Fermentation in a Single Stirred-Tank Reactor, Batch versus Fed-Batch Fermentation. **Harvesting Microbial Cells Disrupting Microbial Cells** **Downstream Processing**	15
Unit III **Applications of enzyme technology in food processing**	Introduction and scope Enzymes source from animals and plants used in food manufacturing technology. Enzyme usage in food applications. Mechanism of enzyme function and reactions in food processes Starch-processing and related carbohydrates. Lipases for the production of food components: interesterified fat Enzymes in protein modification: hydrolyse Enzymes in bread making. Enzymes in dairy product manufacture. Enzymes in fruit and vegetable processing. Enzymes in fish and meat processing Beer Production using Immobilized Cell Technology.	15

Unit IV Applications of microbial technology in food process operations and production, biofuels and biorefinery	Microbial biomass production: mushrooms, SCP Fermented foods from: meat and fish, bread, Vegetables (sauerkraut, cucumber), Legumes and Oil Seeds soya bean fermentations Beverages: Stimulant Beverages fermentations, Alcoholic beverages Food additives and supplements- Vitamins, Natural food preservatives, Microbial production of colours and flavours, Polyhydric alcohols: low-calorie sweetener , Microbial exopolysaccharides Process Food wastes- for bioconversion to useful products (Compost, biofuels, biomass cheap source of raw material in fermentation etc).	15

Learner's Space: Applications of microbial technology in food process operations.

References:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
4. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
5. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
6. Alexander N. Glazer and Hiroshi Nikaido -Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition
7. Michael Waites and Morgan , Rockney and Highton -Industrial microbiology : An Introduction
8. Robert Whitehurst and Maarten Van Oort - Enzymes in food technology 2nd ed
9. Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield, NH, USA **(**2007)

Evaluation pattern M.Sc. Biotechnology (Autonomous) 2023 -2024

- The examination of 100 marks per Theory Paper for each course will be conducted in the pattern of 40 marks of internal assessment/Project work and 60 marks for Semester end examination. The student will have to secure a minimum of 40% marks in the Internal assessment and Semester end examination per theory paper.

- The Semester examinations of 100 marks per Practical Paper at the end of each semester will be conducted. The student will have to secure a minimum of 40% marks in the examination per practical paper.

- In M.Sc Part-I Semester II, the students will have to undergo On Job Training in any subject related laboratories, companies or research institutions.

OR

- The Project work will be carried out by the student with the guidance of the concerned Faculty Member who will be allotted the student as the Guide for the Project.

Evaluation Pattern for M.Sc. Biotechnology (Theory)

1.	**INTERNAL ASSESSMENT**		**40 Marks**
1.1 1.2 1.3	One class test (Objectives/ Multiple Choice) Assignment/ Project/ Presentation/Book or Research paper review report/Business proposal presentation/Case-study Active Participation, Overall performance		20 Marks 15 Marks 05 Marks
2.	**EXTERNAL ASSESSMENT (Semester End Examination)**		**60 Marks**
	N.B. 1. All questions are compulsory 2. All questions carry equal marks.		
	Q.1.	**Based on Unit-I, II, III & IV** Multiple choice questions/Fill in the blanks /Match the column/Give one word/Name the following/Give an example/Explain the term/Define/Give significance/State the role of/ State True or false.	**12**
	Q.2.	**Unit-I** Long Answer Question Short Answer Question	**12** 12/08/06 04/02
	Q.3.	**Unit-II** Long Answer Question Short Answer Question	**12** 12/08/06 04/02
	Q.4.	**Unit-III** Long Answer Question Short Answer Question	**12** 12/08/06 04/02
	Q.5	**Unit-IV** Long Answer Question Short Answer Question	**12** 12/08/06 04/02

Evaluation Pattern
M.Sc Biotechnology (PRACTICAL)

1.	EXTERNAL ASSESSMENT	100 Marks
	Experiment –1(Major technique) Experiment –2 (Major technique) Experiment -3 (Minor technique) Experiment -4 (Minor technique) Viva Journal	25 25 15 15 10 10
	TOTAL MARKS	100

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