Syllabus M.Sc. Microbiology

(Two Year Course- Semester System)

As per NEP-2020

(Effective from Academic Session 2026-2027 Onward)

SCHOOL OF APPLIED SCIENCES

SURESH GYAN VIHAR UNIVERSITY

JAIPUR – 302017 Rajasthan, India

OUTCOME BASED EDUCATION

Programme outcomes (POs)

Students will be able to

PO 1	PG Graduands are Professionally Competent with characteristic Knowledge-bank, Skill set, Mind-set and Pragmatic Wisdom in their chosen fields.
PO2	PG Graduands demonstrate the desired sense of being seasoned and exhibit unequivocal Spiritedness with excellent qualities of productive contribution to society and nation in the arena Science and Technology.
PO3	PG Graduands are mentored such that they exert Leadership Latitude in their chosen fields with commitment to novelty and distinction.
PO4	PG Graduands are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining Cultural and Civilized personality.
PO5	PG Graduands get ability to apply the process of science by formulating hypotheses and design experiments based on the scientific method.
PO6	PG Graduands get ability to foster an innovative mindset and entrepreneurial skills to translate biotechnological research into commercial products or services.
PO7	PG Graduands enhance critical thinking and problem-solving skills to address complex scientific challenges and innovate solutions.
PO8	PG Graduands are directed to develop proficiency in designing and conducting data analyses using statistical software and tools, interpreting results, and drawing meaningful conclusions.

Program Specific Outcomes (PSOs)

PSO 1	Development and enhancement of skills required in the Bioprocess industry and medical field.
PSO2	Ability to perform analytical techniques/experimental techniques in industrial scenario for the products recovery aid in the development of new therapeutics as drugs/biobased products.
PSO3	Provoking the analysis of biological data using indifferent approaches based on basic computational and bioinformatics skills.

SURESH GYAN VIHAR UNIVERSITY
Accredited by NAAC with 'A+' Grade

SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
M.Sc. Microbiology
(Effective from Academic Session 2026-27)

Year: I **Semester: I AUTUMN/PAVAS**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-IX	Social Outreach, Discipline & Extra Curriculum Activities (AECC)	AECC	2	0	0	0	0	100	-
B	**Program Core**									
1	MB9001	Biochemistry	DCC	3	3	0	0	3	40	60
2	MB9002	Immunology and Immunotechnology	DCC	3	3	0	0	3	40	60
3	MB9003	Cell and Molecular Biology	DCC	3	3	0	0	3	40	60
4	MB9004	Bioanalytical Techniques	DCC	3	3	0	0	3	40	60
5	MB9005	Cell and Molecular Biology Lab	DCC	2	0	0	3	3	60	40
6	MB9006	Biochemistry and Immunology Lab	DCC	2	0	0	3	3	60	40
7	MB9007	Introduction to Computational Biology and AI Lab	DCC	2	0	0	3	3	60	40
8	MB9008	Bioanalytical Techniques Lab	DCC	2	0	0	3	3	60	60
		TOTAL		**22**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

L= Lecture	**T=Tutorial**	**CIE=Continuous Internal Evaluation**
S= Seminar	**P= Practical**	**ESE= End Semester Examination**

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

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SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
M.Sc. Microbiology
(Effective from Academic Session 2026-27)

Year: I **Semester: II SPRING/BASANT**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	**University Core**									
1	SODECA-X	Social Outreach, Discipline & Extra Curriculum Activities (AECC)	AECC	2	0	0	0	0	100	
B	**Program Core**									
1	MBX001	Genetic Engineering and Application	DCC	3	3	0	0	3	40	60
2	MBX002	Genetics and Microbiology	DCC	3	3	0	0	3	40	60
3	MBX003	Bioinformatics	DCC	3	3	0	0	3	40	60
4	MBX004	Research Methodology and Scientific Communication Skills	SEC	2	0	0	3	3	100	-
5	MBX005	Genetic Engineering and Application Lab	DCC	2	0	0	3	3	60	40
6	MBX006	Genetics and Microbiology Lab	DCC	2	0	0	3	3	60	40
7	MBX007	Bioinformatics Lab	GEC	2	0	0	3	3	60	40
8	MBX008	Project Proposal Preparation and Presentation	DCC	2	0	0	1	1	100	-
C	**Program Electives (Any one)**									
1	MBX009	Nanobiotechnology	DSE	3	3	0	0	3	40	60
2	MBX010	Drug Designing and Development	DSE	3	3	0	0	3	40	60
3	MBX011	Antivirals and Vaccine Development	DSE	3	3	0	0	3	40	60
4	MBX012	Molecular Diagnostics	DSE	3	3	0	0	3	40	60
5	MBX013	Bio-entrepreneurship and Bio-business management	DSE	3	3	0	0	3	40	60
6	MBX014	Emerging Technologies	DSE	3	3	0	0	3	40	60
7	MBXMOC1	MOOC (through SWAYAM/NPTEL etc) *Under Credit Transfer Scheme*	DSE/GSE							
D		**University/Open Elective**								
		Opt from the list of University Electives								
		Total		**24**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

L= Lecture	**T=Tutorial**	**CIE=Continuous Internal Evaluation**
S= Seminar	**P= Practical**	**ESE= End Semester Examination**

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Signature of Member Secretary

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SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
M.Sc. Microbiology
(Effective from Academic Session 2026-27)

Year: II **Semester: III Autumn/PAVAS**

S. No	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A		**University Core**								
1	SODECA-XI	Social Outreach, Discipline & Extra Curriculum Activities (AECC)	AECC	2	0	0	0	0	100	-
B		**Program Core**								
1	MBY001	Bioprocess Engineering	DCC	3	3	0	0	3	40	60
2	MBY002	Animal Biotechnology	DCC	3	3	0	0	3	40	60
3	MBY003	Biostatistics and Data Analysis	DCC	3	3	0	0	3	40	60
4	MBY004	Agricultural and industrial microbiology	DCC	3	3	0	0	3	40	60
5	MBY007	Bioprocess Engineering Lab	DCC	2	0	0	3	3	60	40
6	MBY008	Animal Biotechnology lab	DCC	2	0	0	3	3	60	40
7	MBY009	Agricultural and industrial microbiology lab	DCC	2	0	0	3	3	60	40
8	MBY010	Industrial Summer Project	DPR	2	0	0	3	3	100	-
9	MBY011	Intellectual Property rights, Biosafety & Bioethics	DCC	2	0	0	0	3	40	60
C		**Program elective (any one)**								
1	MBY005	Project Proposal Preparation and Presentation	SEC	2	0	0	3	3	40	60
2	MBY006	Critical Analysis of Classical Papers	GEC	2	0	0	3	3	40	60
3	MBY012	Pharmaceutical Biotechnology	DSE	3	3	0	0	3	40	60
4	MBY013	Advanced Clinical Biochemistry	DSE	3	3	0	0	3	40	60
5	MBY014	Food and Dairy Technology	DSE	3	3	0	0	3	40	60
6	MBY015	Environmental Biotechnology	DSE	3	3	0	0	3	40	60
7	MBYMOC1	MOOC (through SWAYAM/NPTEL etc) *Under Credit Transfer Scheme*	DSE/GSE							
D		**University/Open Elective**								
		Opt from the list of University Electives								
		Total		**24**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

L= Lecture	**T=Tutorial**	**CIE=Continuous Internal Evaluation**
S= Seminar	**P= Practical**	**ESE= End Semester Examination**

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

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SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
M.Sc. Microbiology
(Effective from Academic Session 2026-27)

Year: II **Semester: IV Spring/BASANT**

S. No.	Course Code	Course Name	Course type	Credits	Contact Hrs/Wk.			Exa m Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A		**Program Core**								
1	MBZ001	Dissertation/ Project work	DPR	16	0	0	3	3	-	100
		Total		**16**						

NOTE: The University Electives are apart from minimum credits required for award of degree.

L= Lecture **T=Tutorial** **CIE=Continuous Internal Evaluation**

S= Seminar **P= Practical** **ESE= End Semester Examination**

Signature of Concerned Teacher **Signature of Convener-BOS**

Signature of Member Secretary

Abbreviations: *DCC- DCC-Discipline Core Courses, AECC-Ability Enhancement Compulsory Courses, DPR-Dissertation/Project/Field Study SEC- Skill Enhancement Course DSE -Discipline Specific Elective GE - Generic Elective AECC*

For the award of
M.Sc. Microbiology (2 Year Course) 2026-2027

Type of Course	No. of courses in the proposed scheme	No. of credits	Minimum Requirement of no. of Credits for M.Sc. Degree
AECC	3	6	
SEC	2	4	
DCC	23(Th + Lab)	37+18	
GEC	2	4	
DSE	2	6	
DPR	2	18	
Total Credits		**93**	**80 (Minimum)**

Program Structure for M.Sc. Microbiology (2 Yrs Course)

Semester	Discipline Core Courses (Credits) (T+P=3+2; T=3)	Generic Elective Course/Discipline specific Elective (3)	University Core courses	Ability Enhancement compulsory Courses	Skill Enhancement Courses		Total Credits
					Skill based	Value added (Credits) L+T+P	
I	**1.** MB9001- Biochemistry (3) **2.** MB9002-Immunology and Immunotechnology (3) **3.** MB9003- Cell and Molecular Biology (3) **4.** MB9004-Bioanalytical Technique (3) **5.** MB9005- Cell and Molecular Biology Lab (2) **6.** MB9006- Biochemistry lab (2) **7.** MB9007-Immunology and Immunotechnology Lab (2) **8.** MB9008-Bioanalytical Techniques Lab (2)			SODECAIX Social Outreach, Discipline & Extra Curriculum Activities (AECC)			22
II	**1.** MBX001-Genetic Engineering and Application (3) **2.** MBX002-Genetics and Microbiology (3) **3.** MBX003- Bioinformatics (3) **4.** MBX005Genetic Engineering and Application Lab (2) **5.** MBX006-Genetics and Microbiology Lab (2) **6.** MBX008 Seminar-1	MBX007 Bioinformatics Lab Discipline specific outcome (Any one)- 3 credits MBX009- Nanobiotechnology BTX011- Antiviral and Vaccine Development MBX012-Molecular Diagnostics MBX013- Bio-entrepreneurship and Bio-business management		SODECAX Social Outreach, Discipline & Extra Curriculum Activities (AECC)	**1.** MBX004 Research Methodology and Scientific Communication Skills (2)		23

		MBX014- Emerging Technologies MBXMOC1- MOOC (through SWAYAM/NPTEL etc) *Under Credit Transfer Scheme* 1.					
Exit option with PG Diploma in Microbiology (with completion of courses equal to a minimum of 45 credits)							
III	**1.** MBY001-Bioprocess Engineering (3) **2.** MBY002-Animal Biotechnology (3) **3.** MBY003-Biostatistics (3) **4.** MBY004- Agricultural and industrial microbiology (3) **5.** MBY005- Bioprocess Engineering Lab (2) **6.** MBY008-Animal Biotechnology Lab (2) **7.** MBY009- Agricultural and industrial microbiology Lab (2) **1.** MBY011- Intellectual Property rights, Biosafety & Bioethics (3)	MBY010- Industrial Summer Project **DSE Course (any one)- 3 credits:** **1.** MBY012-Pharmaceutical Biotechnology **2.** MBY013-Advanced Clinical Biochemistry **3.** MBY014-Food and Dairy Technology **4.** MBY015-Environmental Biotechnology **5.** MBYMOC1- MOOC (through SWAYAM/NPTEL etc) *Under Credit Transfer Scheme*		SODECAXI- Social Outreach, Discipline & Extra Curriculum Activities (AECC)	MBY005- Project-Proposal Preparation and Presentation (2)	-	32
IV	MBZ001- Dissertation/ Project work (16 Credits)		-	-	-	-	16
Award of M. Sc in Microbiology (with completion of courses equal to a minimum of 93 credits)							

Semester I

MB9001	**BIOCHEMISTRY**
Version	III
Prerequisite	All students are expected to have a general knowledge of biomolecules and its chemistry.
Learning objective	The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.
Course Outcome	On completion of this course, students should be able to: **CO1**: Explain the chemical basis of life, including water properties, pH, buffers, and biomolecular hierarchy. **CO 2**: Students will be equipped with a deep understanding of sugars and lipids, their structures, functions, and importance in biological systems. **CO 3**: Evaluate the structure-function relationship of proteins, analyze enzyme catalysis, and interpret enzyme kinetics, including Michaelis-Menten equations and the role of enzymes in metabolic regulation. **CO 4**: Students will be able to analyze the structure and Function of DNA, RNA, and Lipids and will have a comprehensive understanding of lipid self-assembly, bio-membrane organization, membrane-bound proteins, and transport phenomena **CO 5**: Understanding and analysis of the role of vitamins in daily life and the key metabolic pathways involved in energy production, nucleotide biosynthesis, and lipid metabolism.
Unit - I	**Chemical basis of life**
Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies.	
Unit -II	**Carbohydrate**
Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.	
Unit - III	**Protein structure and enzyme kinetics**
Amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification. Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies.	
Unit-IV	**Structure and function of DNA, RNA and Lipids**
Self-assembly of lipids, micelle, bio-membrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material.	
Unit-V	**Role of vitamins & cofactors in metabolism**
Vitamins and their role in daily life. Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism pathway.	

Reference books	1. Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman. 2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth. 3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons. 4. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426(6968), 884-890. 5. Richards, F. M. (1991). *The Protein Folding Problem*. Scientific American, 264(1), 54-63.
Mod of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic Council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	2	1	2	3	2	2	1	3	1	3
CO2	2	3	1	2	2	1	1	1	1	3	2
CO3	1	2	2	1	1	1	2	2	1	1	1
CO4	2	3	1	3	1	2	3	2	1	2	2
CO5	3	1	2	2	2	2	1	1	1	2	2

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MB9002	IMMUNOLOGY AND IMMUNOTECHNOLOGY
Version	III
Prerequisite	All students are expected to have knowledge of immune system and viruses.
Learning objective	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection.
Course Outcome	On completion of this course, students should be able to: **CO1**: Explain the fundamental concepts of immunology, including innate and acquired immunity and the role of primary and secondary lymphoid organs. **CO2**: Describe the immune responses generated by B and T lymphocytes, including immunoglobulins, cell signaling, and antigen processing and presentation. **CO3:** Analyze antigen-antibody interactions and apply advanced immunological techniques for assessing immune reactions. **CO4**: Evaluate different types of vaccines, vaccine technologies, and the principles behind active and passive immunization. **CO5**: Discuss clinical immunology aspects, including immunity to infections, hypersensitivity, autoimmunity, transplantation, tumor immunology, and immunodeficiency.
Unit-I	**Immunology: fundamental concepts and overview of the immune system**
Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.	
Unit-II	**Immune responses generated by B and T lymphocytes**
Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.	
Unit-III	**Antigen-antibody interactions**
Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.	
Unit-IV	**Vaccinology**

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.	
Unit-V	**Clinical immunology**
Immunity to infection: bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immune deficiencies, acquired or secondary immune deficiencies, autoimmune disorder, anaphylactic shock, immune senescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.	
Reference books	1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman. 2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub. 3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology.* New York: Garland Science. 4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press. 5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press. 6. Parham, P. (2005). *The Immune System*. New York: Garland Science.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	1	1	1	2	1
CO2	2	2	1	2	2	1	2	2	2	3	2
CO3	1	1	2	1	1	1	1	3	1	1	1
CO4	3	2	1	2	2	2	2	1	2	3	3
CO5	1	3	2	1	1	1	1	2	3	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MB9003	CELL AND MOLECULAR BIOLOGY
Version	III
Prerequisite	All students are expected to have a basic knowledge of cell and its organelles.
Learning Objective	The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive. To create an understanding about cause of cancer and the mechanism involve in cancer regulation.
Course Outcome	**CO1**: Explain the universal features and internal organization of cells, including cell membranes, intracellular organelles, and the nuclear compartment. **CO2**: Describe the processes and regulation of the cell cycle, cell division, cell differentiation, cell interactions, and modes of cell death. **CO3**: Analyze molecular mechanisms of cellular signaling, membrane transport, and intracellular vesicular trafficking. **CO4**: Discuss chromatin structure, dynamics, and transcriptional and post-transcriptional control mechanisms. **CO5**: Understand genome instability, mutations, proto-oncogenes, oncogenes, tumor suppressor genes, and their roles in cell transformation.
Unit-I	**Dynamic organization of cell**
Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.	
Unit-II	**Cell division and cell cycle**
Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans- membrane signaling; cell motility and migration; cell death: different modes of cell death and their regulation.	
Unit-III	**Cellular signaling, transport and trafficking**
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.	
Unit-IV	**Chromatin structure and dynamics**

Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin- Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, transcriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs).	
Unit-V	**Genome instability and cell transformation**
Mutations, proto-oncogenes, oncogenes and tumor suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, 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.	
Reference books	1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science. 2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). 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. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland. 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings. 6. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	1	2	1	1	2
CO2	2	2	1	3	2	2	2	3	2	2	3
CO3	3	1	1	1	2	2	1	1	1	1	1
CO4	1	3	2	2	3	2	3	2	1	3	2
CO5	2	2	3	1	1	3	2	1	2	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

BT9004	Bioanalytical Techniques
Version	I
Prerequisite	All students are expected to have a basic knowledge of tools and techniques used in life sciences.
Learning objective	The Learning Objective Of Course are: 1. To Create an understanding regarding the technical applications of various tools which are being used in life sciences. 2. To develop an understanding about tools and techniques for electrophoretic, centrifugation, spectroscopic techniques, radio chemical methods, and microscopy.
Course Outcome	**CO1**: Explain the principles and applications of various microscopy techniques, including electron microscopy and centrifugation techniques. **CO2**: Describe the principles, types, and applications of different spectrophotometric techniques in biology. **CO3**: Understand the various chromatographic techniques and their applications in the isolation and analysis of biomolecules. **CO4**: Discuss the principles and applications of electrophoresis techniques and various blotting methods in molecular biology. **CO5**: Analyze the principles and applications of radio tracer techniques and understand safety measures in handling radioisotopes.
Unit-I	**Principles and applications of Microscopy**
Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM. Centrifugation Techniques: Principles, type of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.	
Unit- II	**Spectrophotometry**
Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. Applications of different Spectroscopic techniques in Biology.	
Unit-III	**Chromatographic Techniques**
Introduction and types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, FPLC and affinity chromatography and instrumental details of each. Applications of Chromatographic techniques in Biology.	
Unit-IV	**Electrophoresis**
Paper and gel electrophoresis, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, Isoelectric focusing. Isotachophoresis. 2-D Electrophoresis, Capillary electrophoresis, Blotting- Southern, Western and Northern blotting, Immunoblotting, Immunoelectrophoresis, Immunostaining and DNA finger printing and ELISA.	
Unit-V	**Radiotracer technique**
Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes. RIA, non-radiolabeling.	
Reference Books	1. Nuclear Magnetic Resonance: Williams 2. Biochemical Techniques theory and practice: White R 3. Analytical Chemistry: Christion G. D. 4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H. 5. An Introduction to Practical Biochemistry: Plummer D. T. 6. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982 7. Tools in Biochemistry David Cooper 8. Methods of Protein and Nucleic acid Research, Osterman Vol I – III 9. Centrifugation D. Rickwood 10. Practical Biochemistry, Vth edition, Keth, Wilson and Walker.

Mode of Examination	written examination
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	1	1	1	2	1
CO2	2	2	1	2	2	1	2	2	2	3	2
CO3	1	1	2	1	1	2	1	3	1	1	1
CO4	3	2	1	2	2	2	2	1	2	3	3
CO5	1	3	2	1	1	3	3	2	3	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

BT9007	Introduction to Computational Biology and AI
Version	I
Prerequisite	Students are expected to have a basic understanding of biology, molecular biology, genetics, and elementary computer operations.
Learning objective	The course is designed to introduce students to computational approaches and artificial intelligence applications in modern biological sciences. The specific objectives of the course are as follows: 1. To provide fundamental knowledge of computational biology and biological databases. 2. To familiarize students with sequence analysis and bioinformatics tools used in biological research. 3. To introduce programming, biological data handling, and visualization approaches. 4. To impart basic concepts of artificial intelligence and machine learning in biological sciences. 5. To expose students to modern applications of computational biology and AI in biotechnology, healthcare, genomics, and drug discovery.
Course Outcome	**CO1**: Understand the principles, scope, and significance of computational biology and artificial intelligence in modern biotechnology. **CO2**: Analyze biological databases, sequence analysis methods, and computational tools used in biological research. **CO3**: Apply basic programming and data handling approaches for biological data analysis and visualization. **CO4**: Evaluate the concepts of artificial intelligence, machine learning, and their applications in biological sciences. **CO5**: Analyze the role of computational biology and AI in genomics, healthcare, drug discovery, precision medicine, and emerging biotechnological applications.
Unit-I	**Introduction to Computational Biology** **8hours**
Introduction to computational biology, scope and significance, interdisciplinary nature of computational biology, biological data types, biological databases, computational approaches in biotechnology, role of computation in modern biological sciences, overview of computational tools used in biological research.	
Unit- II	**Sequence Analysis Basics** **7hours**
Introduction to biological sequences, DNA and protein sequence analysis, sequence alignment concepts, Introduction to BLAST, applications of sequence analysis in biotechnology and healthcare.	
Unit-III	**Programming and Data Handling** **7hours**
Introduction to programming concepts, basics of Python/R for biological sciences, handling biological datasets, data preprocessing basics, introduction to data visualization, graphical representation of biological data, overview of computational workflows in biological research.	
Unit-IV	**Foundations of Artificial Intelligence** **7hours**
Introduction to artificial intelligence, history and evolution of AI, AI vs Machine Learning vs Deep Learning, basics of machine learning, supervised and unsupervised learning (conceptual overview), pattern recognition, biological applications of AI and machine learning.	
Unit-V	**Applications in Biotechnology** **7hours**
Applications of computational biology and AI in genomics, drug discovery, precision medicine, agriculture, healthcare, diagnostics, omics technologies, biomedical data analysis, ethical considerations, challenges, and future prospects of AI in biotechnology.	

Reference Books	1. Mount, D.W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press. 2. Lesk, A.M. (2019). Introduction to Bioinformatics. Oxford University Press. 3. Xiong, J. (2006). Essential Bioinformatics. Cambridge University Press. 4. Baldi, P. and Brunak, S. (2001). Bioinformatics: The Machine Learning Approach. MIT Press. 5. Rashidi, H.H. and Buehler, L.K. (2000). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press. 6. Alpaydin, E. (2021). Introduction to Machine Learning. MIT Press. 7. Goodfellow, I., Bengio, Y., and Courville, A. (2016). Deep Learning. MIT Press. 8. Bishop, C.M. (2006). Pattern Recognition and Machine Learning. Springer. 9. Jones, N.C. and Pevzner, P.A. (2004). An Introduction to Bioinformatics Algorithms. MIT Press.
Mode of Examination	written examination
Recommended By BOS on:	
Approved by academic council on:	

Co- PO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	3	3	2	1	1	1	2	1
CO2	2	2	1	2	2	1	2	2	2	3	2
CO3	1	1	2	1	1	2	1	3	1	1	1
CO4	3	2	1	2	2	2	2	1	2	3	3
CO5	1	3	2	1	1	3	3	2	3	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

Semester II

MBX001	GENETIC ENGINEERING AND APPLICATION
Version	III
Prerequisite	All students are expected to have a general and basic knowledge of molecular biology and Genetics.
Learning Objective	The learning objectives of course are: to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.
Course Outcome	**CO1**: Understand the impact of genetic engineering in modern society and the fundamental requirements for conducting genetic engineering experiments. **CO**2: Explain the various vectors used in genetic engineering and their applications in maximizing gene expression. **CO3**: Describe the principles and types of PCR techniques, and their applications in molecular diagnostics and mutation detection. **CO4**: Discuss the methods for gene manipulation, construction of libraries, and study of protein-DNA interactions. **CO5**: Understand gene silencing techniques, genome editing technologies, and the creation of transgenic organisms.
Unit-I	**Introduction to tools for genetic engineering**
Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymer tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.	
Unit-II	**Vectors in genetic engineering**
Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Blue script vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmides; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	
Unit-III	**PCR techniques**
Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.	
Unit-IV	**Gene manipulation and protein DNA interaction**

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase foot printing; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
Unit-V	**Gene silencing and genome editing technologies**
Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies gene targeting; creation of transgenic and knock-out mice; disease model	
Referenc e books	1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications. 2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub. 4. Selected papers from scientific journals, particularly Nature & Science. 5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	3	2	1	1	2
CO2	2	2	1	3	2	2	2	3	2	2	3
CO3	3	1	1	1	2	1	1	1	1	1	1
CO4	1	3	2	2	3	2	3	2	3	3	2
CO5	2	2	3	1	1	3	2	1	2	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX002	GENETICS AND MICROBIOLOGY
Version	III
Prerequisite	All students are expected to have a general knowledge of molecular bioligands basic concept of Genetics.
Learning objective	The learning objective of course are: to take students through basics of genetics and classical genetics covering prokaryotic/ phage genetics to yeast and higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.
Course Outcome	**CO1**: Recall the historical developments and fundamental concepts in genetics, including the cell cycle and Mendelian genetics. **CO2**: Explain the genetics of bacteria, bacteriophages, and yeast, including gene mapping and genetic recombination. **CO3**: Describe microbial characteristics, including morphology, growth, and bacterial genetics. **CO4**: Classify and compare microbial diversity, including various types of microorganisms and their evolutionary aspects. **CO5**: Explain the methods for controlling microorganisms and their ecological impact, including sterilization, antibiotics, and host-pathogen interactions.
Unit-I	**Bacterial genetics and Gene Regulation in Prokaryotes**
Transformation, Conjugation, Transduction, Genomics and Evolution: Role of Horizontal Gene Transfer (HGT) in bacterial evolution and the spread of antimicrobial resistance. Principles of Gene regulation: Operon Model: Negative Control: The lac operon (Structure, Catabolite repression, cAMP-CAP role) and the trp operon (Attenuation mechanism). Positive Control and Global Regulation: Stringent response (ppGpp), heat shock response (Sigma factors), and two-component regulatory systems (e.g., EnvZ-OmpR).	
Unit-II	**Genetics of bacteria, bacteriophages and Yeast**
Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene. Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.	
Unit-III	**Microbial Characteristics**
Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.	
Unit-IV	**Microbial Diversity**
Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archaea, Thermopiles; eukaryote: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes. Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroid's and prions.	

Unit-V	**Control of microorganisms**
Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms. Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.	
Reference books	1. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principles and Analysis*. Sudbury, MA: Jones and Bartlett. 2. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W.H. Freeman. 3. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown. 4. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**1**	**1**	**2**	**1**	**3**	**1**	**2**	**1**	**1**	**2**
CO2	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
CO3	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**
CO4	**1**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
CO5	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**3**

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX003	BIOINFORMATICS
Version	III
Prerequisite	All students are expected to have a general knowledge of biology and chemistry basic principles.
Learning objective	The objectives of this course are to provide theory and practice 0cal experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
Course Outcome	**CO1**: Recall fundamental concepts of bioinformatics, including genomic research, computational biology, and key bioinformatics resources. **CO2:** Explain sequence analysis and alignment techniques, including file formats and database submissions. **CO3**: Apply similarity searching tools such as BLAST and FASTA for sequence alignment and pattern recognition. **CO4**: Analyze protein identification methods and predict protein structures using primary, secondary, and tertiary prediction techniques. **CO5**: Evaluate phylogenetic analysis methods and construct phylogenetic trees using tools like ClustalW and MEGA6.
Unit-I	**Introduction to Bioinformatics** **7hours**

Introduction to genomic research and data generation, Genome projects, requirement of computational biology and bioinformatics, contribution of bioinformatics in biotechnology. Information Resources: NCBI, EBI, ExPasy Entrez & SRS System. Primary Sequence & Structure Databases: GenBank, Swissport/Uniprot, EMBL, PIR, PDB, KEGG, Prosite, Pfam, etc. Genome Databases (at NCBI, EBI).

Unit-II	**Sequence analysis, Sequence alignment and gene prediction** **7hours**

Nucleotide sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; Sequence File formats: fasta, GenBank, embl, Swiss-prot, pdb, nbrf, pir and multiple sequences formats. Sequence alignment; pairwise alignment techniques; Multiple sequence alignment.

Unit-III	**Similarity Searching Tools:** **7hours**

Sequences Alignment: Brute Force method, Dot matrix method, Global (Needleman- Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming. BLAST and FASTA, Theory and Algorithms, variants of BLAST and FASTA, PSI-BLAST, Statistical Significance. Sequence Pattern and Profiles: Concepts of motif, pattern and profile. Gene Prediction: In silico gene finding. Prokaryotes: ORF finding (Shine-Dalgarno sequences). Eukaryotes: Hidden Markov Models (HMMs) for splice site detection; Tools: Glimmer, Augustus.

Unit IV	**Protein Identification and Protein structure prediction** **7hours**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Production of Protein Structure & Modeling Protein Primary & Secondary Structure, Prediction Methods – Introduction to various methods. Tertiary structure prediction (Homology & Threading Methods) Profile.

Unit-V	**Phylogenetic Analysis and High-Performance Computing** **8hours**

Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny definition and description of Phylogenetic trees and various types of trees Phylogenetic Analysis. Searching Databases: Data Submission. Phylogenetic tree building methods, ClustalW and MEGA6. High-Performance Computing: Introduction to Linux operating system; Basics of command-line navigation (ls, cd, grep, chmod). Brief Introduction to: Python/Perl for Biologists (string manipulation, parsing FASTA files)

Reference books	1. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press. 2. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience. 4. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell. 5. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss. 6. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture and Function*
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic councilon:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	1	2	1	3	2
CO2	2	2	1	3	2	2	2	3	2	2	3
CO3	3	1	1	1	2	1	1	1	1	1	1
CO4	1	3	2	2	3	2	3	2	3	3	2
CO5	2	2	3	1	1	1	2	1	2	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX004	RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
Version	III
Prerequisite	All students are expected to have a basic knowledge of life sciences and their applications in research.
Learning objective	The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.
Course Outcome	**CO1:** Understand research methodologies, literature search techniques, and bibliometric analysis in life sciences. **CO2:** Develop research hypotheses, distinguish between hypothesis-driven and hypothesis-generating research, and apply them effectively in scientific projects. **CO3:** Design experiments, analyze data using statistical software, and present findings with clarity and precision. **CO4:** Enhance formal presentation skills, defend research findings, and participate in group discussions effectively. **CO5:** Master technical writing skills, navigate the scientific publication process, and adhere to ethical standards in scientific communication
Unit-I	**Introduction to Research Methodology**
Fundamentals of Research Methodology, Applications in life sciences, Literature Search: Use of databases, framing query with examples, Bibliometric: Citation, Impact factor, Eigen factor.	
Unit-II	**Problem Identification & Formulation**
Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance	
Unit-III	**Data Analysis& Paper Writing**
Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing.	
Unit-IV	**Presentation skills**
Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research	
Unit-V	**Scientific communication**
Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.	

Reference Books	1. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research.* Oxford: Oxford University Press. 2. *On Being a Scientist: a Guide to Responsible Conduct in Research.* (2009). Washington, D.C.: National Academies Press. 3. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. American Scientist, 78 (Nov-Dec 1990), 550-558. 4. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively*. Delhi: Macmillan India. 5. Movie: Naturally Obsessed, The Making of a Scientist.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	1	3	2	3	3	2	3	1
CO2	2	2	1	1	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	1	1	1	1	1
CO4	2	3	1	2	2	1	1	1	1	2	2
CO5	1	2	1	1	1	2	2	1	1	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX009	**Nanobiotechnology**
Version	I
Prerequisite	Basic principles of Biotechnology and its applications
Learning Objectives:	This course deals with applications resulting from the combination of biotechnology and nanotechnology in the fields of medicine and environment
Course Outcome	**CO 1**: Recognize key milestones and progress in the development of nanobiotechnology. **CO 2**: Understand the various types of nanomaterials used in biotechnological applications, including carbon nanotubes and nanowires. **CO 3**: Understand the various types of transducing elements and their applications in bio-nanotechnology. **CO 4**: Understand the applications of nanobiotechnology in the treatment of infectious diseases. **CO 5**: Learn about the detection of food contaminants and the role of nanobiotechnology in the food industry.
UNIT-I	**Introduction of nanobiotechnology** **08 hours**
Introduction, history and Timeline of Nanobiotechnology, Development of nanobiotechnology – timelines and progress, overview.	
UNIT-II	**Synthesis and Characterization of nanomaterials** **08 hours**
Nanomaterials for Bio-technological Applications, Carbon Nanotubes, Nanowires, synthesizing nanoparticles, Green synthesis of nanoparticles, characterization of nanoparticles. Introduction to biomimetics in nanotechnology	
UNIT –III	**Nanobiotechnology detection system** **06 hours**
Various types of transducing elements and their applications in Bio-Nanotechnology, Electrochemical transducer, optical transducer, biosensors in nanotechnology, Quantum dots, gold nanoparticle as biosensors, DNA detection, small scale system for drug delivery.	
UNIT-IV	**Nanobiotechnology in chronic and infectious disease and Nano-diagnostics** **07 hours**
Application of Nanobiotechnology in the treatment of Infectious Diseases, Nanotechnology Applications in Cancer Diagnosis and Therapy; Nano-diagnostics (Molecular Imaging & Biosensors): Imaging Agents: Quantum dots for bioimaging, Gold nanoparticles for CT imaging, Iron oxide (SPIONs) for MRI contrast enhancement Nanobiosensors: Electrochemical sensors, cantilever-based sensors, Surface Plasmon Resonance (SPR) sensors, Microfluidics and Lab-on-a-Chip (LOC) devices	
UNIT-V	**Nanobiotechnology in environment, food sciences and Ethics** **07 hours**
Nanobiotechnology in environment, detection of food contaminants, food industry, Food preservation, waste water treatment. Ethical, Safety & Regulatory Issues: EPA, FDA, and Indian guidelines for nanomedicine; Environmental fate of nanoparticles; Societal impact.	
Text Book	*Bio-nanotechnology*by David S. Goodsell, 2004, Wiley Publications
Reference Books	1. Rolf E. Hummel, *Electronic Properties of materials*, Narosa Publishing House 2. Raghavan.V., *Materials Science & Engineering – A First Course*, 5th edition, Prentice Hall of India 3. Khanna. O. P., *A Text Book of Material Science & Metallurgy*, Revised edition, Dhanpat Rai Publications
Mode of Evaluation:	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended by BOS on :	

Adopted by Faculty on:	
Approved by Academic Council on :	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	3	3	2	3	3	2	3	1
CO2	2	2	1	1	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	2	1	1	2	1
CO4	3	1	2	2	2	3	1	1	3	2	2
CO5	2	2	1	2	1	1	1	1	1	1	3

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX010	Drug Designing and Development
Version	I
Prerequisite	All students are expected to have a basic knowledge of Bioinformatics and drugs
Learning objective	The learning objective of course are: To create an understanding regarding the Basics of Molecular Modelling and Drug Designing
Course Outcome	**CO 1**: Understand the basic concepts and stability profiles of biotechnological products. **CO 2**: Understand the historical perspectives and basic principles of drug targeting and delivery systems. **CO 3**: Gain a comprehensive understanding of various types of vaccines, including multivalent subunit vaccines, purified macromolecules, synthetic peptide vaccines, and recombinant antigen vaccines. **CO 4**: Understand the basic concepts of the drug design cycle, including Structure-Activity Relationship (SAR) and Rational Drug Design. **CO 5**: Understand the fundamentals of molecular modeling, including quantum mechanical and molecular orbital methods.
Unit-I	**Biotechnological products** **8 hours**
	Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.
Unit-II	**Basic principles of molecular dynamics** **7 hours**
	Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.
Unit-III	**Vaccines** **7 hours**
	Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptidevaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotypevaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novelvaccine delivery systems.
Unit-IV	**Drug Design** **7 hours**
	Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) &Hans equation
Unit-V	**Molecular Modelling** **7 hours**
	Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.
Reference books	1. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition), Addison Wesley Longman, Essex, England, 1996. 2. Alan Hinchliffe, Modelling Molecular Structures, 2nd Edition, John-Wiley, 2000. 3. Alan Hinchliffe, Molecular Modelling for Beginners, John-Wiley, 2003. 4. N. Cohen (Ed.), Guide Book on Molecular Modeling in Drug Design, Academic Press, San Diego, 1996. 5. D. Frenkel and B. Smith, Understanding Molecular Simulations. From Algorithms to Applications, Academic Press, San Diego, California, 1996. 6. C. Rauter and K. Horn, X-ray crystallography and drug design, Elsevier, 1984. 7. M. Kalos and P. A. Whitlock, Monte Carlo Methods. John Wiley & Sons, New York, 1986. 8. J.A. McCammon and S.C. Harvey. Dynamics of Proteins and Nucleic Acids. Cambridge University Press,

	Cambridge, 1987. 9. D.C. Rapaport. The Art of Molecular Dynamics Simulation. Cambridge University Press, Cambridge, England., 1995
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	1	3	2	3	3	2	3	1
CO2	2	2	1	2	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	1	1	1	1	1
CO4	2	3	1	2	2	1	1	1	1	2	2
CO5	1	2	1	1	1	2	2	1	1	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX011	**Antivirals and Vaccine development**
Version	1.0
Prerequisite	All students are expected to have a general knowledge of basic microbiology.
Learning objective	The learning objective of course are: To create an understanding regarding the virology.
Course Outcome	**CO 1**: Understanding the principles and types of conventional vaccines, including killed and attenuated vaccines. **CO 2**: Understanding the use of animal models in vaccine development and testing. **CO 3**: Understanding the immune response triggered by vaccines and its role in protection against infectious diseases. **CO 4**: Understanding the principles and methods of designing and screening antiviral drugs. **CO 5**: Exploring in silico approaches for drug designing and their applications in drug discovery and development.
Unit-I	**Conventional vaccines** **5 hours**
	Conventional vaccines -killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues.
Unit-II	**Animal models** **4 hours**
	Animal models for infectious diseases and vaccine studies, transgenic and knockout animal models, vaccine potency and safety testing, preclinical evaluation of vaccines and antivirals, toxicity studies, challenge studies, ethical considerations in animal experimentation.
Unit-III	**Immune markers** **5 hours**
	Vaccine induced immune response and immune markers of protection, immunological memory, cytokine profiling, antibody-mediated and cell-mediated immunity, immunogenicity assessment, evaluation of vaccine efficacy and safety.
Unit-IV	**Designing and screening for antivirals** **5 hours**
	Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals-mechanism of action & drug resistance.
Unit-V	**Drug designing** **5 hours**
	Antisense RNA, siRNA, miRNA, ribozymes, in silico approaches for drug designing.
Reference books	1. Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker. 2. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July 2005. Publisher: Wiley, John & Sons, Incorporated. 3. Chimeric Virus -like Particles as Vacc ines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor). Latest edition / Pub. Date: November 1996 Publisher: Karger, S. Inc. 4. Vaccines. Stanley A. Plotkin, Walter A. Orenstein. Latest edition / Pub. Date: September 2003. Publisher: Elsevier Health Sciences.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommende	

d By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	3	3	1	3	3	2	3	2
CO2	2	1	3	2	2	2	2	2	1	2	1
CO3	1	2	3	1	1	3	1	1	2	1	3
CO4	2	1	1	1	2	1	1	1	1	2	2
CO5	1	2	1	3	1	1	2	1	3	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX012	MOLECULAR DIAGNOSTICS
Version	II
Prerequisite	All students are expected to have a general knowledge of genomics, microbial diseases, inherited diseases and Cancer.
Learning objective	The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer. • .
Course Outcome	**CO 1**: Comprehensive understanding of DNA, RNA, and protein structures and functions. **CO 2**: Detailed knowledge of various PCR techniques (Real-time, ARMS, Multiplex) and hybridization methods (ISH, FISH, ISA). **CO 3**: Understanding of direct detection and identification methods for pathogenic organisms, especially those that are slow-growing or lack in vitro cultivation systems. **CO 4**: Understanding of new mutational mechanisms and familial cancer syndromes. **CO 5**: Understanding of genetic aberrations in cancer and their detection using next-generation sequencing.
Unit-I	**Genome biology in health and disease**
DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.	
Unit-II	**Genome: resolution, detection & analysis**
PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.	
Unit-III	**Detection and identity of microbial diseases**
Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of *in vitro* cultivation as well as genotypic markers of microbial resistance to specific antibiotics.	
Unit-IV	**Detection of inherited diseases**
Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes.	
Unit-V	**Molecular oncology**
Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.	

Reference books	1. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings. 2. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press. 4. Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical* laboratorian Totowa, NJ: Humana Press.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	1	3	2	3	3	2	3	1
CO2	2	2	1	1	2	2	2	2	1	2	1
CO3	1	2	2	1	1	1	1	1	1	1	1
CO4	2	3	1	2	2	1	1	1	1	2	2
CO5	1	2	1	1	1	2	2	1	1	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX013	Bio-entrepreneurship and Bio-business management
Version	IV
Prerequisite	All students are expected to have a general knowledge of Microbiology.
Learning objective	Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects.
Course Outcome	**CO1**: Understanding the scope and significance of bio-entrepreneurship. **CO2**: Strategies and processes involved in negotiating with financiers, government, and regulatory authorities. **CO3**: Preparation of business plans, including statutory and legal requirements. **CO4:** Understanding regulatory compliances and procedures from agencies like CDSCO, NBA, GCP, GLA, and GMP. **CO5**: Understanding of the various entrepreneurial opportunities in industrial biotechnology and will be equipped with knowledge about the essential requirements, marketing strategies, support schemes, with starting and running a biotech business.
Unit-I	**Innovation and entrepreneurship in bio-business**
Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.	
Unit-II	**Bio markets - business strategy and marketing**
Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.	
Unit-III	**Finance and accounting**
Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.	
Unit-IV	**Technology management**
Technology – assessment, development & upgradation, managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP). .	
Unit V	**Entrepreneurship Opportunity in Industrial Biotechnology**

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Bio pesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics.	
Reference Books	1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion. 2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier. 3. Onetti, A., & Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge. 4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press. 5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	3	1	3	3	1	3	3	2	3	2
CO2	2	1	1	2	2	2	2	2	1	2	1
CO3	1	2	3	1	1	3	1	1	2	1	3
CO4	2	1	1	1	2	1	1	1	1	2	2
CO5	1	2	1	1	1	1	2	1	3	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBX014	Emerging Technologies
Version	II
Prerequisite	All students are expected to have a general knowledge of techniques applicable in biotechnology.
Learning objective	This course is broad-based in nature encompassing several new technologies that current researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.
Course Outcome	**CO 1:** Apply and interpret data from con focal, multiphoton, and advanced fluorescence microscopy techniques. **CO 2**: Use mass spectrometry for proteomics, structural biology, and imaging applications, and interpret the resulting data. **CO 3**: Perform high throughput screening, target identification, and bioinformatics analyses, and use mathematical modeling to generate testable predictions. **CO 4**: Utilize structural biology methods for protein and nucleic acid analysis, and apply CRISPR-Cas systems for genome engineering and therapeutic research. **CO 5**: Create and use nanobodies for protein structure-function studies, molecular imaging, and therapeutic applications.
Unit-I	**Optical microscopy method**
Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beam splitter; beam scanning, signal-to- noise ratio, multichannel images. nonlinear microscopy: multi photon microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Stimulated Emission Depletion (STED).	
Unit-II	**Mass spectroscopy**
Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbit rap, fragmentation of peptides; proteomics, nano LC-MS; Phosphor proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.	
Unit-III	**Systems biology**
High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions.	
Unit-IV	**Structural biology AND CRISPR –CAS**
X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small- angle X-ray scattering, Atomic force microscopy. History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for *in vivo* genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.	
Unit-V	**Nanobodies**
Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.	

Reference books	Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press. Phillips, R., Kondev, J., & Theriot, J. (2009). Physical Biology of the Cell. New York: Garland Science. Nelson, P. C., Radosavljević, M., & Bromberg, S. (2004). Biological Physics: Energy, Information, Life. New York: W.H. Freeman. 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. 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. Lander, E. (2016). The Heroes of CRISPR. Cell, 164(1-2), 18-28. doi:10.1016/j. cell.2015.12.041.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	3	3	2	3	2
CO2	1	1	1	2	2	2	2	2	1	2	1
CO3	2	1	2	1	1	3	1	2	2	1	1
CO4	2	1	1	1	2	1	1	1	1	2	3
CO5	2	2	3	1	2	1	2	3	3	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY001	BIOPROCESS ENGINEERING
Version	III
Prerequisite	All students are expected to have a general knowledge of application of microbes in biological processes.
Learning Objective	The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.
Course Outcome	The student will be able to conceptualize about **CO1**: Explain the basic principles and methods for the isolation, screening, and maintenance of industrially important microorganisms along with different modes of bioreactor operation **CO2**: Interpret and illustrate the relationship between bioprocess variables and significance of strain improvement techniques in optimizing the productivity of microorganisms for industrial applications. **CO3**: Apply bioprocess engineering principles of upstream and downstream processing to design efficient bioprocesses for different products and solve problems related to scaling up and scale down. **CO4**: Analyze and assess different strategies for optimizing bioprocess parameters to maximize yield and productivity of industrially important biochemicals and therapeutic products while ensuring product quality. **CO5**: Assess the environmental and economic impact of bioprocessing techniques in biofuel production and other applications and develop strategies for the efficient isolation, screening, and maintenance of specific microorganisms tailored for industrial applications.
Unit-I	**Basic principle of biochemical engineering**
Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.	
Unit-II	**Bioreactor design and analysis**
Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.	
Unit-III	**Downstream processing and product recovery**
Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.	
Unit-IV	**Application of enzyme technology in food processing**
Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; inter esterified fat; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.	
Unit-V	**Applications of microbial technology in food process operations and production, biofuels and biorefinery**

Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery	
Reference books	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. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering.* New York: M. Dekker. 4. Bailey, J. E., & Ollis, D. F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw-Hill. 5. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology.* Boca Raton: CRC/Taylor & Francis.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination / PPT
Recommended By BOS on	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY002	ANIMAL BIOTECHNOLOGY
Version	II
Prerequisite	All students are expected to have a general knowledge of Animal Biotechnology.
Learning objective	The learning objectives of course are: To create an understanding regarding the Gene transfer, animal biotechnology and gene regulation.
Course Outcome	**CO 1**: Differentiate between primary culture, explant culture, suspension culture, and established cell line cultures. **CO 2:** Discuss the applications of different types of culture media in biotechnological research and commercial settings. **CO 3**: Analyze the commercial applications of cell culture, such as in the production of monoclonal antibodies and vaccines. **CO 4:** Evaluate methods for mass production, harvesting, purification, and assays of biologically important compounds. **CO 5**: Present findings and research outcomes effectively through reports, presentations, and discussions.
Unit-I	**Introduction to animal biotechnology**
Introduction to animal biotechnology. Equipment's and required materials for animal cell culture technology. Characteristics of cells in culture; Growth and main tenancy of cells in culture; Cells and Celllines, Culture media: Natural and Chemical Defined Media; Advantages and Disadvantages of Serum and Protein based media. Isolation and Disaggregation of tissues by Mechanical and Enzymatic Methods. Primary and established cell in cultures. Monoclonal antibodies. Immunotoxins as therapeutic agents Stem cell culture, embryonic stem cells and their applications.	
Unit-II	**Cell Culture**
Primary culture: behavior of cells, properties, utility; Explant culture; suspension culture; Established cell line cultures: definition of cell lines, maintenance and management, cell adaptation; Measurement of viability and cytotoxicity; Cell cloning; cell synchronization and cell manipulation; Various methods of separation of cell types; advantages and limitations; flow cytometry.	
Unit-III	**Techniques for Cell Culture**
Basic techniques of mammalian cell cultures in vitro: Serum & protein free defined media and their applications; Measurement of viability and cytotoxicity; Cell synchronization; Cell transformation; Scaling up of animal cell culture; Stem cell cultures; embryonic stem cells and their applications; Somatic cell genetics; Apoptosis: Measurement of cell death.	
Unit-IV	**Commercial application**
Commercial applications of cell culture: Stem cells and their applications, Hybridoma Technology and Monoclonal antibodies; Tissue culture as a screening system; cytotoxicity and diagnostic tests; Mass production of biologically important compounds (e.g. Vaccines); Harvesting of products; purification and assays; Organ cultures and tissue engineering	
Unit-V	**Animal genomics**
Genetic distance analysis, breed characterization on the basis of DNA markers, genetic markers for quantitative traits loci, marker assisted selection for incorporation of desirable traits DNA markers with economic traits, restriction fragment length polymorphism (RFLP) of different structural genes.	

CO-PO-	**Reference books**	1. Animal Cell Culture: Essential Methods" by John M. Davis 2. Principles of Tissue Culture & Biotechnology" by S. S. Purohit 3. Introduction to Genetic Analysis" by Anthony J. F. Griffiths et al. 4. "Biotechnology: Applying the Genetic Revolution" by David P. Clark and Nanette J. Pazdernik 5. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney
	Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
	Recommended By BOS on:	
	Approved by academic council on:	

PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	3	3	2	3	2
CO2	1	1	1	2	2	2	2	2	1	2	1
CO3	2	1	2	1	1	3	1	2	2	1	1
CO4	2	1	1	1	2	1	1	1	1	2	3
CO5	2	2	3	1	2	1	2	3	3	1	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY003	BIOSTATISTICS AND DATA ANALYSIS
Version	III
Prerequisite	All students are expected to have a general knowledge of Mathematics.
Learning objective	The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.
Course Outcome	**CO1**: Define the scope and importance of biostatistics in biological sciences, including the collection, classification, and tabulation of data. **CO2**: Apply probability analysis and understand different probability distributions such as Binomial, Poisson, and Normal distributions in biological contexts. **CO3**: Calculate measures of central tendency (mean, median, mode) and interpret graphical representations (histograms, frequency polygons) of biological data. **CO4**: Analyze relationships between variables using correlation and regression techniques, including the interpretation of correlation coefficients and regression models. **CO5**: Evaluate hypothesis testing methods (parametric and non-parametric), including ANOVA and chi-square tests, for biological data analysis and interpretation.
Unit-I	**Definitions Scope of biostatistics** **8 Hours**
Definitions Scope of biostatistics, probability analysis – variables in biology, collection, classification and tabulation of data– Graphical and diagrammatic representation–scale diagrams–histograms–frequency polygan– Frequency curves. Measures of central tendency–arithmetic mean, median and mode–calculation of mean, median & mode in series of individual observations, discrete series continuous open – end classes. Introduction to statistical software and spreadsheet-based data analysis.	
Unit I	**Correlation and Regression** **7 Hours**
Probability classical & axiomatic definition of probability, Theorems on total and compound Probability), Elementary ideas of Binomial, Poisson and Normal distributions Bivariate Data: Scatter diagram. Correlation and regression Simple correlation – correlation coefficient. Regression-simple, linear regression. Correlation coefficient and its properties, Correlation ratio. Rank – Spearman's and Kendall's measures of correlation.	
Unit-II	**Statistical Inference and Hypothesis Testing** **7 Hours**
Basic ideas of significance test–Hypothesis testing level of significance–Test based on student 't', 'chi' square and goodness of fit. 'F' test - ANOVA. statistical interpretation of biological experiments.	
Unit-V	**Probability and Data analysis** **7 Hours**
Probability: counting, conditional probability, discrete and continuous random variables; probability distributions and their biological applications, data preprocessing and normalization, introduction to statistical computing using GarphPad	
Unit-V	**Population Statistics** **7 Hours**
Concepts of population and sample, advantages of sampling, census and sample surveys, Basic concepts in sampling and designing of a large scale surveys. Types of sample – the convenience sample, Judgment sample and the probability sample; simple random sampling with and without replacement. Unit II Systematic sampling, Stratified sampling, Estimation of mean, Proportion and standard error using the above probability sampling, probability proportional to size sampling, Estimation of sample size for clinical experiments, sources of error in surveys.	

Reference books	1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan. 2. Aitken, M., Broadhursts, B., &Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science. 3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley. 4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press. 5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY004	AGRICULTURAL AND INDUSTRIAL MICROBIOLOGY
Version	I
Prerequisite	All students are expected to have a general knowledge of General Microbiology, Microbial Physiology, Biochemistry.
Learning objective	The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.
Course Outcome	On completion of this course, students should be able to: **CO1**: Analyze the role of soil microorganisms in biogeochemical cycles (carbon, nitrogen, phosphorus, sulfur) and evaluate their contribution to soil fertility and plant health. **CO 2**: Formulate and produce various biofertilizers (Rhizobium, Azotobacter, PSB, Mycorrhiza, Cyanobacteria) using appropriate carrier materials and assess their quality as per BIS standards. **CO 3**: Design and apply microbial biocontrol agents (Trichoderma, Pseudomonas fluorescens, Bacillus thuringiensis, NPV) for sustainable management of plant pathogens and insect pests. **CO 4**: Explain the principles of fermentation technology, bioreactor design, and downstream processing, and differentiate between solid-state and submerged fermentation processes. **CO 5**: Develop and optimize industrial-scale production protocols for commercially important microbial products including antibiotics (penicillin), organic acids (citric acid), enzymes (amylase), ethanol, amino acids (MSG), and biopolymers (xanthan gum).
Unit - I	**Soil Microbiology**
Soil Ecosystem: Types of soil microorganisms, Rhizosphere microbes, Phyllosphere microbiology; Rhizoplane; Quorum sensing in root colonization. Carbon Cycle: Decomposition of cellulose, Role of cellulolytic and lignolytic microbes (fungi and bacteria). Nitrogen fixation: Symbiotic (Rhizobium, Bradyrhizobium), vs. Non-symbiotic/Free-living (Azotobacter, Azospirillum, Clostridium, Cyanobacteria), Phosphorus Cycle: Phosphate solubilization by Bacillus, Pseudomonas, Aspergillus, Penicillium; Mechanisms (organic acid production, phosphatase enzymes).	
Unit -II	**Biofertilizers and Organic Farming**
Biofertilizers: Definition, Production Technology, Isolation, identification, mass multiplication, carrier materials (peat, charcoal, lignite, vermiculite), and quality control of: Rhizobium inoculants (specificity and cross-inoculation groups) Azotobacter and Azospirillum; Organic Farming: IFOAM standards; Role of Panchagavya, Jeevamrut, Beejamrut, and other indigenous formulations. Quality Standards: BIS specifications for biofertilizers (IS 8268-1976 for Rhizobium); Field demonstration and efficacy testing.	
Unit - III	**Biocontrol Agents and Plant-Microbe Interactions (7 hours)**
Plant Pathogenic Microbes: Overview of fungi (Fusarium, Pythium, Rhizoctonia, Sclerotium), bacteria (Agrobacterium, Xanthomonas, Ralstonia), and viruses (TMV, CMV). Mechanisms of Biocontrol: Antibiosis, Mycoparasitism (Trichoderma species), Competitive exclusion (Siderophore production for iron sequestration), Bacterial biopesticides: Bacillus thuringiensis (Bt) – Cry toxin mechanism, Fungal biopesticides: Metarhizium anisopliae (green muscardine disease), Viral biopesticides: Nuclear Polyhedrosis Virus (NPV) and Granulosis Virus (GV) for lepidopteran pests	
Unit-IV	**Production of Industrially Important Microbial Products – I**
Production of Industrially Important Microbial Products: Vitamin B12, Monosodium Glutamate (MSG), Xanthan gum, Lysine, Laccase, Protease, Gluconic acid, Cephalosporin	
Unit-V	**Production of Industrially Important Microbial Products - II**
Production of Industrially Important Microbial Products: Penicillin, Tetracycline, Citric acid, Acetic acid, Amylase, Cellulase & Xylanase, Ethanol, Wine	

Reference books	Alexander, M. (1977). Introduction to soil microbiology (2nd ed.). John Wiley & Sons. Bagyaraj, D. J., & Rangaswami, G. (2017). Agricultural microbiology (2nd ed.). PHI Learning. Paul, E. A. (2014). Soil microbiology, ecology and biochemistry (4th ed.). Academic Press. Subba Rao, N. S. (2014). Soil microbiology (5th ed.). Oxford & IBH Publishing. Subba Rao, N. S. (1988). Biofertilizers in agriculture. Oxford & IBH Publishing. Glick, B. R. (2015). Beneficial plant-bacterial interactions. Springer. Casida, L. E. (2009). Industrial microbiology. New Age International Publishers. Crueger, W., & Crueger, A. (2000). Biotechnology: A textbook of industrial microbiology (2nd ed.). Panima Publishing. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of fermentation technology (3rd ed.). Elsevier. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2009). Industrial microbiology: An introduction. Wiley-Blackwell. Patel, A. H. (2014). Industrial microbiology. Macmillan India.
Mod of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic Council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	1	2	1	2	3	2	2	1	3	1	3
CO2	2	3	1	2	2	1	1	1	1	3	2
CO3	1	2	2	1	1	1	2	2	1	1	1
CO4	2	3	1	3	1	2	3	2	1	2	2
CO5	3	1	2	2	2	2	1	1	1	2	2

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY005	PROJECT PROPOSAL PREPARATION AND PRESENTATION
Version	II
Prerequisite	All students are expected to have a general knowledge of Biotechnology.
Learning objective	The learning objective of course is: to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.
Course Outcome	The student will be able to conceptualize about **CO 1**: Formulate a scientific question; **CO 2**: Present scientific approach to solve the problem; **CO 3**: Interpret, discuss and communicate scientific results in written form; **CO 4**: Gain experience in writing a scientific proposal; **CO 5**: Learn how to present and explain their research findings to the audience effectively.
Unit-I	**Project proposal preparation**
Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources. Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.	
Unit-II	**Poster presentation**
Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.	
Unit-III	**Oral presentation**
At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.	
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on	
Approved by academic council on	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY006	CRITICAL ANALYSIS OF CLASSICAL PAPERS
Version	III
Prerequisite	All students are expected to have a basic knowledge of biology and chemistry.
Learning objective	The objectives of this course are to familiarize students with classic literature to make them appreciate how ground- breaking discoveries were made without, necessarily, use of high-end technologies.
Course Outcome	**CO 1**: Overview of what constitutes a classical paper in biomedical research. **CO 2**: Analysis of experimental design and methodologies used in classical studies. **CO 3**: Impact of data interpretation on the scientific community and subsequent research. **CO 4**: Evaluate methods, tools, sample size, and selection process. **CO 5**: Provide your opinion on significance and quality.
Unit-I	**MOLECULAR BIOLOGY (Any four papers)**

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from *Pneumococcus* type III. Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58. **Note:** This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
2. Independent functions of viral protein and nucleic acid in growth of bacteriophage Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56. **Note:** Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.
3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8. **Note:** In this one page paper Watson and Crick first described the structure of DNA double helix Study help - Watson_Crick_Nature_1953_annotated.
4. Transposable mating type genes in *Saccharomyces cerevisiae* James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979 .**Note:** This paper provided evidence for 'cassette hypothesis' of yeast mating type switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNA rearrangement.
5. Messelson& Stahl experiment demonstrating semi-conservative replication of DNA. Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82 **Note:** The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology" .
6. *In vivo* alteration of telomere sequences and senescence caused by mutated *Tetrahymena* telomerase RNAs Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990 **Note:** This paper demonstrates that the telomerase contains the template for telomere synthesis

Unit-II	**CELL BIOLOGY (Any four papers)**

1. A protein-conducting channel in the endoplasmic reticulumSimon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80 **Note:** This paper demonstrates the existence of a protein conducting channel Study help - A brief history of Signal Hypothesis
2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15 **Note:** In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion.
3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45 **Note:** Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC) Suggested reference paper - A biochemical assay for identification of PCC.
4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16 **Note:** This paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*
5. A complete immunoglobulin gene is created by somatic recombination Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14 **Note:** This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.
6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognitionBuck L and Axel R; Cell. 1991 Apr 5;65(1):175-87 **Note:** This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epithelium where a large family of odorat receptors is expressed.

Unit-III	Developmental biology and genetics
1. Mutations affecting segment number and polarity in *Drosophila* Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980 **Note:** This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well. 2. Information for the dorsal--ventral pattern of the *Drosophila* embryo is stored as maternal mRNA Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7 **Note:** This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes. 3. Hedgehog signalling in the mouse requires intraflagellar transport proteins Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7 **Note:** One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. 4. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it. Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.	
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	2	2	1	3	1
CO2	1	2	1	2	2	2	3	2	2	1	1
CO3	1	2	2	1	3	1	1	3	3	3	3
CO4	3	1	1	1	2	3	1	2	1	1	2
CO5	1	2	3	1	2	1	1	3	2	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY012	Pharmaceutical Biotechnology
Version	II
Prerequisite	All students are expected to have a basic concept of general biology, chemistry and biochemistry.
Learning objective	Understand the principles and applications of biotechnology in drug development and biopharmaceutical production, including ethical, regulatory, and practical laboratory skills.
Course Outcome	**CO 1**: Gain a foundational understanding of biotechnology's role and applications in pharmaceutical sciences. **CO 2**: Understand the sources, forms, mechanisms, and kinetics of drug action, as well as the factors modifying drug effects. **CO 3**: Perform and understand preclinical evaluations of drug potency, activity, and toxicity, including special toxicity tests. **CO 4**: Understand the regulatory requirements and processes for preclinical and clinical drug testing and new drug applications. **CO 5**: Learn and apply GMP principles in the pharmaceutical industry, ensuring compliance with organizational, environmental, and contamination control standards.
Unit-I	**Brief introduction to Pharmaceutical Biotechnology**
Brief introduction to Biotechnology with reference to Pharmaceutical Sciences. Enzyme Biotechnology- Methods of enzyme immobilization and applications. Biosensors- Working and applications of biosensors in Pharmaceutical Industries. Brief introduction to Protein Engineering. Basic principles of genetic engineering.	
Unit-II	**General Pharmacology**
Sources of drugs, different dosage forms and routes of drug administration, mechanism of action of drugs. Combined effect of drugs, factors modifying drug action, tolerance and dependence, Pharmacogenetics, kinetics - Absorption, Distribution, Metabolism and Excretion of drugs.	
Unit-III	**Preclinical drug evaluation**
Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenecity and mutagenecity	
Unit-IV	**Regulatory consideration**
Regulatory consideration for pre-clinical testing and clinical testing of drugs, biologics and medical devices. New Drug Applications for Global Pharmaceutical Product	
Unit-V	**Good manufacturing practices**
Organization and personnel, responsibilities, training, hygiene. Premises: Location, design, plant layout, construction, maintenance and sanitation, environmental control, utilities and services like gas, water, maintenance of sterile areas, control of contamination. Controls on animal house.	
Reference books	1. Laurence Brunton, Bruce A Chabner, Bjorn Knollman (2011) Goodman and Gilman's the Pharmacological Basis of Therapeutics, 12th Edition, and McGraw Hill Education. 2. Roop K Khar, Vyas SP (2013) Lachman/Liebermans: The Theory and Practice of Industrial Pharmacy, 4 th Edition, CBS. 3. Gregg N Milligan, Alan DT Barrett (2015) Vaccinology: An Essential Guide, 1 st Edition, Wiley-Blackwell. 4. Judy Owen, Jenni Punt, Sharon Stranford (2013) Kuby Immunology, 7th Edition, W. H. Freeman.
Mode of	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT

Examination	
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	2	2	1	3	2
CO2	1	1	1	2	2	2	2	2	1	1	1
CO3	2	2	2	1	1	1	1	3	2	1	2
CO4	3	1	1	1	2	3	1	1	1	3	3
CO5	2	3	3	1	2	1	2	3	3	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY013	ADVANCED CLINICAL BIOCHEMISTRY
Version	II
Prerequisite	All students are expected to have a basic concept of general biology, chemistry and biochemistry.
Learning objective	The learning objective of course are: To create an understanding regarding Blood, its function, neurotransmitters, neurohormones, composition function and regulation of body secretions, organ function test and Cancer.
Course Outcome	**CO 1**: Understand the detailed composition of blood and its various functions. **CO 2**: Understand the composition, functions, and regulation of various body secretions, including saliva, gastric, pancreatic, intestinal, and bile secretions. **CO 3**: Understand liver function tests and related disorders such as jaundice, hepatitis, fatty liver, gallstones, and cirrhosis. **CO 4**: Understand the clinical significance of enzymes in health and diseases. **CO 5**: Understanding the role of cancer markers in the diagnosis, prognosis, and monitoring of oral cancer, breast cancer, and gastrointestinal tract cancer.
Unit-I	**Blood and its function, Synaptic transmission, Neurotransmitters & Neurohormones.**
Blood composition and its function. Blood-Pressure, Mechanism and regulation of blood coagulation. Thalassemia. Haemorrhagic disorder–hemophilia, purpura ,porphyries, circulating anticoagulants. sickle cell anemia, Synaptic transmission, Neurotransmitters and Neurohormones, Biochemistry of vision**.**	
Unit-II	**Composition function and regulation of body secretions**
Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates ,lipids, proteins and nucleic acids. Structure of Nephron, Composition and formation of urine. Clinical significance of urinary components. homeostatic regulation of water and electrolytes. Acid-Base balance,-Acidosis and Alkalosis. Composition and biochemical analysis of CSF and amniotic fluid.	
Unit-III	**Organ function test**
Liver function test and related disorder: Jaundice, hepatitis, fatty liver and gall stone, Cirrhosis. Renal function test and related disorders, Gastric and pancreatic function test. Diagnostic test for lipo proteins disorders. Obesity–Definition, Genetic and environmental factors leading to obesity	
Unit-IV	**Enzyme: Clinical significance in health and diseases**
Clinical significance of enzymes in health and diseases. biochemical diagnosis of diseases by enzyme assays. GOT, SGPT, CPK, alkaline phosphatase, cholinesterase and LDH. Inborn errors of metabolism: diabetes mellitus, Gaucher's disease, taysach's disease, Niemann pick disease, phenylketonuria, alkaptonuria, albinism, maple syrup disease, Sexual Transmitted Disease	
Unit-V	**Oncology**
Oncology–Cancer markers fororal Cancer, Breast cancer and gastro intestinal tract cancer. Alphafeto proteins, Carcinoembryonic antigens, Leukemia. Free radicals in diseases- Introduction, Types of free radicals, free radical induced lipid peroxidation. Scavengers–Superoxide dismutase, catalase, peroxidase and antioxidants	

Reference books	1.ClinicalBiochemistry:AnIllustratedColourText,4ebyAllanGaw,MichaelJ. Murphy(2008) 2.Marks'BasicMedicalBiochemistry:AClinicalApproachbyMichaelA.LiebermanandAllanMarks(2008) 3.TextbookofBiochemistrywithClinicalCorrelationsbyThomasM.Devlin.(2010) 4.ClinicalChemistry:Techniques,Principles,CorrelationsbyMichaelL.Bishop,EdwardP.Fodyand Larry E.Schoeff (2009) 5.ClinicalBiochemistry(Fundamentals of Biomedical Science) by Nessar Ahmed(2011) 6.EssentialsofMedicalBiochemistry: With Clinical Casesby N.V. Bhagavanand Chung- EunHa (2011) 7.MedicalBiochemistryataGlancebyJ. G. Salway(2012)
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	2	2	1	3	1
CO2	1	2	1	2	2	2	3	2	2	1	1
CO3	1	2	2	1	3	1	1	3	3	3	3
CO4	3	1	1	1	2	3	1	2	1	1	2
CO5	1	2	3	1	2	1	1	3	2	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY014	Food and dairy Microbiology
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Microbiology basic principles.
Learning objective	The learning objective of course are: To create an understanding regarding the life science, Togain knowledge about industrial food fermentations, Quality assurances in foods, foods preservation methods, fermentation of milk products and beverages and Advanced Food Microbiology.
Course Outcome	**CO 1**: Understanding the use of starter cultures in fermentation processes. **CO 2**: Understanding mycotoxins in food with reference to Aspergillus species. **CO 3**: Understanding the role of biosensors in the food industry. **CO 4**: Studying the microbiology of fermented milk products like acidophilus milk and yogurt. **CO 5**: Understanding the concept of genetically modified foods.
Unit-I	**Industrial Food fermentations**
Starter cultures their biochemical activities, production and preservation of the following fermented foods. a. Soy sauce fermentation by Mouldsb. Fermented vegetables–Sauerkraut. Fermented Meat–Sausages d. Production and application of Bakers Yeast e. Application Microbial enzymes In food industry	
Unit-II	**Quality Assurance in foods**
Food Infections and intoxications; bacterial with examples of infective and toxic types –Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria. Mycotoxins In Food with reference to Aspergillus Species. Quality Assurance: Microbiological quality standards of food. Government Regulatory practices and policies.FDA, EPA, HACCP, ISI.	
Unit-III	**Food Preservation methods**
Radiations-UV, Gammaandmicrowave, Temperature Chemical And naturally occurring antimicrobials. Biosensors In The Food Industry.	
Unit-IV	**Fermentation of Milk products and Beverages**
Microbiology of cheese and beverage fermentation. Microbiology of fermented milk products (acidophilus milk, yoghurt). Role of microorganisms in beverages–tea and coffee fermentations. Vinegar Fermentation	
Unit-V	**Advanced Food Microbiology**
Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry [Protease,Lipases]. Utilization And Disposal Of Dairy By-product–whey	
Reference books	1.FoodMicrobiology.2ndEditionByAdams 2.BasicFoodMicrobiologybyBanwartGeorgeJ. 3.FoodMicrobiology:FundamentalsandFrontiersbyDolle 4.Biotechnology:FoodFermentationMicrobiology,Biochemistryand Technology.Volume2byJoshi. 5.FundamentalsofDairyMicrobiologybyPrajapati. 6.EssentialsofFoodMicrobiology.EditedbyJohnGarbult.ArnoldInternationalStudentsEdition. 7.DairyMicrobiologybyRobinson.VolumeII andI.
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	

Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	1	3	2	1	3	1
CO2	1	2	1	2	1	2	3	3	2	1	1
CO3	3	2	2	2	3	3	1	3	3	3	3
CO4	2	1	1	1	2	3	3	1	1	1	2
CO5	1	2	3	3	3	1	1	3	2	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY015	**Environmental Biotechnology**
Version	1.0
Prerequisite	All students are expected to have a basic knowledge of Environmental Sciences.
Learning objective	The learning objective of course are: To create an understanding regarding the Environmental Biotechnology.
Course Outcomes	**CO 1**: Understanding of various conventional fuels (firewood, plant, animal, water, coal, and gas) and their environmental impacts. **CO 2**: Comprehensive understanding of bioremediation techniques for soil and water contaminated with oil spills, heavy metals, and detergents. **CO 3**: In-depth knowledge of municipal waste and industrial effluent treatment processes. **CO 4**: Awareness of the environmental significance and implications of genetically modified microbes, plants, and animals. **CO 5**: Overview of biodegradation processes for basic structures found in hydrocarbons and xenobiotics.
Unit-I	**Conventional fuels and their environmental impact 8 hours**
	Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol
Unit-II	**Bioremediation 7 hours**
	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.
Unit-III	**Waste Treatment 7 hours**
	Treatment of municipal waste and Industrial effluents. Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)
Unit-IV	**Bioleaching 7 hours**
	Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.
Unit-V	**Biodegradation 7 hours**
	Overview of Biodegradation, Degradation of Basic Structures found in Hydrocarbons & Xenobiotics, Biodegradation of Xenobiotics, PCBs (Poly Chlorinated Biphenyls), DDT, Nitrobenzene, Biomagnification, Wastewater, Primary, Secondary, Tertiary treatment processes, Conventional Air Pollutants & Acid rain & Acid mine drainage, An overview of process of Bioremediation
Reference books	1. Environmental Science, S.C. Santra 2. Environmental Biotechnology, Pradipta Kumar Mohapatra 3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter 4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill 5. Agricultural Biotechnology, S.S. Purohit 6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer 7. Introduction to Environmental Biotechnology, Milton Wainwright 8. Principles of Environmental Engineering, Gilbert Masters 9. Wastewater Engineering – Metcalf & Eddy

Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	1	2	2	1	3	1
CO2	1	2	1	2	2	2	3	2	2	1	1
CO3	1	2	2	1	3	1	1	3	3	3	3
CO4	3	1	1	1	2	3	1	2	1	1	2
CO5	1	2	3	1	2	1	1	3	2	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MBY011	INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS
Version	II
Prerequisite	All students are expected to have a general knowledge of biology and Stem cell.
Learning objective	The learning objective of course is: To create an understanding regarding the Stem cell biology, their types and Application.
Course Outcome	**CO 1**: Define and understand the various types of intellectual property: patents, trademarks, copyright, industrial design, traditional knowledge, and geographical indications. **CO 2**: Understand the different types of patents and the Indian Patent Act 1970 along with recent amendments. **CO 3**: Understand the principles of biosafety and biosecurity, including biological safety cabinets and primary containment for biohazards. **CO 4**: Learn about international regulations such as the Cartagena Protocol, OECD consensus documents, and Codex Alimentarius. **CO 5**: Learn about the ethical considerations in cloning, stem cell research, human and animal experimentation, and animal rights/welfare.
Unit-I	**Introduction to IPR**
Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.	
Unit-II	**Patenting**
Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application-forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India.	
Unit-III	**Biosafety**
Biosafety and Biosecurity - introduction; biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment	
Unit-IV	**National and international regulations**
International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).	
Unit-V	**Bioethics**
Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare,	

Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.	
Reference books	1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub. 2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI 3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct. 4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell. 5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/ 6. Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies*, MIT Press 7. World Trade Organization. http://www.wto.org 8. World Intellectual Property Organization. http://www.wipo.int 9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
Mode of Examination	Assignment/Quiz/Viva-Voce/student seminar/written examination/PPT
Recommended By BOS on:	
Approved by academic council on:	

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1	2	2	1	3	2
CO2	1	1	3	2	2	2	2	2	1	1	1
CO3	1	2	2	3	1	3	1	3	1	1	2
CO4	1	1	2	1	3	1	1	1	1	2	3
CO5	2	1	3	1	2	1	3	3	3	2	1

1. Slight (low) **2. Moderate (Medium)** **3. Substantial (High)**

MB602	**DISSERTATION**
Version	II
Prerequisite	All students are expected to have a general knowledge of Microbiology and basic principles of Chemistry.
Learning objective	The learning objectives of course are: to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.
Course Outcome	**CO 1**: In-depth knowledge of the chosen area of research. **CO 2**: Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis. **CO 3**: Competence in research design and planning. **CO 4**: Capability to create, analyse and critically evaluate different technical solutions and Ability to conduct research independently. **CO 5**: Ability to perform analytical techniques/experimental methods. .
Unit-I	**Planning and performing experiments**
Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.	
Unit-II	**Thesis writing**
At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.	
Mode of Examination	student seminar/PPT
Recommended By BOS on:	
Approved by academic council on:	

SCHOOLOF APPLIED SCIENCES
M.Sc. Microbiology
DETAILED SYLLABUS

SC602 DISSERTATION/PROJECTWORK **C (L, T,P)=14 (0,0,0)**

CLASS IV Sem M.Sc. Microbiology	**EVALUATION**
Schedule Per Week Practicals:	Examination Time = Three (3) Hours Max. Marks =100 [Internal Assessment (60) & Semester End Exam (40)]

The Project work will involve in depth practical work on a problem suggested by the supervisor of the candidate. The student will submit the dissertation of the work done. The dissertation submitted by the candidate shall be evaluated by one External expert, Head of the Department and supervisor of the candidate. The examination shall be held in the department and the dissertation etc. will NOT be required to be mailed to the external examiner. The distribution of the marks will be as under**.**

Max. Marks: 100

Dissertation Record	60 marks
VivaVoce	40 marks
Total	100marks