DAYANANDA SAGAR UNIVERSITY

SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU – 560 111, KARNATAKA.

SCHOOL OF BASIC & APPLIED SCIENCES

SCHEME & SYLLABUS
FOR
MASTER OF SCIENCE (M.Sc.) – 2021

SPECIALIZATION: MICROBIOLOGY

(With effect from 2020-21)

(Updated from I to IV Semesters)

SCHEME – M.Sc. – MICROBIOLOGY – 2020-21 ONWARDS

I SEM – M.Sc. – MICROBIOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
1	208	20MSC5101	FUNDAMENTALS OF CHEMISTRY	CR	4	-	-	-	4	60	40
2	208	20MSC5102	BIOMOLECULES	CR	4	-	-	-	4	60	40
3	208	20MSC5103	MOLECULAR GENETICS	CR	4	-	-	-	4	60	40
4	208	20MSC5104	GENERAL MICROBIOLOGY	CR	4	-	-	-	4	60	40
5	208	20MSC5105	BIOINFORMATICS – I (PROTEOMICS)	CR	2	-	-	-	2	60	40
6	208	20MSC5106	BIOSTATISTICS	CR	2	-	-	-	2	60	40
7	208	20MSC5171	ANALYSIS OF BIOMOLECULES – LAB	CR	-	-	6	-	3	100	0
8	208	20MSC5172	TECHNIQUES IN MICROBIOLOGY AND GENETICS – LAB	CR	-	-	6	-	3	100	0
GRAND TOTAL = 800					**20**	**-**	**12**	**-**	**26**	**560**	**240**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

SCHEME – M.Sc. – MICROBIOLOGY – 2020-21 ONWARDS

II SEM – M.Sc. – MICROBIOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
1	208	20MMB5201	PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY	CR	4	-	-	-	4	60	40
2	208	20MMB5202	MICROBIAL PHYSIOLOGY	CR	4	-	-	-	4	60	40
3	208	20MSC5201	MOLECULAR BIOLOGY	CR	4	-	-	-	4	60	40
4	208	20MSC5202	ANALYTICAL TECHNIQUES	CR	4	-	-	-	4	60	40
5	208	20MSC5203	BIOINFORMATICS – II (GENOMICS)	CR	2	-	-	-	2	60	40
6	208	20MSC5204	EVOLUTION AND DEVELOPMENTAL BIOLOGY	CR	2	-	-	-	2	60	40
7	208	20MMB5271	PROKARYOTIC, EUKARYOTIC AND MICROBIAL PHYSIOLOGY - LAB	CR	-	-	6	-	3	100	0
8	208	20MSC5271	BIO-ANALYTICAL TECHNIQUES-LAB	CR	-	-	6	-	3	100	0
GRAND TOTAL = 800					**20**	**-**	**12**	**-**	**26**	**560**	**240**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

SCHEME – M.Sc. – MICROBIOLOGY – 2020-21 ONWARDS

III SEM – M.Sc. – MICROBIOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
1	208	20MMB5301	IMMUNOLOGY AND MEDICAL MICROBIOLOGY	CR	4	-	-	-	4	60	40
2	208	20MMB5302	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY	CR	4	-	-	-	4	60	40
3	208	20MMB53XX	ELECTIVE – I	CR	3	-	-	-	3	60	40
4	208	20MMB53XX	ELECTIVE – II	CR	3	-	-	-	3	60	40
5	208	20MMB53XX	ELECTIVE – III	CR	3	-	-	-	3	60	40
6	208	20MSC5301	CLINICAL RESEARCH	CR	2	-	-	-	2	60	40
7	208	20MSC5302	SCIENTIFIC WRITING AND IPR	CR	2	-	-	-	2	60	40
8	208	20MSC5303	RESEARCH METHODOLOGY	CR	2	-	-	-	2	60	40
9	208	20MMB5371	IMMUNOLOGY, MEDICAL AND INDUSTRIAL MICROBIOLOGY – LAB	CR	-	-	6	-	3	100	0
10	208	20MMB5372	PRACTICAL BASED ON ELECTIVES (I To III)	CR	-	-	6	-	3	100	0
GRAND TOTAL = 1000					**23**	**-**	**12**	**-**	**29**	**680**	**320**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

LIST OF PROGRAM ELECTIVE COURSES

SL	COURSE CODE	COURSE
1	20MMB5321	ENVIRONMENTAL MICROBIOLOGY
2	20MMB5322	AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY
3	20MMB5323	GENETIC ENGINEERING
4	20MMB5324	AQUATIC MICROBIOLOGY
5	20MMB5325	SOIL MICROBIOLOGY
6	20MMB5326	PHARMACEUTICAL MICROBIOLOGY

SCHEME – M.Sc. – MICROBIOLOGY – 2020-21 ONWARDS

IV SEM – M.Sc. – MICROBIOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
1	208	20MSC5401	PROJECT WORK	CR	-	-	36	-	18	240	160
					-	**-**	**36**	**-**	**18**	**240**	**160**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5101**					
TITLE OF THE COURSE	**FUNDAMENTALS OF CHEMISTRY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To reintroduce the students to the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
- To make the students to understand the interdisciplinary nature of chemistry and to integrate knowledge of various branches of chemistry with other higher biological courses.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will acquire a foundation of chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary concepts in chemistry.	L2
CO2	Students will familiarize with the basic concepts related to chemical bonding, electrochemistry, thermodynamics, chemical kinetics, stereochemistry, reaction mechanism and their interdisciplinary role in thorough understanding of higher biological courses	L3

COURSE CONTENT:	
MODULE 1 General Chemistry	**13 Hrs**
Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.	
MODULE 2 Physical Chemistry	**13 Hrs**

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation. Thermodynamics: First & second laws of thermodynamics, enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential. Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis.	
MODULE 3 Organic Chemistry - I	**13 Hrs**
Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids. Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.	
MODULE 4 Organic Chemistry - II	**13 Hrs**
Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (2077).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5102**					
TITLE OF THE COURSE	**BIOMOLECULES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To create in depth understanding about fundamentals of biomolecules, their structure and significance.
- To know about the structural and functional classification of biomolecules

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be able to draw structures of biomolecules and comprehend their properties based on the structures.	L2
CO2	They will have a better understanding of metabolism of these biomolecules in second and third semesters.	L3

COURSE CONTENT:	
MODULE 1 CARBOHYDRATES	**13 Hrs**
Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides. **Complex Carbohydrates:**Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.	
MODULE 2 AMINO ACID AND PROTEINS	**13 Hrs**
Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination –amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent. **Secondary structure**: α-, PP-, 310 and π-helix, β pleated sheet, β and bend, Peptide	

bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains	
MODULE 3 PROTEIN CONFORMATION AND FOLDING	**13 Hrs**
Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen. **Quaternary structure:**Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition. **Protein folding:** Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins-protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.	
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MODULE 4 LIPIDS AND NUCLEIC ACID	**13 Hr**
Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation. **Nucleic acids:** Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5103**					
TITLE OF THE COURSE	**MOLECULAR GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To understand the functions and structures of nucleic acids and proteins.
- To understand the concepts of transcription, translation, control of gene expression, mutations, DNA repair and DNA recombination

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	In-depth knowledge of biological and/or medicinal processes through the investigation of the underlying molecular mechanisms	L3
CO2	At the end student will gain an understanding of chemical and molecular processes that occur in and between cells	L3
CO3	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L4
CO4	Explain the principles of cloning and genetic manipulation and their application in genetic analysis	L3
CO5	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L2

COURSE CONTENT:	
MODULE 1	**13Hrs**
Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance. **Organization of Chromosomes:** Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.	

MODULE 2	**13Hrs**
Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*. **Mechanism of Recombination:** Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA	
MODULE 3	**13Hrs**
Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders. **Transposons and Molecular mechanism of transposition:**Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis	
MODULE 4	**13Hrs**
Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA). **Medical Molecular Genetics:** Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**

2. **NO**

TEXT BOOKS :

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5104**					
TITLE OF THE COURSE	**GENERAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To deliberate existing theories about the origin of life, microbial evolution and systematics
- To understand basic techniques, morphological, biochemical and cultural characteristics
- To study the applications of microbes with respect to various

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students are equipped with strong grounding in fundamental aspects of the basic microbiology.	L1
CO2	Enable to understand the diversity of microbial, structure, function and their environment	L2
CO3	To apply the importance of microbes in different fields and enable students to employ the knowledge	L3

COURSE CONTENT:

MODULE 1: History and Systematics of Microorganisms **13Hrs**

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques	**13Hrs**
Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.	
MODULE 3: Applied Microbiology-I	**13Hrs**
Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveria bassiana*. Medical Microbiology: pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases: Malaria and Filaria.	
MODULE 4: Applied Microbiology-II	**13Hrs**
Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals. **Industrial Microbiology**: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1. No	
2. No	
TEXT BOOKS :	
1.	Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2	Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3	Dubey, R.C. Microbiology 1st Edition. Chand and company.
4	Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1998.
5	Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

1 Edward Alcamo. Microbiology. Cliffs Notes 1996.

2 Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.

3 Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.

4 Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5105**					
TITLE OF THE COURSE	**BIOINFORMATICS – I (PROTEOMICS)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand proteins at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating proteomic targets

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be familiarized with detection and assay techniques for various biomolecules.	L2
CO2	They will have an understanding of composition of inorganic materials.	L3

COURSE CONTENT:

MODULE 1 **13 Hrs**

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2 **13 Hrs**

Introduction to protein structure. Data generation; Generation of large scale molecular

biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips). Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools. Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
3. No
4. No

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5106**					
TITLE OF THE COURSE	**BIOSTATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To demonstrate the significance of statistical analysis in biology.
- To understand basic definitions, usage of proper mathematical calculations to analyse the biological data

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be able to execute and understand proteins at a virtual platform which will enable them for pharmaco-proteomic studies	L3

COURSE CONTENT:	
MODULE 1 Measures of Central Tendencies, Dispersion And Correlation	**13 Hrs**
Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance	
MODULE 2 Probability Distributions and Testing of Hypothesis	**13 Hrs**
Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of statistical software, SPSS for various applications in Biostatistical program.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5171**					
TITLE OF THE COURSE	**ANALYSIS OF BIOMOLECULES - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To familiarize the students with good lab practice and laboratory instruments.
- To create in depth understanding about detection of biomolecules.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be familiarized with detection and assay techniques for various biomolecules.	L3
CO2	They will have an understanding of composition of inorganic materials.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

TEXT BOOKS:

1. 1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5172**					
TITLE OF THE COURSE	**TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**-**	**6**	**-**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To equip students with the basic microbiological techniques
- To gain insight to different genetic interactions and their effect on phenotype
- To understand the role of allele frequency in evolution and genetic diversity

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand microbial structure, functions and their environment	L3
CO2	Students will be capable to recognise various gene interactions, predict crosses and decipher the role of alleles in inheritance.	L3
CO3	Ability to calculate allele frequency and its role in genetic diversity.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2.	Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3.	Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4.	Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus* and *Puccinia*.
5.	Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria and Rivularia.*
6.	Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7.	Study of mitosis in onion root tips
8.	Study of *Drosophila* mutant types.
9.	Mounting of polytene chromosomes – in *Drosophila.*
10.	Preparation of buccal smear to study Barr bodies.

11.	Concept of Multiple Alleles in Humans (Blood group).
11.2.	Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

TEXT BOOKS :

1. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

REFERENCES :

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MMB5201**					
TITLE OF THE COURSE	**PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To understand microbial diversity, classification, structure of different groups of microbes and their functions
- To strengthen the knowledge on cell and cellular organisation of prokaryotic and eukaryotic systems
- To know about the economic importance

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Enable students to relate the principles in classifying microbes	L3
CO2	Apply the knowledge in identifying different microorganisms and to study their life cycles	L3
CO3	Elucidate the role of beneficial and harmful effects	L5

COURSE CONTENT:	
MODULE 1: BIOLOGY OF VIRUS	**13Hrs**
Difference between prokaryotic and eukaryotic microorganisms. Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification, Cultivation and Purification assay of virus. Bacteriophages - structural organization and life cycle - lytic, lysogenic.Application of viruses. Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV), (Ultra-structure, replication and importance). Viral related agents - viroid and prion.	
MODULE 2: BIOLOGY OF BACTERIA	**13Hrs**
Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, polyhydroxybutyrate granules, glycogen, oil droplets, and sulphur	

globules), endospores and exospores. Reproduction in bacteria.
Special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae, Archaebacteria and extremophiles.
Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time; Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of microorganisms based on environmental and nutritional requirements.

MODULE 3: BIOLOGY OF FUNGI & PROTOZOA	**13Hrs**

General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, Sex and mating in fungi fungal spores – dormancy and dispersal.
Type studies: *Aspergillus*, *Saccharomyces*, *Pythium*, *Rhizopus*, *Fusarium*, *Puccinia* and *Agaricus* (Classification, Ultrastructure, reproduction, lifecycle, importance).
General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania, Amoeba, Entamoeba*and *Plasmodium.* Cultivation of protozoa.

MODULE 4: BIOLOGY OF ALGAE	**13Hrs**

General characteristics of Algae, occurrence, thallus organization, classification, ultra-structure of cell, vegetative, asexual and sexual reproduction.Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas, Spirogyra, Diatoms, Sargassum and Porphyra.* Symbiotic algae: Lichens. Economic importance of algae.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. No
2. No

TEXT BOOKS :

1.	Sambamurty, A.V.S.S.. A Textbook of Algae. I.K. International Publishing. (2005).
2.	Alexopoulos, C. J. and Mims, C.W. Introduction to Mycology, Wiley.(2001)
3.	Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
4.	Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

1.	Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press. 2005
2.	Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MMB5202**					
TITLE OF THE COURSE	**MICROBIAL PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To learn the fundamentals of molecular microbial physiology such as microbial structure, energetics, metabolism and genetics
- To understand antimicrobial resistance, differentiation, and ecology of microbes with respect to their genotype as well as phenotype

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the complexity of microbial structures, genetics and metabolism.	L2
CO2	Enable to grasp the mechanisms of various interactions that exist between the microbes, microbes and higher forms of life/environment	L4

COURSE CONTENT:	
MODULE 1 : MICROBIAL METABOLISM	**13Hrs**
Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Brief account of porphyrins. **Photosynthesis:** Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways, Methanogenesis. **Fermentation**: Alcohol fermentation, Lactic acid: Homo- and Heterolactic acid fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation. **Fungal and bacterial secondary metabolism:** Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones. Bioluminescence – mechanism and significance.	
MODULE 2: ENZYMOLOGY	**13Hrs**
Enzymes: Definition, classification, nomenclature, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups.Effect of temperature, pH and	

substrate concentration on reaction rate. Isozymes, Enzyme Kinetics and co-enzyme action
Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters, hyperbolic and LB plot. Regulation of enzymes: Covalent and noncovalent modification; Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive. Ribozymes and abzyme.

MODULE 3: MICROBIAL RESPIRATION AND BIOENERGETICS	**13Hrs**

Introduction: Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain.
Bacterial aerobic respiration: Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation, structure of bacterial ATPase. Theories of ATP formation, generation and maintenance of PMF and inhibition of electron transport chain. Electron transport chain in heterotrophic and chemolithotrophic bacteria.
Anaerobic respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria.

MODULE 4 : MICROBIAL CELL MEMBRANE PHYSIOLOGY	**13Hrs**

Metabolite transport: Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (PTS, role of permeases in transport, different permeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms (Bacteria and fungi) and their mechanisms.
Stress physiology: Osmotic stress and osmoregulation by glutamate and disaccharide trehalose, Osmotic Control of Gene Expression. Aerobic to anaerobic transitions in facultative microorganisms (E. coli); Oxidative stress - superoxide dismutase and catalase, Regulation of the Oxidative Stress Response, pH stress and acid tolerance; Thermal stress and heat shock response (genes); Nutrient stress and starvation stress, stringent Control.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. No
2. No

TEXT BOOKS :

1. Moat, A.G. and Foster, W.2002. Microbial Physiology, Fourth Edition, John Wiley and Sons, New York.
2. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge
3. Donald Voet and Judith G. Voet, 2011. Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.
4. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.

REFERENCES :

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Brown Publishers.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5201**					
TITLE OF THE COURSE	**MOLECULAR BIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To introduce the basic concepts of central dogma of molecular biology
- To provide in-depth knowledge of DNA replication and repair mechanisms with proteins involved in these processes.
- To give substantial knowledge on the processes involved in gene expression and its regulation in prokaryotes and eukaryotes.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will understand the key events of central dogma comprising mechanism of replication, transcription and translation.	L1
CO2	Student will understand the molecular mechanisms of expression, regulation, and maintenance of genetic information, within a biological system.	L2
CO3	Student will be able to critically think in the field of application of molecular biology.	L3

COURSE CONTENT:

MODULE 1: DNA replication and repair **13Hrs**

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA.C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere

synthesis- telomerases regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model. **Mechanism of DNA Repair:** DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.
MODULE 2: Gene expression – Transcription **13Hrs**
Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination- Rho dependent and Rho independent. **Eukaryotic Transcription**: Composition of eukaryotic RNA polymerases, Role of enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, elongation and termination. Post transcriptional modifications of mRNA (5' cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.
MODULE 3: Gene expression- Translation **13Hrs**
Protein synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in eukaryotes. **Protein targeting and localization**: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.
MODULE 4: Regulation of gene expression in prokaryotes and eukaryotes. **13Hrs**
Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage. **Regulation of eukaryotic gene expression**: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, post-transcriptional control. **Gene Silencing:** transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. NO
2. NO

TEXT BOOKS :

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition)
2 James D. Watson. Molecular Biology of the Gene (7th Edition)
3 Benjamin A Pierce. Genetics A conceptual approach (5th Edition)
4 Robert Weaver. Molecular Biology. (4th Edition)

5 Nancy L Craig. Molecular Biology: Principles of Genome Function.

REFERENCES :

1 Pukkila P J., 2001. Molecular Biology: The Central Dogma.(https://doi.org/10.1038/npg.els.0000812)

2 Mejía-Almonte, C., Busby, S. J. W., Wade, J. T., van Helden, J., Arkin, A. P., Stormo, G. D., … Collado-Vides, J. (2020). Redefining fundamental concepts of transcription initiation in bacteria. Nature Reviews Genetics. (doi:10.1038/s41576-020-0254-8)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5202**					
TITLE OF THE COURSE	**ANALYTICAL TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To create detailed understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To acquaint students with concepts, principles and advanced application of cuttingedge techniques.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will receive adequate knowledge of high-end techniques like Microarray, Mass spectroscopy & NMR	L3
CO2	Students will be able to have a basic understanding of techniques used in drug discovery.	L3

COURSE CONTENT:	
MODULE 1	**13 Hrs**
Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS. **Structural elucidation:** CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.	
MODULE 2	**13 Hrs**
Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques. **Mass spectrometry:** principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom	

bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips.
MODULE 3 **13 Hrs**
Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC **Radioactivity:** Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.
13 Hrs
MODULE 4
Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications. **Techniques in drug discovery:** General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5203**					
TITLE OF THE COURSE	**BIOINFORMATICS – II (GENOMICS)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand genes at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating genomic targets

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be able to execute and understand genes at a virtual platform which will enable them for pharmaco-genomic studies	L2

COURSE CONTENT:	
MODULE 1	**13 Hrs**
Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs	
MODULE 2	**13 Hrs**
Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB	

files, parsing BLAST files. General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5204**					
TITLE OF THE COURSE	**EVOLUTION AND DEVELOPMENTAL BIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**0**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To provide students with a deeper insight into the evolutionary processes, both selective and random.
- To provide a comprehensive understanding of the concepts of early animal development.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Describe evolutionary history of complex multicellular life forms	L3
CO2	Explain the molecular and genetic background of animal and plant development	L3
CO3	Describe evolutionary history of complex multicellular life forms	L4
CO4	Interpret, analyse and present experimental results and conclusions in a scientific manner.	L3
CO5	Learning comparative anatomy, developmental mechanisms of organs, and methodologies to integrate genetics	L2

COURSE CONTENT:	
MODULE 1	**13Hrs**
Ecology and Evolution **Ecology and Evolution** **Ecology:** Introduction, biotic and abiotic factors, Biomes **Population ecology:** Dynamics of population, Population growth-Exponential model Logistic growth model **Community ecology**: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views **Ecosystems:** Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems **Evolution:** Introduction, Early ideas of evolution, Darwinian view of life.	

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change. **Natural selection:** Stabilizing, directional, and disruptive selection. **Microevolutionary and Macroevolutionary phenomena:** insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2	**13Hrs**
Developmental Biology **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; **Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination **Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum **Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MMB5271**					
TITLE OF THE COURSE	**PROKARYOTIC, EUKARYOTIC AND MICROBIAL PHYSIOLOGY – LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**6**	**0**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To make students learn and identify microbes based on biochemical tests
- To estimate biomolecules by quantitative and qualitative methods

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be equipped with microbial isolation and identification techniques	L2
CO2	Knowledge of estimating biomolecules and enzyme kinetic studies will be imparted.	L1

List of Laboratory/Practical Experiments activities to be conducted (if any) :	
1.	Isolation and culturing of fungi (yeasts and molds) by Dilution plate method, Warcup method implant and impression.
2.	Anaerobic culturing methods – anaerobic jar and its use, thioglycollate media culturing.
3.	Isolation and identification of microscopic algae from soil and water.
4.	Isolation and identification of protozoa from soil and water.
5.	Biochemical test: Catalase, Oxidase, IMViC, starch, casein and Gelatin hydrolysis, Hydrogen sulfide production in TSIA, Identification of bacteria by API methods.
6.	Growth measurement of bacteria (turbidity method) and fungi (Linear method).
7.	Estimation of DNA and RNA.
8.	Estimation of proteins
9.	Estimation of enzyme activity – amylase and protease.
10.	Enzyme kinetics – K_m and V_{max} of amylase

TEXT BOOKS :

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.

2. Caldwell. D.R. (2095). Microbial Physiology and metabolism, Brown Publishers.

SEMESTER	**II**
YEAR	**I**
COURSE CODE	**20MSC5271**
TITLE OF THE COURSE	**BIO-ANALYTICAL TECHNIQUES - LAB**

	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
SCHEME OF Instruction	**-**	**-**	**6**	**-**	**26**	**3**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Practical exposure for biomolecules and their quantification using standard estimations and spectroscopy
- Biophysical equipments will be explored for the analysis of biomolecules

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have hands on practical exposure for quantitation of biomolecules using modern techniques and equipments	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column

chromatography

9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

TEXT BOOKS:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5301**					
TITLE OF THE COURSE	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MMB5201	PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY

COURSE OBJECTIVES :

1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection.
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.	L3
CO2	To introduce the classes of antibiotics and the resistant mechanisms encoded in bacteria and to neutralise these antimicrobial agents.	L3
CO3	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L4

COURSE CONTENT:	
MODULE 1: Immune System and Immune Responses	**13Hrs**
Innate, adaptive, humoral and cellular immunity. Primary and secondary immune responses. Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Immunoglobulin genes: organization and assembly. Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules. T-cell receptor; B and T cell activation. Antigen processing, antigen presentation, Complement system – pathways, component, properties and functions. Immune response to cancer. Hypersensitivity reactions - types (I, II, III, and IV).	

MODULE 2: Autoimmune Disorders, Transplantation and Pathogenic Diseases	13Hrs
Autoimmune diseases- Insulin dependent Diabetic mellitus, Rheumatoid arthritis, Myasthenia gravis and their treatment. **Tissue transplantation-** Graft versus host reaction and rejection, xenotransplantation, tolerance. **Host Microbe Relationship-** Normal microbial flora of human body and its significance. Koch's Postulates. Mode of entry of pathogen into human host. Infections and its types- nosocomial infections and non-infectious diseases. Immune response to infectious diseases; viral, bacterial, fungal and protozoal infections (Hepatitis, HIV, *Mycobacterium tuberculosis, Salmonella typhi, Tricophyton* spp., *Candida albicans, Plasmodium vivax*, *Entamoeba histolytica*).	
MODULE 3: Immunological Techniques and Diagnostic Microbiology	**13Hrs**
Techniques- Immunoprecipitation; Agglutination; Immuno-electrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA, Western blotting; Tissue typing methods for tissue and organ transplantations. Polyclonal and monoclonal antibodies. Hybridomas and their production. **Diagnostic Microbiology**: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Biomedical waste management and treatment.	
MODULE 4: Vaccines and Antimicrobial Prophylaxis	**13Hrs**
Vaccines: Active and passive immunization, Immunization protocol. Conventional vaccines, live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. Novel vaccines subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, Small pox, DPT, Polio, Measles, Hepatitis-B. **Antimicrobial Prophylaxis**: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and anti-protozoans- causes, mechanism and prevention. Probiotics as therapeutic agents.	

TEXT BOOKS :

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.

7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag. Mackie and McCarthey (2096) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
8. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
9. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher. Kufe (2003) Cancer Medicine. BC Decker Inc
10. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
11. Jenson, Wright robinson (2097) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
12. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
13. Nester Roberts Pearsall Anderson (2097) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5302**					
TITLE OF THE COURSE	**INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.

2. To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology.	L3
CO2	It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments.	L2
CO3	To gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products.	L4

COURSE CONTENT:	
MODULE I: Introduction to Industrial Microbiology	**13Hrs**
Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers. Basic components and design of typical fermenter. Types of fermenter-Laboratory, pilot-scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, chemostat, submerged and solid-state fermentation. Different parameters affecting fermentation.	

MODULE II: Industrial Bioprocessing	13Hrs
Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development. **Downstream processing:** Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. **Productions and Applications**: Alcohol production, organic acids (citric acid), enzymes: amylases-(Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Applications of genetic engineering in industrial bioprocessing. Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.	
MODULE III: Scope of Food Microbiology and Food Preservation	**13Hrs**
Scope and Development of food microbiology. Food as a substrate for microorganisms; Principles and methods of food preservation by Physical, Chemical and food Additives, Bio-preservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – *Clostridium*. Virus- *Hepatitis A*, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins,). Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread and Idli. Nutritional and therapeutic importance: Single cell Protein, Probiotics and Symbiotics; Neutraceuticals, Quorn and Single Cell Oil and their industrial production). Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.	
MODULE IV: Dairy Microbiology	**13Hrs**
Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage; principles of quality control tests for milk; bacteriological grading. Microbiology of dairy products: cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products. Biosensors in Food Industry; Genetically modified foods; Food fortification.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Stanbury PF, Whitakar A and Hall SJ (2099) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
3. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
6. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
7. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
8. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
9. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 2096
10. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
11. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
12. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
13. John G. Essentials of Food Microbiology. Arnold International Students Edition.
14. Frazer W.C. Food Microbiology. McGraw Hill, New York. 2079.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5321**					
TITLE OF THE COURSE	**ENVIRONMENTAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. The course makes students understand distribution of microorganisms in nature, their habitat and interaction with other organisms.

2. The course enables the students to understand the importance of microorganisms in the environment, their role in the biogeochemical cycles and also their applications. The beneficial and harmful microorganisms are studied which helps them to know the impact of microbes in the environment.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Students will have fundamental understanding of the distribution and habitat of microorganisms in nature.	L3
CO 2	They can apply the knowledge in studying microbial diversity in various environmental niches.	L4
CO 3	Students are aware of the role of microorganisms in the environment.	L2
CO 4	They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L1
CO 5	The course helps them to apply knowledge in employing microbes in various fields.	L4

COURSE CONTENT:	
MODULE I: Soil Microbiology	**10Hrs**
Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (Rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health.	

Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation. **Diversity in anoxic eco system**: Methanogens-reduction of carbon monoxide-reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.
MODULE II: Aquatic Biology and Sewage Treatment **10Hrs**
Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; Marine microbiology; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG). **Sewage treatment**: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.
MODULE III: Aerobiology **10Hrs**
Air microflora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Greenhouse effect, Ozone depletion, UV radiation and Acid rain. Aeroallergens and Allergies: Causes and tests for detection of aero allergens
MODULE IV: Bioleaching and Biodegradation **10Hrs**
Bioleaching: Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution. **Biodegradation:** Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose, lignin, paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water '*in-situ'* remediation- Engineering developments - Constructed wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology,2ndEdition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5322**					
TITLE OF THE COURSE	**AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. The course aims to impart knowledge about the interaction of microorganisms with plants, mainly crop plants. The beneficiary aspects of the microbes by helping the plant growth and also increasing the plant health by avoiding diseases and disorders are studied.

2. The course also deals with the plant diseases caused by microorganisms, where microorganisms play a major role in plant health and yield. Collectively, the course helps students to gain fundamental knowledge of role of microorganisms in agriculture.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO 1	The students will be equipped with knowledge about the importance of microorganisms in agricultural field.	L3
CO 2	They can understand how to employ microorganisms to enhance agricultural productivity.	L4
CO 3	The knowledge of plant pathology will help students to understand microbial diseases in plants, so they understand disease predictions and the prevention measures.	L2
CO 4	They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L1
CO 5	The course helps them to apply knowledge in employing microbes in various fields.	L4

COURSE CONTENT:	
MODULE I: Plant-Microbe Interactions	**10Hrs**

Distribution of microorganisms in soil, soil fertility evaluation and improvement. Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation:Symbiotic nitrogen fixation, (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation *Azotobacter,Azospirillum*). Concepts of siderophores and VAM with suitable examples. Application of nitrogen fixing genes in rDNA technology in agriculture research.

MODULE II: Bioinoculants and Biological Control	**10Hrs**

Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- *Rhizobium, Azotobacter, Azospirillum*, Cyanobacteria,Phosphate solubilizing microorganisms and *Azolla*. Carrier-based inoculants–production,applications and limitations.

Biopesticides: Types and mechanism of application of different varieties. Examples includes *Pseudomonas fluroscence, Bacillus thuringiensis*, *Trichoderma harzianum, Trichoderma viridae,* Nuclear Polyhedrosis Virus. Production, applications and limitations.

MODULE III: Host Pathogen Interaction and Defense Mechanism	**10Hrs**

Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Koch's postulates. Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle/Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant-mechanical forces, microbial enzymes, toxins and growth regulators.

Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defences (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, PGPR and plantibodies.

MODULE IV: Plant Diseases and Their Management	**10Hrs**

Plant diseases- Red rust of tea (Algae), Grain and head smut of Sorghum (Fungi), Root knot of mulberry (Nematode). Papaya ring spot (Virus), Sandal Spike Disease (Mycoplasma), Citrus canker (Bacteria).

Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept. Diagnosis of plant diseases, regulatory, farming education and awareness.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**

2. **NO**
TEXT BOOKS :

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006
13. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5323**					
TITLE OF THE COURSE	**GENETIC ENGINEERING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5201	MOLECULAR BIOLOGY

COURSE OBJECTIVES :

1. To understand how DNA can be manipulated using different enzymes.
2. Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
3. Diverse methods to visualise modified genetic materials.
4. Applications of genetic engineering.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3
CO2	It will also teach techniques to detect the engineered DNA, RNA and protein	L4
CO3	Students will also learn various applications where genetic engineering can be used.	L2

COURSE CONTENT:

Module I: Basic Concepts **10Hrs**

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.

Module II: Cloning and expression vectors **10Hrs**

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.;

Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Module III: Cloning strategies and study of protein-DNA interactions 10Hrs

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Module IV: Sequencing, PCR and its applications 10Hrs

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1**.NO**
2. **NO**

TEXT BOOKS :

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd. 10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5324**					
TITLE OF THE COURSE	**AQUATIC MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To make students understand the diversity of microorganisms in aquatic environments, ecology and biogeochemistry.
2. To know the importance of aquatic microbes and to derive their utility in various fields.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of this course, student will be able to understand microbial diversity in aquatic environments.	L2
CO2	Students understand the role of aquatic microorganisms in biogeochemical cycles.	L3
CO3	Students will have a better knowledge about the application of aquatic microorganisms in various fields	L4

COURSE CONTENT:	
MODULE I: Aquatic Environment	**10Hrs**
Aquatic environment and distribution of microorganisms. Major environmental conditions influencing microflora in aquatic environment. Aquatic ecosystem- fresh water (ponds, lakes, stream), marine (estuaries, mangroves, deep sea, hydrothermal vents). Microbes in atmospheric water, surface water, stored water, groundwater, mineral water, spring water, well water. Nutrients in aquatic environments and food chain. Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients).	
MODULE II: Marine Microbiology	**10Hrs**
Marine environment–properties of seawater, chemical and physical factors of marine environment-Ecology of coastal, shallow and deep sea microorganism - significance of	

marine microflora. Diversity of microorganism - Archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa in the mangroves and coral environments - Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association. Water zonations- upwelling and downwelling, ocean currents. Benthic microorganisms. Marine microflora and biofouling. Barophilic and Barophiles, Halophilic archaebacteria and extremozymes. Sea food contamination. Bioluminescence.

MODULE III: Aquatic Microflora and Water Treatment	**10Hrs**

Introduction to Water cycle. Techniques for the study of aquatic microorganisms. Role and importance of aquatic microbial ecosystem. Microbial consortia. Surface attachment and biofilm development. Antibacterial and bioactive compounds from aquatic microorganisms.

Waste Water Treatment: Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.

MODULE IV: Water Pollution and Diseases	**10Hrs**

Water pollution, microbial changes induced by inorganic and organic pollutants. Metals as pollutants. Algal blooms. Biological and chemical control of algal blooms. Formation of biofilm. Algal toxicity. Biomagnifications. Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filteration and Disinfection. Water borne diseases (Waterborne diseases *Travellers'* Diarrhea, *Giardia, Salmonella, Escherichia coli*, *Cholera* and *Hepatitis* A) and control measures.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1**.NO**
2. **NO**

TEXT BOOKS :

1. Elements of microbiology- Pelczar, Reid and Chan
2. Aquatic microbiology-Rheinheiner
3. Microbiology-Prescott, M.J, Harley, J. P. and Klein, D. A.
4. Gerhard Rheinheimer Aquatic Microbiology, John Wiley and sons, ISBN 0471718033.

5. Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment and Freshwater Microbiology: John Wiley, John Wiley and sons David C. Sigee ISBN-9780471485285.
6. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for Environmental microbiology. CRC press.
8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press
9. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
10. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
13. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5325**					
TITLE OF THE COURSE	**SOIL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To observe importance of soil and soil microorganisms, life cycles in the nature, for plants growing.
2. Explains geochemical significant processes of the microbial activities and the soil factors controlling and limiting microbial activities.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To understand the fundamental concepts and techniques in soil microbial diversity	L2
CO2	Basic and applied concepts environmental problems and available solutions towards them.	L3
CO3	To make use of how microorganisms may be utilised in soil microbiology and in agriculture.	L4

COURSE CONTENT:	
MODULE I: Microbes and Soil Fertility	**10Hrs**
Soil profile, Soil morphology, Biotic and abiotic interactions; Habitat and niche; Soil as an environment for microorganisms. Role of microbes in soil fertility. Microbial interactions in soil - mutualism, commensalism, amensalism, synergism, parasitism, predation and competition. Soil pathogens and soil microflora and human health. Isolation of soil viruses; Genetic exchange between the communities.	
MODULE II: Diversity and Distribution of Microorganisms	**10Hrs**
Rhizosphere, Mycorrhizosphere, Actinorhizae, spermosphere, rhizoplane; symbiotic association in root nodules. Methods of enumeration, rhizosphere effect, factors influencing rhizosphere microbes. PGPR, Siderophores and VAM. Roles of microbes in biogeochemical cycles: Carbon, nitrogen, phosphorus, sulphur. Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide, reduction	

of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.
MODULE III: Biofertilizer and Biopesticides **10Hrs**
Biological nitrogen fixation - types (symbiotic nitrogen fixation (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation (*Azotobacter, Azospirillum*); mechanism, microorganisms and factors affecting; Genetic engineering of BNF. Biofertilizer - types, production, applications and quality control. Cultivation and mass production of bioinoculants- *Azotobacter, Rhizobium, Azospirillum*, Cyanobacteria, Phosphate solubilising microorganisms, *Azolla, Frankia* and VAM. Biopesticides – viral, bacterial and fungal- Types and applications (*Pseudomonas fluroscence, Bacillus thuringiensis, Trichoderma* and Nuclear Polyhedrosis Virus).
MODULE IV: Soil Pollution and Biodegradation **10Hrs**
Soil pollution: Nature and sources of pollutants: Industrial, agricultural and municipal wastes, fertilizers, pesticides, radio nucleotides, fossil fuels, acid rains and oil spills. Heavy metals toxicity. Soil erosion - control methods, soil acidification, monitoring and control of soil pollution. **Biodegradation**: Decomposition of organic matter by microorganisms - cellulose, hemicellulose, lignin, xylan and pectin. Effect of pesticides on soil microflora. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Preparation of farmyard manure, animal manures, rural and urban composts and vermicompost.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1**.NO**
2. **NO**

TEXT BOOKS :

1. Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
2. Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
3. McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
4. Metting FB. 1993. *Soil Microbial Ecology - Applications in Agricultural and Environmental Management*. Marcel Dekker.
5. The Nature and Properties of Soil, Brady.
6. Agrios G.N. (2009), Plant Pathology. 5th Ed. Academic Press.
7. Paul E.A.2007. Soil Microbiology: Ecology and Biochemistry,3 Edn. Academi Press.
8. John L. Havlin et al., 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). Prentice Hall.
9. Coyne M. 1999. Soil Microbiology Delmar Cengage Learning
10. Rangaswami . Gand D.J. Bagyaraj. (1998) Agricultural Microbiology. 2nd Ed. PHI. India.

11. Subbarao, N.S. and Dommergues, Y.R. (1998) Microbial interactions in agriculture and forestry. Science publishers.
12. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons, Inc, New York.
13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.
14. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi.
15. SubbaRao, N.S. 1995. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5326**					
TITLE OF THE COURSE	**PHARMACEUTICAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To make students understand the applications of microorganisms in production of pharmaceutically active compounds.

2. To know the importance of microbiology knowledge in maintaining the microbial standards in pharmaceutical productions.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of this course, student will be able to Identify different antimicrobial agents, antibiotics produced by them and it's mode of action.	L2
CO2	Basic and applied concepts clinical problems and available solutions towards them.	L3
CO3	Process involved in drug discovery and development and regulatory guidelines in pharmaceuticals product production.	L4

COURSE CONTENT:

MODULE I: Antibiotics **10Hrs**

Antibiotics and Synthetic antimicrobial agents: β-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides. Antifungal antibiotics: Griseofulvin; Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics. Synthetic antibiotics: Sulphonamides; Chloramphenicol; Quinolone. Chemical disinfectants, antiseptics and preservatives. Therapeutic and prophylactic usage of drugs. Adverse reactions of drugs. Microbial resistance.

MODULE II: Mechanism of Action of Antibiotics **10Hrs**

Inhibition of cell wall synthesis, nucleic acid and protein synthesis. Microbial resistance to antibiotics. Molecular principles of drug targeting; Drug delivery system in gene

therapy. Mode of action of non–antibiotic antimicrobial agents; Mode of action of bacterial killing by quinolinones; Bacterial resistance to quionolinones.
Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.

MODULE III: Microbial formulation and Applications of Microbial Enzymes **10Hrs**

Biochemical and molecular basis of screening for the active ingredients from microbes. Application of microbial enzymes in therapeutics. Microbial fermentation for the production of pharmaceutical compounds (Any two). Vaccine: Synthetic peptide vaccines, Multivalent subunit vaccines, DNA vaccines. Secondary metabolites from microorganisms. Database for Drug designing; Preclinical, clinical trials and Toxicology (LD50 and ED50).

MODULE IV: Regulatory Aspects in Pharmaceuticals **10Hrs**

Design and layout of sterile product manufacturing unit. Designing of Microbiology laboratory, Biosafety levels in setting up lab and safety measures. Introduction to pharmacopoeia; FDA regulation and IP, BP, USP; Reimbursement of drugs and biological; legislative perspectives; GMP and GLP in pharmaceuticals; Quality control through WHO; ICH process. GCP Guidelines. Good Regulatory Practices, Clinical Research Regulations. Regulation and legislation for drugs, cosmetics, medical devices, biologicals and herbals formulation. Food & nutraceuticals in India. Intellectual property rights.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Hugo, WB and Russell, AD. Pharmaceutical Microbiology, (2003). Blackwell Science, Oxford, UK.
2. Krogsgaard L, Lilijefors T. and Madsen, U. Textbook of Drug Design and Discovery, (2004). Taylor and Francis, London.
3. Geoffrey Hanlon and Norman Hodges. Essential Microbiology for pharmacy and pharmaceutical science. (2013).Wiley Blackwell.
4. S. P. Vyas & V. K. Dixit. Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
5. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi.
6. Gregory Gregoriadis. Drug Carriers in biology & Medicine. (2001). Academic Press New York.
7. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S. Microbiology. (1990). Harper and Row Publishers, Singapore.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5301**					
TITLE OF THE COURSE	**CLINICAL RESEARCH**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
2. To equip students with the proper designing and planning of clinical trial.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.	L3
CO2	Students will gain the concepts of designing and monitoring of clinical research studies.	L4

COURSE CONTENT:	
MODULE I: Concepts of Clinical Research	**13Hrs**
General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The area under the curve (AUC) of the concentration-time profiles, absolute bioavailability, Volume of Distribution (Vd). maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD50 & ED50. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.	
MODULE II: Regulatory Perspectives of Clinical Research	**13Hrs**
Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial,	

Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
7. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
8. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
9. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
10. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5302**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING AND IPR**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.	L3
CO2	They will also get an idea about patent laws and will know how to file a patent	L4

COURSE CONTENT:	
MODULE I: Scientific writing	**13Hrs**
Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing-Plagiarism. Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.	
MODULE II: Intellectual Property Rights	**13Hrs**
Intellectual property rights-TRIPS, GATT-International conventions patents and	

methods of application of patents-Legal implications- Biodiversity and farmer rights.
Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1**.NO**
2. **NO**

TEXT BOOKS :

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5303**					
TITLE OF THE COURSE	**RESEARCH METHODOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Students understand research terminology one that can be used to carry out different approaches to research

2. To be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate knowledge of research processes (reading, evaluating and developing)	L2
CO2	Compare and contrast qualitative and quantitative research	L4

COURSE CONTENT:

MODULE I **13Hrs**

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE II: **13Hrs**

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.**NO**

2. **NO**

TEXT BOOKS :

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5371**					
TITLE OF THE COURSE	**IMMUNOLOGY, MEDICAL AND INDUSTRIAL MICROBIOLOGY - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.
- To impart basic understanding of principles, and key concepts relevant to industrial microbiology.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L3
CO2	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology.	L3

List of Laboratory/Practical Experiments activities to be conducted:
1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Dental caries susceptibility assay by Snyder's agar test.
3. Serological reactions: 4. Agglutination - Blood grouping and Rh typing 5. Precipitation reactions: i. Ouchtlerlony Double Diffusion, ii. Radial Immune Diffusion.

6. Assay for susceptibility and resistance of antibiotics by Kirby Bauer method.
7. Isolation of lymphocytes from peripheral blood.
8. Identification of different types of blood cells.
9. Production and estimation of amylase from microbial sources.
10. Production of organic acids (lactic acid and citric acid) from microbes.
11. Detection and quantification siderophore produced by *Pseudomonas spp.*
12. Study of different types of fermenters (Models/ Charts)
13. Immobilization technique: whole cell or enzyme- sodium alginate gel methods

TEXT BOOKS:

1. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
2. Mackie and McCarthey (2096) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
3. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
4. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
5. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
6. Jenson, Wright robinson (2097) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
7. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
8. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
9. Stanbury PF, Whitakar A and Hall SJ (2099) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
10. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
11. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
12. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5372**					
TITLE OF THE COURSE	**PRACTICAL BASED ELECTIVE-I**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- The course will help in making the students learn techniques to study microbial interactions and their impact in nature.
- The course imparts practical knowledge in screening the microorganisms for their employment in various fields.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students have fundamental practical knowledge of the techniques to study microbial interactions and their role in environment.	L3
CO2	Students will learn many techniques to study the impact of microorganisms in different applied microbiological studies.	L3

List of Laboratory/Practical Experiments activities to be conducted:	
1.	Study of microbial interactions in soil (antagonism).
2.	Isolation of cellulose and pectin degrading microbes.
3.	Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) –(3 Units)
4.	Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
5.	Effect of seed borne fungi on seed germination and seed vigour.
6.	Estimation of total phenols in diseased and healthy plant tissues.
7.	Isolation of Plasmid DNA
8.	Demonstration-Restriction Enzyme digestion
9.	Demonstration- Ligation of DNA fragment

REFERENCES:

1. Nicholl DST. An Introduction to Genetic Engineering. Cambridge University Press, 2002.
2. Sandhya M. Genetic Engineering: Principles and Practice. MacMillan India. 2008.
3. Primrose SB and RM Twyman. Principles of Gene Manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
4. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja
5. Practical Microbiology – R.C Dubey, D.K Maheshwari, S Chand and Company, New Delhi.
6. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education.
7. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20MSC5401**					
TITLE OF THE COURSE	**PROJECT WORK**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**36**	**-**	**18**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations

2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares students for productive careers and lifelong learning.	L5