J.C. Bose University of Science & Technology, YMCA Faridabad

(NAAC Accredited "A" Grade University of State Govt. established by Haryana State Legislative Act No.21 of 2009)

Department of Life Sciences

(w.e.f. 2020)

Scheme and Syllabi

M.Sc. Microbiology

(SEMESTER- I and II)

(w.e.f 2020)

ANNEXURE-I

Scheme of M.Sc. Biotechnology

SEMESTER-I

Sr. No.	Course Code	Subject	Teaching Hours per Week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total	4	
1	MLS−101	Cell Biology	4			25	75	100	4	DCC
2	MLS−102	Structure and Functions of Biomolecules	4			25	75	100	4	DCC
3	MLS−103	General Microbiology	4			25	75	100	4	DCC
4	MLS−104	Molecular Biology	3			25	75	100	3	DCC
5	MLS−105	Biostatistics	3			25	75	100	3	DCC
6	MLS−106	Lab Course− I (Based on MLS 101−102)			**6**	30	**70**	**100**	**3**	DCC
7	MLS−107	Lab Course− II (Based on MLS 103− 105)			**6**	30	**70**	**100**	**3**	DCC
8	MLS−108	MOOC*								
	Total Marks							**700**	**24**	

DCC: Discipline Core Course; MOOC: Massive Online Open Course, L: Lecture; T: Tutorial; P: Practical

*The students have to pass at least one mandatory MOOC course with 4−6 credits (12−16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1st semester to 3rd semester as notified by the university.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration ass specified below:

Programme Duration for M.Sc./M.Tech./MA/MBA: Sem. I to Sem. III

The passing of a MOOC course is mandatory for the fullfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen−paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

ANNEXURE-II

Scheme of M.Sc. Biotechnology

SEMESTER-II

Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MLS−201	Biotechniques	4			25	75	100	4	DCC
2	MLS−202	Metabolism	4			25	75	100	4	DCC
3	MLS−203	Bioinformatics and Biomolecular Modelling	3			25	75	100	3	DCC
4	MLS−204	Genetic Engineering	3			25	75	100	3	DCC
5	MLS−205	Environment and Ecology	4			25	75	100	4	DCC
6	MLS−206	Lab Course− I (Based on MLS 201−202)			6	30	70	100	3	DCC
7	MLS−207	Lab Course− II (Based on MLS 203− 205)			6	30	70	100	3	DCC
8	MLS−208	Audit Course**	2	0	0	25	75	100	0	AUD
	Total Marks							**800**	**24**	

** The students have to choose one Audit course from the list provided by the department/ university.
Only passing of the audit course is mandatory.

Semester-I

Course Code: MLS-101
Subject: Cell Biology
No. of Credits: 04

L	P
4	0

Maximum Marks: 100
Theory Exam: 75
Sessional: 25

Course Objectives: To understand structural and functional aspects of cells and basic mechanisms underlying cell signaling and cell division

Unit-I

Biomembranes: Molecular composition and arrangement, functional consequences, Transport Recapitulation of the plasma membrane; diffusion, active transport and pumps, uniports, symports and antiports, Donnan equilibrium; ion movements and cell function: acidification of cell, organelles and stomach, Maintenance of cellular pH; cell excitation; bulk transport; Receptor mediated endocytosis, Transepithelial transport

The Extra Cellular Matrix and Cell interactions, Cell walls, The ECM and cell-matrix, nteractions,Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata Ca^{++} Dependent and Ca^{++} Independent Homophilic cell-cell adhesion

Unit-II

Cytoskeleton and cell movement: Structure and organization of actin filaments, Actin, myosin and cell movements, Structure and dynamic organizations of microtubules, Microtubule motors and movement, Intermediate filaments, Cilia and flagella, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Auxin and cell expansion, Cellulose fibril synthesis and orientation, Protein sorting and transport, Protein uptake into the ER, Membrane proteins and Golgi sorting, Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway.

Unit-III

Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, The events of M phase, Meiosis and fertilization, Genome organization, Chromosomal organization of genes and non-coding DNA, Mobile DNA, Morphological and functional elements of eukaryotic chromosomes, Cell – Cell signalling, Signaling molecules and their receptors, Function of cell surface receptors, Pathways of intracellular signal transduction, Signaling networks

Unit-IV

Cell death and cell renewal: Programmed cell death, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, The development and causes of cancer, Oncogenes, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing

Course Outcomes:

CO1.Students will know about the cell and its biology, which will help the students to understand the origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function –how they obtain energy, synthesize new molecules, communicate, proliferate and survive.

CO2.Students will understand the structures and purposes of basic components of cell cycle.

CO3.Students will understand the cellular components underlying cell movements and cytoskeleton.

CO4.The understanding of cells is used for learning the processes such as, cell death and cell renewal, stem cells and biology of cancer etc.

Suggested Readings:

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc.,USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York
3. Cell and Molecular Biology by De Robertis
4. Molecular Cell Biology, Lodishet al., W.H. Freeman and Company (8th Ed. 2016)

Semester-I

Course Code: MLS-102
Subject: Structure and Functions of Biomolecules
No. of Credits: 04

L	P
4	0

Maximum Marks: 100
Theory Exams: 75
Sessional: 25

Course Objectives: To learn about structure and boding in water, its significance as biological solvent, study of carbohydrates, Aminoacids, proteins, lipids, nucleic acids

Unit-I

Water : Structure, hydrogen bonding, as a biological solvent, ionization and fitness of the aqueous environment for living organisms; pH; Buffers; Henderson-Hasselbalch equation; Physiological buffers.

Carbohydrates : Structure, occurrence and biological importance of important monosaccharides, oligosaccharides and polysaccharides; Ring structures and anomeric forms; mutarotation; sugar derivatives; reactions of monosaccharides; Glycosamino glycans; Hetero polysaccharides of bacterial and algal cell walls; Proteoglycans; Glycoproteins; Lectins.

Unit-II

Amino acids and Proteins : Common structural features, classification by R group, Zwitter ion structures, acid-base properties and titration curves of amino acids; Essential amino acids; Separation of amino acids; Peptides including biologically active peptides; Classification anddifferent structural levels (Primary, secondary, tertiary & quaternary) of proteins; Ramachandran plot; Determination of amino acid composition of proteins; Characteristic amino acid composition of proteins; Determination of amino acid sequences of proteins; Effect of amino acid sequence on the function of a protein and stability of α-helix; Protein folding and role of chaperons in protein folding; Chemical synthesis of polypeptides.

Unit-III

Lipids : Classification, structures, nomenclature and properties of fatty acids; Essential fatty acids; Acylglycerols; Characterization of fats-Saponification value, iodine number, rancidity, acid value, Reichert-Meisselnumber; Structure and properties of different types of phospholipids and sphingolipids (sphingomyelins, cerebrosides & gangliosides); Structure and functions of prostaglandins, Prostacyclins, Thromboxanes, and Leukotrienes; Terpenes of biological significance; Sterols and bile acids.

Unit-IV

Nucleic Acids: Structure and properties of purines and pyrimidine bases; Nucleosides and Nucleotides; Biologically important nucleotides; Nucleic acids as the genetic material – experimental evidences; Chargaff's rules; The covalent backbone of nucleic acids; Double helical model of DNA structure; Structural polymorphism of DNA (A,B and Z-DNA) and RNA; Denaturation & annealing of DNA; Biological functions of nucleotides; Chemical synthesis of oligonucleotides.

Course Outcomes:

After the successful completion of the course the learner would be able to
CQ.1.comprehend the importance of chemical foundation in living organisms

CQ.2.analyzethe various types of weak interactions between the biomolecules and water
CQ.3.correlate how the large biomolecules such as proteins, carbohydrates, lipids, nucleic acids are made from the simple precursors
CQ.4. interpret the structure-functionrelationships oftheproteins, carbohydrates, lipids, and nucleic acids

Suggested Readings:

i) *Liljas, Anders***Textbook of structural biology** New Jersey: World Scientific, cop. 2009
1) Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry. 6 th ed. Freeman, 2006.
2) D.A. Harris. Bioenergetics at a glance. John Willey and Sons Ltd, 1995.
3) Nelson.D.L, Cox. M. M. Lehninger's .Principle of Biochemistry. 6 th ed. Freeman, 2009
4) Voet and Voet. Biochemistry.4th edition, John Wiley, 2010.

Semester-I

Course Code: MLS-103
Subject: General Microbiology
No. of Credits: 04
L P
4 0

Maximum Marks: 100
Theory Exam: 75
Sessional: 25

Course Objectives: To study the fungi, bacteria, virus, microbial; classification and taxonomy, Sterilization methods and microbial ecology

Unit – I

Fungi: Introduction and classification: Thallus organisation, cell structure and cell wall composition, Nutrition, reproduction (vegetative, asexual and sexual), life cycles, Classification of fungi. and Economic importance of fungi. History and contributions of various scientists to this science with particular reference to the contribution of the following scientists A.V.Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch, Alexander Fleming and Joseph Lister.

Morphology and arrangement of bacterial cells, Bacterial- flagella, Fimbriae, capsule, spores and cysts, cell walls of Gram +ve and Gram –ve bacteria, Nutritional requirements and nutritional categories of microorganisms, Physical factors for growth, Enrichment culture techniques for isolation of microorganisms, pure culture techniques and preservation techniques, study of growth curve, measurement of growth.

Unit – II

Distinguishing features of bacteria, viruses, fungi, protozoa, algae. Introduction to Microbial Classification and Taxonomy, Taxonomic ranks, Various approaches for identification of microorganisms including molecular approaches; Gram (+) and Gram (-) bacteria of medical and industrial importance. Characteristics of Mycobacterium and Mycoplasmas; photosynthetic prokaryotes (purple bacteria, green bacteria, cyanobacteria) and actinomycetes; brief account of different types of viruses with special reference to lambda phage, herpes, adenoviruses and retroviruses, viriods and prions; fungi and algae of industrial importance.

Unit – III

Sterilization methods- dry heat, moist heat, radiations, filtration, and gaseous sterilization. Validation of sterilization processes; Factors affecting antimicrobial action, Mode of action of antimicrobial agents, Antibiotics and their mode of action, Microbiological assay of antibiotics (ampicillin, streptomycin, tetracycline etc.), Disinfectants, Types of toxins and their mode of action.

Unit – IV

Microbial ecology: Biogeochemical cycles; Physical environment: Microenvironment & Niche, Microorganisms and ecosystems. Soil microbiology: Types & functions of microorganisms in soil. Microorganism associations with vascular plants (Mycorrhizae, Rhizobia), Microorganism growth in Foods. Methods to control food spoilage, Food borne diseases

Course Outcomes:

CO1. Student will understand the diversified branches of microbiology

CO2.Student will know the aspects of microbial growth and physiology

CO3.Students will learn about the morphology and physiological characteristics of different groups of microorganisms

CO4.This course will make the students to understand various sterilization methods

Suggested Readings:

1) Jacquelyn G. Black. Microbiology-Principles and explorations 8 th edition: Publisher John Wiley & Sons 2012

2) Prescott, Harley and Klein- Microbiology-7 th edition; Publisher: McGraw Hill science 2007 Gerard J. Tortora, Berdell, R. Funke, Christine L. Case

3) Microbiology: An Introduction. 11th edition, Publisher: Benjamin Cummings. 2012

4) Atlas RM. Principles of Microbiology. 2ndedition. 1997

5) WM.T.Brown Publishers.2.Black JG. Microbiology: Principles and Explorations. 7thedition. Prentice Hall, 2008

Semester-I

Course Code: MLS-104
Subject: Molecular Biology
No. of Credits: 03
L P
3 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives:

To make students understand the complex molecular mechanisms occurring in cell and the applications of molecular technologies.

Unit-I

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair.
Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5‟-Capformation, Transcription termination, 3‟-end processing and .polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

Unit-II

Translation: Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co- and post translational modifications of proteins.
Protein Localization: Synthesis of secretory and membrane protein, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins

Unit-III

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of Antisense and ribozymetechnologies
Homologous Recombination: Holliday junction, gene targeting, gene disruption, FLP/FRT and' Cre/Lox recombination, RecA and' other recombinases Molecular Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis,Chromosome micro dissection and micro cloning.

Course Outcomes:

After the successful completion of the course the learner will get complete idea about the
CQ.1. DNA replication, recombination and repair, transcription and translation
CO2.Students will be aware of protein localization
CO3.Students will understand the biology and application of antisense and ribozyme technologies

Suggested Readings:

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA
3. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
4. Molecular Biology LabFax, T.A Brown (Ed.), Bios Scientific Publishers Ltd., Oxford.

Semester-I

Course Code: MLS-105
Subject: Biostatistics
No. of Credits: 03
L P
3 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives:

The paper develops concepts about types of data observed in biological experiments, its handling and processing. It develops concepts of hypothesis and formulation of experiments. It gives understanding of various statistical operations needed to carryout and process the biological data.

Unit-I

Types of data, Collection and Graphical representation of data, Measures of central tendency: Mean, Median, Mode, Quartile, and Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression.

Unit-II

Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.

Testing of hypothesis: Parameter and Statistic, Sampling distribution and Standard error, Null and Alternative hypotheses, Simple and composite hypotheses, Two types of errors, Level of significance and Power of the test, One tailed and two tailed tests.

Unit-III

Tests of significance: t and Z tests for mean and proportion for one and two samples, Chi square test of goodness of fit and independence. F test, Analysis of variance for one way and two way classification, Elementary ideas of Designs of Experiments

Important statistical softwares and their applications

Course Outcomes:

After the successful completion of the course the learner will get complete idea about the

CQ.1. An ability to apply knowledge of statistics to design and conduct experiments, as well as to analyze and interpret data related to domain of biology

CQ.2. An ability to apply the knowledge of basic mathematical & statistical tools used in biological research/ biotechnology in industry and research lab

CQ.3. An ability to understand the principle and application of Differential Calculus, Differential Equations and various Computational Techniques

Suggested Readings:

1. Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10th Edition, Wiley Series.
2. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2nd Edition,

CRC Press
3. Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd.
4. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House
5. B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers, JPB

Semester-I

Course Code: MLS-106
Subject: Lab Course-1
No. of Credits: 03
L P
0 6

Maximum Marks: 100
Theory exam: 70
Sessional: 30

1. Preparation of mitotic and meiotic chromosomes
2. Calculation of morphometric data and preparations of idiogram.
3. Determination of chiasma frequency and terminalization coefficient
4. Preparation of polytene chromosomes and mapping
5. Titration of amino acids
6. Colorimetric determination of pK
7. Model building using space filling/ball and stick models
8. Reactions of amino acids, sugars and lipids
9. Isolation of DNA and protein
10. Quantization of Proteins and Sugars
11. Analysis of oils-iodine number, saponification value, acid number
12. UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
13. Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis

Semester-I

Course Code: MLS-107
Subject: Lab Course-II
No. of Credits: 03

Maximum Marks: 100
Theory Exam: 70
Sessional: 30

L P
0 6

1. Isolation of genomic DNA
2. Southern blotting
3. RFLP analysis
4. Isolation of RNA
5. Isolation of polyA +RNA
6. Northern blotting
7. Preparation of probes
8. In vitro Transcription
9. In vitro translation
10. Metabolic labeling of proteins and immune precipitation
11. Descriptive statistics: Systemic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion (using calculators).
12. Correlations (Product Moment and Spearman's Rank Correlation) and Linear Regression Tests of significance (Mean, Standard Deviation, proportion, Correlation Coefficient)
13. Chi Square Test of Goodness of fit, test of independence of attributes, Analysis of Variance (One way and Two way)
14. Preparation of Graphs and statistical calculations using software

ANNEXURE-II

Scheme of M.Sc. Biotechnology

SEMESTER-II

Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MLS−201	Biotechniques	4			25	75	100	4	DCC
2	MLS−202	Metabolism	4			25	75	100	4	DCC
3	MLS−203	Bioinformatics and Biomolecular Modelling	3			25	75	100	3	DCC
4	MLS−204	Genetic Engineering	3			25	75	100	3	DCC
5	MLS−205	Environment and Ecology	4			25	75	100	4	DCC
6	MLS−206	Lab Course− I (Based on MLS 201−202)			6	30	70	100	3	DCC
7	MLS−207	Lab Course− II (Based on MLS 203− 205)			6	30	70	100	3	DCC
8	MLS−208	Audit Course**	2	0	0	25	75	100	0	AUD
	Total Marks							**800**	**24**	

** The students have to choose one Audit course from the list provided by the department/ university.
Only passing of the audit course is mandatory.

Annexure -B

J.C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA FARIDABAD
DEPARTMENT OF LIFE SCIENCES

M.Sc. (Biotechnology) Syllabus, Semester-II

Course Code: MLS-201
Subject: Biotechniques
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: To learn various techniques used in biological sciences and their applications in different research works. The course also aims to make students learn about modern instruments for various analytical works.

Unit-I

Microscopy: Light Microscopy – Magnification, resolving power, Numerical aperture, Limit of Resolution, Bright field, Phase contrast, Fluorescence microscopy. Principle and applications of Electron Microscopy (SEM and TEM), Cryogenic Electron Microscopy, Confocal Microscopy, Atomic Force Microscopy, Polarised Light Microscopy

Centrifugation Techniques: Principle of sedimentation, centrifugation, types of rotors, general applications of centrifugation, ultracentrifugation, analytical centrifugation, preparative centrifugation, precautions and safety aspects

Unit-II

Spectrophotometric Techniques: Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Raman SpectroscopyCircular dichroism (CD), Molecular structure determination using X-ray diffraction, Xray crystallography and NMR, Different types of mass spectrometry and surface plasmon resonance method

Unit-III

Principles and different types of ELISA, Radioimmune Assay (RIA), Immunoprecipitation, flowcytometry, Genomic Insitu Hybridisation (GISH). Chromosome walking, Chromosome painting. Chromosome Banding Techniques.

Unit-IV

Principles and applications of Chromatography. Ion exchange chromatography, Gel filtration chromatography, Hydrophobic interaction chromatography, Affinity chromatography, GC, HPLC.

Electrophoresis-Agarose Gel electrophoresis, Polyacrylamide Gel Electrophoresis (Native, SDS PAGE), 2-Dimenional Gel electrophoresis,

Course Outcomes:

CO-1- To impart knowledge and application of various bioanalytical techniques

CO-2- Students will learn centrifugation and electrophoretic techniques involved in isolation, purification and analysis of biomolecules.

CO-3- Students will learn spectrophotometric techniques for qualitative and quantitative analyses of biomolecules.

CO-4- Students will gain the knowledge and will analyses the biophysical techniques for theIsolation, Identification and Quantification of Biomolecules

Suggested Readings:

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Andreas Hofmann and Samuel Clokie (8^{th} Edition).
2. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, Harald Ganther (3^{rd} Edition)
3. Crystallography Made Crystal Clear - Gale Rhodes, academic Press (3^{rd} Edition).
4. Molecular Biology and Biotechniques: the fundamental approach- Aga Syed Sameer (2^{nd} Edition).
5. Biotechniques- Theory and Practice, S.V.S Rana, Rastogi Publication (1^{st} Edition).
6. Principles of Immunodetection and Immunotechniques: Preview and Emerging Applications, Shelza Thakur, Navnit Kumar Mishra, Hardeep Singh Tuli, Anil K. Sharma (1^{st} Edition)

Semester-II

Course Code: MLS-202
Subject: Metabolism
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: Students will learn about different metabolic pathways related to carbohydrate, proteins, nucleic acid and fatty acids, including its significance and regulation in biological system.

Unit I

An overview of metabolism including catabolism and anabolism, Bioenergetics, ATP synthesis, Electron transport chain, Phosphorylation, Oxidative phosphorylation, Substrate phosphorylation and photophosphorylation.

Unit II

Carbohydrates – Fermentation, Pathways and regulations of glycolysis (Entner-Doudoroff pathway), citric acid cycle, pentose phosphate pathway, gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate pathways, Cori cycle, anaplerotic reactions, glucuronate pathway. Energetics of metabolic cycle.

Unit III

Fatty acid metabolism including catabolism and anabolism. Ketone bodies metabolisms, keto acids, fatty acid synthesis and oxidation, cholesterol synthesis and regulation, Biosynthesis and degradation of tri-acyl-glycerol and phospholipids, diseases caused by abnormal metabolic pathway.

Unit IV

Catabolism of amino acids, glucogenic and ketogenic amino acids, disorders of amino acid metabolism. Biosynthesis of urea and urea cycle, related disorders, Nucleotides, de novo synthesis and breakdown of purine and pyrimidine nucleotides, regulation, salvages pathway, inhibitors of nucleotide metabolism, disorders of nucleotide metabolism and Vitamins and role in metabolic synthesis.

Course Outcomes:

CO-1- To comprehend various biochemical changes in living system.

CO-2- Recognize how the catabolic and anabolic breakdown of the substances is associated with the release during synthesis of biomolecules

CO-3- Assessing the role of different inhibitors in metabolic pathways.

CO-4- Provide deeper insight in the understanding, application and regulation ofvarious metabolic pathways

Suggested Readings:

1. Biochemistry and Molecular Biology, Elliott and Elliott, Oxford University press, New York, USA (4^{th} edition).
2. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, McGraw Hill, New York, USA. (28^{th} edition)
3. Biochemistry, Voet and Voet, John Wiley (4^{th} edition).
4. Nelson DL Cox, MM Lehninger's Principal of Biochemistry (7^{th} edition).
5. Biochemistry, Satyanarayana U, Chakrapani U, Elsevier (5^{th} edition).
6. Fundamentals of Biochemistry, JL Jain, Sanjay Jain, Nitin Jain, S Chand (4^{th} edition)

Semester-II

Course Code: MLS-203

Subject: Bioinformatics and Biomolecular Modelling

No. of credits: 3

L	**P**
3	**0**

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: This course is meant to impart knowledge to students for analysing and interpreting vast biological data using computational techniques. The course is designed in such a way that it gives a walkthrough of the major aspects of bioinformatics such as the development of databases and computationally derived hypothesis. We will focus on DNA and protein sequence databases and analysis, secondary structures and 3D structural analysis.

Unit I

Introduction to bioinformatics and Biological databases: Introduction to genomics and proteomics databases- nucleic acid sequence databases; GenBank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases; Swiss-Prot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results), BLAST vs FASTA, file formats- FASTA, ClustalW, Databank search- data mining, data management and applications.

Unit II

Sequence alignment: Nucleic acid and protein sequence information, composition and properties, Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM 250, BLOSUM 62, global and local sequence alignment, similarity searching (FASTA and BLAST), Identification of genes in genomes, primer designing, Phylogenetic analysis with reference to nucleic acids and protein sequences using PHYLIP, DISTANCES, and GROWTREE, Identification of ORFs, Identification of motifs.

Unit III

Protein structure and Molecular Interaction: Introduction to protein structure, secondary structure prediction, tertiary structure prediction, protein modelling; principles of homology and comparative modelling, threading, structure evaluation and validation and Modelling, applications; Molecular docking, Autodoc.

Applications of Bioinformatics in various fields: Environment, biotechnology, molecular biology, neurobiology, agriculture, drug designing, biomedical genome medicines, medical microbiology.

Course Outcomes:

CO-1- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis

CO-2- To gain knowledge about various Biological databases that provide information about nucleic acids and protein

CO-3- Understanding of the concept of pairwise sequence alignment and tools for pairwise alignment, also students will learn about Multiple Sequence Alignment, its significance,

algorithms and tools used for MSA.

CO-4- The students will learn about biological macromolecular structures and structure prediction methods

Suggested Readings:

1. Bioinformatics: Sequence and Genome Analysis, David W. Mount, Cold Spring Harbor Laboratory Press, New York, USA (2nd Edition).
2. Bioinformatics: A primer, P. Narayan, New Age International Publishers (1st Edition).
3. Bioinformatics Principles and Applications, Harshawardhan P. Bal, Tata McGraw- Hill Publishing Company (1st Edition).
4. Understanding Bioinformatics, Marketa Zvelebil and Jeremy O. Baum, Garland Science (1st Edition).
5. Bioinformatics: Methods and Applications (Genomics, Proteomics and Drug Discovery), S. C. Rastogi, Namita Mendiratta and Parag Rastogi, Prentice Hall ofIndia (4th Edition).
6. Fundamental Concepts of Bioinformatics, Dan E. Krane and Michael L. Raymer Pearson Education (1st Edition).
7. Bioinformatics For Dummies, Jean Michael Claverie and Cerdic Notredame, Wiley India Pvt Ltd (2nd Edition).

Semester-II

Course Code: MLS-204
Subject: Genetic Engineering
No. of credits: 3

L	**P**
3	**0**

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: To understand the basic concepts in Gene cloning; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications of genetic engineering as well as genome editing tools.

Unit-I

Recombinant DNA technology: Restriction and modification enzymes; Restriction Digestion-Partial as well as complete digestion, Linkers and adaptors. Vectors - Plasmids, Cosmids, bacteriophage and other viral vectors, bacterial and yeast artificial chromosomes; Expression vectors, shuttle vectors. Plasmid incompatibility. Introduction of DNA into living cells. Selectable and Screenable markers. Selection of transformed and recombinant cells. Insertional inactivation of genes. Ti plasmid and Agrobacterium mediated Gene transfer. Functions of different of Vir genes.

Unit-II

The construction of cDNA and Genomic libraries. Genomics and its application, Expressed sequence tags, Human genome project- strategies and implications, Gene therapy: principles, strategies. DNA sequencing methods, Maxam and Gilbert's chemical and Sanger's chain termination methods, and Pyrosequencing.
Polymerase chain reaction and its application in research. TA cloning. Real time/quantitative PCR.

Unit-III

Differential gene expression profiling by Microarray. Differential protein expression profiling. The Southern, Northern, Western blotting. Analysis of DNA-Protein Interactions-Electromobility shift assay, ChIP assay, DNase Foot printing. Protein-protein interactivestudy: The yeast two hybrid system, Random amplification of polymorphic DNA (RAPD), RFLP (Restriction fragment Length Polymorphism), Site-directed mutagenesis.

Course Outcomes:

CO-1- Provide deeper insight in the understanding, application of the tools of restriction digestion and modification system as well as cloning.

CO-2- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences

CO-3- To train students in strategizing research methodologies employing genetic engineering techniques.

CO-4- To expose students to methods and application of DNA sequencing in biotechnological research

Suggested Readings:

1. Gene Cloning and DNA analysis- an introduction - T. A Brown, Wiley-Blackwell (7^{th} Edition)
1. Molecular Biotechnology: Principles and applications of Recombinant DNA- Bernard R Glick, Jack J Pasternak (3^{rd} Edition)
2. Principles of Biotechnology- Christina A. Crawford, Grey House Publishing (1^{st} Edition)
3. Principles of Gene Manipulation and Genomics- Primrose, S. B., & Twyman, Wiley-Blackwell (7^{th} Edition)
4. Biotechnology-David P. Clark, Nanette J. Pazdernik, Elsevier Science (2^{nd} Edition)
5. Plant Biotechnology and Genetic Engineering- C M Govil, Ashok Aggarwal, Jitender Sharma, PHI Learning (1^{st} Edition)

Semester-II

Course Code: MLS-205
Subject: Ecology and Environment
No. of credits: 4

L	P
4	0

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: The objective of this course to make awareness among the youngstudents about the surrounding environment, basic concepts of ecology, the impact of climate change and its mitigation, biodiversity and conservation.

UNIT I

Environment: Introduction to ecology and basic environmental concepts; Physical environment, biotic environment, laws and limiting factors, ecological models, biotic and abiotic interactions, climate and soil pattern of world.
Habitat ecology: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement and major habitat types of the subcontinent.

UNIT II

Population ecology: Characteristics of a population; population growth curves; population dynamics and regulation; life history strategies (*R* and *K* selection), age structured populations, Competition and coexistence, intra-specific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions, Species interactions; Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis; Mechanisms of litter fall decomposition and climatic factors associated with decomposition.

UNIT III

Community ecology: Nature, structure and attributes of community, analysis of communities (analytical and synthetic characters), levels of species diversity and its measurement, edges and ecotones, ecological succession: types, mechanisms, changes involved in succession, concept of climax, models of succession, ecological adaptations.
Ecosystem ecology: Structure and function, energy flow through ecosystems, food webs, biogeochemical cycles, resilience of ecosystem, primary production and methods of measurement, global pattern and controlling factors, ecosystem management/restoration.

UNIT IV

Environment and Development: Environmental Challenges faced by India and the world; Climate change and global warming, different types of pollution – air, water and soil, energy crisis and resource conservation, National and global environmental education programs and organisations, Environment Impact Assessment (EIA), Environmental Laws and policies.
Biodiversity: Assessment, international conventions, changing environment. conservation and management, biodiversity act and related sustainable development, natural resource management in changing environment

Course Outcomes:

CO-1- Students will be exposed to the fundamental aspects of ecology.

CO-2- They will get idea about the interactions and interdependence of abiotic and biotic factors in nature. They will also learn about the impact of anthropogenic activities on the environment and need for conservation

CO-3- Student will develop an understanding of the ecological principles that link individuals at populations, community and ecosystem levels.

CO-4- Students will learn about the environmental issues faced by India and world, various national and global organisations working towards environment protection and biodiversity conservation.

Suggested Readings:

1. Ecology: From Individuals to Ecosystems, Michael Begon, Colin R. Townsend, John L. Harper, Wiley-Blackwell (3rd Edition).
2. Ecology: Principles and Applications, J. L. Chapman and Michael Reiss, Cambridge University Press, U.K. (1st Edition).
3. Ecology and Environment, P.D. Sharma, Rastogi Publications, India (13th Edition).
4. A text book of Ecology, R. S. Ambasht and N. K. Ambasht, CBS Publ. & Distr. New Delhi. (15th Edition).
5. Fundamentals of Ecology, E. P. Odum and G. W. Barrett, Brooks/Cengage Learning India Pvt. Ltd., New Delhi (5th Edition).
6. Concepts of Ecology, E. J. Kormondy, Prentice Hall of India, New Delhi (4th Edition).
7. Ecology, N. S. Subrahmanyam and A.V.S.S. Sambamurty, Narosa Publishing House, New Delhi (2nd Edition).
8. Ecology: Theory and Applications, P. Stiling, PHI Learning Pvt. Ltd. New Delhi (4th Edition).
9. Essentials of Ecology and Environmental Sciences, S V. S. Rana, PHI Learning Pvt. Ltd. New Delhi (4th Edition).

Semester-II

Course Code-MLS -206

Subject: Lab Course-I (Based on MLS 201-202)
No. of Credits-3

L	P
0	6

1. Isolation of total protein by acetone precipitation from biological sample and its quantitation by Bradford method.
2. Analysis of proteins. Native PAGE and SDS PAGE, Visualization of protein bands by Coomassie staining
3. Determination of molecular weight of a given protein by Gel filtration
4. To check the validity of Lambert-Beer's law
5. Determination of concentration and purity of DNA by spectrophotometer
6. Estimation of RNA by orcinol method
7. Estimation of DNA by DPA method
8. Determination of starch in plant tissues
9. Determination of total soluble sugars by ferricyanide method
11. Quantitative determination of free amino acid content in germinating seeds
12. Estimation of beta carotene in carrots by spectrophotometry
13. Estimation of ascorbic acid in lemon juice by calorimetric method

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Semester-II

Course Code-MLS -207
Subject: Lab Course-II (Based on MLS 203-205)
No. of Credits-3

L	**P**
0	**6**

1. PCR amplification of DNA from unknown source
2. Preparation of restriction enzyme digests of DNA samples
3. Determination of nucleotide sequence of DNA by dideoxy chain termination method
4. To study physical and chemical characteristics of soil and water samples collected from different locations
5. Assessment of density, frequency and abundance of plants/ animals in a community using various techniques i.e., transect, quadrate etc.
6. To determine the dissolved oxygen/free carbon dioxide/nutrients, hardness, alkalinity pH and conductivity of water samples collected from different locations
7. To record the biotic and abiotic components of water in different ecosystems
8. Determination of species diversity index and importance value index of local vegetation
9. Retrieve sequences from different Nucleic acid and protein databases
10. Data mining for sequence analysis by use of Bioinformatics' tools
11. Pair wise and multiple alignments of sequences using different softwares
12. Evolutionary studies / phylogenetic analysis of DNA and protein sequences

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

J.C. Bose University of Science & Technology, YMCA Faridabad

(NAAC Accredited "A" Grade University of State Govt. established by Haryana State Legislative Act No.21 of 2009)

Department of Life Sciences
(w.e.f.2021)

Syllabi for
M.Sc.
Microbiology
(Semester III and IV)

PROGRAM OUTCOMES OF PG PROGRAM OF FACULTY OF SCIENCES

PO1	**Knowledge**	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	**Research Aptitude**	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	**Communication**	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	**Problem Solving**	Capability of applying knowledge to solve scientific and other problems
PO5	**Individual and Team Work**	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	**Investigation of Problems**	Ability of critical thinking, analytical reasoning and research-based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	**Modern Tool usage**	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	**Science and Society**	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	**Life-Long Learning**	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	**Ethics**	Capability to identify and apply ethical issues related to one‘s work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	**Project Management**	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

PROGRAM SPECIFIC OUTCOMES (PSOs)

The program specific outcomes (PSO‘s) are the statement of competencies/abilities that describes the knowledge and capabilities of the post-graduate will have by the end of program studies.

After successful completion of M. Sc. Microbiology, the students will be able to

PSO1	The detailed functional knowledge of theoretical concepts and experimental aspects of microbiology.
PSO2	To integrate the gained knowledge with various contemporary and evolving areas in microbial sciences with the knowledge to handle microbes and basic instrumentation used in microbiological laboratory.
PSO3	To understand, analyze, plan and implement qualitative as well as quantitative knowledge of various basic techniques to isolate, characterize the microbes. The course will help them to impart the knowledge of the basic principles of bacteriology, virology, mycology, immunology and parasitology including the nature of pathogenic microorganisms, pathogenesis, laboratory diagnosis, transmission, prevention and control of diseases common in the country
PSO4	Provide opportunities to excel in academics, research or Industry.

SEMESTER-III

Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MMT−301	Industrial Microbiology	4			25	75	100	4	DCC
2	MMT−302	Medical Microbiology	4			25	75	100	4	DCC
3	MMT−303	Immunology	4			25	75	100	4	DCC
4	MMT−304	Genetics	4			25	75	100	4	DCC
5	MMT−305	Lab Course− I (Based on MMT 301−302)			6	30	70	100	3	DCC
6	MMT−306	Lab Course− II (Based on MMT 303− 304)			6	30	70	100	3	DCC
7	MMT-307	Seminar						25	1	DCC
8	XXX	*Open Elective Course	3	0	0	25	75	100	3	OEC
	Total							**725**	**26**	

DCC- Discipline core course

***OEC – Open Elective Course-** The students have to choose one Open elective course related to another branch of Science/Engg. /other discipline required for enhancing professional performance as provided by the department/university-

OES-301A- Waste Management in Daily Life

OES-302A- Environmental Conservation

OCH 307A- Chemistry for sustainable Development

L – Lecture; T-Tutorial, P – Practical

SEMESTER-IV

Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MMT−401	Food Microbiology	4			25	75	100	4	DCC
2	MMT−402	Environmental and Agricultural Microbiology	4			25	75	100	4	DCC
3	MMT−403	Plant Pathogen Interaction	4			25	75	100	4	DCC
4	MMT−404	Lab Course-I (Based on MMT 401)			6	30	70	100	3	DCC
5	MMT-405	Lab Course-II (Based on MMT 402−403)			6	30	70	100	3	DCC
6	MMT-406	Project Report			12	-	-	100	6	
	Total							**600**	**24**	

Course Code: MMT−301
Subject: Industrial Microbiology
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives: To introduce and understand the concept of industrial microbiology. Screening of metabolites. Strain development and maintenance of industrially important microorganism. Fermentation- its types and different components. Production of fermented beverages and fermentation processes involved in the production of antibiotics etc.

UNIT I

Introduction to Industrial microbiology. Screening for new metabolites - primary and secondary metabolites. Strain development through selection, mutation, recombination and other genetic and biochemical methods. Maintenance of industrially important microorganisms.

UNIT II

Fermentation- Batch, Continuous and Synchronous. Substrates for fermentations- types and availability. Different components of Fermenter, Bioreactors, Design and working of a typical bioreactor (aeriation, agitation and control). Downstream processing Introduction to immobilization technology.

UNIT III

Fermented beverages like wine, beer. Production of alcohol (ethanol), wine, beer, sauerkraut, organic acid (citric acid, lactic acid), amino acid (lysine, glutamic acid), nucleotides and related compounds. Production of enzymes. Michalis-Menton Equation. Protease and amylase production.

UNIT IV

Fermentation process involved in antibiotics (streptomycin, tetracycline, penicillin), hormones, vitamins, steroid production. Synthesis of commercial products by recombinant microorganisms, biopolymers, human insulin, growth hormones, interferon and vaccines.

Suggested Readings:

- Reed G (2004) Prescott and Dunn's Industrial Microbiology. CBS Publishers & Distributors. 4th edition.
- Glazer AN and Nikaido H (2007) Microbial biotechnology: Fundamentals of Applied Microbiology. Cambridge University Press. 2nd edition.
- Willey JM and Guthart LA (2016) Prescott’s Microbiology. McGraw-Hill Education. 10th edition.
- Stanbury P, Whitaker A, and Hall S (2016) Principles of Fermentation Technology. Butterworth-Heinemann. 3rd edition.
- Waites MJ, Morgan NL, Rockey JS, and Higton G (2013) Industrial Microbiology: An introduction. Wiley-Blackwell. 1st edition.

Course Outcomes:

After completion of the course the learners will be able to:

CO1- Understood knowledge of bioprocess technology- upstream and downstream processing of major bioproducts.

CO2- Learnt various processes involved in strain development as well as maintenance of industrially important microorganisms.

CO3- Understood the operation, structure, and functions of various bioreactors.

CO4- Understood the role of bioprocessing for the production new drugs and vaccines.

Mapping of CO and PO for MMT−301

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3
CO3	3	3	3	2	3	3	2	3	3	2	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT−302
Subject: Medical Microbiology
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives: To introduce and understand the concept of medical microbiology, normal microflora of human body, pathogenicity and epidemiology of infectious diseases, bacterial diseases spread, bacterial zoonoses and biosafety practices in biological sciences.

UNIT I

Introduction to medical microbiology and medically important microorganisms; normal microflora of Human body. Collection, transportation and examination of pathologic specimens. Isolation and identification of pathogenic organism.

UNIT II

Pathogenicity: virulence factors, microbial adherence, spreading and establishment of pathogens. Bacterial toxins-their types. Epidemiology of infection diseases. Food poisoning and Food infections.

UNIT III

Brief account of bacterial diseases spread through air (diphtheria and tuberculosis), food and water (typhoid, cholera, and dysentery), soil (anthrax, tetanus, and gas gangrene) and contact (leprosy, and conjunctivitis). Bacterial zoonoses (bubonic plague and salmonellosis) and protozoal diseases (malaria).

UNIT IV

Nosocomial and emerging microbial infection diseases. Biosafety practices in biological sciences and disposal of biomedical waste. Bio-terrorism. Biological war. Etiology. Epidemiology. Pathogenesis. Symptomology. Pathology. Disease diagnosis and treatment of fungal diseases: Candidiasis, Histoplasmosis, Aspergillosis, Cryptococcosis, and Dermatomycosis.
Different types of techniques for diagnostic of corona. Antimicrobial resistance.

Suggested Readings:

- Murray PR, Rosenthal KS, Kobayashi GS and Pfaller MA (2020) Medical Microbiology. Elsevier. 9th edition.
- Sastry A and Bhat S (2018) Essentials of Medical Microbiology. Jaypee Brothers 2nd edition.
- Sastry A and Bhat S (2018) Review of Microbiology & Immunology. Jaypee Brothers 7th edition.
- Cruikshank R (1965) Medical Microbiology. Churchill Living stone Pub. 11th edition.
- Volk WA, Gebhardt BM, Hammarskjold ML and Kadner R (1995) Essentials of Medical Microbiology. Lippincott Williams and Wilkins. 5th edition.

Course Outcomes:
After completion of the course the learners will be able to:
CO1- Learn the concepts of medical microbiology.
CO2- Understood the pathogenicity and epidemiology of infectious diseases.
CO3- Understood the brief account of bacterial disease spread and protozoal diseases.

CO4- Understood the importance and level of biosafety at laboratory and industrial levels.

Mapping of CO and PO for MMT−302

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	2	3	3	2	3	3	3	3	3
CO3	3	3	3	2	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3	3	3	2	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT−303
Subject: Immunology
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives: This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. A description of cells involved in the immune response either innate or acquired. How the immune system recognizes self from non-self. B and T cell maturation and specific responses.

Unit I

Cells and organs of immune system. Primary, secondary and tertiary lymphoid organs. Types of immunity - Innate and adaptive, Humoral and cell-mediated, Active and passive, PAMP: TLR, Clonal selection theory. Immunological memory, Antigens and immunogens, B and T cell epitopes; Haptens. Structure and functions of antibodies. Classes of immunoglobulins. CDRs, Valence, affinity and avidity. Antibody variants - Isotypes, Allotypes and Idiotypes.

Unit II

The immunoglobulin genes: organization and assembly; generation of immunological diversity; Allelic exclusion. Major histocompatibility complex (MHC): structure and organization of MHC. Antigen processing and antigen presentation. T cell Receptor: Superantigens. B cell activation and maturation. T cell development and activation. Cytotoxic T cell mediated killing. Complement system and mechanism of its fixation. Complement deficiencies. V(D)Jrecombination, somatic hypermutation and class switch recombination of immunoglobulins: mechanism and regulation.

Unit III

Immunological tolerance. Autoimmunity and associated disorders. Allergy and hypersensitivity, types of Hypersensitivity. Transplantation immunology - Graft rejection, graft versus hostreaction. Immune response to infectious diseases – viral, bacterial, protozoal. Immunosuppression - immunodeficiency diseases. Communicative Viral Diseases.

Unit IV

Role of cytokines, lymphokines and chemokines. Vaccine and its different types. Different types of Vaccines for COVID-19. Hybridoma Technology: Production of murine monoclonal antibodies (MoAbs)-Fusion strategies, HAT Selection; Strategies for production of human MoAbs-Humanization and antigenization ofMoAbs-Chimeric, CDR-grafted

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Suggested Readings:

- Punt J, Stranford SA, Jones PP, and Judith AO (2019) Kuby immunology. WH Freeman.8th edition.
- Abbas AK, Lichtman AH, and Pillai S (2016) Cellular and Molecular Immunology.Saunders. 9th edition.
- Male DK, Brostoff J, Roth D, and Ivan R (2012) Immunology. Gower Medical PublishingLondon. 8th edition.
- Gupta SK (2010) Essentials of Immunology. Arya Publication. 2nd edition.
- Khan FH (2009) The Elements of Immunology. Pearson Education India. 1st edition.

Course Outcomes:

After completion of the course the learners will be able to:

CO1- Understood the concept of innate and adaptive immunity.

CO2- Understood the various mechanisms that regulate immune responses and maintain tolerance.

CO3- Elucidated the reasons for immunization and awareness of different vaccination.

CO4- Understood the stages of transplantation response and success of various transplant procedures.

Mapping of CO and PO for MMT−303

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	1	2	3	3	2	3	2	3	2	3	3	3
CO2	3	3	3	3	3	3	2	3	2	2	3	2	3	3	3
CO3	3	3	3	3	3	3	2	3	3	2	3	3	2	2	3
CO4	3	3	3	3	2	3	2	3	3	2	3	3	2	2	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT−304
Subject: Genetics
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives: To develop and demonstrate an understanding of the structure and functionof genes and the organization of the human genome; the patterns of inheritance and clinical manifestations of genetic diseases; chromosomes, chromosomal abnormalities, and the clinical features of common chromosomal disorders.

Unit I

Mendelian vs. Non-Mendelian inheritance, monohybrid and dihybrid crosses, Mendelian Principles-Dominance, Segregation and Independent assortment. Extensions of Mendelian principles: Codominance, Incomplete dominance, Multiple Allelism. Gene interactions-Epistasis, Collaboratory gene action, Duplicate genes, Complementary Gene action, Complementation Test. Pleiotropy. Phenocopy. Probability and Pedigree analysis. Sex limited and sex influenced characters. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL. Extrachromosomal Inheritance, Maternal effect.

Unit II

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction andsex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
Linkage maps, recombination, tetrad analysis (Ordered and unordered Tetrad analysis), mappingwith molecular markers, mapping by using somatic cell hybrids. Linkage Group

Unit III

Cytogenetics: Chromosome: structure and nomenclature, centromere and telomere; Structural andnumerical alterations of chromosomes: Deletion, duplication, Pericentric and Paracentric inversion, Inversion heterozygotes, Inversion homozygotes. Reciprocal and nonreciprocal translocation, Homozygotes as well as Heterozygote Trans locants. Ploidy (Aneuploidy and Euploidy) and their genetic implications.

Unit IV

Mutation: Types, causes and detection, mutant types – lethal, conditional, Base substitution and frame shift Mutation. Biochemical, loss of function, Gain of function, Germinal verses Somatic mutants, Ames Test.
Epigenetics: Introduction, methylation, histone modifications.
Allele frequency, Gene Frequency, Hardy Weinberg Equilibrium

Suggested Readings:

- Gardner EJ (2005) Principles of Genetics. John Wiley & Sons Ltd. 8th edition.
- Tamarin RH (2017) Principles of Genetics. Tata McGraw-Hill Publishing Comp. Ltd. 7th edition.
- Pierce BA (2016) Genetics – A conceptual approach. WH Freeman Company. 6th edition.
- Snustad DP and Simmons MJ (2015) Principles of Genetics. John Wiley and Sons. 7th edition.
- Hartl and Jones (2017) Genetics-Principles and Analysis. Jones & Bartlett. 9th edition.

Course Outcomes:

After completion of the course the learners will be able to:

CO1- Understood the building block for genetics i.e. life cycles of model organisms, basic genetic experiments, polyploidy, and QTL.

CO2- Learn the organization of genome and specialized chromosomes, chromosomal theory of inheritance, linkage, inheritance modes in nature, maternal inheritance, crossing over, and recombination.

CO3- Understood the important hereditary diseases, their inheritance patterns, and pedigree analysis

CO4- Understood the significance and impact of mutations.

Mapping of CO and PO for MMT−304

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	3	2	3	3	3	3	3	2	3	3
CO2	3	3	2	3	2	3	2	3	3	2	3	2	3	3	3
CO3	3	3	2	3	2	3	2	3	3	3	3	3	2	3	3
CO4	3	3	3	3	2	3	2	3	3	3	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT 305
Subject: Lab Course - I (Based on MMT 301−302)
Number of Credits: 3
L P
0 6

1. To study the basis equipment's and other requirements in microbiology lab, their principles and working: Microscope, Autoclave, Laminar Flow Bench, Hot air Over, Incubator, Centrifuge, pH meter, and Spectrophotometer etc.
2. To perform microbial staining techniques (Concept of dyes):
   i. Simple direct staining technique
   ii. Negative staining technique (Capsule staining)
   iii. Differential staining technique-Gram staining technique
3. To prepare culture media-liquid and solid for microbes; preparation of slant, gradient plate, and deep tubes (concept of nutrition).
4. To perform biochemical characterization of microorganisms (Catalase and Oxidase).
5. To perform IMVIC test from the provided bacteria samples.
6. To isolate protease, amylase, and lipase producing strains.
7. To perform efficiency assessment of PGPR (Production of HCN, ammonia, phosphate solubilization antibiotic, and IAA).
8. To perform whole cell and enzyme immobilization.
9. To perform production of alcohol from molasses/cane sugar.
10. To perform production of vinegar.
11. To check the antifungal activity of microbes by dual culture technique.
12. To isolate cellulose producing strains from natural environment.
13. To demonstrate wine production using grape juice.
14. To perform the cultivation of edible mushroom from the provided spawns.

Virtual Labs:
https://www.vlab.co.in
www.vlab.iitb.ac.in/vlab
www.onlinelabs.in www.powershow.com
https://vlab.amrita.edu
https://sites.dartmouth.edu
A minimum of eight practical's should be done from the above-mentioned list.
****** *Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Skills developed:
After the successful completion of this course students will be able to:
CO1- Understood the basis equipment's and other requirements in microbiology lab, their principles, and working.
CO2- Understood different microbial staining techniques, method of preparation of different culture media, and efficiency assessment of PGPR.
CO3- Performed cell and enzyme immobilization technique, produced alcoholic beverages, and isolated cellulose producing strain.

Mapping of CO and PO for MMT−305

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	3	3	3	3	2	3	2	3	3	3
CO2	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	2	3	3	2	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT−306
Subject: Lab Course-II (Based on MMT 303−304)
No. of Credits-3
L P
0 6

1. To perform experiment using ammonium sulphate precipitation of antibodies in serum.
2. To perform experiment on the preparation of antigen -adjuvant (FCA) emulsion.
3. To perform experiment on the collection of blood from mice and separation of serum.
4. To perform experiment on antibody purification from the serum collected from immunized mice: affinity purification/chromatography.
5. To perform experiment on double diffusion and Immune-electrophoresis
6. To perform experiment on radial immune diffusion
7. To perform experiment of Band analysis of different types of plasma antibodies by SDS PAGE
8. To perform agglutination Reaction: a) Tube Agglutination Reaction b) Slide Agglutination Reaction c) Indirect Agglutination Inhibition Reaction
9. To perform experiment for Identification of histological slides of lymphoid tissue - Spleen, thymus, lymph node and bone marrow
10. To perform experiment of Mitosis - Onion root tip squash preparation- Preparation of Karyotypes, Determination of Mitotic index.
11. To perform experiment on Mendelian Inheritance and gene interactions using suitable examples/ seeds
12. To perform experiment on study of Linkage, Recombination, gene mapping using the available data
13. To perform experiment of centromere mapping by tetrad analysis
14. Analysis of pattern of inheritance of given pedigree.
15. Calculation of recombination frequency
16. To perform experiment on Bacterial gene mapping by interrupted conjugation method
17. Calculation of co-transformation and co-transduction frequency
18. Calculation of deviation in phenotypic ratios of different intergenic gene interactions
19. To perform experiment on comparison of ploidy level with respect to given example.

**A minimum of eight practical's should be done from the above-mentioned list.*
** Addition or deletion of the lab experiments can be done as per the availability of resources in lab.*

Skill Developed-
At the end of laboratory course, learners-
CO 1- understood the basic Immunological aspects to be performed in the laboratory.
CO 2- learnt to analyze genetic problems and will be able to approach a research problem statistically.
CO 3-understood the centromere mapping as well as to calculate phenotypic ratios of different gene interactions

Mapping of CO and PO for MMT−305

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3
CO2	3	3	2	3	3	3	3	3	3	3	3	2	2	3	3
CO3	3	3	3	3	3	3	2	2	3	2	2	3	2	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Seminar:
Seminar will be of 30-45minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

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DEPARTMENT OF LIFE SCIENCES

Program M.Sc. (Microbiology)

Mapping of the Courses with the Employability/Entrepreneurship/Skill Development

M.Sc. Microbiology III (Program Code: 758)

Sr. No.	Course Code	Course Name	Employability	Entrepreneurship	Skill Development
1	MMT-301	Industrial Microbiology	√	√	√
2	MMT-302	Medical Microbiology	√	√	√
3	MMT-303	Immunology	√		√
4	MMT-304	Genetics	√		√
5	MMT-305	Lab Course I (based on MMT 301 -302)	√	√	√
6	MMT-306	Lab Course II (based on MMT 303 -304)	√	√	√
7	MMT-307	Seminar	√	√	√
8	XXX	OEC	√		√

SEMESTER-IV

Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MMT−401	Food Microbiology	4			25	75	100	4	DCC
2	MMT−402	Environmental and Agricultural Microbiology	4			25	75	100	4	DCC
3	MMT−403	Plant Pathogen Interaction	4			25	75	100	4	DCC
4	MMT−404	Lab Course-I (Based on MMT 401)			6	30	70	100	3	DCC
5	MMT-405	Lab Course-II (Based on MMT 402−403)			6	30	70	100	3	DCC
6	MMT-406	Project Report	0	0	10	-	-	100	6	
	Total							**600**	**24**	

Course Code: MMT−401
Subject: Food Microbiology
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives: To understand the concept of food microbiology, milk microbiology, bio preservation and food safety legislations, food borne infections and intoxications, and applications of microbes for different types of food production.

Unit I

Historical development and applications of food microbiology. Major food-born outbreaks in past. Microorganisms (bacteria, molds, yeast, and viruses) in food microbiology. Food safety, Food safety objectives (FSO). Food legislation: Enforcement and Govt. Regulatory practices and policies. FDA, EPA, HACCP, FSA, FSSAI act.

Unit II

Fermented and non-fermented milk products. Microbiological examination of milk and milk products. Legal standards for milk and milk products. Starter culture (Dairy and Meat Industry). Fermented meat, beef and poultry products. Microbiology of lactic cultures. Dairy products and their manufacturing. Plant-based products. Food beverages. Microbial spoilage of different foods.

Unit III

Different methods of food preservation: Freezing, Dehydration, Lyophilization, Temperature, filtration and use of chemical preservatives. Food borne infections. Bacterial food poisoning (*Staphylococcus, Bacillus, Escherichia coli, Vibrio cholera, Clostridium* etc.). Fungal food poisoning (*Aspergillus, Penicillium, Fusarium* etc.). Protozoan food poisoning (*Antamoeba and Giardia* etc.).

Unit IV

Microorganisms as food: Single cell protein, algae as food, and mycoprotein from fungi for use as food and feed. Industrially used SCP. Advantages of SCP. Mushroom production and its applications. Fruit and vegetable processing. Nutraceuticals: Probiotics and Prebiotics. Genetically engineered food products. Detection of microorganisms in food- conventional methods and Recent Methods . Food safety and Food security.

Suggested Readings:

- Garbult J (1997) Essentials of Food Microbiology. Arnold International Students. 2nd edition.
- Aneja KR, Pranay J, and Raman A (2008) A Text-book of Basic and Applied Microbiology. New Age International Publishers. 1st edition.
- Aneja KR and Mehrotra RS (2011) Fungal Diversity & Biotechnology. New Age International Publishers. 1st edition.
- Adams MR and Moss MO (2007) Food Microbiology. Royal Society of Chemistry Publication Cambridge. 3rd edition.
- Frazier WC and Westhoff DC (1998) Food Microbiology. Tata McGraw Hill Publishing Company Ltd. 18th Edition.

Course Outcomes:

After completion of the course the learners will be able to:

CO1- Understood the concepts of food microbiology.

CO2- Understood the concept of food safety objectives, regulatory practices, and policies.

CO3- Understood the brief account of food-borne infections and preservation methods.

CO4- Understood the applications of food microbiology.

Mapping of CO and PO for MMT−401

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	3	2	3	3	3	2	3	3	3	3
CO2	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT−402
Subject: Environmental and Agricultural Microbiology
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam-:75
Sessional: 25

Course Objectives: The main goal of this course is to introduce the concept of microbial diversity with reference to the environmental aspects. Student will learn about the basic microbiological principles, the methods used in microbial ecology for solid and liquid treatments and their practical applications.

Unit I

Basics of Environmental Microbiology**.** Microbial diversity in terrestrial, aquatic, atmospheric, stratosphere, and animals. Microbial diversity in extreme environment: thermophiles, psychrophiles, oligotrophs, alkaliphiles, acidophiles, and metallophiles etc. Microbial ecology of Soil.

Unit II

Microbiology of degradation of Xenobiotics in Environment Ecological considerations, decay behavior & degradative plasmids. Hydrocarbons, substituted hydrocarbons, oil, pollution, surfactants, pesticides, Bioremediation of contaminated soils and waste land. Biopesticides in integrated pest management. Solid wastes; sources and management (composting wormiculture and methane production). Lignin degradation: Lignocellulolytic microorganism and their biotechnological applications.

Unit III

Bioformulations: Biofertilizers and Biopesticides (Bacillus and Trichoderma). Mass cultivation of microbial inoculants; green manuring; Microbial products and plant health: PGPR (plant growth promoting rhizobacteria).
Microbial Diversity Identification from Rhizosphere: Molecular methods of identification-DGGE, TGGE, T-RFLP, 16sDNA gene sequencing, Metagenomics and RNA sequencing. Microbial communication system; Quorum sensing

Unit IV

Eco physiological interactions in microbes & higher plants- Interaction with plant roots, interaction with aerial plant structures microbial diseases of plant with specific examples of mycorrhiza, Lichens, Rhizobacteria. Phosphate solubilizing bacteria and fungi (including mycorrhiza), potassium solubilizing bacteria and fungi (including mycorrhiza).

Suggested Readings:

- Atlas RM and Bartha R (1993) Microbial Ecology: Fundamentals and Applications. Benjamin Cummings Publishing Co. 3rd Edition.
- Varnam AH and Evans MG (2000) Environmental Microbiology. Manson Publishing Ltd. 1st edition.
- Christon JH, Ronald L, Garland JL, Lipson DA, Aaron LM, and Stetzenbach LD (2007) Manual of Environmental Microbiology. Wiley-Blackwell. 3rd edition.
- Grant WD and Long PE (1981) Environmental Microbiology. Springer US. 1st edition.
- Mitchel R and Ji-Dong G (2009) Environmental Microbiology. Wiley-Blackwell. 2nd

edition.

Course Outcomes:
After completion of the course the learners will be able to:
CO1- Understood the diverse roles of microorganisms in natural environments and their relationship.
CO2- Understood the processes involved in treatment of waste water.
CO3- Acquired knowledge of bioremediation and its related applications.
CO4- Understood the extreme habitats in which organisms survive.

Mapping of CO and PO for MMT−402

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT−403
Subject: Plant-Pathogen Interactions
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives: Students will get basic knowledge about the subject of plant pathology, its concepts, and principles. To acquaint with different strategies for managing plant diseases.

Unit I

Introduction to the concept of plant pathogen interaction. Effect of microbial infections (bacterial, fungal and viral) on plant physiology of crops with special focus on cereal crops (rice and wheat), pulse crop (soybean and pigeonpea), cash crops (cotton and sugarcane), and oilseed crop (mustard and sunflower).

Unit II

Host parasite interaction. Recognition concept and infection. Symptomatology. Disease development- role of enzymes, toxins, growth regulators. Defense strategies- oxidative burst; Phenolics, Phytoalexins, Pathogenesis Related (PR) proteins, and Elicitors. Altered plant metabolism as affected by plant pathogens.

Unit III

Biological control of plant pathogen using bacteria, fungi and viruses. *B, thurinigiensis* as microbial pesticides. Nuclear polyhedrosis virus as pesticides and concept of mycopesticides. *Trichoderma* as biopesticides. Cell wall degrading enzymes. Siderophores, Biosurfactants, Mycoparasitism, Nematophagy, and Mycophagy.

Unit IV

History and important milestones in disease control. Disease forecasting and its relevance in Indian farming. Commercial production of antagonistic bacteria, their delivery systems, application and monitoring. Biological control in integrated disease management (IDM) and organic farming system. Biopesticides available in market. Quality control system of biocontrol agents. Marketing strategies of biopesticides.

Suggested Readings:

- George NA (1969) Plant pathology. Academic Press. 5th edition.
- Mehrotra RS and Agrawal A (2017) Plant Pathology. McGraw–Hill Education. 3rd edition.
- Mehrotra RS and Agrawal A (2017) Fundamentals of Plant Pathology. McGraw–Hill Education. 1st edition.
- Sigee DC (2014) Bacterial Plant Pathology: Cell and Molecular Aspects. Prashant Book Agency. 1st edition.
- Basu AN and Giri BK (1993) The essentials of Viruses, Vectors and Plant diseases. Wiley Eastern Limited. 1st edition.

Course Outcomes:

After completion of the course the learners will be able to:

CO1- Developed detail insight on the relationship between plant-pathogen interactions.

CO2- Understood the diverse mechanisms opted by microbes for biological control of plant pathogens
CO3- Understood the role of disease forecasting helping in detecting pathogenesis.
CO4- Developed a scientific understanding regarding bacteria, fungal, and viral infections of plants.

Mapping of CO and PO for MMT−403

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	3	3	3	3	3	2	3	3	3	3
CO2	3	3	2	3	2	3	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	2	3	3	2	2	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT 404
Subject: Lab Course - I (Based on MMT 401)
Number of Credits: 3
L P
0 6

1. To perform preparation and sterilization of culture media: Nutrient agar, Potato dextrose agar (PDA) etc.
2. To perform different isolation techniques:
   i. Pour plate
   ii. Spread plate
   iii. Streak plate
3. To perform microbiological analysis of food products.
4. To perform enzymatic test of milk by methylene blue reductase test.
5. To isolate clinically important microorganisms from samples.
6. To perform characterization of microorganisms: Culture characteristics and staining.
7. To study effect of UV radiations on the micro-organisms.
8. To perform Antibiotic susceptibility tests by disc diffusion and well diffusion method.
9. To perform determination of minimal inhibitory concentration (MIC) and MBC.
10. To perform isolation of microflora from human skin.
11. To perform isolation of microflora from human throat.
12. To check beta hemolysis on blood agar medium.

****A minimum of eight practical's should be done from the above-mentioned list.***
*** **Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course Outcomes:
After the successful completion of this course students will be able to:
CO1- Understood the preparation and sterilization of culture media and different isolation techniques.
CO2- Understood methods for the characterization of clinically important microorganisms, their characteristics, and staining techniques.
CO3- Understood antibiotic susceptibility test, minimum inhibitory concentration, and well diffusion method.

Mapping of CO and PO for MMT−404

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	3	3	3	2	2	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT 405
Subject: Lab Course - II (Based on MMT 402-403)
Number of Credits: 3
L P
0 6

1. To perform detection of dissolved oxygen of water.
2. To perform determination of BOD from given water sample.
3. To perform determination of total dissolved solids of water.
4. To perform determination of COD from provided water sample.
5. To perform presumptive test for coliform bacteria.
6. To perform confirmed and completed test for coliform bacteria.
7. To perform detection of Coliform and *E. coli* from sewage sample.
8. To perform construction of Winodgradsky column for monitoring gradients of microorganism (chemotrophs).
9. To perform the growth kinetics experiment of the provided bacterial samples using spectrophotometer.
10. To perform isolation of aquatic plant pathogen by baiting technique.

****A minimum of eight practical's should be done from the above-mentioned list.***
*** ***Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course Outcomes:
After the successful completion of this course students will be able to:
CO1- Understood different biochemical parameters used for estimating water quality of samples.
CO2- Learn different techniques for isolating various plant pathogens.
CO3- Understood different physiochemical analysis used nowadays for detection of coliforms.

Mapping of CO and PO for MMT−405

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

Course Code: MMT-406
Subject: Project Report
No. of credits: 6

Course Objectives:
The objective of this course is to provide students with a hands-on training in specialized area of sciences.

Contents:
- The student will be reading and analysing the published information in the chosen area of science under direct mentoring of a faculty member and will participate in research activity.
- Preparation and submission of Review article.

Course Learning Outcomes:
Students will acquire the following:
- Knowledge on techniques and tools of research.
- Quantitative and qualitative data analysis.
- Analysis and interpretation of data in the perspective of existing knowledge.

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DEPARTMENT OF LIFE SCIENCES

Program M.Sc. (Microbiology)

Mapping of the Courses with the Employability/Entrepreneurship/Skill Development

M.Sc. Microbiology IV (Program Code: 758)

Sr. No.	Course Code	Course Name	Employability	Entrepreneurship	Skill Development
1.	MMT- 401	Food Microbiology	√	√	√
2.	MMT- 402	Environmental and Agricultural Microbiology	√	√	√
3.	MMT-403	Plant Pathogen Interaction	√		√
4.	MMT-404	Lab Course I (based on MMT 401)	√	√	√
5.	MMT-405	Lab Course II (based on MMT 402)	√	√	√
6.	MMT-406	Project Report	√	√	√