Annexure –4.4

SAGE University, Bhopal

School of Sciences

M.Sc. (MICROBIOLOGY)

II Year Syllabus

SESSION: 2020-21

M.Sc. MICROBIOLOGY

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1 To provide in-depth knowledge about core areas of Microbiology.

PEO2 To make students competent in the field of microbiology and allied areas by providing them hands on experience in basic techniques.

PEO3 To instill the ability for research and entrepreneurship in the students along with professional ethics and communication skills.

PEO4 To inculcate and promote knowledge technical skills in core areas of biological sciences.

PEO5 To inspire the students to pursue higher education and research in reputed institutes at national and international level in the field of science.

PROGRAM OUTCOMES (POs)

The degree programs offered at the Department of Biosciences empowers research-based in-depth study of Microbiology.

PO1 It equips the student to work independently in laboratory.

PO2 The student will have a conceptual understanding of Microbiology.

PO3 The student will gain the laboratory skills of high standards.

PO4 Student will be able to critically evaluate and analyze experimental data.

PO5 Student will gain skills in science communication both verbal and written.

PO6 Comprehend the scientific articles, present scientific topics and research results in spoken and written forms, both.

PO7 It allows having a thorough perseverance and competency in specific areas of Microbiology in addition to a broad-based integrative standing of basic biological concepts.

PO8 It endows the understanding of research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PO9 To provide students with an understanding of the role of microbiology in societal development.

PO10 Comprehensive knowledge of microbiology and skills to analyze problems involving different biological techniques.

CURRICULUM COMPONENTS OF M. Sc. BIOTECHNOLOGY

Components	Credits
Program Core (18 Courses)	**72**
Program Elective (Discipline Electives) (06Courses)	**24**
Program Elective (Generic Electives) (04 Courses)	**08**
Ability & Skill Development (Ability Enhancement Courses) (04 Courses)	**10**
Ability & Skill Development (Skill Enhancement Courses) (06 Courses)	**12**
Project-Based Learning (PBL)/MOOCs (04 courses)	**08**
Project (02 Courses)	**10**
Total	**144**

SCHEME
M.Sc. MICROBIOLOGY

	Semester First															
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Weightage (Theory)**						**Weightage (Practical)**			**Total**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**TOT**	**CE^**	**ESE**	**TOT**	**GT**
MB20M101	General Microbiology	4	-	-	4	3	30	05	05	10		100	-	-	-	100
MB20M102	Microbial Physiology and Metabolism	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M103	Microbial Genetics	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M104	Biochemical and Molecular Techniques	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
Refer Table 1	DSE- I	3	-	-	3	3	30	05	05	10	50	100	-	-	-	100
MB20M107	LAB- I	-	-	4	2	2	-	-	-	-	-	-	50	50	100	100
MB20M108	LAB- II	-	-	4	2	2	-	-	-	-	-	-	50	50	100	100
PB20M101	Project Based Learning-I	-	-	4	2	2	-	-	-	-	-	-	50	50	100	100
Total					**25**											**800**

^Two assessment by panel of expert

L-Lecture, T-Tutorial, P-Practical, ESE-End Semester Exam. MSE- Mid Semester Exam, ASG- Assignment, TA- Teacher's Assessment, ATTD-Attendance, TOT-Total, CE-Continuous Evaluation, GT- Grand Total

	Semester Second															
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Weightage (Theory)**						**Weightage (Practical)**			**Total**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**TOT**	**CE^**	**ESE**	**TOT**	**GT**
MB20M201	Microbial and Enzyme Technology	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M202	Immunology	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M203	Bioinformatics	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M204	Medical Microbiology	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
Refer Table 2	DSE- II	3	-	-	3	3	30	05	05	10	50	100	-	-	-	100
MB20M207	LAB- III	-	-	4	2	2	-	-	-	-	-	-	50	50	100	100
MB20M208	LAB- IV	-	-	4	2	2	-	-	-	-	-	-	50	50	100	100
PB20M201	Project Based Learning- II	-	-	4	2	2	-	-	-	-	-	-	50	50	100	100
Total					**26**											**800**

^Two assessment by panel of expert

L-Lecture, T-Tutorial, P-Practical, ESE-End Semester Exam. MSE- Mid Semester Exam, ASG- Assignment, TA- Teacher's Assessment, ATTD-Attendance, TOT-Total, CE-Continuous Evaluation, GT- Grand Total.

	Semester Third															
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Weightage (Theory)**						**Weightage (Practical)**			**Total**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**TOT**	**CE^**	**ESE**	**TOT**	**GT**
MB20M301	Bioprocess Engineering & Technology	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M302	Agricultural Microbiology	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M303	Food and Dairy Microbiology	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M304	Environmental Microbial Technology	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
Refer Table 3	DSE- III	3	-	-	3	3	30	05	05	10	50	100	-	-	-	100
MB20M307	LAB- V	-	-	8	4	2	-	-	-	-	-	-	100	100	200	200
PB20M301	Project Based Learning- III	-	-	4	2	2	-	-	-	-	-	-	50	50	100	100
Total					**25**											**800**

^Two assessment by panel of expert

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	Semester Fourth															
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Weightage (Theory)**						**Weightage (Practical)**			**Total**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**TOT**	**CE^**	**ESE**	**TOT**	**GT**
Refer Table 4	DSE-IV/ MOOC- I	4	-	-	4	3	30	05	05	10	50	100	-	-	-	100
MB20M402	Project	-	-	40	20	3	-	-	-	-	-	-	250	250	500	500
Total					**24**											**600**

^Two assessment by panel of expert

L-Lecture, T-Tutorial, P-Practical, ESE-End Semester Exam. MSE- Mid Semester Exam, ASG- Assignment, TA- Teacher's Assessment, ATTD-Attendance, TOT-Total, CE-Continuous Evaluation, GT- Grand Total.

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LIST OF DISCIPLINE SPECIFIC ELECTIVES (DSE)

Table 1: Semester One (DSE- I)		
S.No.	**Course Code**	**Course Title**
1.	**MB20M105**	Cell and Molecular Biology
2.	**MB20M106**	Genetics

Table 2 : Semester Second(DSE- II)		
S.No.	**Course Code**	**Course Title**
1.	**MB20M205**	Genetic Engineering
2.	**MB20M206**	Molecular Diagnostics

Table 3 : Semester Third(DSE- III)		
S.No.	**Course Code**	**Course Title**
1.	**MB20M305**	Microbial Diversity and Ecology
2.	**MB20M306**	Intellectual Property Rights, Bio-safety and Bioethics

Table 4 : Semester Fourth(DSE- IV)		
S.No.	**Course Code**	**Course Title**
1.	**MB20M401**	Applied Microbiology
2.	**MB20M403**	Python
		MOOC- I

Syllabus
SEMESTER – I

Core Course-I

COURSE CODE	GENERAL MICROBIOLOGY	Total Lec.:60
MB20M101		**4 – 0 – 0**
Learning Objectives	• The objectives of this course are to introduce the students to the field of microbiology. with special emphasis on microbial diversity, morphology, physiology and nutrition; • Methods for control of microbes and host-microbe interactions.	
Pre-requisite	Nil.	
UNIT	**CONTENT**	**HOURS**
I	Introduction, history and scope of Microbiology. General characteristics and composition of prokaryotes and eukaryotes. classification of microorganisms: haekel's three kingdom concept, whittaker's five kingdom concept, three domain concept of carl woese , classification and salient features of bacteria according to bergeys manual of determinative bacteriology. Nomenclature and modern methods of bacterial taxonomy.	14
II	Morphology and ultra-structure of bacteria: size, shape, and arrangement of bacteria, ultra structure of bacterial cell wall of eubacteria and archeabacteria. Protoplast and spheroplast formation and L-form.Components external to cell wall: Structure and function of flagella, fimbriae and pilli, capsule- types, composition and function, slime layers, S-layers. Prokaryotic cell membrane and cytoplasmic matrix – cell membrane structure and function of bacteria and archeabacteria, mesosomes, ribosomes, cytoplasmic inclusion bodies (polyhydroxy butyrate, polyphosphate granules, oil droplets, cyanophycin granules) and nucleoid. Bacterial response to external stimulus and bacterial endospores:	12

	Chemotaxis and phototaxis structure, formation and germination of bacterial endospore.	
III	Bacterial nutrition: Basic nutritional requirements, growth factors, nutritional categories, physical requirements of bacterial growth. Bacteriological media: types (complex, synthetic, differential, enrichment and selective media) and their uses, culture characteristics of bacteria on different media. Cultivation of bacteria: aerobic and anaerobic culture, pure culture techniques, shaker and still culture, maintenance and preservation of microbial culture.Bacterial growth: growth kinetics, growth curve. Batch, continuous and synchronous culture. Measurement of growth and influence of environmental factors affecting growth.	12
IV	General concept of Prokaryotic and Eukaryotic genome. Genome of *E. coli*. Genetic recombination and transformation. Transduction: generalized and specialized transduction, phage conversion. Plasmid: types and their significance, conjugation and chromosomal mobilization. *E. coli* as model prokaryotes.	10
V	Staining methods: fixation, types of dyes, simple staining, differential staining (Gram and Acid-fast staining), staining of specific structures (capsule, flagella and spore staining), control of microorganisms: microbial death curve, concept of bio-burden, thermal death time and decimal reduction time. Factors influencing the effectiveness of antimicrobial agents. Control of microorganisms by physical agents: heat (moist and dry), filtration and radiation. Chemical control of microorganisms: halogens, phenol and other phenolic compounds, heavy metals, alcohols, ethylene oxide and aldehydes.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will understand the relevance2 of historical events and major discoveries in microbiology.	
CO2	They will be able to critically **evaluate**[5]the diversity in microbiology.	
CO3	Students will **understand** [1] the scope of Microbiology and nutritional requirements of microbes.	
CO4	Students will **understand**[2]the diversity and correlate with taxonomic classification of microorganisms.	
CO5	Students will be able to **understand**[2] various physical and chemical control methods of Microbes.	
Text Books:	• J Pelczar, ECS Chan and NR Krieg, Microbiology. 5th edition,1993, McGraw Hill M Book Company. • GJ Tortora, BR Funke and CL Case,Microbiology: An Introduction. 9th edition, 2008, Pearson Education. • C P Baveja , Textbook of Microbiology.6thedition, 2019, Arya Publication. • DK Maheshwari, Text Book of Micribiology . 6thedition, 2013,S Chand.	
Reference Books:	• J Cappucino and N Sherman, Microbiology: A Laboratory Manual. 9th edition,2010, Pearson Education Limited. • J M Wiley, L M Sherwood and Woolverton, C J Prescott's, Microbiology. 9th edition2013, McGraw Hill International. • R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. • R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology. 5th edition, 2005, McMillan. • H F Lodish ,Molecular Cell Biology 8th edition, 2016, New York: W.H. Freeman.	

	• J EKrebs, B Lewin, S T Kilpatrick, Goldstein, Lewin's Genes XI, 2014, Sudbury: Jones and Bartlett.

Core Course-II

COURSE CODE	MICROBIAL PHYSIOLOGY AND METABOLISM	Total Lec.:60
MB20M102		**4 – 0 – 0**
Learning Objectives:	• The objectives of this course are to introduce the students to the field of microbiology with special • Emphasis on microbial diversity, morphology, physiology and nutrition; • Metabolic pathways in Microbes	
Pre-requisites	Microbiology/ General Microbiology.	
UNIT	**CONTENT**	**HOURS**
I	Growth and cell division: Measurement of growth, growth physiology, cell division,growth yields, growth kinetics, steady state growth and continuous growth.	10
II	Solute Transport: Introduction; Primary and Secondary transport; Kinetics; Membrane transport protein- Porins and aquaporins, mechano-sensitive channels; ABC transporter; Group translocation PEP-PTS system; catabolite repression; inducer exclusion and inducer expulsion.	10
III	Central Metabolic Pathways and Regulation: glycolysis and its regulation; Gluconeogenesis; Pentose-Phosphate Pathway; Entner-Doudoroff Pathway; Citric AcidCycle; alternate TCA; Glyoxylate Pathway and its regulation. Examples of pathway engineering of carbon metabolic pathways to develop industrial useful strains: Co-metabolism of pentoses and hexoses; Succinic and citric acid production. Nitrogen metabolism: Inorganic Nitrogen assimilation-nitrate and ammonia assimilation; Regulation of glutamate synthetase; General reaction of amino acid and Stickland reaction; Glutathione – Distribution in Bacteria; Biosynthesis and role in redox regulation; Outline of amino acid biosynthesis; protein utilization; detail account on biochemistry of glutamate producing strains. Enzymes: Introduction, activation energy, enzyme kinetics, significance of Km, catalytic efficiency, turnover number. Methods of plotting enzyme kinetics data: Lineweaver –Burk plot, saturation kinetics. Enzyme inhibition, models and type of inhibition.	16
IV	Metabolism of lipids: Biosynthesis and degradation of lipids and its regulation in E.coli; Lipid accumulation in yeast. Metabolism of nucleotides: Purine and pyrimidine biosynthesis; deoxyribonucleotide synthesis; regulation of purine and pyrimidine biosynthesis; inhibitors of nucleotide biosynthesis. Physiological Adaptation and Intracellular signaling: Introduction to two component system; response to physiological stress: aerobic-anaerobic shifts-Arc and Fnrsystem;osmotic homeostasis; response to nutritional stress: phosphate supply- Pho regulon; and stringent response.	14
V	Commercial products of microbes: Antibiotics, biopolymers, biosensors, biopesticides Production of biofuels.Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, and anticancer, antifungal, antiplasmodial, anti-inflammatory compounds.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **identify**[3] the major categories of microorganisms and analyze their classification, diversity, and ubiquity.	
CO2	They will be able to identify and **demonstrate**[2] the structural, physiological, and genetic	

	similarities and differences of the major categories of microorganisms
CO3	Students will be able toidentify and **demonstrate[2]** how to control microbial growth.
CO4	They will be able to **demonstrate[2]** and evaluate the interactions between microbes, hosts and environment
CO5	Students will be able to**apply[3]**the concepts learntto health and disease.
Text Books:	• J Pelczar, E C S Chan and N R Krieg, Microbiology. 5th edition,1993, McGraw Hill M Book Company • GJ Tortora, BR Funke and CL Case,Microbiology: An Introduction. 9th edition, 2008, Pearson Education. • C P Baveja , Textbook of Microbiology. 6th edition, 2019, Arya Publication. • D K Maheshwari, Text Book of Microbiology. 6th edition, 2013, S Chand.
Reference Books:	• J Cappucino and N Sherman, Microbiology: A Laboratory Manual. 9th edition, 2010, Pearson Education Limited. • J M Wiley, L M Sherwood and Woolverton, C J Prescott's, Microbiology. 9th edition 2013, McGraw Hill International. • R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. • R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology. 5th edition, 2005, McMillan • H F Lodish ,Molecular Cell Biology 8th edition, 2016, New York: W.H. Freeman. • J EKrebs, B Lewin, S T Kilpatrick, Goldstein, Lewin's Genes XI, 2014, Sudbury: Jones and Bartlett.

Core Course-III

COURSE CODE	MICROBIAL GENETICS	Total Lec.:60
MB20M103		**4– 0 – 0**
Learning Objectives::	• This course enables student to understand fundamental principles of Microbial genetics. • Concepts of gene transfer in microbes. • Mutational analysis. • Genetic analysis.	
Pre-requisites:	None.	
UNIT	**CONTENT**	**HOURS**
I	Genetic analysis of bacteria: Importance and uses of mutation analysis. Inheritance in bacteria, types of mutations, spontaneous and induced mutagenesis, isolating mutants, selecting mutants, mutant enrichment. Reversions versus suppression.Complementation tests, recombination tests and gene replacements. Cloning genes by complementation. Cloning genes by marker rescue.	10
II	Gene transfer and mapping by conjugation: Basis of fertility in bacteria. Self transmissable and mobilizable plasmids. Molecular mechanism of gene transfer by conjugation – genes and proteins involved. Regulation of gene transfer by conjugation. Hfr strains. Mapping bacterial genomes using Hfr strains. Chromosomal DNA transfer by plasmids – by integrated plasmids, by chromosome mobilization and by creation of prime factors. Transfer systems in gram positive bacteria. Ti plasmid transfer system and its application in creating transgenics Lytic bacteriophages: Lytic development cycle using phages T4 and T7 as models. Regulation of expression of genes in phage T4 – transcriptional activators, anti-termination, a new sigma factor and replication-coupled transcription. Regulation of gene expression in phage T7 – a phage-encoded RNA polymerase. Replication of T4 versus T7 phages – recent advances. Replication and packaging of filamentous phages M13 and f1 – recent advances. Genetic analysis of phages – complementation and recombination tests with phages. Genetic experiments with the rII genes of phage T4. Deciphering the genetic code using rII mutants. Constructing phage genetic linkage maps using two-factor and three factors crosses.	15
III	Gene transfer by transformation and transduction: Natural transformation andcompetence. Molecular basis of natural transformation – DNA uptake competence systems in gram positive and gram negative bacteria. Regulation of competence in B.subtilis. Importance of natural transformation. Artificially induced competence. Generalized versus specialized transduction - T4 and lambda phage. Mapping bacterial genes by transduction.	10
IV	Lambda phage – gene and promoter organization. Lambda lyticcyle – regulation of gene expression – very early, early and late genes. Establishment and maintenance of lysogeny. Regulation of gene expression in lysogenic phase – role of cI, cII and cIII proteins. Lambda immunity region and immunity to superinfection. Events leading to induction – role of cI and cro repressors in regulating the events. Other lysogenic phages – P2 and P4. Lysogenic phages and bacterial pathogenesis Transposons:	15

	Discovery of transposition. Classes of bacterial transposons. Regulation of transposition activity. Effects of transposition in bacteria. Genetic requirements for transposition.	
V	Assays to analyze transposition events – suicide vectors and mating outassays. Molecular mechanisms of transposition – genetic evidence supporting the mechanisms. Conjugative transposons. Transposon mutagenesis. Cloning out genes by transposon mutagenesis. Mu transposon, Mud transposons and gene fusions, mini-Mu elements and their use in in vivo cloning. Yeast Ty-1 transposon. Site-specific recombination – loxP-Cre system, phase variation system in Salmonella. Gene regulation: Control of gene expression. Positive gene regulation, negative gene regulation and attenuation, using the lac, gal, trp, ara and tol operons. Model organisms used in genetic studies: yeast (Saccharomyces Cerevisiae), fruitfly (Drosophilamelanogaster), nematode worm (Caenorhabditiselegans), mouse (Musmusculus), Arabidopsis (Arabidopsis thaliana).	10

Course Outcomes as per Bloom's Taxonomy	
CO 1	Students will be able to**understand**[2]genetic mutations and analysis of mutation
CO 2	They will **understand**[2]the types of gene transfer and of regulation and mis-regulation
CO 3	Students will be able tocritically **evaluate**[4]gene transfer mechanisms.
CO 4	They will**know**[2]the scope of flow of genetic information.
CO 5	They willbeable to **design**[6] experiments to manipulate cellular and molecular processess
Text Books:	• J Pelczar, E C S Chan and N R Krieg, Microbiology. 5th edition,1993, McGraw Hill M Book Company • GJ Tortora, BR Funke and CL Case,Microbiology: An Introduction. 9th edition, 2008, Pearson Education. • C P Baveja , Textbook of Microbiology. 6th edition, 2019, Arya Publication. • D K Maheshwari, S Chand, Text Book of Microbiology.6th edition, 2013.
Reference Books:	• J Cappucino and N Sherman, Microbiology: A Laboratory Manual. 9th edition, 2010, Pearson Education Limited. • J M Wiley, L M Sherwood and Woolverton, C J Prescott's, Microbiology. 9th edition 2013, McGraw Hill International. • R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. • R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology. 5th edition, 2005, McMillan • H F Lodish ,Molecular Cell Biology 8th edition, 2016, New York: W.H. Freeman. • J EKrebs, B Lewin, S T Kilpatrick, Goldstein, Lewin's Genes XI, 2014, Sudbury: Jones and Bartlett.

Core Course-IV

COURSE CODE	BIOCHEMICAL AND MOLECULAR TECHNIQUES	Total Lec.:60
MB20M104		**4 – 0 –0**
Learning Objectives	• The objective of this laboratory course is to introduce students to experiments in biochemistry. • The course is designed to teach students the utility of set of experimental methods in biochemistry in a problem oriented manner.	
Pre-requisites	Basics of biochemistry and molecular biology.	

UNIT	CONTENT	HOURS
I	Introduction to Biochemical and Molecular techniques. Microscopy:Phase contrast, confocal, fluorescence, scanning& transmission electron microscopy.	5
II	Molecular analysis: DNAIsolation and purification: (a) genomic and plasmid DNA, (b) RNA, (c) proteins. PCR, Principles, types of PCR. DNA sequencing: Various methods of DNA sequencing- Protocols and strategies for c-DNAcloning, analysis of genomic DNA by southern hybridization, amplification of DNA by the polymerase chain reaction, preparation of radio-labeled DNA and RNA probes, synthetic oligonucleotide probes, expression of cloned genes in cultured cells, screening expression with antibodies and oligonucleotides. Rapid DNA sequencing methods; Maxam-Gilbert technique, Sanger's Dideoxynucleotide sequencing, gene walking, foot printing, RNA sequencing.	15
III	Applied Molecular Techniques: Blotting: Principles, types of blotting, immunoblotting- Southern, Northern, Western and Dot blots. Gene silencing: RNA interference (RNAi).Knockout, Knockdown.	5
IV	Biochemical Analysis: Chromatography &Spectroscopy: Gel filtration, ion exchange & affinity chromatography, TLC, HPLC, GC basic conceptElectrophoresis and Isoelectric focusing (IEF): Polyacrylamide gel electrophoresis (PAGE), agarose gel electrophoresis, Native PAGE, SDS-PAGE, 2D electrophoresis, mass spectrometry Principles, kinds of pH gradients used in IEF-free carrier ampholytes, immobilized pH gradients.	15
V	Bioinformatics: Databases, sequence analysis, phylogenetic inference package, sites andcentres.	5

Course Outcomes as per Bloom's Taxonomy

CO 1	Students will**understand**[2]properties of biomolecules that are used for their analysis.
CO 2	They will understand the principle **concepts** in using analytical and preparatory techniques.
CO 3	Students will**understand**[2] and **analyze**[2]to quantify and assay for a biomolecule.
CO 4	The student will be able to handle the equipment available and **identify**[2]the suitable and appropriate **experiments** for their research.
CO 5	The student would have gained sufficient **knowledge**[2] about the assays and analyzing data.
Text Books:	• J M Berg, J L Tymoczko and L Stryer, Biochemistry VI edition 2006, W.H Freeman. • U Satyanarayana, Biochemistry V edition 2017, Elsvier.
Reference Books:	• H F Lodish ,Molecular Cell Biology 8th edition, 2016, New York: W.H. Freeman. • J EKrebs, B Lewin, S T Kilpatrick, Goldstein, Lewin's Genes XI, 2014, Sudbury: Jones and Bartlett.

Discipline Specific Electives-I

COURSE CODE	CELL AND MOLECULAR BIOLOGY	Total Lec.: 45
MB20M105		3– 0 –0
Learning Objectives:	• 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. • Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek.	
Pre-requisites	None.	

UNIT	CONTENT	HOURS
I	Dynamic Organization of a cellUniversal features of cells; cell chemistry and biosynthesis: chemical organization ofcells; internal organization of the cell - cell membranes: structure of cell membranesand concepts related to compartmentalization in eukaryotic cells; intracellularorganelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes,ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.	8
II	Chromatin Structure and dynamicsChromatin organization - histone and DNA interact genome: 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, trancriptional 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), protein translation machinery, ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code translation product cleavage, modification and activation.	12
III	Cell Signalling and traffickingMolecular mechanisms of membrane transport, nuclear transport, transport acrossmitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmicreticulum through Golgi apparatus to lysosomes/cell exterior.	10
IV	Manipulating and studying cells, Isolation of cells and basics of cell culture; observing cells under a microscope, differenttypes of microscopy; analyzing and manipulating DNA, RNA and protein.	10
V	Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; celldifferentiation: stem cells, their differentiation into different cell types and organizationinto specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans membrane signalling; cell motility and migration; cell death: different modes of cell deathand their regulation.	5

Course Outcomes as per Bloom's Taxonomy

CO1	**Students will understand**[2] cell structure and organization

CO2	They will be able to critically **evaluate** the diversity in structure function relationship of cellular components
CO3	They will know the scope of cell biology and **understand**[2] the flow of genetic information.
CO4	They will **understand**[2]the cellcycle and implications of regulation and misregulation
CO5	They will be able to apply knowledge gained to **design**[5] experiments to manipulate cellular and molecular processes.
Text Books:	• G M Cooper, R E Hausman, The Cell: a Molecular Approach 6th edition, 2013, Sunderland. • J Hardin, G Bertoni, Becker's World of the Cell 8th edition, L J Kleinsmith& W. M Becker, 2012, Benjamin Cummings.
Reference Books:	• B Alberts, B Johnson, A Lewis, J Raff, M Roberts, P Walter, Lewins Gene VI 2008, New York: Garland Science. • H F Lodish, Molecular Cell Biology 8th edition, 2016, New York W H Freeman.

Discipline Specific Electives-I

COURSE CODE	GENETICS	Total Lec.:45
MB20M106		**3-0-0**
Learning Objectives	• The objectives of this course are to take the students through the basics of genetics and classical genetics encompassing prokaryotic/phage genetics to yeast and higher eukaryotic domains. • On covering all classical concepts of Mendelian genetics across these life-forms, the students will be exposed to the concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.	
Pre-requisites	None.	

UNIT	CONTENT	HOURS
I	Genetics of Bacteria and Bacteriophages 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 a gene.	4
II	Yeast Genetics 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.	4
III	Genetics as a model of higher eukaryotes monohybrid&dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in the context of developmental mechanisms. Laws of segregation in plant crosses, inbreeding, selfing, heterosis, maintenance of genetic purity, gene pyramiding.	8
IV	Population Genetics & Genetics of Evolution Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection, Fishers theorem, Hardy-Weinberg equilibrium, linkage disequilibrium; in-breeding depression & mating systems; population bottlenecks, migrations, Bayesian statistics; adaptive landscape, spatial variation & genetic fitness.	8
V	Quantitative Genetics of complex traits (QTLs) Complex traits, mapping QTLs, yeast genomics to understand biology of QTLs.	6

Course Outcomes as per Bloom's Taxonomy	
CO1	Student will be able to **describe**[2]the fundamental molecular principles of genetics.
CO2	They will **understand**[2]the relationship between phenotype and genotype in human genetic traits.
CO3	They will be able to **describe**[2]the basics of genetic mapping.
CO4	Students will**understand**[2]how gene expression is regulated.
CO5	Students will**understand**[2]principles of Population Genetics.
Text Books:	• Gardner, M J Simmons, D P Snustad, Principles of Genetics VIII edition, 2006, John Wiley & Sons.

	• A J F Griffiths, C Lewontin, W.M Gelbart,Introduction to GeneticAnalysis IX edition, W H Freeman.
Reference Books:	• M J Simmons, Principles of Genetics V edition 2009, John Wiley and Sons. • W S Klug, M Cummings, C A Spencer, Concepts of Genetics. IX edition, 2009, Benjamin Cummings. • P J Russell, Genetics- A Molecular Approach III edition, 2009, Benjamin Cummings.

Practical Papers

COURSE CODE	LAB I	Practical : 60
MB20M107		**2**
	1. Isolation of Pure culture of Bacteria and culture techniques 2. Effect of UV radiations, pH, disinfectants, chemicals and heavy metal ions on Microbes. 3. Role of Nutrition on growth of bacteria 4. Isolationand biochemical characterization of soil bacteria. 5. Biochemical Characterization of bacteria(10 reactions) 6. Microbial degradation, decolourization and adsorption of organic dyes (by free and immobilized). 7. Preparation of biosensors of urease and determination of its activity 8. Glucose uptake by *E. coli / Saccharomyces cerevisiae*[Active and Passive diffusion] 9. Genetic Transfer-Conjugation, gene mapping	

COURSE CODE	LAB II	Practical : 60
MB20M108		**2**
	1. Calibration of an ocular micrometer for different objectives of microscope. 2. Measurement of microorganisms by the use of an ocular micrometer. 3. Effect of colchicine on cell division. 4. Genomic DNA Extraction. 5. Agarose gel electrophoresis. 6. Plasmid DNA isolation and DNA quantitation. 7. Restriction Enzyme digestion of plasmid DNA. 8. 16 s rRNA Polymerase Chain Reaction and analysis by agarose gel electrophoresis 9. Separation of given amino acids by paper chromatography. 10. Separation of amino acids by Thin Layer Chromatography. 11. To study microorganisms under dark-field microscope. 12. Determination of molecular weight of enzymes using PAGE technique.	

Project Based Learning I

COURSE CODE	PROJECT BASED LEARNING
PB20B101	
Learning Objectives:	• Integrating the knowledge and skills of various courses on the basis of multidisciplinary projects. • Develop the skill of critical thinking and evaluation. • To develop 21st century success skills such as critical thinking, problem solving, communication, collaboration and creativity/innovation among the students. • To enhance deep understanding of academic, personal and social development in students. • Employ the specialized vocabularies and methodologies.
General Guidelines:	• PBL will be an integral part of UG/PG Programs at different levels. • Each semester offering PBL will provide a separate Course Code, two credits will be allotted to it. • Faculty will be assigned as mentor to a group of 30 students minimum by HoS. • Faculty mentor will have 4 hours/week to conduct PBL for assigned students. • Student will select a topic of their choice from syllabus of any course offered in respective Semester (in-lines with sustainable development goals). • Student may work as a team maximum 3 or minimum 2 members for single topic. • For MSE, student's performance will be assessed by panel of 2 experts either from other Department/school, or from same department/school based on chosen topic. This will be comprised of a presentation by student followed by viva-voce. It will be evaluated for 30 marks. • 20 marks would be allotted for continuous performance assessment by concerned guide/mentor. • For ESE, student will need to submit a project report in prescribed format, duly signed by concerned guide/mentor and head of the school. The report should be comprised of following components: 1. Introduction 2. Review of literature 3. Methodology 4. Result and Discussion 5. Conclusion and Project Outcomes 6. References • In ESE, viva-voce of students will be conducted on the basis of report, by one external and one internal faculty which is of 50 Marks. Student will need to submit three copies for 1. Concerned School 2. Central Library 3. Self. The integrity of the report should be maintained by student. Any malpractice will not be entertained. • Writing Ethics to be followed by student, a limit of 10 % plagiarism is permissible. Plagiarism report is to be attached along with the report. • Project could be a case study/ analytical work /field work/ experimental work/ programming or as per the suitability of the program.

Syllabus
SEMESTER – II

Core Course-I

COURSE CODE	MICROBIAL ENZYME TECHNOLOGY	Total Lec.:60
MB20M201		**4 – 0– 0**
Learning Objectives:	• This course provides the theory and knowledge relevant to the enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics. • Techniques employed in enzymes purification and characterization is also emphasized in this course. Students will also be introduced to the theory as well as applications of enzyme technology in food, medical, and household industries. Finally this course serves to provide an awareness of the current and possible future applications of enzyme technologies. • This course also emphasizes on the development of attitude and capability of the students to work in a group and gather information on the related field for lifelong learning.	
UNIT	**CONTENT**	**HOURS**
I	Extraction and purification of microbial enzymes. Importance of enzyme purification, different sources of enzymes. Extracellular and intracellular enzymes. Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation (using Temperature, salt, solvent, pH, etc.), liquid-liquid extraction, ionic exchange,gel chromatography, affinity chromatography and other special purification methods. Enzyme crystallization techniques. Criteria of purity of enzymes. Pitfalls in working with pure enzymes.	15
II	Enzyme inhibition and Co-factors, Irreversible, reversible, competitive, non-competitive and un-competitive inhibition with suitable examples and their kinetic studies.Allosteric inhibition, types of allosteric inhibition and their significance in metabolic regulation & their kinetic study Vitamins and their co-enzymes: structure and functions with suitable examples Metallo enzymes and Metal ions as co-factors and enzyme activators.	15
III	Immobilization of microbial enzymes, Methods viz. adsorption, covalent bonding, entrapment & membrane confinement and their analytical, therapeutic & industrial applications. Properties of immobilized enzymes**.**	10
IV	Enzyme Engineering, Chemical modification and site-directed mutagenesis to study the structure-function relationship of industrially important enzymes.	10
V	Microbial enzymes in textile, leather, wood industries and detergents. Enzymes in clinical diagnostics. Enzyme sensors for clinical processes and environmental analyses. Enzymes as therapeutic agents.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **distinguish** the fundamentals of enzyme properties, nomenclatures, characteristics and mechanism.	
CO2	They will be able to **apply** biochemical calculation for enzyme kinetics.	
CO3	Students will be able to**compare** methods for production, purification, characterization and immobilization of enzymes.	
CO4	Students will be able to**discuss** various applications of enzymes that can benefit human life.	
CO5	They will **discover** the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.	

Text Books:	• J Pelczar, E C S Chan and N R Krieg, Microbiology. 5th edition,1993, McGraw Hill M Book Company • GJ Tortora, BR Funke and CL Case,Microbiology: An Introduction. 9th edition, 2008, Pearson Education. • C P Baveja,Textbook of Microbiology. 6th edition, 2019, Arya Publication. • D K Maheshwari, S Chand, Text Book of Microbiology. 6th edition, 2013.
Reference Books:	• J Cappucino and N Sherman, Microbiology: A Laboratory Manual. 9th edition, 2010, Pearson Education Limited. • J M Wiley, L M Sherwood and Woolverton, C J Prescott's, Microbiology. 9th edition,2013, McGraw Hill International. • R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. • R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology5th edition, 2005, McMillan

Core Course-II

COURSE CODE	IMMUNOLOGY	Total Lec.:60
MB0M202		**4– 0-0**
Learning Objectives:	• The objectives of this course are to make students learn about the structural features of the components of the immune system as well as their function. • The major emphasis of this course will be on the development of the immune system and mechanisms by which our body elicit the immune response. • This will be imperative for the students as it will help them to think like an immunologist and predict about the nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiment.	
UNIT	**CONTENT**	**HOURS**
I	Immunology fundamental concepts and anatomy 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.	10
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 signalling; 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.	10
III	Antigen-antibody interactions: Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immune electron microscopy; surface plasmon resonance, biosenor assays for assessing ligand –receptor interaction, CMI techniques-lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, 26 microarrays, transgenic mice, gene knock outs.	10
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, 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.	8
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;	22

	tumorimmunology – tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency - primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunesenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.Immunogenetics: Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.	

Course Outcomes as per Bloom's Taxonomy	
CO1	Student will be able to **evaluate**[3] the usefulness of immunology in different pharmaceutical companies.
CO2	They will be able to**identify**[2] the proper research lab working in the area of their own interests.
CO3	They will be able to**apply**[2] their knowledge and design immunological experiments to demonstrate immunological process.
CO4	Student will be able to**understand**[2]the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.
CO5	Student will be able to**communicate**[3] the principles, theories, problems and research results associated with questions that lie within the immunological framework to specialists and laymen orally and in writing.
Text Books:	• T Kindt, R Goldsby, B Osborne, B& J Kuby , Kubyimmunology, 2006, New York: W H Freeman. • J Brostoff, J K Seaddin, D Male, D & I M Roitt , Clinical immunology, 2002 , London: Gower Medical Pub.
Reference Books:	• K Murphy, P Travers, M Walport, C Janeway , Janeway'simmunobiology, 2012, New York: Garland Science. • Fundamental immunology, W E Paul, 1993, New York: Raven Press. • J WGoding, Monoclonal antibodies: Principles and practice, 1986, London: Academic Press. • P Parham, the Immune System2005, New York: Garland Science.

Core Course-III

COURSE CODE	BIOINFORMATICS	Total Lec.:60
MB20M203		**4 – 0 – 0**
Learning Objectives	The objectives of this course are to provide students with the theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	
UNIT	**CONTENT**	**HOURS**
I	Bioinformatics basics: Computers in biology and medicine; Introduction to Unixand Linux systems and basic commands; Database concepts; Protein and nucleic aciddatabases; Structural databases; Biological XML DTD's; pattern matching algorithmbasics; databases and search tools: biological background for sequence analysis;Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; databasemining tools.	10
II	DNA sequence analysis: gene bank sequence database; submitting DNA sequences todatabases and database searching; sequence alignment; pairwise alignment techniques;motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genomesequencing.	15
III	Multiple sequence analysis; multiple sequence alignment; flexible sequence similaritysearching with the FASTA3 program package; use of CLUSTALW and CLUSTALX formultiple sequence alignment; submitting DNA protein sequence to databases: where andhow to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updatingsubmitted sequences, methods of phylogenetic analysis.	15
IV	Protein modelling:introduction; force field methods; energy, buried and exposedresidues; side chains and neighbours; fixed regions; hydrogen bonds; mapping propertiesonto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures;sequence alignment- methods, evaluation, scoring; protein completion: backboneconstruction and side chain addition; small peptide methodology; software accessibility;building peptides; protein displays; substructure manipulations, annealing.	10
V	Protein structure prediction: protein folding and model generation; secondary structureprediction; analysing secondary structures; protein loop searching; loop generatingmethods; homology modelling: potential applications, description, methodology,homologous sequence identification; align structures, align model sequence; constructionof variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mysterysequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methodsof structure prediction, prediction using inverse folding, fold prediction; significanceanalysis, scoring techniques, sequence-sequence scoring; protein function prediction;elements of in silico drug design;Virtual library: Searching PubMed, current content,science citation index and current awareness services, electronic journals, grants and funding information.	10
Course Outcomes as per Bloom's Taxonomy		
CO 1	Students will **develop**[3] the understanding of the basic theory of these computational tools.	

CO 2	They will gain working **knowledge**[2] of these computational tools and methods.
CO 3	They will be able to appreciate their relevance for **investigating** specific contemporary biological questions.
CO 4	Students will be able to critically **analyse**[4]and **interpret** the results of their study
CO 5	They will be able to **analyze**[2], **interpret**, and **present** methodology and results from primary literature in the discipline
Text Books:	• A M Lesk, Introduction to bioinformatics, 2002, Oxford University Press. • D W Mount, Bioinformatics: Sequence and genome analysis, 2001, NY Cold Spring Harbor Laboratory Press. • P E Bourne, G U Jenny, Structural bioinformatics, 2009, Wiley-Blackwell. • A M Lesk, Introduction to protein science: Architecture, function, and genomics,2004, Oxford University Press.
Reference Books:	• A D Baxevanis, B F Ouellette, Bioinformatics: A practical guide to the analysis of genes and proteins, 2001, New York: Wiley-Interscience. • J Pevsner, Bioinformatics and functional genomics, 2015, Wiley-Blackwell.

Core Course-IV

COURSE CODE	MEDICAL MICROBIOLOGY	Total Lec.:60
MB20M204		**4 – 0 – 0**
Learning Objectives:	• Knowledge of the pathogenesis of diseases, interventions for effective treatment, and mechanisms of health maintenance to prevent disease	
Pre-requisites	Nil.	

UNIT	CONTENT	HOURS
I	General topics on Medical Microbiology: History, Koch's postulates microbiology andmedicine, classification of medically important bacteria; Morphology and growth and nutrition of bacteria, infection - source, modes of transmission, portal of entry into thesusceptible host, prevention; bacterial pathogenicity; Identification of bacteria – staining methods, culture methods, biochemical tests other recent methods; sterilization and disinfection; normal microbial flora; antimicrobial agents, drug resistance and drug sensitivity test.	10
II	Systematic Microbiology: Diseases caused by Gram positive cocci - sore throat, pneumonia etc.; diseases caused by Gram negative cocci - meningitis, gonorrhea; diseases caused by Gram positive bacilli - tuberculosis, diphtheria, tetanus, gas gangrene etc diseases caused by Gram negative bacteria of family Enterobacteriaceae - enteric fever, bacillary dysentery, UTI etc.; diseases caused by other Gram negative bacilli - cholera, plague, whooping cough,wound infection, septicemiaetc.	10
III	Sexually transmitted diseases; diseases caused by mycoplasma, Chlamydia, rickettsia; overview of medical mycology – superficial, subcutaneous, systemic and opportunistic mycosis.	10
IV	Overview of medical parasitology: Important protozoal diseases: Malaria, Leishmaniasis, amoebiasis giardiasis etc., and helmenthic diseases: Ascariasis, Ankylostomiasis, filariasis, Taeniasis, Echinococcosis, Schistosomiasis etc.	15
V	Overview of medical virology: (Herpesvirus, Poliovirus, Rabiesvirus, Arboviruses, Hepatitis, HIV etc.). Bacteriology of water, milk and air; opportunistic infections, Immunoprophylaxis.	15

Course Outcomes as per Bloom's Taxonomy	
CO 1	Students will develop an **understanding**[2] of the basic concept of health and disease.
CO 2	They will gain working **knowledge**[2] of culturing tools and methods.
CO 3	They will be able to appreciate their relevance for **investigating**[4] specific contemporary biological questions.
CO 4	Students will be able to critically **analyse**[4] and interpret the results of their study.
CO 5	They will be able to **analyze**[4], **interpret**, and present methodology and results from primary literature in the discipline.
Text Books:	• JPelczar, E C S Chan and N R Krieg, Microbiology, 5th edition, 1993, McGraw Hill M Book Company. • GJ Tortora, BR Funke and CL Case, Microbiology: An Introduction. 9th edition, 2008, Pearson Education. • C P Baveja , Textbook of Microbiology, 6th edition, 2019, Arya Publication. • D K Maheshwari, S Chand, Text Book of Micribiology, 6th edition, 2013.

Reference Books:	• J Cappucino and N Sherman, Microbiology: A Laboratory Manual, 9th edition, 2010, Pearson Education Limited. • J M Wiley, L M Sherwood and Woolverton, C J Prescott's, Microbiology, 9th edition 2013, McGraw Hill International. • R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. • R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology, 5th edition, 2005, McMillan.

Discipline Specific Electives-II

COURSE CODE	GENETIC ENGINEERING	Total Lec.:45
MB20M205		**3-0-0**
Learning Objectives	• The objectives of this course are to teach students with various approaches to conducting genetic engineering that they can apply to their future career 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. • This technology has revolutionized the way modern biological research is done and has impacted mankind with a number of biological products and processes.	
Pre-requisites:	None.	

UNIT	CONTENT	HOURS
I	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; homopolymeric tailing; labellingof DNA: nick translation, random priming, radioactive and non-radioactive probes,hybridization techniques: northern, southern, south-western and far-western and colonyhybridization, fluorescence *in situ* hybridization.	10
II	Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids;Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosomevectors (YACs; BACs); Principles for maximizing gene expression expressionvectors;pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc*;Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusionbodies; mammalian expression and replicating vectors; Baculovirus and *Pichia*vectorssystem, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	10
III	Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases;types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdownPCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products;T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR inmolecular diagnostics; viral and bacterial detection; sequencing methods; enzymaticDNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNAsequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP,DGGE, RFLP.	10
IV	Insertion of foreign DNA into host cells; transformation, electroporation, transfection;construction of libraries; isolation of mRNA and total RNA; reverse transcriptase andcDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomicarrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay.	10
V	DNAfootprinting; methyl interference assay, chromatinimmunoprecipitation; protein-protein interactions using yeast two-hybrid system;phage display.	5

Course Outcomes as per Bloom's Taxonomy	
CO 1	Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical **knowledge**[2] of this technology.

CO 2	In **understand**[2] basics of Molecular biology.
CO 3	The students should be able to set up biological research**experiments**[5] as well as placement in the relevant biotech industry.
CO 4	**Comprehend**[3]the skills required to do experimental cloning.
CO 5	They will be able to **design**[4]experiments using advanced tools of selecting vectors for cloning; sequencing analysis, PCR, expression of cloned products
Text Books:	• R W Primrose, S B Twyman, Principles of gene manipulation: An introduction to genetic engineering, 2001, Oxford: Blackwell Scientific Publications. • T A Brown, Genomes 3rd edition, 2006, New York: Garland Science Pub. • Selected papers from scientific journals, particularly Nature & Science. • Technical Literature from Stratagene, Promega, Novagen, New England Biolabetc.
Reference Books:	• M R Green, J Sambrook, Molecular cloning: A laboratory manual, 2012, NY: Cold Spring Harbor Laboratory Press.

Discipline Specific Electives-II

COURSE CODE	MOLECULAR DIAGNOSTICS	Total Lec.: 45
MB20M205		**2 – 0-0**
Learning Objectives:	• The objectives of this course are to sensitize the students about the recent advances in molecular biology and various facets of molecular medicine • alter many aspects of modern medicine including the pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer	
Pre-requisites:	None.	
UNIT	**CONTENT**	**HOURS**
I	Genome Biology in Health & Disease DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.	5
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.	10
III	Diagnostic metabolomics Metabolite profile for biomarker detection in the body fluids/tissues under various metabolic disorders by making use of LCMS & NMR technological platforms.	6
IV	Detection & Identity of Microbial Diseases Direct detection & 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.	4
V	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 the new mutational mechanism of the unstable triplet repeats, von-HippelLindau disease: recent acquisition in the growing number of familial cancer syndromes. Quality Assurance & Control Quality oversight; regulations and approved testing.	5
Course Outcomes as per Bloom's Taxonomy		
CO 1	Students will **learn**[2] about Health and disease.	
CO 2	They will **know**[2] basics of techniques of diagnostics.	
CO 3	They will understand the **usage**[3]of available online resources of diagnostics.	
CO 4	Students will learn computational data **analysis**[4] in disease biology.	
CO 5	They will be **Introduced**[2] to big data.	
Text Books:	• R J Brooker, Genetics: Analysis & principles, 2009, NY: McGraw-Hill. • Glick, B. R., Pasternak, J. J., & Patten, C. L. Molecular biotechnology: Principles and applications of recombinant DNA, 2010, Washington, DC: ASM Press.	
Reference Books:	• A M Campbell, L J Heyer Discovering Genomics, Proteomics, and Bioinformatics, 2006, San Francisco: Benjamin Cummings. • W B Coleman, G J Tsongalis, Molecular diagnostics: For the clinical laboratorian, 1997, Totowa, NJ: Humana Press.	

Practical Papers

COURSE CODE	LAB III	Practical : 60
MB20M207		2

1. Microbial production , Extraction , purification and Confirmation of alpha amylase/ Lipase.
2. Determination of efficiency of enzyme purification by measuring specific activity atvarious stages viz. Salt precipitation, dialysis, electrophoresis etc.
3. Studies on enzyme Activation and Inhibition of extracted alpha amylase /Lipase.Effectofheavy metal ions, Chelating agents activators and inhibitors.
4. Immobilization of cells and enzyme using Sodium alginate and egg albumin and measurement of enzyme activity [amylase/Lipase].
5. Studies on impact of immobilization on enzyme activity in terms of temperature tolerance and $V_{max}$and K_m using various forms of alpha amylase/Lipase.
6. Immunodiagnostics using commercial kits.
7. Blood smear identification of leucocytes by Giemsa stain.

COURSE CODE	LAB IV	Practical : 60
MB20M208		2

1. To access scientific data from Literature data bases (PUBMED, LITDB, Medline)
2. To access nucleic acid databases for retrieval of gene sequence.
3. To access protein databases for retrieval of amino acid sequence of target protein.
4. To perform pair wise sequence alignment using Dot matrix.
5. To perform multiple sequence alignment using BLAST.
6. To perform multiple sequence alignment using CLUSTAL-W and to find conserved sequences using JAL view.
7. To prepare Phylogenetic tree and Cladogram using CLUSTAL-W
8. 3D protein structure prediction and structure refinement using Swiss-PDB viewer

Project Based Learning II

COURSE CODE	PROJECT BASED LEARNING
PB20B201	
Learning Objectives:	• Integrating the knowledge and skills of various courses on the basis of multidisciplinary projects. • Develop the skill of critical thinking and evaluation. • To develop 21st century success skills such as critical thinking, problem solving, communication, collaboration and creativity/innovation among the students. • To enhance deep understanding of academic, personal and social development in students. • Employ the specialized vocabularies and methodologies.
General Guidelines:	• PBL will be an integral part of UG/PG Programs at different levels. • Each semester offering PBL will provide a separate Course Code, two credits will be allotted to it. • Faculty will be assigned as mentor to a group of 30 students minimum by HoS. • Faculty mentor will have 4 hours/week to conduct PBL for assigned students. • Student will select a topic of their choice from syllabus of any course offered in respective Semester (in-lines with sustainable development goals). • Student may work as a team maximum 3 or minimum 2 members for single topic. • For MSE, student's performance will be assessed by panel of 2 experts either from other Department/school, or from same department/school based on chosen topic. This will be comprised of a presentation by student followed by viva-voce. It will be evaluated for 30 marks. • 20 marks would be allotted for continuous performance assessment by concerned guide/mentor. • For ESE, student will need to submit a project report in prescribed format, duly signed by concerned guide/mentor and head of the school. The report should be comprised of following components: 1. Introduction 2. Review of literature 3. Methodology 4. Result and Discussion 5. Conclusion and Project Outcomes 6. References • In ESE, viva-voce of students will be conducted on the basis of report, by one external and one internal faculty which is of 50 Marks. Student will need to submit three copies for 1. Concerned School 2. Central Library 3. Self. The integrity of the report should be maintained by student. Any malpractice will not be entertained. • Writing Ethics to be followed by student, a limit of 10 % plagiarism is permissible. Plagiarism report is to be attached along with the report. • Project could be a case study/ analytical work /field work/ experimental work/ programming or as per the suitability of the program.

Syllabus
SEMESTER – III

Core Paper-I

COURSE CODE	BIOPROCESS ENGINEERING & TECHNOLOGY	Total Lec: 60
MB20M301		4 – 0 – 0
Learning Objectives:	• The objective of this course is to educate students about the fundamental concepts of bioprocess technology and its related applications. • Prepare students to meet the challenges of the new and emerging areas of bioprocess industry.	
Pre-requisites:	Elementary biology	
UNIT	**CONTENT**	**HOURS**
I	Basic principles of Biochemical engineering Isolation, screening and maintenance of industrially important microbes, microbial growth and death kinetics, strain improvement for increased yield and other desirable characteristics.	10
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 biotransformations, 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.	10
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.	10
IV	Applications 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, interesterifiedfat,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.	15
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	15

	biorefinery.	
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will **identify**[1] role of microorganisms in industries.	
CO2	They will be able to **understand**[2] the **design** and operations of various fermenters.	
CO3	They will be able to**understand**[2]fundamental principles for basic methods in production technique for bio-based products.	
CO4	Students willbe able to **analyse**[4] yield and production rates in a biological production process, and also **interpret** data.	
CO5	Students willbe able to**critically**[5]analyze any bioprocess from an economics/market point of view.	
Text Books:	• M.L Shuler, F.Kargi, Bioprocess engineering: Basic concepts, 2002, Upper Saddle River, NJ Prentice Hall. • M. El-Mansi, C.F Bryce, Fermentation microbiology and biotechnology, 2007, Boca Raton CRC/Taylor & Francis.	
Reference Books:	• P.F Stanbury, A. Whitaker, Principles of fermentation technology, 1997, OxfordPergamon Press. • Pauline M. Doran, Bioprocess Engineering Principles second edition, 2013, Science direct. • H.W Blanch, D.S Clark, Biochemical engineering, 1997, New York M. Dekker. • J.E Bailey, D.F Ollis, Biochemical engineering fundamentals, 1986, New York: McGraw-Hill.	

Core Paper-II

COURSE CODE	AGRICULTURE MICROBIOLOGY	Total Lec: 60
MB20M302		4 – 0 – 0
Learning Objectives:	• The course aims to expose students to the basic scientific evidence and technical aspects of the different disciplines of agricultural microbiology (mainly for plants and crops). • It clarifies major scientific, ecological and sociological aspects of microbiology in agriculture.	
Pre-requisites:	Elementary Biology	
UNIT	**CONTENT**	**HOURS**
I	Microorganisms of soil, Rhizosphere and phyllospheremicroflora, Brief account of Microbial interactions: antagonism, symbiosis, mutualism, commensalisms, synergism and parasitism, Nutrient cycle: Carbon cycle, nitrogen cycle, phosphorous cycle and sulphur cycle.	10
II	Role of enzymes and toxins in pathogenesis, Fungal diseases of plants: Rusts of wheat, linseeds; late blight of potato; red rot of sugarcane, Bacterial diseases of plants, Citrus canker, blight of rice, And Viral diseases of plants: Leaf curl of Papaya, vein clearing of lady's finger.	15
III	Physical and chemical control of plant diseases, Bacterial control of insect pests Bacillus thuringiensis as bacterial insecticide, Viral control of insect pests Nuclear polyhedrosisvisuses (NPV) and cytoplasmic polyhedrosis viruses (CPV), Fungal control of insect pests (Entomopathogenic fungi, Metarhiniumanisopliae, Beauveriabassiana, Verticilliumlecani, Hirsutellathompsoni).	15
IV	Storage fungi: Categories of storage fungi, conditions during storage in relation to damage of seeds, harmful effects, Mycotoxins and their effect on human being, General idea about quarantine, Production of biogas and alcohol from agricultural wastes.	10
V	Biofertilizers, Types, production and application, Mycorrhizae, Types and their application in agriculture and forestry, Vermicomposting, Reclamation of waste agricultural land by microorganisms.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will **clarify**[2] application of microorganisms in varied fields of agricultural.	
CO2	They will be able to **critically**[5] discuss the need for agricultural microbiology and explain their limitations.	
CO3	They will **understand**[2] role of microorganism in improving plant growth.	
CO4	They will gain **knowledge**[1] of sampling and microbial analyses.	
CO5	They will be able to**analyze**[5]various aspects provided by microbes for betterment of agriculture.	

Text Books:	• N.S. SubbaRao , Soil Microbiology, Fourth edition, 2017, Oxford and IBH Publishing CO. PVT., LTD., New Delhi. • G.Rangaswami, D J Bhagyaraj, Agricultural Microbiology, 2011, Prentice Hall of India, New Delhi, 2nd edition. Evans GM, Furlong JC.
Reference Books:	• Gareth G. Evans, Judy Furlong, Environmental Biotechnology- Theroy and application, 2010, Wiley-Blackwell. • RM Maier,IL Pepper, CP Gerba, Environmental microbiology, 2009, Elsevier. • LG Ljungdahl, MW Adams, LL Barton, JG Ferry, Biochemistry and Physiology of Anaerobic Bacteria, 2003, Springer.

Core Paper-III

COURSE CODE	FOOD AND DAIRY MICROBIOLOGY	Total Lec: 60
MB20M303		4– 0 – 0
Learning Objectives:	• The objective of the course is to provide students instruction in the general principles of food microbiology. • The course covers the biology and epidemiology of food borne microorganisms of public health significance. • Understand food spoilage microorganisms, the microbiology of food preservation, principles and methods for the microbiological examination of foods, micro biological quality control, and quality schemes.	
Pre-requisites:	None	
UNIT	**CONTENT**	**HOURS**
I	Food Microbiology: Micro-organisms and their importance in food microbiology–molds, yeast, bacteria, general features and classification, principles of food preservation, asepsis, control of microorganisms (anaerobic conditions, high temperature, low temperature, drying), factors influencing microbial growth in food–extrinsic and intrinsic factors, chemical preservation and food additives, canning process for heat treatment, Fermented foods.	15
II	Contamination and spoilage-cereals, sugar products, vegetables, fruits, meat and meat products, fish and sea food, poultry and canned food, detection of spoilage and characterization, methods of food preservation. Food poisoning and foodborne infections; Bacterial toxins and mycotoxins in food.	10
III	Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI, NABL.	15
IV	Microbiology of raw and pasteurized milk, Biochemical changes in fermented milk, Study on spoilage organisms in dairy industry, probiotics. Classification of various groups of microorganisms associated with diary industry, Acid fermented milks (Yoghurt, cultured butter milk), Starter cultures for fermented dairy products (Streptococcus thermophilus, Lactobacillus bulgaricus).	15
V	Cheese production: Steps involved in manufacture of cheese, preservation, classification and nutritional aspects. Application of microbial enzymes in food industry	5
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **understand**[2]the principles of microorganisms during various food-processing and preservation steps.	
CO2	Students will r**ecognize**[4] the characteristics, isolation, detection and identification of microorganisms related to food industry.	
CO3	They will **understand**[2] the significance and activities of microorganisms in food.	
CO4	They will be able to **analyze**[5] the importance of microbiological quality control programmes in food production.	

CO5	They will be able to**describe**[5] the rationale for the use of standard methods and procedures for the microbiological analysis of food.
Text Books:	• WC Frazier,DC Westhoff, Food Microbiology, 2018, McGraw-Hill, New York. • JM Jay, Modern Food Microbiology, 2006, Chapman and Hall, New York. • B Ray, Fundamentals of Food Microbiology, 2013, CRC Press, USA.
Reference Books:	• Adams, Food Microbiology 2nd Edition, 2010, Royal Society of chemistry. • Elmer Marth and James Steele, Applied Dairy Microbiology, 2001, CRC Press. • Richard K. Robinson, Dairy Microbiology by Robinson Volume I and II, 2002, wiley.

Core Paper-IV

COURSE CODE	ENVIRONMENTAL MICROBIAL TECHNOLOGY	Total Lec: 60
MB20M304		4 – 0 – 0
Learning Objectives:	• The objective of this course is to impart knowledge about structure, composition and functioning of microbial communities of diverse environment. • The use of microbial population in agriculture, mineral recovery, management of various types of pollutants and conversion processes of various types of wastes into value added products will be discussed.	
Pre-requisites:	None	
UNIT	**CONTENT**	**HOURS**
I	Microbial ecology: basic concepts, types and microbial habitats, factors affecting microbial population, Microbial interactions: competition, commensalism, parasitism, and mutualism, commensalisms, synergism, and Population ecology: characteristics of population, population growth curves(r and k selection) population regulation, Conservation and management of microbial diversity,biodeterioration and biodegradation.	10
II	Microorganism of air, enumeration of air micro flora, Significance of air micro flora, Brief account of air borne transmission of bacteria, fungi, pollens and viruses, Air borne diseases and their prevention.	15
III	Soil microbiology, microflora of soil, soil microorganisms associated with plants: rhizosphere, mycorrhizae, Role of microorganisms in organic matter decomposition (cellulose, hemi cellulose, and lignin), Bioleaching; introduction, application of bacterial leaching techniques, properties of bioleaching, Microbial degradation of xenobiotics, petroleum and oil spills in environmental decay behaviours and degradative plasmid.	10
IV	Water microbiology: aquatic microorganisms; fresh water and sea water microflora. Microorganisms and water quality, water pollution, Water purity test and indicator organisms, method used in environmental studies –BOD, COD, DO, Common water born disease and their control measure, Water purification, flocculation, chlorination and purification.	10
V	Microbiology of waste water and effluent treatments, aerobic process: primary, secondary and tertiary treatment: trickle filter, oxidation ponds and stabilization ponds, principle of aerobic digestion, Bioremediation of contaminations. Extremophiles –acidophilic, alkalophilic, thermophilic microbes with adaptation and application in ecosystem, Microbial biofilms: physiology, morphology, biochemistry of microbial biofilms, mechanism of microbial adherence, beneficial and harmful role of biofilms.	15
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **critically**[5] discuss the need for environmental microbiology.	
CO2	They will gains **knowledge**[1] about significant applications of microbes in solving	

	environmental pollution problems.
CO3	They will **understands**[2] microbial diversity in the environment by culture-dependent and culture-independent approaches.
CO4	They will be able to **summarize**[2]the role of microbes in bioremediation of environmental pollutants.
CO5	They will be able to designing**experiments**[3] on microbe-based processes for production industries.
Text Books:	• G Rangaswami, DJ Bhagyaraj, Agricultural Microbiology, 2001, Prentice Hall of India, New Delhi, 2nd edition. • NS SubbaRao, Soil Microbiology, 1995, Oxford & IBH Publishing Co. Pvt. Ltd, 4th edition. • J ChristonHurst, L. R Crawford, J L. Garland, Environmental Microbiology, 2007, ASM Press. • P.K. Jjemba, Environmental Microbiology: Principles and Applications, 2004, Science Publishing Inc.
Reference Books:	• R. Mitchel and J-D Gu, Environmental Microbiolog2nd edition, 2009, Wiley Blackwell. • R. Maier, I. Pepper and C. Gerba, Environmental Microbiology 2nd edition, 2009, Academic Press. • N. Okafor, Environmental Microbiology of Aquatic & Waste systems by 1st edition, 2011, Springer, New York.

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Discipline Specific Elective III

COURSE CODE	Microbial Diversity and Ecology	Total Lec.: 45
MB20M305		**3-0-0**
Learning Objectives:	• Prepare students with the knowledge of Microbial diversity and ecology. • To produce students whose concepts are clear about ecology and microbial population.	
Pre-requisite	None.	
UNIT	**CONTENT**	**HOURS**
I	Microbial Systematics: Overview of course, what is microbial systematics. Concept of identification, nomenclature and classification, the species concept, importance of morphological, biochemical and physiological differences for species delineation.	5
II	Morphological, Biochemical and Molecular Taxonomy: Concept of chemotaxonomy and use of membrane fatty acids, lipid, protein, quinone, peptidoglycan as biomarker, tree nomenclature: tree rooting, trees and distances, trees and character evolution, gene trees and species, trees, consensus trees, molecular chronometers in phylogeny: single gene & multi-gene sequence based microbial typing	12
III	Phylogenetic Analysis and Whole genome: Whole genome comparisons, tree-building algorithms: distance-matrix methods, minimum evolution, maximum parsimony, maximum likelihood and Bayesian, inference, model fitting and hypothesis testing, Sources and types of errors in phylogenetic inference	10
IV	Microbial Ecology:How to do microbial sampling, isolations, concept of diversity (α, β & Y), calculation of diversity indices (richness and evenness) and rarefaction analysis, collection of ecological samples for community analysis	8
V	Modern Approaches to Study Microbial Diversity:Omics in diversity analysis (metagenomics, metaproteomics, metatrancriptomics), techniques used in microbial ecology, conservation of microbes, culture collections and microbial resources, preserving and exploiting microbial resources.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **understand[2]** the concepts of ecology	
CO2	They will **develop[3]**knowledge about microbial diversity.	
CO3	Students will **understand[2]** the concepts of microbial sampling andisolations.	
CO4	They will learn to **apply[3]** the knowledge for community analysis.	
CO5	They will **develop[3]** the knowledge of phylogenetic study.	
Text Books:	• J Pelczar, ECS Chan and NR Krieg, Microbiology. 5th edition,1993, McGraw Hill M Book Company. • GJ Tortora, BR Funke and CL Case,Microbiology: An Introduction. 9th edition, 2008, Pearson Education. • C P Baveja , Textbook of Microbiology.6th edition, 2019, Arya Publication. • DK Maheshwari, Text Book of Micribiology . 6th edition, 2013,S Chand.	
Reference Books:	• J Cappucino and N Sherman, Microbiology: A Laboratory Manual. 9th edition,2010, Pearson Education Limited. • J M Wiley, L M Sherwood and Woolverton, C J Prescott's, Microbiology. 9th	

	edition2013, McGraw Hill International. • R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. • R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology. 5th edition, 2005, McMillan. • H F Lodish ,Molecular Cell Biology 8th edition, 2016, New York: W.H. Freeman. • J EKrebs, B Lewin, S T Kilpatrick, Goldstein, Lewin's Genes XI, 2014, Sudbury: Jones and Bartlett.

Discipline Specific Elective III

COURSE CODE	INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS	Total Lec:45
MB20M306		**2 – 0 – 0**
Learning Objectives:	• To provide basic knowledge on intellectual property rights and their implications in biological research and product development. • To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products. • To understand ethical issues in biological research.	
Pre-requisites:	None	
UNIT	**CONTENT**	**HOURS**
I	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.	5
II	Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; 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: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.	10
III	Biosafety and Biosecurity - introduction; historical background; introduction to 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; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.	5
IV	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 -	5

	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).	
V	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	5
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will **understand**[2] different types of intellectual property rights in general and protection of products derived from biotechnology research.	
CO2	They will be able to **analyze**[4]issues related to application and obtaining patents.	
CO3	They will **understand**[2]ethical aspects related to biological, biomedical, health care and biotechnology research.	
CO4	They will **gain knowledge**[2] of biosafety and risk **assessment** of products derived from recombinant DNA research.	
CO5	They willbe able to **explain**[5] **the** environment release of genetically modified organisms, national and international regulations.	
Text Books:	• P. Ganguli, Intellectual property rights: Unleashing the knowledge economy, 2001, New Delhi: Tata McGraw-Hill Pub. • H. Kuhse, Bioethics: An anthology, 2010, Malden, MA: Blackwell.	
Reference Books:	• World Intellectual Property Organisation. http://www.wipo.int • International Union for the Protection of New Varieties of Plants. http://www.upov.int • National Portal of India. http://www.archive.india.gov.in • National Biodiversity Authority. http://www.nbaindia.org • Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct. • Office of the Controler General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/ • Recombinant DNA Safety Guidelines, 1990, Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf	

Syllabus
SEMESTER – IV

Discipline Specific Elective III

COURSE CODE	Applied Microbiology	Total Lec.: 45
MB20M401		**3-0-0**
Learning Objectives	• Prepare students with the concept of microbiology and bioinformatics. • To demonstrate students various computational approach.	
Pre-requisite	None.	
UNIT	**CONTENT**	**HOURS**
I	Production of Microbial Products, Bacteriocins and bioemulsifiers, production of microbial enzymes- lipases and protease, rapid detection techniques for pathogenic microorganisms, total ATP measurement, PCR and immunological based assays.	8
II	Plant Pathology and Pests, Introduction to phytiatary science and its importance, plant disease triangle, diseases caused by fungi: *Sclerotiumrolfsii* and *Macrophominaphaseolina* (collar rot disease, charcoal rot), bacteria: *Xanthomonascampestris* (black rot), actinomycetes: *Streptomycesscabies* (common scab), infections caused by pest: *Helicoverpaarmigera* and *Spodopteralitura*, biological and chemical control methods for plant diseases and pest management.	10
III	Nanobiotechnology, Introduction, development of nanobiotechnology, nanoparticular carrier systems, micro and nanofluidics, applications: biosensors, drug and gene delivery systems, chip technologies, nano-imaging, nanomedicine and cancer diagnostics and treatment.	9
IV	Environmental Microbiology and Wastewater Management, Aeromicrobiology, microorganisms in indoor and outdoor air environment, nature of bioaerosols, their fate and transport; aeroallergens and allergies. Soil microorganisms and their significance in soil quality management. Microorganisms in aquatic environments and their significance in water quality management. Brief introduction to various stages of wastewater treatment: Primary, secondary and tertiary treatment. Definition of extremophiles its domain, Energy transduction in extremephiles in general, physiology and biochemistry of various extremophiles such as thremophiles, acidophiles, alkalophiles, psychrophiles and halophiles, indicator microorganisms for water quality, definition of biosensors, its various types and biotechnological significance, use of microorganisms as dead living cells and immobilized cells for removal of heavy metals from wastewater.	9
V	Microbial Biogeochemistry, The role of microbes in biosphere: microbes and the origin and evolution of life on earth, microbial diversity, structural, physiological and genetical, exploration and quantification of the microbial diversity; cultivation and non-cultivation approaches; complementarities between cultivation and non-cultivation approaches; microbial crusts: formation, composition and function, microbial aspects of biogeochemical cycling of C, N, P and S, survival strategies of microbes in extreme habitats, microbial leaching: copper, gold, uranium.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **recall**[1] the concepts of Bioinformatics.	
CO2	The students will **understand**[2] the analysis of microbial data using.	
CO3	They will be able to **apply**[3] the concept of Chemoinformatics.	

CO4	They will **develop**[3] the awareness for Molecular Modelling.
CO5	Students will be able to **analyse**[4]protein structure and predict its function.
Text Books:	• J Pelczar, ECS Chan and NR Krieg, Microbiology. 5th edition, 1993, McGraw Hill M Book Company. • GJ Tortora, BR Funke and CL Case,Microbiology: An Introduction. 9th edition, 2008, Pearson Education. • DK Maheshwari, Text Book of Micribiology . 6thedition, 2013,S Chand.
Reference Books:	• R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. • R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology. 5th edition, 2005, McMillan.

Practical

COURSE CODE	LAB V	Practicals:120
MB20M307		4

1) Bioanalytics

a) Analytical techniques like HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates.

2) Agriculture Microbiology

a) To study bacterial and fungal diseases in plants.
b) Isolation of rhizobia from root nodules of leguminous plants.
c) Testing of nodulation ability of rhizobia.
d) Inoculation of seeds with rhizobia.

3) Food and Dairy Microbiology

a) Detection of adulterants in spices, pulses, sugar, tea.
b) Detection of adulterants in milk and milk products.
c) Isolation of microorganisms from spoiled food.
d) Isolation of pathogenic microorganisms from food.

4) Environmental Microbial technology

a) Determination of Total Dissolve Solids (TDS) of given water sample.
b) Determination of chemical oxygen demand (COD) of given water sample.
c) Determination of Dissolved oxygen (DO) of given water sample.
d) Determination of BOD of given water sample.
e) Determination of total bacterial population by standard plate count technique.
f) Determination of the most probable number (MPN) of coliform bacteria in water

FOURTH SEMESTER

Discipline Specific Elective IV

COURSE CODE	**PYTHON**	**Total Lec.: 45**
BT20M401		**3-0-0**
Learning Objectives	• To understand why Python is a useful scripting language for developers. • To learn how to design and program Python applications. • To develop the ability to write database applications in Python • Finally this course serves to provide an awareness of the current and possible future applications of Programming.	
Pre-requisite	Basics of computers	
UNIT	**CONTENT**	**HOURS**
I	Introduction to Python, use IDLE to develop programs, Basic coding skills, working with data types and variables, working with numeric data, working with string data, Python functions, Boolean expressions, selection structure, iteration structure, Illustrative Programs, Exercises	10
II	Define and use functions and modules, working with recursion, Basic skills for working with lists, work with a list of lists, work with tuples, work with dates and times, get started with dictionaries, Illustrative programs, Exercises.	10
III	An introduction to file I/O, use text files, use CSV files, use binary files, Handle a single exception, handle multiple exceptions, Illustrative programs, Exercises	5
IV	Object Oriented Programming, An introduction to classes and objects, define a class, work with object composition, work with encapsulation, work with inheritance, override object methods, Illustrative programs, Exercises	10
V	An introduction to relational databases, SQL statements for data manipulation, Using SQLite Manager to work with a database, Using Python to work with a database, Creating a GUI that handles an event, working with components, Illustrative programs, Exercises	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **develop**[3] algorithmic solutions to simple computational problems	
CO2	They will **learn**[1] to Read, write, execute by hand simple Python programs.	
CO3	They will be able to **design**[6] simple Python programs for solving problems.	
CO4	Students will be able to**define**[5] a Python program into functions.	
CO5	They will be able to **develop**[3] Python programs with conditionals and loops.	
Text Books:	• Michael Urban and Joel Murach, Python Programming, 2016. • Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010. • Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, 2011, Network Theory Ltd.	
Reference Books:	• Allen B. Downey,"Think Python: How to Thinklike a Computer Scientist, 2nd edition, Updated for Python 3, 2016, Shroff/OReilly Publishers. • Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, 2013, Wiley India Edition. • Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, 2016, Pearson India Education Services Pvt. Ltd.	

Project Based Learning III

COURSE CODE	PROJECT BASED LEARNING
PB20B301	
Learning Objectives:	• Integrating the knowledge and skills of various courses on the basis of multidisciplinary projects. • Develop the skill of critical thinking and evaluation. • To develop 21st century success skills such as critical thinking, problem solving, communication, collaboration and creativity/innovation among the students. • To enhance deep understanding of academic, personal and social development in students. • Employ the specialized vocabularies and methodologies.
General Guidelines:	• PBL will be an integral part of UG/PG Programs at different levels. • Each semester offering PBL will provide a separate Course Code, two credits will be allotted to it. • Faculty will be assigned as mentor to a group of 30 students minimum by HoS. • Faculty mentor will have 4 hours/week to conduct PBL for assigned students. • Student will select a topic of their choice from syllabus of any course offered in respective Semester (in-lines with sustainable development goals). • Student may work as a team maximum 3 or minimum 2 members for single topic. • For MSE, student's performance will be assessed by panel of 2 experts either from other Department/school, or from same department/school based on chosen topic. This will be comprised of a presentation by student followed by viva-voce. It will be evaluated for 30 marks. • 20 marks would be allotted for continuous performance assessment by concerned guide/mentor. • For ESE, student will need to submit a project report in prescribed format, duly signed by concerned guide/mentor and head of the school. The report should be comprised of following components: 1. Introduction 2. Review of literature 3. Methodology 4. Result and Discussion 5. Conclusion and Project Outcomes 6. References • In ESE, viva-voce of students will be conducted on the basis of report, by one external and one internal faculty which is of 50 Marks. Student will need to submit three copies for 1. Concerned School 2. Central Library 3. Self. The integrity of the report should be maintained by student. Any malpractice will not be entertained. • Writing Ethics to be followed by student, a limit of 10 % plagiarism is permissible. Plagiarism report is to be attached along with the report. • Project could be a case study/ analytical work /field work/ experimental work/ programming or as per the suitability of the program.