ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF BIO SCIENCES

(RSBSC)

DEPARTMENT OF MICROBIOLOGY

Course Structure and Syllabus

Based on National Education Policy -2020

FOR

M.Sc. Microbiology

2 Year Single Major

W.E.F. 2025-26

W.E.F. 2025-26

STRUCTURE OF THE SYLLABUS FOR 2 YEAR PG PROGRAMME

SCHOOL NAME - Royal School of Biosciences (RSBSC)

DEPARTMENT NAME - Department of Microbiology

PROGRAMME NAME - Postgraduate programme (PG)

1st SEMESTER				
COURSE CODE	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
MIB154M101	General Microbiology	400	4	4-0-0
MIB154M102	Mycology, Phycology and Virology	400	4	4-0-0
MIB154M103	Microbial genetics	400	4	4-0-0
MIB154M104	Microbial Biochemistry	400	4	4-0-0
MIB154M115	Practical on General Microbiology, Mycology, Phycology and Virology	400	2	0-0-4
MIB154M116	Practical on Microbial Biochemistry and Microbial Genetics	400	2	0-0-4
MOOCs 1	*MOOCs/online course will be identified by the dept. from the list of courses available on the MOOC online platform/SWAYAM portal	400	4	
	TOTAL CREDIT FOR 1st SEMESTER		**24**	16-0-8
2nd SEMESTER				
COURSE CODE	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
MIB154M201	Immunology	500	4	4-0-0
MIB154M202	Molecular Biology and recombinant DNA technology	500	4	4-0-0
MIB154M203	Applied Microbiology & Enzyme technology	500	4	4-0-0
MIB154M204	Microbial Genomics, Proteomics & Bioinformatics	500	4	4-0-0
MIB154M215	Practical on Immunology, Molecular Biology, & Enzyme technology	500	2	0-0-4
MIB154M216	Practical on Genomics, Proteomics & Bioinformatics	500	2	0-0-4
MOOCs 1	*MOOCs/online course will be identified by the dept. from the list of courses available on the MOOC online platform/SWAYAM portal	100	4	
	TOTAL CREDIT FOR 2nd SEMESTER		**24**	16-0-8
TOTAL CREDIT FOR 1st YEAR = 48				
3rd SEMESTER				
COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
MIB154M301	Parasitology, Medical and Veterinary Microbiology	500	4	4-0-0
MIB154M302	Food Microbiology	500	4	4-0-0

MIB154M303	Inheritance Biology	500	4	4-0-0
MIB154M316	Microbial fermentation technology	500	4	4-0-0
MIB154M304	Practical on Medical Microbiology and Food Microbiology	500	2	0-0-4
MIB154M305	Practical on fermentation technology	500	2	0-0-4
TOTAL CREDIT FOR 3rd SEMESTER			**20**	16-0-8
OR 3rd SEMESTER (For students with 3rd and 4th Semester Research)				
MIB154R321	RESEARCH PROJECT – PHASE I	500	20	0-0-20
4th SEMESTER				
COURSE CODE	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
MIB154P221	Dissertation (students with research in 4th Sem)	500	20	
(for 'Coursework only' in lieu of Research)				
MIB154M401	Soil and Environmental Microbiology	500	4	4-0-0
MIB154M402	Industrial Microbiology and Fermentation Technology	500	4	4-0-0
MIB154P221	Dissertation – 2 [One year PG (course work + research)]	500	12	
OR 4th SEMESTER (For students with 3rd and 4th Semester Research)				
MIB154R421	RESEARCH PROJECT – PHASE 2	500	**20**	
TOTAL CREDIT FOR 2nd YEAR = 40				

SYLLABUS (1ST SEMESTER)

Paper I: General Microbiology		**Subject code: MIB154M101**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

The course is developed with the following objectives:

- To enable the students to develop a historical perspective of the subject of microbiology
- To understand the fundamental principles of microbiology like Koch's postulates
- To explain the scientific organization of microbial organisms into taxons and introduce to the students, the major system of microbial classification
- To enable understanding of the general and ultra-structural organization of the bacterial cell
- To impart the basic skills for the culture of microbes

Course Outcome:

- CO-1:Remember the basic concepts of General Microbiology and History.
- CO-2:Understandingof media preparation, sterilization techniques, and cultivation of microbes.
- CO-3:apply the knowledge of microbiology techniques and conceptsin research.
- CO-4:Analysis of the problem associated with microbes in humans, animals, and plants.
- CO-5: Evaluate their understanding of expanding their future prospect forpursuing an entrepreneurial venture

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Introduction to the world of microbes, Scope of microbiology, major contribution of scientists in development of microbiology, Refutation of a biogenesis. Classification of Micro-organism: History of bacterial classification. Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese; Basis of microbial classification, molecular approaches in microbial classification, concept of microbial species; Principle and classification of bacteria on the basis of*Bergey's manual of Determinative bacteriology*.	**12**
II	Overview of prokaryotes and their differences with eukaryotic organism. Morphology and fine structure of bacteria, archaea**:**cell walls of archaea, Gram negative, Gram positive eubacteria, cell membranes – structure, composition and properties.	**12**
III	Structure and function of cell appendages and inclusions: capsule, flagella, fimbrae, pili, cilia, gas vesicles, chromosomes, carboxysomes, magnetosomes, phycobillisomes, nucleoid, plasmids (types of plasmids and function); Bacterial spores: Regulation of spore formation. Reserve materials, inorganic and organic inclusions.	**12**

IV	Microbial nutrition, culture media, culture methods- pure culture techniques, Growth curve, generation time, synchronous, batch and continuous culture; Measurement of growth and factors affecting growth, Sterilization and disinfection, Microbial diversity and extremophiles: Microbial diversity, distribution ecological niche, abundance and density. Extremophiles – Psychrophiles, acidophiles, alkaliphiles, thermophiles, barophiles etc., non-culturable bacteria (Metagenomics), Methanogens, Methanotrophs and Methylotrophs.	**12**
Total		**48**

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology.* 4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
4. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited by Paniker CKJ). University Press Publication.

References:

1. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT. Brown Publishers.
2. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
3. Frazier WC and Westhoff DC. (2005). *Food Microbiology*. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
4. Martin A. (1977). *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London.

Paper II: Phycology, Mycology and Virology		**Subject code: MIB154M102**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- This course introduces the basic features of algae,fungi and their importance.
- The contents are also designed to help students understand about their habitat and the reproduction of these organisms.
- Further, the course also provides a detailed study ofviruses, virusoids, and prions.

Course Outcome:

Modules	Topics / Course content	Periods
I	**Phycology (Algae)** General Characteristics Morphology, cellular structure, pigmentation, and reproduction Classification systems (Fritsch and modern molecular approaches) Major Groups of Algae Cyanophyta (Blue-green algae), Chlorophyta (Green algae), Bacillariophyta (Diatoms), Rhodophyta (Red algae), Phaeophyta (Brown algae) Algal Physiology and Ecology Algal photosynthesis and CO_2 fixation pathways Algal blooms and eutrophication Bioindicators and ecological roles of algae Applications of Algae Algae in biotechnology: biofuels, pharmaceuticals, and nutraceuticals Algae as biofertilizers and in wastewater treatment	**12**
II	**Mycology (Fungi)** General Characteristics Morphology, cell wall composition, types of spores, and reproduction Classification of fungi (traditional and molecular) Major Fungal Groups Zygomycota, Ascomycota, Basidiomycota, Deuteromycota Fungal Physiology and Ecology Growth kinetics, nutritional requirements, secondary metabolism Mycorrhizae, fungal ecology, and fungal biodiversity Fungal Pathogenesis and Applications Human and plant pathogenic fungi: mechanisms of infection and virulence Industrial and pharmaceutical uses of fungi: enzymes, antibiotics, and organic acids Mycotoxins and food spoilage	**12**
III	**Virology** Nature and Structure of Viruses Virus morphology, symmetry, and genome organization Classification of viruses (Baltimore classification and ICTV taxonomy) Viral Replication and Genetics Lytic and lysogenic cycles Replication strategies of DNA and RNA viruses Mutation, recombination, reassortment, and evolution Bacteriophages Lytic and temperate phages Phage therapy and phage display technology Viruses and Disease Viral pathogenesis and host immune responses Emerging and re-emerging viral infections (e.g., SARS-CoV-2, Zika, Ebola)	**12**
IV	**Applied and Molecular Aspects** Diagnostic Virology and Vaccines Diagnostic techniques: PCR, ELISA, plaque assay, electron microscopy Antiviral strategies and vaccine development Industrial and Environmental Mycology Bioremediation and bio-control agents Fungal biomass in fermentation and food industries	**12**

	Algal Biotechnology Genetic engineering of algae Algal bioplastics and carbon sequestration Recent Advances CRISPR/Cas systems in virus and fungal research Metagenomics of algal and fungal communities Algae and fungi in climate change mitigation	
Total		**48**

- ❖ CO-1:Memorize the basic concepts of Algae, Fungi, and viruses.
- ❖ CO-2:Understandingof the diversity, distribution, cell structure, life cyclesand economic importance of both algae and fungi.
- ❖ CO-3:Demonstrate knowledge of microbiology techniques and conceptsin phycology and mycology and virology research.
- ❖ CO-4:to categorizethe problem and disease associated with fungus and virus in human, animals andplants.
- ❖ CO-5: Conclude their future prospect forpursuing an entrepreneurial venture.

Detailed Syllabus:

Text Books:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group,New York
3. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
4. Raham LE, Graham JM and Wilcox LW. (2009). Algae.2nd edition. Benjamin Cumming, New York.
5. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
6. Webster J. (1980). Introduction to Fungi.2nd edition. Cambridge University Pres
7. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology.6th edition BlackwellPublishing Ltd.
8. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
9. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology,
   Molecular biology, Pathogenesis and Control.2nd edition. ASM press Washington DC.

References:

1. Wagner EK, Hewlett MJ. (2004). Basic Virology.2nd edition.Blackwell Publishing.
2. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
3. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
4. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
5. Versteeg J. (1985). A Color Atlas of Virology.Wolfe Medical Publication.
6. Levy JA, Conrat HF, Owens RA. (2000). Virology.3rd edition.Prentice Hall publication, New Jersey.

Paper III: Microbial Genetics		**Subject code: MIB154M103**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- This course is design to make the students understand the concept of genetics and the principles underlying the processes which control the expression of the genes in prokaryotes and also design to understand the mechanism involve in the transfer of different genes among inter and intra species that leads to change in phenotype.

Course Outcome:

- CO-1: Memorize the basic concepts of DNA andGenetic material.
- CO-2: Understanding of the DNA structure, chromosome organization in microbes.
- CO-3: Apply the knowledge of DNA and chromosome in genetic issue detection in human and plant.
- CO-4: Analysis of the genetic disease associated with microbes in humans, animals, and plants.
- CO-5: Determine the future prospect to cure genetic disorder.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Introduction to Microbial Genetics** History and importance of microbial genetics Genetic material in microbes (DNA, RNA, plasmids, and viruses) Prokaryotic vs. Eukaryotic genomes Characteristics of microbial chromosomes and plasmids Gene Structure and Function Structure of genes and operons in bacteria (e.g., the lac operon) Genetic elements: Chromosomes, plasmids, transposons Gene expression regulation in prokaryotes Methods in Microbial Genetics DNA extraction and sequencing techniques Gene cloning, PCR, and recombinant DNA technology	**12**
II	**Gene Expression and Regulation in Microbes** Gene Expression Mechanisms Transcription and translation in prokaryotes Mechanisms of gene regulation (induction and repression) Operons and Regulons The lac operon, trp operon, and other examples of bacterial gene regulation Global gene regulation and regulatory networks Two-component signal transduction systems Regulatory RNAs Small RNAs (sRNAs) and their role in gene regulation Riboswitches and attenuation	**12**
III	**Genetic Variation, Mutation, and Repair Mechanisms** Mutation and Genetic Variation Types of mutations (point mutations, insertions, deletions) Causes of mutations (spontaneous, induced, environmental factors) DNA Repair Mechanisms Repair pathways: Mismatch repair, nucleotide excision repair, base excision repair Mechanisms of recombination: Homologous and site-specific recombination Horizontal Gene Transfer Transformation, conjugation, and transduction in bacteria Antibiotic resistance and the spread of resistance genes Role of mobile genetic elements (plasmids, transposons)	**12**
IV	**Advanced Topics in Microbial Genetics and Applications** Microbial Evolution and Phylogenetics Microbial genome evolution Horizontal gene transfer and its role in microbial diversity Phylogenetic tree construction and interpretation Genome Editing and Synthetic Biology CRISPR-Cas systems in bacteria and their applications Synthetic biology and microbial engineering Applications of genetic engineering in biotechnology and medicine Applications of Microbial Genetics in Medicine and Environment Genetic factors influencing pathogenicity and virulence Microbial genetics in vaccine development Microbial biotechnology in agriculture, waste management, and environmental cleanup	**12**

Total	48

Text Books:

1. James D Watson *et al*. (2009). Molecular biology of the gene. 5th Edition, Pearson.
2. Karp, G. (2010);*Cell and Molecular Biology: Concepts and Experiments*, 6th edition, . John Wiley &Sons.Inc.
3. Stanley R Maloy. Microbial Genetics. 5th Edition, Narosa publishing house.
4. Daniel J Fairbanks. Genetics: The Continuity of Life, Wadsworth Publishing, ISBN-10: 0534252796

References:

1. Peter J Russel. Genetics. Pearsons Education India, ISBN-10: 9332571627.
2. William Klug, Michael Cummings, Charlotte A Spencer, Michael A Palladino. Concept of Genetics, 10th edition, Pearsons.

Paper IV: Microbial biochemistry		**Subject code: MIB154D101**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

This course focuses on the concepts of biochemistry and important microbial macromolecules and their role in metabolism. On completion of the course a student will be well versed with the knowledge of different metabolic pathways in bacteria and eukaryotes.

Course outcome:

- CO-1: Remember the basic information about the Chemistry of Life and biomolecules.
- CO-2: Understanding the structure of biomolecules such as proteins, enzymes, lipids etc.
- CO-3: apply the knowledge for the synthesis and application of biomolecules in industries and the agriculture sector
- CO-4: Analysis of the role of the different biomolecules to maintain crucial life functions.
- CO-5: Determine the future prospect of synthesis of biomolecules at the commercial level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Introduction to Biochemistry** Structure of atoms, molecules, and chemical bonds; Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.); Principle of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).	**12**

II	**Structure and Function of Biomolecules** **Proteins:** Amino acids: Structure, classification, and properties. Protein structure: Primary, secondary, tertiary, and quaternary structures. Protein folding and denaturation. Techniques for protein analysis: Electrophoresis, chromatography, mass spectrometry. **Carbohydrates and Lipids:** Carbohydrates: Structure, classification, and function (monosaccharides, oligosaccharides, polysaccharides). Lipids: Types, structure, and functions (phospholipids, glycolipids, sterols). Role of glycoproteins and glycolipids in cell recognition and signaling.	**12**
III	**Enzyme Biochemistry and Kinetics** Enzyme Structure and Function: Enzyme classification and nomenclature. Active site, enzyme specificity, and mechanism of catalysis. Enzyme cofactors: Coenzymes, prosthetic groups, and metal ions. **Enzyme Kinetics:** Michaelis-Menten equation, Lineweaver-Burk plot. **Enzyme inhibition:** Competitive, non-competitive, and uncompetitive inhibitors. Allosteric enzymes and regulation. Enzyme regulation in metabolic pathways. Metabolism of Biomolecules: Overview of catabolism and anabolism. Role of ATP in energy transfer and metabolism.	**12**
IV	**Metabolic Pathways and Bioenergetics** **Carbohydrate Metabolism:** Glycolysis: Pathway, regulation, and ATP yield. TCA cycle (Krebs cycle): Reactions, energy production, and regulation. Glycogen metabolism and regulation. Gluconeogenesis and pentose phosphate pathway. **Lipid Metabolism:** Fatty acid oxidation: Beta-oxidation and ATP production. Biosynthesis of fatty acids and triglycerides. Cholesterol metabolism and its regulation. Protein Metabolism: Amino acid catabolism: Deamination, urea cycle, and amino acid degradation. Protein synthesis and regulation. **Bioenergetics:** Overview of the thermodynamics of metabolism. ATP generation via oxidative phosphorylation. Electron transport chain and oxidative phosphorylation.	**12**
Total		**48**

Text Books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.

Berg, J. M., Tymoczko, J. L. and Stryer.(2006). *Biochemistry*, 6th Edition, W.H Freeman and Co.

Reference Books:

1. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York.

Practical on General Microbiology, Mycology, Phycology & Virology

Subject code: MIB154C115

L-T-P-C-0-0-8-4 **Credit units: 4** **Scheme of evaluation: (P)**

Course Objective:

- The objective of the course is to familiarize the student with basic practical knowledge in microbiology and biochemistry

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	1: Preparation of buffer, chemical solutions, stock solution. 2: Microscope principle, operation, and study of various components of the microscope. 3: Sterilization process for glassware,culture media, and preparation of culture plates. pure culture preparation and subculturing technique.	**24**
II	4: Determining of bacterial growth curve and microbial growth measurement by direct cell count method,Effect of pH, temperature, and chemicals on bacterial growth. 5: Serial dilution method and bacterial colony counting. 6: Staining technique-simple, Gram's staining, spore staining, Acid-fast staining. Staining of Fungus. 7: Determination of bacterial motility (Bacterial twitching and swimming motility test, motility observation by hanging drop method).	**24**
III	8: Isolation and identification of fungi (*Aspergillus, Penicillium, Fusarium, Alternaria,* Nostoc etc.) using selective media Potato Dextrose Agar (PDA), Sabouraud Dextrose Agar (SDA) etc. 9: Lactophenol Cotton Blue Staining **f**or fungal identification (e.g., *Aspergillus*, *Penicillium*, *Rhizopus*)	**24**

IV	10: Identification of Major Algal Groups Chlorophyta (e.g., *Spirogyra*, *Chlamydomonas*), Cyanophyta (e.g., *Oscillatoria*, *Nostoc*), Bacillariophyta (e.g., diatoms) 11. Demonstration: Bacteriophage Plaque Assay and Viral Cytopathic Effects (CPE) Using image slides	**24**
Total		**96**

SYLLABUS (2nd SEMESTER)

Paper I: Immunology		**Subject code: MIB154M201**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- This course is designed to provide knowledge about the immune response in the body along with the basic structure of antigens and antibodies. Further, the syllabus also includes the application of antigens and antibodies in the different serological tests.

Course Outcome:

- CO-1: Remember the basic concepts about the innate and adaptive immune system.
- CO-2: Understanding of the antigen, antibody structure, and working mechanism of the Immune system.
- CO-3: apply the knowledge of antigen, antibody, RIA and other techniques in HLA typing and related research.
- CO-4: Analysis of autoimmune disease and other related issues.
- CO-5: Determine the future prospect to solve immunity-relatedissues.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	History and scope of immunology: types of immunity – innate and acquired, passive and active. Physiology of immune response- Humoral and cell mediated immunity, Lymphoid organs. Immunohaematology of blood groups, ABO and RH compatibility.	**12**
II	Antigens and Antibodies: structure and properties (types, iso and allo). haptens, adjuvants; antigen specificity; Immunoglobulins (antibodies) – structure, heterogeneity – types and subtypes, properties (physico-chemical and biological). Antigen – Antibody reactions; agglutination, haemagglutination, precipitation, Complement fixation, major histocompatibility complex(MHC-I &II).	**12**
III	Immunofluorescence; enzyme linked immunosorbent assay (ELISA), radioimmunoassay.Hybridoma technology – monoclonal antibodies and its uses. Complement pathways. Hypersensitivity-anaphylaxis, cytotoxic reaction. Cytokines. Organization and expression of Ig genes and rearrangements.	**12**

IV	Hypersensitivity, Autoimmunity, Transplantation immunology and tumorimmunology.HLA tissue typing, major histocompatibility complex.Immunotoxins; vaccines and its types, toxoidsnational immunization programmes, newer generation vaccines	**12**
Total		**48**

Text Books:

3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
4. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.
5. Berg, J. M., Tymoczko, J. L. and Stryer.(2006). *Biochemistry*, 6th Edition, W.H Freeman and Co.
6. Janis Kuby. (2013). Immunology. 7th Edition, WH Freeman.

References:

1. Kathleen parkTalaro (2017). Foundations in Microbiology. 10th Edition, McGraw Hill. Science
2. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York.

Paper II: Molecular biology and Recombinant DNA technology Subject code: MIB154M202

L-T-P-C-4-0-0-4 Credit units: 4 Scheme of evaluation: (T)

Course Objective:

- This course provides detail information regarding nucleic acid, DNA replication, transcription, and translation. The course also discusses details about different cloning vectors.

Course outcome:

- CO-1: Remember the basic concept of genome organization and omics approaches.
- CO-2: Understanding of the replication, Transcription, and mechanism in the cell.
- CO-3: apply the knowledge of genome organization in mutation and virulence gene study.
- CO-4: Analysis of genetic material to correlate gene mutation and its impact on function.
- CO-5: Determine the future prospect to solve genetic disorders.

Detailed Syllabus:

Modules	Topics / Course content	Periods

I	**O**rganization of DNA in eukaryotic cell; palindromic DNA; Types of RNA-rRNA; mRNA (the 5' cap, non-coding region, initiation codon, coding region, termination codon; Poly (A) region, post transcriptional modification,differences between prokaryotic and eukaryotic mRNA; tRNA (structure of tRNA-clover leaf model); superhelicity in DNA.Dispersive, conservative and semi-conservative models; Watson and Crick's model of DNA replication (experimental evidence); Enzyme involved in DNA replication (DNA polymerase I, Pol II, Pol III, DNA ligase); Mechanism of DNA replication; Models of DNA replication, inhibitors of DNA replication.Exonuclease and endonuclease.	**12**
II	Gene diversity; split genes, overlapping gene; molecular nature of mutation, spontaneous and induced mutation; DNA damage and repair – types of damage (deamination, oxidative damage, alkylation, pyrimidine dimmers); repair pathways – methylation – directed mismatch repair, nucleotide excision repair, base excision repair, recombination repair, SOS repair.	**12**
III	Gene Regulation and expression- Gene regulation – negative regulation – *E. coli lac* operon (structural, operator, promoter and repressor genes), Positive regulation – *E. coli trp*-operon.Central dogma; RNA polymerase; Site of transcription. Transcription – chain initiation, chain elongation, chain termination, RNA turnover; translation – charging of tRNA, initiation of polypeptide synthesis, elongation of the polypeptide chain, translocation, termination of the polypeptide chain;	**12**
IV	Cloning vectors **–** Plasmids, phages and cosmids, phagemids, Ti plasmids, other viral vectors (M13 and retroviruses); Cloning strategies, cloning and selection of individual genes; Gene libraries– cDNA and genomic libraries. Expression vectors, promoter probe vectors, vectors used for construction of library – artificial chromosomes; BAC vectors, YAC vectors. Working principle of PCR, requirements, types of PCR, application of PCR, Sequencing of DNA and protein in brief. Recombinant products – human growth hormone (insulin somatotropin), vaccines (hepatitis B virus vaccine, FMD vaccine), interferons.	**12**
Total		**48**

Text Books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. James D Watson *et al*. (2009). Molecular biology of the gene. (4th Edition), Pearson

References:

1. Gerard J Tortora, Berdell R Funke, Christine L Case. . Microbiology: An Introduction. Dorling Kindersley (india) Pvt Ltd.
2. Karp, G.(2010). *Cell and Molecular Biology: Concepts and Experiments*, 6th edition,.John Wiley &Sons.Inc.

L-T-P-C-4-0-0-4 **Credit units: 4** **Scheme of evaluation: (T)**

Course Objective:

- The course is designed to give an idea about the diversity of microbes and their identification.
- The syllabus is also design to understand the role of microbe in waste treatments especially degradation of xenobiotics compound. Further the course is design to give the basic idea about the microbial biotechnology and the application of different microbes in the industries.
- The course is also designed to allow students to understand about different microbial enzymes produce by microbes, their purification technique and its application in different fields. Further, students will also learn about the products (antibiotics, biofuel etc.) that can be produced from microbes.

Course outcome:

- CO-1: Remember the basic concept of microbiology related to the application in various fields.
- CO-2: Understanding the synthesis mechanism of Biopolymers and bioplastics, Bioprocess technology, beer,wingetc.
- CO-3: Apply the knowledge of microbes to produce enzymes at a commercial scale.
- CO-4: Analysis of microbial potential for the benefit of society, environment, and industries.
- CO-5: Determine the future prospect to solve issues related to mankind and the environment.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Introduction to Microbial Diversity, identification of unknown microbes: Strategy and methods, newer approaches for exploring unculturable bacteria from environmental samples like sewage. Microorganism for waste treatment, treatment of wastes - Sewage disposal, compost making, methane generation. Microbiology of degradation of xenobiotics in environment: hydrocarbons, oil pollution, surfactants, pesticides.	**12**
II	General concepts of microbial biotechnology. Microorganisms as factories for the production of novel compounds, Nature of microbial polysaccharides, mechanism of synthesis; Biopolymers and bioplastics, Bioprocess technology, beer brewing, cheese manufacture, mold–modified foods, Wine, Vinegar, The fermentation process, procedure and equipments, Ideal bioreactors, Batch, fed batch, CSTR, PFR, Multiphase bioreactors, packed bed, bubble column fluidized trickle bed, immobilization. Aseptic, septic and anaerobic fermenters.	**12**
III	Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme immobilization. Application of enzymes (food industries and pharmaceutical). Enzymes in diagnostic assays. Enzyme electrodes, immunoenzyme techniques.	**12**

IV	Commercial products of microbes: Antibiotics, biopolymers, biosensors, biopesticides, Production of biofuels. Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, antiplasmodial, anti-inflammatory compounds.	**12**
Total		**48**

Text Books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Barnett, H. L. and Hunter, B. B. (1960). Illustrated Genera of Imperfect Fungi.Burgess Publishing Co., Minnesota.
3. Breed and Buchanan ((2003). Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5)
4. Cook T. (2002) Microbial Biodiversity: Saving Bacteria to save ourselves, Harvard Science Review, 26-28.
5. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.

References:

1. Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. Nature Reviews 2, 141-150.
2. Pace N. (1997) A Molecular View of Microbial Diversity and the Biosphere, Science, 276, 734-740.
3. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York

Practical on Immunology, Molecular biology and Enzyme technology Subject code: MIB154C215

L-T-P-C- 0-0-8-4 Credit units: 4 Scheme of evaluation: (P)

Course Objective:

- The objective of the course is to familiarize the student with basic practical knowledge in immunology and molecular biology

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	1: Determination of blood groups and Rh factor and Demonstration of agglutination reaction with reference to widal test and VDRL test.2: Demonstration of haemagglutination with reference to *Treponema pallidum* Haemagglutination test. 3: Demonstration of ODD (Ouchtlerlony Double Diffusion)-an immunological technique used in the detection, identification, and quantification of antibodies and antigens.	**24**
II	4: Separation and characterization of serum-by-serum electrophoresis method. 6: Separation and characterization of lymphocytes from blood, Demonstration of Antigen-antibody reaction by ELISA.	**24**
III	7: Demonstration of replica plating technique, Determination of expression of beta-galactosidase in *E. coli.* 8: Isolation of antibiotic-resistant*E. coli* by gradient plate method. 9: Primer Designing for Bacterial DNA amplification and PCR (polymerase chain reaction). 10: Plasmid DNA isolation from bacteria.	**24**
IV	11. Separation of DNA by agarose gel electrophoresis. 12: Restriction digestion of bacterial DNA. 13: Separation of protein by SDS PAGE. 14. Extraction of Enzyme from Microbial Source (e.g., Amylase, Peroxidase), Effect of pH and Temperature on Enzyme Activity	**24**
Total		**96**

SYLLABUS (3rdSEMESTER)

Paper I: Parasitology, Medical and Veterinary Microbiology		**Subject code: MIB154M301**
L-T-P-C-3-0-0-3 (TP)	**Credit units: 4**	**Scheme of evaluation:**

Course Objective:

The course is developed with the following objectives:

- To enable the students,to develop a proper understanding of different pathogenic microbes.
- To understand the mode of transmission and life cycle of human and animal pathogens.
- To enable understanding of the mode of action of anti-microbial agents.
- To impart the basic skills for the diagnosis and identification of pathogenic microbes.

Course outcome:

- CO-1:Remember the basic concept of pathogenesis and transmission and life cycle.
- CO-2:Understandingof normal microflora of human body; role of resident flora. Host-parasite relationships, Infectiontype.
- CO-3: apply the knowledge of antimicrobial agents and antibiotics as chemotherapeutic agents.
- CO-4:Analysis of the Emerging communicable diseases (Plague, Anthrax) and their control.
- CO-5: Determine the future prospect of different therapeutic agents.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Introduction to medical parasitology-classification. Pathogenesis, transmission, life cycle, lab diagnosis, treatment of Protozoa-*Entamoeba, Toxoplasma, Cryptosporidium, Leishmania,Trypanosoma, Plasmodium, Giardia, Trichomonas*and*Balantidium.* Introduction to *Mycobacteria, Brucella, Listeria, Pasturella*andErysepelas. Spirochetes, *Rickettsiae, Chlamydia, Mycoplasma* and *Ureoplasma.*	**12**
II	Discovery of pathogenic micro-organisms; normal microflora of human body; role of resident flora. Host-parasite relationships, Infection, type and source. Disease cycle (sources of diseases, reservoirs, transmission of pathogens); Intoxications (exotoxins and endotoxins and their mechanism of action). Antimicrobial agents and antibiotics: Antiseptics, chemotherapeutic agents, effect of antibiotics on protein, nucleic acid, cellwall and cytoplasmic membrane.	**12**
III	Morphology, classification, cultural characteristics, pathogenicity and laboratory diagnosis of Staphylococci, Streptococci, Pneumococci, Neisseriae (Gonococci and Meningococci), *Haemophilus, Bordetella, Corynebacterium, Clostridium.*	**12**
IV	Study of Enterobacteriaceae (*E. coli, Klebsiella, Salmonella, Shigella, Proteus*), Vibrios and Nonfermenting Gram negative bacilli. Emerging communicable diseases (Plague, Anthrax) - symptom, identification, monitoring and surveillance and quarantine administration.	**12**
Total		**48**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Text Book Of Medical Mycology by JagdishChander, Mehta Publishers, New Delhi
3. Sherris Medical Microbiology : An Introduction to Infectious Diseases by Kenneth Ryan, McGraw-Hill Medical.
4. Jawetz, Melnick, &Adelberg's Medical Microbiology (Lange basic), McGraw-Hill Medical
5. Medical Microbiology by Patrick R. Murray, Michael A. Pfaller, & Ken S. Rosenthal, Elsevier
6. Text book of microbiology by Ananthanarayan and Paniker. Medical Microbiology by Cedric Mims, John Playfair and Ivan roitt. Mosby-wolfe

References:

1. Jawetz, Melnick, &Adelberg's. (2013). Medical Microbiology. 26th Edition. McGraw-Hill.
2. Dey, N.C., Dey, T.K. and Sinha, D., 1999. Medical Bacteriology including Medical Mycology and AIDS. 17th edition, New Central Book agency. Kolkatta.
3. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis
4. Chatterjee, 1986. Medical Parasitology. Tata McGraw Hill, New Delhi.
5. Karyakarte, R.P. and Damle, A.S., 2005. Medical Parasitolog. Revised edition. Published by Books and Allied (P) Ltd., Kolkatta.
6. JeyaramPaniker, 2004. Text book of Medical Parasitology. 5th edition, JAYPEE brothers, Medical Publishers (P) Ltd, New Delhi.
7. Veterinary Microbiology and Microbial Disease" by P J Quinn and B K Markey

SYLLABUS (3rdSEMESTER)

Paper II: Food Microbiology		**Subject code: MIB154M302**
L-T-P-C-3-0-0-3	**Credit units: 4**	**Scheme of evaluation: (TP)**

Course Objective:

The course is developed with the following objectives:

- To enable the students to develop a proper understanding of different food-born microbes.
- To understand the principles of food preservation.
- To enable understanding of food born infection and intoxication.
- To impart the basic skills for laboratory testing and quality control of food.

Course outcome:

- CO-1: Remember theMicro-organisms and their importance in food microbiology – molds, yeast, bacteria.
- CO-2: Understanding of the organisms, and different factors those influence microbialgrowth in food.

- ❖ CO-3: Apply the knowledge of microbes in Food fermentation – Bread, vinegar, fermented vegetables, fermented dairy products.
- ❖ CO-4: Analysis of the microbial potential for fermentation and product development.
- ❖ CO-5: Evaluate their understanding of expanding their future prospect forpursuing an entrepreneurial venture

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Micro-organisms and their importance in food microbiology – molds, yeast, bacteria, general features, classification; principles of food preservation; asepsis – control of micro-organisms (anaerobic conditions, high temperature, low temperature, drying); factors influencing microbial growth in food – extrinsic and intrinsic factors; chemical preservation and food additives; canning process for heat treatment. Contamination and Spoilage – Cereals, Sugar products, vegetables, fruits, meat and meat products; milk and milk products, fish and sea food, poultry spoilage of canned food; detection of spoilage and characterization.	**12**
II	Food-borne infections and intoxications – bacterial: *Brucella, Bacillus, Clostridium, Escherichia, Shigella, Staphylococcus, Vibrio, Yersinia*and non-bacterial intoxication (withexamples of infective and toxic types) – Protozoa, algae, fungi and viruses; food borne outbreaks– laboratory testing procedures, preventive measures, GMP and Hazard Analysis and Critical Control Point. Food control agencies and its regulations; Employee's health standards, waste treatment, disposal and quality control.	**12**
III	Food fermentation – Bread, vinegar, fermented vegetables, fermented dairy products; experimental and industrial production methods; spoilage and defects of fermented dairy products; oriental fermented foods – its quality standard and control.	**12**
IV	Microbial cells as food (Single cell protein), mushroom cultivation; fermented beverages –beer and wine; steroid conversion – industrial enzymes, production of amylases, proteinases, cellulases, amino acid production – glutamic acid and lysine; pickles, olives, soy sauce,genetically modified (GM) foods.	**12**
Total		**48**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Food Microbiology by William C Frazier. Tata Mgraw Hill
3. Food Microbiology by dams and Moss. Springer Verlag
4. Basic food microbiology by Banwart. Cbs Publishers & Distributors Pvt Ltd.
5. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
6. Fundamental Principles of Bacteriology A J Salle

References:

1. Adams MR & MO Moss (2005). Food Microbiology, New Age International (P) Limited. Publishers; 1st Edition, New Delhi.
2. James M Jay (2004). Modern Food Microbiology, CBS Publishers & Distributors; 4th Edition, New Delhi.
3. William Frazier and Dennis Westhoff (2008) - Food Microbiology McGraw Hill Education; 4 edition.

Paper: Inheritance Biology		**Subject code: MIB154M303**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

The course is developed with an objective to understand the fundamental principles of Mendelian inheritance, including multiple allelism, lethal alleles, gene interactions, and sex-linked transmission. The course is also designed to enable the students to apply the principles of inheritance as formulated by Mendel and understand basic aspects of the flow of genetic information from DNA to proteins. Further, this course will enable students to understand the structure and its functional role in encoding genetic material.

Course outcome:

- CO-1: Remember the basic concept of genetics.
- CO-2: Understanding the transmission of character from one generation to the next generation.
- CO-3: Apply the mendelian law and another concept to recognize the genetic disorder
- CO-4: Analysis Patterns of inheritance of character generation to generation
- CO-5: Determine the scope to fix the genetic disoder.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Rules of Inheritance:Milestones in genetics, Mendelian genetics- Examples In pea plants, Drosophila and human, Patterns of inheritance, concept of gene.	**12**
II	Chromosomes as genetic material: Inheritance, Types, structure, Mitosis, Meiosis, polytene chromosome. DNA as the genetic material: - Structure, replication, gene expression-transcription, translation, and recombination.	**12**

III	Genome – Prokaryotic and Eukaryotic genome organization, Organelle genomes and Jumping genes, Genetic basis of heritable change – Mutation and its effects, chromosomal variations, Chromosomal syndromes	**12**
IV	Animal development – Embryogenesis, Genes involved in early development in Drosophila, Basic body axis formation, Evolution of body plan	**12**
Total		**48**

Textbooks:

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.

2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC. New York.

3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.

4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork

5. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

Reference Books:

1. Griffiths,AJF, Wessler SR, Lewontin RC, Gelbart WM and JH Miller 2005, Introduction to genetic analysis W.H. Freeman and Company, New York.

2. Simmons S 2006, Principles of genetics, 4th Edition, John Wiley & Sons (Asia) Pte Ltd. New Jersey.

Practical on Medical Microbiology and Food Microbiology		**Subject code: MIB154C313**
L-T-P-C-0-0-4-2	**Credit units: 3**	**Scheme of evaluation: (T/P/TP)**

Course Objective:

- The objective of the course is to familiarize the student with basic practical knowledge in Parasitology, Medical, Veterinary and food Microbiology.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	1.Collection, transport and preservation of different samples from animal sources. 2.Isolation, identification and characterization of microorganisms from animal sources. of microorganisms. 3.Study of antibiogram, Study of LD50 against disinfectants.	**24**
II	. 4.Collection of milk samples from infected milking cow shed areas and application of COB (Clot on boiling) Test 5:MR (Milk Ring) Test to study the level of adulteration of milk.	**24**
III	6.Identification of *Candida* by microscopical examination (Staining and germ tube formation) and cultural characteristics. 7.Rapid detection tests in Microbiology: i) Dip stick test for detection of Malarial parasite ii) Dot EIA for detection of Typhoid fever. iii) Comb assay for detection of *Mycobacterium tuberculosis*	**24**
IV	8.Screening of antibiotics producing microbes from soil. 9.Production and assay enzymes: a). Amylase b). Protease c). Lipase	**24**
Total		**96**

SYLLABUS (4th SEMESTER)

Paper I: Soil and Environmental Microbiology		**Subject code: MIB154M401**
L-T-P-C-3-0-0-3	**Credit units: 4**	**Scheme of evaluation: (TP)**

Course Objective:

The course is developed with the following objectives:

- To enable the students to develop a proper understanding of soil and environment microbes.
- To understand the role of microbesin the environment.
- To enable understanding of the application of microbes such as a biofertilizer
- To impart the basic knowledge of environmental microbes and their application.

Course outcome:

- CO-1:Remember the agriculturally important and environment-friendly microbe.
- CO-2:Understandingofvarious soil types, Rhizosphere, and rhizoplane. Nitrogen fixation: A symbiotic and symbiotic nitrogen fixation system.
- CO-3: apply the knowledgefor the Production of biofertilizers and biopesticides
- CO-4:Analysis of the role of microbes in terrestrial and aquatic ecosystems.
- CO-5:Determine the future prospect of different microbial consortia for agriculture and environmental issue.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Aero-microbiology - droplet nuclei, aerosol, assessment of air quality, brief account of airborne microbes – bacteria, fungi, and viruses, their diseases and preventive measures; Phylloplane and Phyllospheremicroflora. Role of microbes in environment – Organic matter decomposition, factors affecting litter decomposition; Biogeochemical cycling of C, N, P and S; Microbial biomass and soil fertility; Biodegradation of hydrocarbons and xenobiotics, Microbial leaching of iron and copper.	**12**

II	Soil Microbiology – Classification of soil-physical and chemical characteristics, soil as a habitat for micro-organisms, microflora of various soil types, Rhizosphere and rhizoplane. Nitrogen fixation: Asymbiotic and symbiotic nitrogen fixation systems – root nodulation symbiotic bacteria (process of root nodule formation), Leghemoglobulin. Microbial interactionssymbiosis, mutualism, commensalisms, amensalism, competition, antibiosis;Actinorrhiza; Mycorrhizal fungi and its effect on plants.	**12**
III	Production of biofertilizers and biopesticides– Quality control, BIS norms of biofertilizers; Biofertilizers (rhizobial inoculants, mass production and method of application); Biopesticides (viral, bacterial and fungal biopesticides); Biopolymers – Polyhydroxybutyrate (PHB), xantham gum.	**12**
IV	Aquatic Microbiology – Water ecosystems – types, fresh water (pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents); Eutrophication, food chain; potability of water, microbial assessment for water quality, water purification, physical, chemical, microbiological characteristics of sewage. Characterization of solid and liquid wastes, physical, chemical and biological (aerobic, anaerobic – primary, secondary, tertiary) treatment; Solid waste treatment; Liquid waste treatment – trickling, activated sludge, oxidation ponds. Formation of biofilm. Biomagnifications.	**12**
Total		**48**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Microbiology: Principles and Explorations by Jacquelyn Black
3. Soil Microbiology by SubbaRao. India Book House Pvt Ltd
4. Environmental Microbiology by Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press
5. Fundamental Principles Of Bacteriology A J Salle

References:

1. SubbaRao NS (2004). Soil Microbiology.Fourth edition, Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi.
2. Mishra RR (2004). Soil Microbiology.First edition, CBS Publishers and distributors, New Delhi.
3. Rangaswami G and Mahadevan A (2002). Disease of Crop Plants in India.Fourth edition, PHI Learning (P) Ltd., New Delhi.
4. Robert, L Tate (1995). Soil Microbiology.First edition, John Wiley and Sons, Inc. New York.
5. R,M, Atlus and Richard Bartha (2000). Microbial Ecology, Fourth edition, An imprint of Addison Wesley Longman, Inc, New York.

SYLLABUS (4th SEMESTER)

Paper II: Industrial Microbiology and Fermentation Technology		**Subject code: MIB154M402**
L-T-P-C-3-0-0-3	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

The course is developed with the following objectives:

- To enable the students,to develop a proper understanding of industrially useful microbes.
- To understand the suitability of microbes and their economic aspect.
- To enable understanding of the growth kinetics and fermentation technology.
- To impart the basic skills for batch culture, fermentation, and secondary metabolite processing.

Course outcome:

- CO-1: Remember the basic concept of the suitability of microbes in industrial processes and their source types.
- CO-2: Understanding of Batch culture in fermentation, growth kinetics of micro-organisms
- CO-3: Apply the knowledge for Continuous culture and scale-up–productivity and product formation,
- CO-4: Analysis of the selection, improvement, and maintenance of industrial important strain.
- CO-5: Determine the future prospect of microbial product development at the commercial level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Brief History of Industrial Microbiology, suitability of microbes in industrial processes and their sources types of fermentation and bioreactors, Recent development in industrial microbiology, the structure of fermentor, and Economic aspects of fermentation processes. Isolation, selection, improvement and maintenance of industrial important strain. Metabolic pathways and metabolic control mechanisms; primary metabolites (alcohols, vitamins, enzymes and organic acids) and secondary metabolites (antibiotics and toxins); substrates for industrial fermentation	**12**
II	Batch culture in fermentation, growth kinetics of micro-organisms, classification of fermentation process; growth and nutrient, growth and product formation, heat evolution, the effect of environment (temperature, pH, high nutrient concentration), media formulation and sterilization, the kinetics of thermal death of micro-organisms.	**12**

III	Continuous culture and scale-up– Continuous culture system, productivity, product formation, power requirement oxygen transfer kinetics, foam, and antifoam-instrument control, physical and chemical environment sensors.	**12**
IV	Downstream processing objectives and criteria, foam separation Precipitation methods filtration devices industrial scale centrifugation and cell disruption methods. liquid –liquid extraction solvent I recovery chromatography. Two phase aqueous extraction, super criticalfluid extraction, ultrafiltration drying devices crystallization and whole broth processing, IPR and bioethics.	**12**
Total		**48**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Industrial Microbiology: An Introduction. Michael J. Waites, Neil L. Morgan, Gary Higton. Wiley-blackwell
3. Principles of Fermentation Technology. Stanbury Pf, Whitaker A, Hall Sj. Elsevier India P Ltd
4. Stanbury, P.F., Whittaker, A and Hall, S.J., (1995) Principles of fermentation technology, Elsevier; 3rd edition.
5. Crueger and Crueger, A., Biotechnology: A text book of Industrial Microbiology, Sinavos association, InoSundeland; 2nd edition.
6. Cassida, J.E., (1968). Industrial Microbiology, New Age International (2007).
7. Presscott and Dunn, S., (1982) Industrial Microbiology. The AVI Publishing Company Inc., USA; 4th edition.

References:

1. Peppler, H. J. and Pearlman, D. (1979). Microbial Technology, Vol 1 and 2, Academic press.
2. Demain, A. L. and Soloman INA, (1986). Manual of Industrial Microbiology and Biotechnology, American society for Microbiology, Washington DC.
3. Chisti, Y., Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology, Vol. 5, John Wiley and Sons, N. Y.
4. Belter, P.A., Cussler, E.L. and Hu, W.S., Bioseparation: Downstream processing for Biotechnology, John Wiley and Sons, N.Y.
5. Agarwal AK &PradeepParihar (2006). Industrial Microbiology. Published by Student Edition, Behind Nasrani Cinema, Chopasani Road, Jodhpur.
6. Patel A H (2005). Industrial Microbiology.Laxmi Publications, New Delhi; Second edition.