Department of Microbiology

The American College, Madurai

(An autonomous institution affiliated to Madurai Kamaraj University)

Since 1881

M.Sc. Microbiology

ProgramCourse descriptions

&

Syllabi

(2018 onwards)

Department of Immunology and Microbiology
The American College, Madurai
Proposed Curriculum for M.Sc Microbiology Program – Revised 2018 onwards

Course Code	Course Title	Hours	Credits	Marks
	Semester I			
MIM 4421	Principles of Microbiology	6	4	80
MIM 4223	Lab. in Principles of Microbiology	3	2	40
MIM 4525	Biological Chemistry	7	5	100
MIM 4541	Cell Biology	7	5	100
MIM 4229	Lab. in Biological Chemistry, Cell and Molecular Biology	3	2	40
MIM 4331	Human Health and Hygiene (CBCS)	4	3	60
	Total	**30**	**21**	**420**
	Semester II			
MIM 4522	Medical Microbiology	7	5	100
MIM 4224	Lab. in Medical Microbiology		2	40
MIM 4540	Immunology	7	5	100
MIM 4228	Lab. in Immunology		2	40
MIM 4430	Molecular Biology and Microbial Genetics	6	4	80
MIM 4346	Dairy Science (CBCS)	4	3	60
	Total	**30**	**21**	**420**
	Semester III			
MIM 5521	Molecular Biotechnology	6	5	100
MIM 5523	Immunotechniques and Immunotechnology	6	5	100
MIM 5225	Lab. in Molecular Biotechnology & Immunotechnology	3	2	40
MIM 5527	Animal Cell Culture	6	5	100
MIM 5229	Lab. in Animal Cell Culture	3	2	40
MIM 5531	Biostatistics and Bioinformatics	6	5	100
	Total	**30**	**24**	**480**
	Semester IV			
MIM 5422	Environmental and Agricultural Microbiology	5	4	80
MIM 5224	Lab. in Environmental and Agricultural Microbiology		2	40
MIM 5426	Food and Industrial Microbiology	5	4	80
MIM 5228	Lab. in Food and Industrial Microbiology		2	40
MIM 5530	Vaccinology		5	100
MIM 5732	Research Project		7	140
	Total	**30**	**24**	**480**
	Grand Total	**120**	**90**	**1800**

Programme Specific Outcomes

PSO No	Upon completion of the M.Sc. degree programme in Microbiology, the postgraduates will be able to
1	Formulate, articulate, retain and apply specialized language and knowledge relevant to the core concepts in biochemistry, cell and molecular biology, and microbiology.
2	Demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods
3	Communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.
4	Demonstrate skills in data collection using statistical techniques and Bioinformatics.
5	Critique how microorganisms are used as model systems to study basic biology, genetics, metabolism and ecology.
6	Analyze the functions of immune system, techniques used in immunological research, occurrence of diseases and the production of vaccines.
7	Evaluate examples of the vital role of microorganisms in agriculture, food, environment, biotechnology, fermentation, medicine, and other industries important to human wellbeing.
8	Apply science to solve problems. Design projects, Formulate hypothesis, undertake experiments and find solutions.
9	Demonstrate the following laboratory skills: aseptic and pure culture techniques, preparation of and viewing samples for microscopy, use appropriate methods to identify microorganisms, estimate the number of microorganisms in a sample, and use common lab equipment.
10	Identify and discuss the ethical issues and responsibilities of doing science

Mapping of Programme Outcomes (POs) with Programme Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	X	X		X		X			X	X
PSO2		X	X	X	X	X	X		X	
PSO3	X	X		X	X	X	X		X	
PSO4	X	X	X	X	X		X	X		X
PSO5	X	X		X	X	X	X			
PSO6	X	X		X	X	X	X		X	
PSO7	X	X	X		X	X	X	X		
PSO8	X	X	X		X	X	X			X
PSO9				X		X	X	X	X	X
PSO10		X		X		X	X	X	X	X

Mapping of Courses with Programme Specific Outcomes (PSOs)

Course Code	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO 10
MIM 4421	✓									
MIM 4223		✓	✓						✓	✓
MIM 4525	✓									
MIM 4541	✓									
MIM 4229		✓				✓				
MIM 4331							✓			
MIM 4522							✓			
MIM 4224		✓								
MIM 4540						✓				
MIM 4228		✓								✓
MIM 4430	✓				✓					
MIM 4346							✓			
MIM 5521					✓					
MIM 5523						✓				
MIM 5225						✓				
MIM 5527										✓
MIM 5229									✓	✓
MIM 5531				✓				✓		
MIM 5422							✓			
MIM 5224							✓			
MIM 5426							✓			
MIM 5228							✓			
MIM 5530						✓				

Semester I

MIM 4421 Principles of Microbiology 6Hrs/4Cr

This course provides students a better understanding about the fundamentals ofmicrobiology. The course includes contributions of eminent scientists in the various fields of microbiology, classifications, microscopic techniques, growth, metabolism, culturing and control of microorganisms.

Course Outcomes:

Upon completion of this course, students will be able to

i. Evaluate the basics concepts of Microbiology
ii. Compile the history of microbiology, the contribution of microbiologists, microscopy and staining of microbes
iii. Revise the methods of isolating, growing, maintaining microbes *in vitro* and the fine structure of microbes, phases of bacterial growth and various control measures
iv. Compare and contrast the diverse and versatile metabolism of microbes, the ways in which nutrients are carried in to the microbial cells and microbial response to stress
v. Use the different methods of classification of microbes

I. Basics of Microbiology: Historical roots– discovery of microorganisms, Spontaneous generation- Germ theory of diseases- contributions of Pasteur, Koch, Jenner and others- scope of microbiology. Microscopy- Principles- types- Simple, compound, light, fluorescence, phase contrast microscope, TEM and SEM- preparation of specimen and staining techniques.

II. Culture, Characteristics and structure of microorganisms: Culture of microorganisms- culture media- types- establishment of pure culture- maintenance and preservation- characterization and identification- Enumeration techniques- Prokaryotic cells – characteristics and cell structure of Bacteria and Archaea, Endospores. Eukaryotic cells- features and structure- Protista and fungi.

III. Microbial nutrition, growthand control: Nutritional requirements- chemical and physical requirements- Nutritional types of microorganisms- bacterial cell cycle – phases of growth, factors affecting growth– Sterilization – physical and chemical methods of control of microorganisms. Antibacterial Antibiotics – classification, mode of action, determination of their efficacy; antifungal and antiviral drugs.

IV. Microbial physiology and metabolism: Bioenergetics- Thermodynamics- Redox reactions- Transport across membrane- Metabolism of chemoorganotrophs- glycolysis- EntnerDuodoroff pathway- Kreb's cycle- fermentation- types. Aerobic and anaerobic electron transport chain- Electron transport chain of *E. coli*- Metabolism of photoautotrophs- bacterial photosynthesis. Overview of other metabolic processes. Overview of protein and fat metabolism- beta-oxidation- transamination- amino acid biosynthesis- peptidoglycan biosynthesis. Bacterial stress response- nutrient stress and starvation, thermal stress and the heat shock response, pH stress, and oxidative stress.

V. Microbial Evolution and Taxonomy: Classification – Binomial and numerical, phylogenetic tree, Haeckel's three kingdom, Whittaker's five kingdom; classification of bacteria, Bergey's classification; molecular taxonomy- polyphasic taxonomy and species concept. Classification of viruses – Baltimore system; classification of fungi – Recent system.

Textbooks:

1. Black, JG. (2013). *Microbiology*. 8th Ed. John Wiley and Sons, Singapore Inc.
2. Sherwood, L., Willey, JM. andWoolverton, C. (2011). *Prescott's Microbiology*. McGraw-Hill.

References:

1. Tortora, GJ.,Funke, BR., & Case, CL. (2018). *Microbiology: An Introduction*. Pearson.
2. Talaro, KP.& Chess, B. (2018). *Foundations in Microbiology*. Tata McGraw-Hill Education Private Limited. New Delhi.
3. Moat, AG., Foster, JW and Spector, MP. (2002). *MicrobialPhysiology*. Wiley-Liss, Inc
4. Pelczar MJ, Chan EC, Krieg NR. (2010). *Microbiology: an application based approach.* McGraw Hill Education Private Limited. New Delhi.
5. Madigan, MT., Martinko, JM., Stahl, D. and Clark, DP. (2013). *Brock Biology of Microorganisms.* 13th Edition. Benjamin Cummings.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO 1**					**5**	
Unit 2	**CO 2**				**4**		
Unit 3	**CO 3**						
Unit 4	**CO 4**		**2**			**5**	
Unit 5	**CO 5**				**4**		
							M=4

MIM 4223 Lab. in Principles of Microbiology 3Hrs/2Cr

The laboratory course starts with basic techniques such as aseptic handling, sterilization techniques, media preparation and isolation of bacteria and fungi from various sources. It also deals with the various staining procedures for bacteria and fungi. Various biochemical methods needed for the identification of unknown bacteria will also be dealt with.

Course Outcomes:

Upon completion of this course, students will be able to

i. Apply aseptic handling techniques and sterilization methods
ii. Demonstrate pure culture isolation techniques and staining methods
iii. Utilize biochemical assays to identify extracellular enzyme production by bacteria.
iv. Analyze bacterial growth and antimicrobial susceptibility by various methods
v. Design experiments aseptically and identify bacteria and fungi by biochemical, as well as microscopic methods.

List of Experiments

1. Aseptic Handling techniques
2. Methods of sterilization and Preparation of culture media
3. Pure culture isolation and maintenance
    a. Isolation and identification of bacteria and fungi from various samples and study of culture characteristics
    b. Maintenance of pure cultures of bacteria and fungi
4. Staining methods:
    a. Simple staining
    b. Differential staining
    c. Lacto phenol cotton blue staining for fungi
5. Motility of bacteria by Hanging drop method
6. Measurement of bacterial cells with micrometer
7. Identification of unknown bacteria by biochemical characterization
    a. IMViC test
    b. Oxidase and catalase tests
    c. Oxidation/fermentation of glucose
8. Determination of bacterial growth curve
9. Effect of physical factors such as temperature and pH on bacterial growth
10. Screening bacteria for the production of extracellular enzymes such as amylase, caseinase, gelatinase, urease, and lipase
11. Determination of antimicrobial susceptibility tests
    a. Minimum inhibitory concentration (MIC) /Minimum Bactericidal Concentration (MBC) Assay
    b. Kirby Bauer method
    c. Agar well diffusion method
    d. Minimum bactericidal concentration

References:

1. Cappuccino JG, Welsh CT. (2017). *Microbiology: a laboratory manual*. Pearson education.
2. Benson HJ. (2001). *Microbiological Applications: A Laboratory Manual in General Microbiology*. The McGraw− Hill Companies.
3. Gunasekaran P. (1995). *Lab Manual in Microbiology*. New Age International Pvt. Ltd., Madras.

Bloom's Taxonomy		K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
Unit 1	CO1			3			
Unit 2	CO2						6
Unit 3	CO3					5	
Unit 4	CO4						6
Unit 5	CO5						6
							M=4.8

MIM 4525 Biological Chemistry 7Hrs/5Cr

This course on biological chemistry includes physical and chemical concepts in biology, composition, structure and functions of carbohydrates, proteins, lipids and vitamins. Enzymes and enzyme kinetics, carbohydrate, proteins, lipids, and vitamin metabolism are taught. It also includes biosynthesis and degradation of purines and pyrimidines.

Course Outcomes:

Upon completion of this course, students will be able to

i. Explain the basic concepts of biochemistry such as chemical bonds, pH, buffer and kinetic properties of biological reactions.
ii. Analyze the biomolecular structures of carbohydrates, proteins, lipids and vitamins.
iii. Evaluate the regulation and mechanism of enzyme activity and the role of thermodynamic principles in metabolic reactions.
iv. Discuss the metabolic pathways of carbohydrates and vitamins.
v. Explain the amino acid, nucleic acid and lipid metabolism.

I. Physical and chemical concepts in biology: Structure of atoms, molecules and chemical bonds; Biomolecule interaction – van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction and covalent bond; Principles of biophysical chemistry- pH, buffer, reaction kinetics, colligative properties.

II. Biomolecules: Composition, structure, classification and function – Carbohydrates, lipids, proteins, nucleic acids and vitamins; Conformation of proteins - Ramachandran plot, primary, secondary, tertiary & quaternary structures, domains, motif and folds.

III. Enzymes and bioenergetics: Enzymes and enzyme kinetics - regulation of enzymatic activity - mechanism of enzyme catalysis - Michaelis-Menten equation – isozymes; Bioenergetics – thermodynamics, free energy, coupled reactions, group transfer and biological energy transducers.

IV. Carbohydrate and vitamin metabolism: Types of metabolism; Carbohydrate metabolism - glycolysis, TCA cycle, oxidative phosphorylation, gluconeogenesis; glycogen metabolism, - Glycogenesis and Glycogenolysis, HMP shunt, uronic acid pathway; Vitamin metabolism **–** vitaminsA and C.

V. Amino acid, nucleic acid and lipid metabolism: Amino acid metabolism – In born errors - Urea cycle; Nucleotides - Biosynthesis and degradation of purines and pyrimidines; Biosynthesis and β-oxidation of fatty acid, ketone bodies, metabolism of phospholipids, glycolipids, cholesterol and HDL.

Textbook:

1. Voet D and Voet G. (1995).*Biochemistry*. 2nd Ed, John Wiley and sons, New York.

References:

1. Lehninger AL, Nelson DL and Cox MM. (2012).*Lehninger Principles of Biochemistry.*6th Ed. CBS Publishers and Distributors, USA.
2. Murray, RK and Grammer DK. (2007).*Harper's Biochemistry*.25th Ed., McGraw Hill, Lange Medical Books.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO1**	**1**					
Unit 2	**CO2**				**4**		
Unit 3	**CO3**		**2**				

Unit 4	**CO4**			**3**			
Unit 5	**CO5**					**5**	
							M=3

MIM 4527 **Cell Biology** **7Hrs/5Cr**

In this course,the basic principles that guide the structure of prokaryotic and eukaryotic cell, and the tools used to understand them are covered. Topics such as membrane structure and composition, transport, and trafficking; the cytoskeleton and cell movement; and the integration of cells into tissues will be discussed. Important cellular processes such as

cell cycle regulation, signal transduction, apoptosis (programmed cell death), and cancer cell biology will also be dealt in depth.

Course Outcomes:

Upon completion of this course, students will be able to

i. Explain the fundamental principles of cell biology
ii. Explain the cell structure and how it relates to cell functions
iii. Identify the cell movement and how it is accomplished
iv. Outline how cells grow, divide, and die and how these important processes are regulated
v. Evaluate cell signaling and how it regulates cellular functions and also how their dysregulation leads to cancer and other diseases

I. **Introduction to Cell**: universal principles, properties, origin and evolution of cells, prokaryotic and eukaryotic cell structure and function, cells as experimental models: *E. coli*, yeasts, vertebrates; tools of cell biology: light and electron microscopy, subcellular fractionation, growth of animal cells and plant cells

II. **Membranes and Transport Mechanisms**: membrane structure and function, dynamics, pumps, carriers, channels, physiology; cellular organelles and membrane trafficking, posttranslational targeting of proteins, mitochondria, chloroplasts, peroxisomes, endoplasmic reticulum, secretory membrane system and golgi apparatus, endocytosis and the endosomal membrane, processing and degradation of cellular components

III. **Cell Communication**: signaling mechanisms, plasma membrane receptors, protein hardware for signaling, second messengers, integration of signals; cellular adhesion and the extracellular matrix, extracellular matrix molecules, cellular adhesion, intercellular junctions, connective tissues

IV. **Cytoskeleton and Cell Movement**: cytoskeleton and cellular motility, actin and actin-binding proteins, microtubules and centrosomes, intermediate filaments, motor proteins, intracellular motility, cellular motility, muscles

V. **Cell Division, Apoptosis, and Cancer**: cell cycle, G1phase and regulation of cell proliferation, S phase and DNA replication, G2 phase, responses to DNA damage, and control of entry into mitosis, mitosis and cytokinesis, meiosis, programmed cell death; cancer: principles and overview

Textbooks:

1. Geoffrey, M., Cooper, H., & Robert, E. (2015). *Cell: A Molecular Approach*. Sinauer Associates Incorporated, U.
2. Pollard, T. D., & Earnshaw, W. C. (2017). *Cell biology*. 3rd Edition. Elsevier

References:

1. Plopper, G., Sharp, D., & Sikorski, E. (Eds.). (2013). *Lewin's Cells*. Jones & Bartlett Publishers.
2. Karp, G. (2016). *Cell and Molecular Biology: Concepts and Experiments 8th Edition with Plus Set*. John Wiley & Son.
3. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., ...& Walter, P. (2017). Molecular Biology of The Cell. Garland Science.
4. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., ...& Walter, P. (2013). *Essential cell biology*. Garland Science.
5. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2016). *Molecular cell biology* (Vol. 8). New York: WH Freeman.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO1**		**2**				
Unit 2	**CO2**					**5**	
Unit 3	**CO3**			**3**			
Unit 4	**CO4**		**2**				
Unit 5	**CO5**			**3**			
							M=3

MIM 4229 Lab. in Biological Chemistry, Cell and Molecular Biology3Hrs/2Cr

This course includeslaboratory experiments involving acidic and alkalimetry, colorimetric estimation of biomolecules, centrifugation, chromatographic separation of amino acids.Estimation and isolation of nucleic acids are also part of this coursework.

Course Outcomes:

Upon completion of this course, students will be able to

i. Explain the principles of basic instruments
ii. Analysebiomolecules qualitatively and quantitatively
iii. Formulate the separation of biomolecules
iv. Design the isolation of nucleic acids from different samples
v. Prepare buffers and other necessary solutions for analysis

List of Experiments:

1. Preparation of biological buffer and solutions
2. Preparative centrifugation
3. Colorimetry
4. Reactions of Carbohydrates
5. Reactions of Proteins
6. Reactions of Lipids
7. Chromatography– (a) Paper (b) Thin Layer (c) HPLC
8. Estimation of DNA by Diphenylamine reaction
9. Estimation of RNA by Orcinol reagent
10. Isolation of Genomic DNA from microorganisms
11. Isolation of Genomic DNA from plant tissue
12. Isolation of Genomic DNA from animal tissue
13. Isolation of plasmid from bacterial cells

References:

1. Palanivelu P. (2009). *Analytical Biochemistry & Separation Techniques - Lab Manual*. 4thedn. Twenty first Century Publications.
2. Geetha KD. (2010). *Practical Biochemistry.* Jaypee Brothers,Medical Publishers Pvt. Limited
3. Jayaraman J. (1996). *Laboratory Manual in Biochemistry*. 5thed. New Age International Pub, New Delhi.
4. Plummer DT. (1997). *An Introduction to Practical Biochemistry.* Tata McGraw Hill Pub Co, New Delhi.

Bloom's Taxonomy		**K1: Rememberin g**	**K2: Understandi ng**	**K3: Applyin g**	**K4: Analyzin g**	**K5: Evaluatin g**	**K6: Creatin g**
Unit 1	**CO 1**					**5**	
Unit 2	**CO 2**				**4**		
Unit 3	**CO 3**				**4**		
Unit 4	**CO 4**					**5**	
Unit 5	**CO 5**					**5**	
							M=4.6

MIM 4331 Human Health and Hygiene - CBCS 4Hrs/3Cr

The course is designed to address broad spectrum of health-related issues within the industry, community, hospitals and health sector. The content covers up para-medical, administrative, financial, social, informational and occupational aspects around the modern healthcare standards. Studies will include, among others, courses in medical, biological,

technological, legal, administrative and social foundations areas. The program provides students with a wider perspective of modern healthcare system and associated health facilitates.

Course Outcomes:

Upon completion of this course, students will be able to

i. Explore and explain the importance of health at the level of individual and society in relevance to the status of health and its standards in the country.
ii. Analyze the factors that determine health in association with the habits and the governmental health care systems and their structure.
iii. Assess the critical factors that provide risk for health and the habits that cause diseases.
iv. Discuss the role of education to maintain public health and the systems that plan and manage the health of the country with its governing bodies and the environment.
v. Compare the role of public and private agencies of national and international importance and the funding available for the maintenance of health at a global level.

I. Health Determinants and Standards: Individual health parameters; determinants of health, key health indicators; importance and source of public-health data health status in India: standards, relevance to social aspects. Future challenges in public health.

II. Community Health Concepts: Determinative factors: Family health history, Physique, Environment, Life-style and Social cultural aspects. Overview of Healthcare Systems in India; Primary healthcare hand-washing, immunization, Secondary healthcare, Tertiary healthcare Hospital interventions intravenous rehydration and surgery.

III. Occupational Health: Risk factors for disease; Diseases and occupational relevance Drugs, Tobacco and Alcohol: Chemical agents, Effects and Side effects.

IV. Heath Planning and Education: Need and Demands, Objectives- Planning Cycle, Management methods, techniques, need and demands – Health Planning and systems in India - History of Public Health in India – role of Union Ministry Health and Family Welfare. Understanding the significance of the environment for human health -Human population pressures and pollution dynamics.Principles and Practices of health education.

V. Health Care Agencies: Role of Public, Private and NGO in Health sector; Expenditure in Health-care Government Plans and Policies in India - UNITAID and Debt2 Health finance schemes; The Global Health Council, The Global Alliance for TB Drug Development, The International AIDS Vaccine Initiative, Malaria Vaccine Initiative World Health Organization (WHO) and Centre for Disease Control and Prevention (CDC): Organization, Objectives and Role of UN Millennium Development Goals.

Textbooks:

1. Edlin G and GolantyE. (2010). *Health & Wellness.*10th Ed. Jones &BarlettPublisher.
2. Skolnik R. (2012). *Global Health 101*.2ndEd. Jones &Barlett Learning.

References:

1. Schneider MJ.(2014).*Introduction to Public Health.*4th Ed. Jones &Barlett.
2. Talaro K. and Talaro A. (1996).*Foundations in Microbiology.* 2nd Ed.WnC. Brown Publishers, Chicago.
3. Parker JE and Park K. (1989). *Textbook of Preventive and Social Medicine*. 12th Ed.BanarsidasBhanot Publishers, India.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO 1**		**2**				
Unit 2	**CO 2**		**2**				
Unit 3	**CO 3**		**2**				
Unit 4	**CO 4**				**4**		
Unit 5	**CO 5**					**5**	
							M=3

Semester II

MIM 4522 **Medical Microbiology** **7Hrs/5Cr**

This course is to provide students with detailed insight in epidemiology, pathogenesis, prevention and treatment of important infectious diseases, and contemporary issues and novel developments in the field of Medical Microbiology. As the (re-) emergence of infectious diseases and antimicrobial resistance development, the course will also address the global health aspects of infectious diseases.

Course Outcomes:

Upon completion of this course, students will be able to:

i. Outline various types of microbial infections and their etiology
ii. Analyze the clinical specimens and laboratory diagnosis of bacteria
iii. Compare the fungal infections and their epidemiology
iv. Revise the clinical manifestations of viruses
v. Identify the clinical symptoms, treatment and prevention of protozoan and helminth infections

I. Introduction to Medical Microbiology: History; Epidemiology – Infection: stages and types, Host-microbe interactions, microbial pathogenesis; Human microbiome in health and disease: Nosocomial infections, Antimicrobial resistance; Bioterrorism; collection and processing of clinical specimens.

II. Medical Bacteriology: Epidemiology, pathogenesis, clinical manifestation, diagnosis, treatment and prevention of *Staphylococcus*; *Streptococcus*; *Neisseria*; *Corynebacterium*; *Bacillus*; *Enterobacteriaceae, Vibrio, Mycobacterium*; *Spirochetes*; *Mycoplasma; Rickettssia*; *Chlamydia*.

III. Medical Mycology: Epidemiology, pathogenesis, clinical manifestation, diagnosis, treatment and prevention of superficial and cutaneous mycoses; subcutaneous mycoses; systemic mycoses caused by dimorphic fungi; opportunistic mycoses; fungal and fungal-like infections of unusual or uncertain etiology; mycotoxins and mycotoxicoses.

IV. Medical Virology: Epidemiology, Pathogenesis, Clinical Manifestation, Diagnosis, Treatment and Prevention of Adenoviruses, Human Herpesviruses, Poxviruses, Picornaviruses, Paramyxoviruses**,** Orthomyxoviruses, Rhabdoviruses, Reoviruses, Retroviruses, Hepatitis Viruses, Unconventional Slow Viruses: Prions, Recent evolutions – Zika, Dengue, Chikungunya, MERS, SARS, Ebola

V. Medical Parasitology: Epidemiology, pathogenesis, clinical manifestation, diagnosis, treatment and prevention of Protozoans; Amoeba; Flagellates; Ciliates; Helminths

Textbooks:

1. Murray PR., Rosenthal KS and Pfaller, MA. (2015). *Medical Microbiology*, 8th ed. Elsevier Health Sciences.
2. Ryan, KJ and Ray CG. (2014). *Medical microbiology*. McGraw Hill.

References:

1. Tille P. (2015). *Bailey & Scott's Diagnostic Microbiology*. 14thedn. Elsevier Health Sciences.

2. Paniker AA. (2005). *Ananthanarayan and Paniker's Textbook of Microbiology* (reprint edn.). Orient Blackswan.

3. Sastry SA. & Bhat S. (2015). *Essentials of medical microbiology*. Jaypee Brothers, Medical Publishers Pvt. Limited.

4. Greenwood D. (ed). (2012). *MedicalMicrobiology*, With STUDENTCONSULT online access, 18. Elsevier Health Sciences.

Bloom's Taxonomy		K1: Rememberin g	K2: Understandin g	K3: Applyin g	K4: Analyzin g	K5: Evaluatin g	K6: Creatin g
Unit 1	CO1	1					
Unit 2	CO2				4		
Unit 3	CO3		2				
Unit 4	CO4			3			
Unit 5	CO5					5	
							M=3

MIM 4224 Lab. in Medical Microbiology 3Hrs/2Cr

This labcourse is designed to give students clinical experience in the area of bacteriology and mycology. Test procedures routinely applied are covered with an emphasis on the isolation, identification, and antimicrobial susceptibility testing of pathogenic microorganisms.

Course Outcomes:

Upon completion of this course, students will be able to

i. Plan the organization of a clinical microbiology laboratory
ii. Perform collections, storage and transport of clinical specimens
iii. Identifyrequirements for the investigation, diagnosis, and treatment of patients suffering from infectious diseases.
iv. Analyze the epidemiology of communicable diseases and their prevention
v. Design experiments to identify the causative agentsofbacterial and fungal diseases

List of Experiments:

1. Laboratory Safety
2. Epidemiology
    1. Effectiveness of Handwashing
    2. A Synthetic Epidemic
    3. Morbidity and Mortality Weekly Report (MMWR) Assignment
3. Bacteriology and Mycology
    1. Enumeration of potential nosocomial infective agents in Health Care Facility (HCF)
    2. Antimicrobial effect of body fluids (saliva, tears, sweat)
    3. Isolation of Normal Microbiota from the Human Body
    4. The Snyder Caries Susceptibility Test
    5. Examination of skin smears, sputum specimens, throat swabs and nasal scrapings: The Staphylococci and Streptococci: Isolation and Identification
    6. Microbiological Analysis of Blood Specimens
    7. Examination of urine: Physical and Microbiological Analysis of Urine Specimens
    8. Examination of skin and hair for fungi
    9. Oral candidiasis
4. Antimicrobial Susceptibility Test (Kirby-Bauer Method) against specific pathogens
5. Broth dilution method
6. Microbial evaluation of cosmetics
7. Microbial evaluation of antidandruff products

Textbooks:

1. Cappuccino JG and Welsh CT. (2017). *Microbiology: A Laboratory Manual*. Pearson education.
2. Benson HJ. (2001). *Microbiological Applications: A Laboratory Manual in General Microbiology*. The McGraw− Hill Companies.
3. World Health Organization. (2003). *Manual of basic techniques for a health laboratory*. World Health Organization.

References:

1. Harley J & Prescott L (2002). *Harley J, Prescott L. Harley-Prescott: Laboratory Exercises in Microbiology,* 5th Ed. McGraw-Hill Company.
2. Pollack RA. (2011). *Laboratory exercises in microbiology*. Wiley Global Education

Bloom's Taxonomy		K1: Rememberin g	K2: Understandin g	K3: Applyin g	K4: Analyzin g	K5: Evaluatin g	K6: Creatin g
Unit 1	CO1			3			
Unit 2	CO2			3			
Unit 3	CO3				4		
Unit 4	CO4						6
Unit 5	CO5						6
							M=22

MIM 4540 Immunology 7Hrs/5Cr

This course introduces the fundamental concepts of Immunology, with an emphasis on immune system, immune response against different diseases and the genetic basis of immune polymorphism. Topics covered are the basic elements of immune system including lymphoid tissues/ organs and cells with immune functions; principles of natural immunity and acquired immunity; cellular and molecular basis of B cell and T cell development and activation, cytokines, immune tolerance. This course also highlights the clinical aspects of immunology including autoimmunity; transplantation immunology, Hypersensitivity reactions, Immune deficiency disorders, tumour immunology and Immunoprophylaxis.

Course Outcomes:

Upon completion of this course, students will be able to

i. Explain the cells and organs of the immune system; antigens, antibody, antibody diversity and antigen-antibody interactions.
ii. Discuss the roles of MHC, maturation, activation and differentiation of T & B cells, cytokines and cytokine receptors in fighting infections
iii. Identify the adverse effects of immune system in hypersensitivity reactions, autoimmunity and immunodeficiency diseases.
iv. Analyze the role of immune system in transfusion and transplantation.
v. Explain the immune surveillance of cancer cells in host and the effector mechanisms against bacterial, viral, fungal and parasitic pathogens.

I. Overview and Components of Immune System: Cells, tissues and organs of immune system; Innate immunity- anatomical barriers, phagocytosis- induced cellular responses- inflammatory responses-natural killer cells. Adaptive immunity- Interaction between innate and adaptive immunity. Antigens – types and properties– Complement system- Cytokines – properties –functional categories – receptors – role in therapy.

II. B, T lymphocytes & MHC molecules: Biology & activation of T & B lymphocytes; Immunoglobulins - structure, isotypes, biological properties, generation of antibody diversity; Antigen and antibody interaction – Kinetics of immune response. Effector responses- cell and antibody mediated immunity. MHC molecules – variability – molecular structure - antigen processing & presentation-MHC haplotypes and polymorphism

III. Immune tolerance, Hypersensitivityreactions, and Autoimmunity: Immune tolerance – types – mechanism – immunologically privileged sites; Gell and Coombs classification; Immediate type I – components – factors – consequences; Antibody mediated (type II) –transfusion and hemolytic disease; Immune complex-mediated (type III) –systemic and localizeddiseases;Delayed type (type IV) – mechanism and examples of DTH.Autoimmunity – factors – organ-specific & systemic diseases – mechanism – therapeutic strategies.

IV. Transfusion andTransplantation Immunology:ABO system - ABO antigens - isohaemagglutinins - Rh antigens - transfusion reactions - transfusion transmitted infections - cross-matching;Transplantation –types of grafts – allograft rejection & its mechanism – immunosuppression – Graft-vs host disease – fetus as allograft.

V. Immune deficiency disorders, Tumor Immunology, Immunity and infection: Primary Immunodeficiency; Secondary immunodeficiency and AIDS; Immunoprophylaxis; Malignant transformation– Tumor antigens – Effector response to tumor cells – cancer immunodiagnosis and immunotherapy. Innate and acquired immunity to intracellular and extracellularbacterial infections, viral infections,fungal infections andprotozoal infections- evasion strategies.

Textbooks:

1. Owen JA., Punt J and Stranford SA. (2013). *Kuby Immunology*. 7th Ed. WH Freeman and Company, New York.
2. Delves PJ, Martin SJ, Burton DR and Roitt IM (2006).*Essential Immunology.* 11th Ed. Blackwell Pub Ltd, UK

References:

1. Pier GB.,Lyczak JB and Wetzler LM(2004). *Immunology, Infection, and Immunity.* ASM press.
2. Coico R. and Sunshine. G. (2015). *Immunology – A Short Course.* 7thedn. Wiley Blackwell, UK.
3. Murphy K. and Weaver C. (2017). *Janeway'sImmunobiology.* 9thedn. Garland Science, New York and London.

Bloom's Taxonomy		K1: Rememberin g	K2: Understandin g	K3: Applyin g	K4: Analyzin g	K5: Evaluatin g	K6: Creatin g
Unit 1	CO1		2				
Unit 2	CO2				4		
Unit 3	CO3					5	
Unit 4	CO4					5	
Unit 5	CO5					5	
							M=4.2

MIM 4228 Lab. in Immunology 3Hrs/ 3Cr

This laboratory course includes preparation of antigens, various bleeding techniques, serological reactions, identification and counting of different types of cells. Surveys of lymphoid organs are also done. Students are taught to immunize animals and assay antibody response by complement mediated hemolysis. Isolation of macrophage and *in vitro* phagocytosis are done.

Course Outcomes:

Upon completion of this course, students will be able to

i. Identify the lymphoid organs
ii. Perform the basic experiments in immunology such as isolation and separation of immunoglobulins.
iii. Prepare soluble, particulate and cellular antigens.
iv. Demonstrate the bleeding techniques and antigen-antibody interactions.
v. Evaluate the cellular immune response

List of Experiments:

1. Survey of lymphoid organs of fish or chick or mice
2. Separation of serum and plasma from whole blood
3. Differential staining of white blood cells and enumeration of WBC by hemocytometer
4. Preparation of Antigens – Soluble, insoluble and adjuvant antigens.
5. Routes of administration and repetitive bleeding.
6. Isolation of lymphocytes – Density gradient centrifugation
7. Isolation and purification of Immunoglobulins – Ammonium Sulphate precipitation
8. Antigen – antibody interactions – Precipitation reactions
9. Antigen – antibody interactions – Haemagglutination assay
10. Viable Cell count – Trypan blue dye exclusion test.
11. Complement mediated hemolysis
12. Serum bactericidal activity
13. Isolation of macrophage from peritoneal cavity of fish.
14. *In vitro* phagocytosis.
15. Complement mediated hemolysis
16. Serum lysozyme activity

References:

1. Myers RL. (1989). *Immunology: A Laboratory Manual*. Wm. C. Brown, Dubuque, Iowa.
2. Hay FC and Westwood OMR (2003). *Practical Immunology*. 4th Ed. Blackwell Science UK.
3. Garvey JS., Cremer NE and SussdofDH (1993).*Methods in Immunology – A Laboratory Text for Instruction and Research*. 3rd Ed. The Benjamin/Cummings Publisher, London.

Bloom's	**K1:**	**K2:**	**K3:**	**K4:**	**K5:**	**K6:**

Taxonomy		Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Unit 1	**CO 1**		**2**				
Unit 2	**CO 2**				**4**		
Unit 3	**CO 3**			**3**			
Unit 4	**CO 4**			**3**			
Unit 5	**CO 5**				**4**		
							M=3.2

MIM 4430 Molecular Biology and Microbial Genetics 6Hrs/4Cr

The course is an introduction to molecular biology and genetics and methods used within these fields. The structure of the genomes, chromosomes, chromosomal structure, and extrachromosomal inheritance is discussed, along with the molecular basis of transmission of genetic information: nucleic acids and proteins. DNA replication, DNA repair, mutations,

recombination, transposition, transcription, translation, and transfer of DNA between bacteria.

Course Outcomes:

Upon completion of this course, students will be able to

i. Explain the mechanisms involved in replication, recombination, transposition and repair of DNA.
ii. Compare the prokaryotic and eukaryotic mechanisms of transcription, translation and gene regulation.
iii. Critique the biology of plasmids and transposons, process of mutagenesis and genetic mapping.
iv. Discuss the life cycle of bacteriophages and genetics of yeast mating type conversion.
v. Assess the mechanisms of genetic exchange in bacteria through transformation, conjugation and transduction.

I. Maintenance of Genome: genome structure, chromatin, and the nucleosome; replication of DNA; the mutability and repair of DNA; homologous recombination; site-specific recombination and transposition of DNA

II. Expression and Regulation of Genome: mechanisms of transcription, RNA splicing, translation, genetic code,transcriptional regulation in prokaryotes and eukaryotes, regulatory RNAs, gene regulation in development and evolution, systems biology

III. DNA damage, repair, mutation and recombination: Genetic nomenclature - Mutagenesis – causes, types, detection. Mutants - isolation and characterization - significance - analysis. - Genetic recombination – types - mapping - complementation analysis; Extrachromosomal DNA: Plasmids – Properties, detection, purification, replication, types, amplification, gene transfer, Partitioning; Mobile DNA – terminology, types, detection, mechanism, Genetic Phenomena, Evolution; Retroposons; Mu DNA.

IV. Phage and Yeast Biology: general properties, structure, stages, counting, Host Restriction and Modification, Lysogenic Cycle; Genetics of Phage T4 - Genetic Mapping; Lytic Growth of Phage l; Lysogeny; Construction of Phage Mutants; Elements of Yeast Genetics - cell cycle, Mating Type Conversion, Expression and Recombination Paradoxes

V. Bacterial Genetic Exchange Mechanisms: Bacterial Transformation- discovery, mechanism and significance; Conjugation- F factor- R factor, chromosome transfer by plasmids and integrative conjugative elements; Transduction- discovery, mechanism, specialized transduction, generalized transduction and significance

Textbooks:

1. Watson, J. D. (2013). Molecular Biology of the Gene. *Molecular biology of the gene.*,7th Ed. Garland Science.
2. Maloy SR.Cronan JE and FreifelderD. (1994). *Microbial Genetics.* 2nd Ed. Jones and Bartlett publication.

References:

1. Snyder L.Champness W&Champness W. (2013). *Molecular Genetics of Bacteria*. American Society for Microbiology.
2. Clark DP and Pazdernik NJ. (2013). *Molecular Biology.* Elsevier.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO 1**	**1**					
Unit 2	**CO 2**				**4**		
Unit 3	**CO 3**		**2**				
Unit 4	**CO 4**			**3**			
Unit 5	**CO 5**					**5**	
							M=3

MIM 4346 Dairy Science – CBCS 4Hrs/3Cr

The aim of the course is to provide an insight into milk, the most loved and widely used food product. Its aim is also to satiate the curiosity of arts and students about milk, the various types available, different milk-yielding animals and the variety of milk products available.

CourseOutcomes:

Upon completion of this course, students will be able to

i. Explain the global production of milk
ii. Assess the nutritive value of different types and grades of milk.
iii. Identify the microbiota of the milk and ways to prevent spoilage of milk
iv. Apply different methods for the collection, preservation, storage, package and distribution.
v. Evaluate the quality and composition of the different types of milk and milk products.

I. Introduction to Dairy Science: History- Worldwide milk consumption- Production. Milk Production in India- White revolution - Various Milk societies in India- Modern milk production- Animal farms

II. Composition of milk: Biosynthesis of milk- structure of milk and milk products- Nutritional composition of commercially available milk- Types of Milk - Milk grading and defects- milk grading techniques- Characterization of flavour defects- effects of milk handling on quality and hygiene of milk

III. Dairy Microbiology: - Normal microflora of milk - Pathogenic microorganisms – contamination, preservation and spoilage - Role of microorganisms in the production of milk products

IV. Dairy Processing and quality control: Dairy collection and transportation - Plant design and development- Pasteurization- packaging and storage of Milk-Distribution of milk-Cleaning and sanitization of dairy equipment -Automatic milking- High quality milk yielding animals- different animals used for milk production

V. Milk Products: Fermented and non-fermented milk products - dried milk products- ice cream- cream-curd/yogurt – butter – cheese- Indian Dairy products-types, nutrition, worldwide production-health benefits.

Textbook:

1. De S. (1980).*Outlines of Dairy Technology*. Oxford University Press, New Delhi.

References:

1. Black JG. (2013). *Microbiology*. 8th Ed. John Wiley and Sons, Singapore Inc.
2. Sherwood L., Willey JM and Woolverton, C.(2011). *Prescott's Microbiology*. McGraw-Hill.

Bloom's Taxonomy		K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
Unit 1	CO1	1					
Unit 2	CO2				4		
Unit 3	CO3		2				
Unit 4	CO4			3			

Unit 5	CO5					5	
							M=3

Semester III

MIM 5521 Molecular Biotechnology 6Hrs/5Cr

This course comprises various techniques for studying the gene, manipulation of gene sequences, cloning strategies and their applications. Special emphasis is given to basic techniques used in genetic engineering such as different vectors, manipulative enzymes, library construction and methods of gene of transfer. The course also covers important topics such as production of transgenic plants & animals, gene therapy and their applications, patenting, rDNA regulations and ethical concerns.

Course Outcomes:

Upon completion of this course, students will be able to

i. Discuss the biology of cloning and expression vectors, principles of gene manipulation, PCR and DNA sequencing techniques.
ii. Critique the techniques involved in gene expression analysis and site directed mutagenesis.
iii. Analyze the principles and applications of various molecular diagnostic methods.
iv. Explain the methods involved in generation of transgenic plants and animals.
v. Evaluate the applications of microarray technology and various types of gene therapy

I. Introduction to rDNA technology: Nucleic acids – manipulation, chemical synthesis, isolation, quantification, labelling, gel electrophoresis;Restriction Endonucleases - types, other enzymes, Cloning vectors - properties, types – plasmids, bacteriophage, hybrid, artificial chromosomes, expression vectors - Plasmid Cloning Vectors, Phage vectors- λ & M13, Cosmids, Phagemids and BAC; Cloning strategies - Construction of genomic and cDNA library, Ligation strategies; chromosome walking, subtractive hybridization, gene transformation in bacteria- selection of recombinants; PCR – types, DNA sequencing techniques.

II. Manipulation of gene expression: Strong and Regulatable Promoters, Fusion Proteins, Translation Expression Vectors; Eukaryotic Expression Systems Heterologous Protein Production, Fungus-Based Expression Systems, Baculo virus–Insect Cell Expression Systems, Mammalian Cell Expression Systems; Directed Mutagenesis procedures and Protein Engineering.

III. Molecular diagnostic methods: Molecular diagnostics – biofluorescent& bioluminescent systems, nucleic acid diagnostic systems- antisense RNA, ribozymes, chimeric RNA-DNA molecules, aptamers, SiRNAs, antibody genes and nucleic acid delivery- molecular diagnosis of genetic disease, RFLP, RAPD as tools of diagnosis

IV. Transgenics: Transgenic Plants – Ti plasmid mediated and physical methods of gene transfer, Chloroplast engineering, gene targeting. Development of pathogen (bacteria and fungus), drought, insecticide and stress resistance plants. Transgenic Animals – methods, applications, Transgenic mice, livestock, poultry and fish.

V. Applications of molecular biotechnology: Gene therapy – types and applications. Approaches for the study of Genomics, Proteomics, metagenomics and their applications. DNA chips and its applications. DNA microarray technology - Protein expression profiling and serial analysis of gene expression. Ethical, legal and social implications of modern biotechnology.

Textbooks:

1. Glick BR and Pasternak JJ. (2017). *Molecular Biotechnology – Principles and Applications of Recombinant DNA Technology*, Panima Publishing Co, New Delhi.
2. Brown TA. (2015).*Gene cloning and DNA analysis – an introduction.* 5th Ed. Blackwell, Oxford.

References:

1. Clark, D. P., &Pazdernik, N. J. (2013). *Molecular biology*. 2nd Ed. Elsevier.
2. Clark, D. P., &Pazdernik, N. J. (2015). *Biotechnology*. Newnes.
3. Satyananrayana U. (2013).*Biotechnology*.1st Ed, Books and Allied (P) Ltd, Kolkata.
4. Desmond ST and Nicholl. (2008).*AnIntroduction to Genetic Engineering*. Cambridge University Press, Oxford.
5. Watson JD, (2007).*Recombinant DNA.* 2nd Ed. Scientific American Books, WH Freeman and Co, New York.
6. Primrose SB and Twyman RM. (2013).*Principles of Gene Manipulation and Genomics*. 7th Ed. Blackwell Scientific Publications, New York.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO**		**2**				
Unit 2	**CO**					**5**	
Unit 3	**CO**				**4**		
Unit 4	**CO**					**5**	
Unit 5	**CO**			**3**			
							M=3.8

MIM 5523 Immunotechniques& Immunotechnology 6Hrs/5Cr

The course deals with the principles, procedures and applications of advanced immunological tools and techniques. The immunological techniques include detection and testing of antigens and antibodies, complement and cellular assays. A section on experimental animal models is included. Immunotechnology includes methods in the production of monoclonal, recombinant antibodies, their applications in clinical diagnosis and treatment. Conventional and modern strategies in vaccine development and their applications are also dealt with.

Course Outcomes:

Upon completion of this course, students will be able to

i. Perform and analyze the mechanisms behind serological assays
ii. Compare the types and principles of effector cell assays and immunofluorescence techniques
iii. Discuss the importance of experimental animal models, gene targeting tools and immunofluorescence techniques
iv. Explain techniques involved in synthesis of monoclonal antibodies
v. Evaluate the applications of recombinant antibodies in clinical diagnosis and treatment

I. Serological assays: Precipitation-double immunodiffusion, Radial immunodiffusion – Immunoelectrophoresis and other types. Agglutination – direct, viral, haemagglutination, passive; reverse passive agglutination – column agglutination technology, agglutination inhibition. Immunochromatography, evaluation of complement, complement components in disease, complement fixation test. ELISA, RIA and Immunoblotting.

II. Effector cell assays and conjugation techniques: Assays for human lymphocytes and monocytes – T & B lymphocyte assays- flow cytometry-lymphocyte activation, mixed lymphocyte culture & cell mediated lympholysis – Enumeration of NK cells, monocyte, macrophage assays – neutrophil functional assays. Antibody labelling- radioisotopes-enzymes and fluorochromes, avidin- biotin conjugation and protein A & G.

III. Experimental animal models, systems and immunofluorescence techniques: Inbred strains – strategies in developing inbred strains – types – adoptive transfer systems – SCID mice and SCID human mice – Gene targeted knock out mice – Inducible gene targeting – the cre/lox system. Immunofluorescence – Direct, indirect, transmitted and epi-illumination fluorescence microscopy.

IV. Monoclonal antibodies: MAb through hybridoma technology production strategies – enrichment techniques – applications – nomenclature of MAbs: Rabbit monoclonal antibodies – advantages: humanizing monoclonal antibodies – HamA, HAcA and RHAs

V. Recombinant antibody fragments: Production strategies – display systems – expression system: types – catalytic antibodies (abzymes) – immunotoxins – chimeric antibodies – bispecific antibodies – single chain FV – diabodies – tetrabodies – intrabodies, plantibodies – plastibodies – applications.

Textbook:

1. Sheehan C. (1997). *Clinical Immunology*.2nd Ed. Lippincott Williams and Wilkins NY.

References:

1. Goldsby RA., Kindt TJ and Osborne BA. (2013). *Kuby Immunology*. 4th Ed. WH Freeman New York.
2. Kontermann R and S Dubel. (2001). *Antibody Engineering*. Springer, Germany

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO 1**		**2**				
Unit 2	**CO 2**					**5**	
Unit 3	**CO 3**			**3**			
Unit 4	**CO 4**						**6**
Unit 5	**CO 5**			**3**			
							M=3.8

MIM 5225 Lab. in Immunotechniquesand Molecular Biotechnology3Hrs/2Cr

In the laboratory component students are introduced to the various tools and techniques that form the basis for the antigen-antibody assays and cellular assays. A special emphasis is given to the strategies for producing immunodiagnostic kits.

Course Outcomes:

Upon completion of this course, students will be able to

i. Utilize the electrophoresis technique for quantitative and qualitative analysis of the antigens, antibodies, plasmids and other DNA molecules.
ii. Select different cells of the immune system to separate them for analysis
iii. Design laboratory tools for the diagnosis of different pathogens
iv. Perform the isolation and purification of plasmids for cloning experiments
v. Select plasmids and restriction enzymes for cloning and screen the recombinants.

List of Experiments:

1. Ouchterlony Double Immuno Diffusion (ODI) – Single Radial Immunodiffusion (SRID)
2. Immunoelectrophoresis – isolation and characterization of serum albumin
3. Rocket immunoelectrophoresis – semi quantitative analysis of antigen
4. Separation of T & B lymphocytes and identification of T cells
5. Microlymphocytotoxicity assay
6. DOT ELISA & Western Blot
7. Immunodiagnostic tests- RPR, WIDAL, VDRL
8. Isolation of plasmids & check by AGE
9. Transformation by $CaCl_2$ method- Competent cell preparation and blue-white screening
10. Screening of recombinants - (a) by antibiotic resistance (b) by blue-white screening
11. Restriction digestion
12. Southern blotting
13. PCR – demonstration

References:

1. Garvey JS, Cremer NE and DH Sussdorf. (1977). *Methods in Immunology*. 3rd Ed. Benjamin Cummings Pub Co, Massachusetts, USA.
2. Hudson L and FC Hay. (1989). *Practical Immunology*.3rd Ed. Blackwell Science Pub, Oxford.
3. Myers RL. (1989). *Immunology – A Laboratory Manual*. Wm C Brown Pub, Dubuque, Iowa. USA.
4. Das, S. and Dash, H.R.(2014). *Microbial Biotechnology-A Laboratory Manual for Bacterial Systems*. Springer.
5. Clark, M.S. ed., 2013. *Plant molecular biology—a laboratory manual*. Springer Science & Business Media.

Bloom's Taxonomy		K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
Unit 1	CO 1		2				
Unit 2	CO 2					5	
Unit 3	CO 3				4		
Unit 4	CO 4					5	
Unit 5	CO 5			3			
							M=3.8

MIM 5527 Animal Cell Culture 6Hrs/5Cr

This course intends to provide students with basic cell culture methods and bioprocessing technology. Students will be taught with various aseptic techniques and environment, media and supplements for cell culture. The disaggregation of tissue, primary cell culture techniques, maintenance of the culture will be given due importance. The cloning and selection of specific cell types with special reference to cells of the immune system and their culturing method, substrate for the cell culture will be dealt. Cloned specific cells line induction and the bioreactors types and their uses in the industry will also be dealt. Apart from the culturing techniques and method, commercial useful products through microbes will also be mentioned.

Course Outcomes:

Upon completion of this course, students will be able to

i. Outline the history and the biology of cultured cells in terms of their properties, advantages and disadvantages.
ii. Explore the role of different culture vessels, substrates, media used in cell culture.
iii. Perform the techniques of primary explants, monolayer culture, and cell line characterization
iv. Utilize animal cell culture for scale up.
v. Apply the learnt techniques for the microscopic observation, cell separation and testing the viability of the cultured cells.

I. Introduction to Animal Cell Culture: History, Advantages and disadvantages, types of tissue culture; Biology of cultured cells - cell types, adhesion, proliferation, differentiation, signaling, evolution, senescence, transformation; laboratory design; equipment and materials; aseptic technique; safety and bioethics

II. Culture Media and Vessels: Culture vessels and substrates, specialized systems;Media, supplements, physico-chemical properties— serum and serum free media; preparation and sterilization; Common microbial contaminants in cell culture – sources, types, monitoring, disposal of contaminated cultures, eradication, Cross-contamination

III. Primary culture and routine maintenance: Primary culture – types, initiation and isolation of the tissue; subculture- propagation, choice of cell line, routine maintenance, methods - Cloning – types - dilution cloning, suspension cloning, isolation of clones - methods; isolation of genetic variants, interaction with substrate.

IV. Induction of differentiation and the transformed phenotype: Differentiation – in vivo expression, proliferation, commitment and lineage, stem cell plasticity, markers and induction of differentiation, transformation and immortalization – role in cell line characterization –genetic instability– aberrant growth control – tumorgenicity.

V. Techniques used in cell culture: Cryopreservation, Quantitation –confocal microscopy,cell counting- cell proliferation – plating efficiency. Cytotoxicity – viability, toxicity and survival – application of cytotoxicity assay – cell separation – antibody based techniques, Specialized techniques - lymphocytes preparation – autoradiography.

Textbook

1. Freshney, RI. (2016). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.* Wiley-Blackwell.

References

1. Mather, JP.& Barnes, D. (1998). *Methods in cell biology. Volume 57: Animal cell culture methods.* Academic press.
2. Sinha, BK.& Kumar, R. (2008). *Principles of Animal Cell Culture: Students Compendium.* IBDC.
3. Butler, M. (2003). *Animal cell culture and technology*. Taylor & Francis.
4. Davis, JM. (Ed.). (2011). *Animal Cell Culture: Essential Methods*. John Wiley & Sons.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO 1**		**2**				
Unit 2	**CO 2**					**5**	
Unit 3	**CO 3**				**4**		
Unit 4	**CO 4**					**5**	
Unit 5	**CO 5**			**3**			
							M=3.8

MIM 5229 Lab. in Animal Cell culture 3Hrs/2Cr

This is a supportive course on cell culture and bioprocess technology. In cell culture part, preparation of media for animal cell culture with special emphasis on the cells of the immune system.

Course Outcomes:

Upon completion of this course, student will be able to

i. Prepare animal cell culture media
ii. Demonstrate different methods of tissue disaggregation
iii. Prepare primary explants and perform *in vitro* cell culture
iv. Perform maintenance and sub-culturing of animal cells
v. Compare the monolayer & suspension culture and their viability

List of Experiments:

1. Aseptic and Sterilization techniques
2. Preparation of media for animal cell culture
3. Primary explants culture from chick embryo
4. Primary culture of lymphoid cells
5. Primary culture of chick organ
6. Disaggregation of tissue – Physical method
7. Disaggregation of tissue – Enzymatic method
8. Primary cell culture – Monolayer Cells
9. Primary cell culture – Suspension Cells
10. Sub culturing technique/Secondary cell culture method.
11. Lymphocytes response to mitogen
12. Cell counting and viability – Trypan blue dye exclusion test, MTT, DAPI staining
13. Visit to cell culture institutes

References:

1. Freshney RI. (2016).*Culture of Animal Cells. A Manual of Basic Techniques.* 2nd Ed. Alan R. LissInc, New York.
2. Harrison, MA. & Rae, IF. (1997). *General Techniques of Cell Culture*. Cambridge University Press.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO1**		**2**				
Unit 2	**CO2**					**5**	
Unit 3	**CO3**				**4**		
Unit 4	**CO4**					**5**	
Unit 5	**CO5**			**3**			
							M=3.8

MIM 5531 Bioinformatics and Biostatistics 6Hrs/5Cr

This course provides a theoretical as well as practical approach towards learning bioinformatics and Biostatistics. It comprises the basics of molecular biology, evolution and genomic tools required to understand bioinformatics concepts better. It deals with the emergence of bioinformatics as a field, its datatypes, data retrieval, databases, sequence alignment, gene and protein structure prediction and molecular phylogeny tools. Biostatistics component is designed to impart a fundamental knowledge on data, scales of measurement, sources and acquisition; organization and presentation of data; descriptive statistics and inferential statistical procedures.

Course Outcomes:

Upon completion of this course, students will be able to

i. Outlinethe evolution of bioinformatics.
ii. Discuss basic concepts in storage, submission, retrieval of data and data formats
iii. Apply the fundamental tools in sequence analysis, structure analysis, molecular docking, drug design and phylogeny
iv. Compile data from different sources, organize and present them
v. Formulate hypothesis, evaluate data and interpret them using data analysis tools.

I. Introduction to bioinformatics: - History: Margaret Dayhoff, Richard Eck, Robert Ledley; bioinformatics - definition, goals - technical toolbox; collecting and storing sequences - DNA sequencing, submission of sequences to the databases, computer storage of sequences, sequence formats; archives and information retrieval –databases indexing – format – search - retrieval systems, and genome browsers.

II. Nucleotide analysis and Phylogeny: Sequence Retrieval, Primer Designing, Editing Sequence Data, Sequence Assembly—CAP3 Program, Restriction Mapping Using NEBcutter, Gene Prediction Using ORF Finder, Gene Prediction Using FGENESB, Dot-Plot, Global and Local Sequence Alignment, BLAST - Interpreting Result; Multiple Sequence Alignment: T-Coffee, MUSCLE, MAFFT, Multiple Sequence Alignment and Phylogenetic Analysis Using MEGA; RNA Analysis - Predicting RNA Secondary Structure, Finding Repeats.

III. Protein Sequence and structure analysis: Protein Sequence Retrieval; Predicting Signal Peptides, Transmembrane Segments, Subcellular Location; Protein BLAST (blastp), (PSI)-BLAST, (PHI)-BLAST, (DELTA-BLAST); CASP; Protein Primary, Secondary, and Tertiary Structure Analysis—ProtParam, SOPMA, PSIPRED, Homology Modelling - SwissModel , Threading (Fold Recognition);ROSETTA, LINUS; Protein Tertiary Structure Analysis – RAMPAGE, SAVeS; Protein Structure Visualization – RasMol, PyMol, Protein Structure Alignment/Superimpose Using SuperPose, Protein Cleft Analysis;Protein–Ligand Interactions - AutoDock4.1 and MGLTools, ClusPro2.0; Drug discovery and development.

IV. Introduction to biostatistics: understanding data, data types, sources, population, sample, sampling methods, scales of measurement – nominal, ordinal, interval and ratio scales - Organizing and presenting data – raw data, organizing – arranging, grouping; tabulation and graphical representation – pie charts, bar charts, column graphs, histograms, Ogive curves, stem-leaf diagram, box plot – properties.

V. Descriptive statistics: measures of dispersion/central tendency – mean, median and mode; measures of spread/dispersion – range, mean deviation, inter quartile range, variance, standard deviation and standard error, distribution. **Inferential statistics**: – chi-square test/goodness of fit; Spearman's rank correlation, Karl Pearson's correlation and regression, student's t-test paired & pooled; introduction to ANOVA (one way).

Textbooks:

1. Lesk, A. (2014). *Introduction to bioinformatics*. Oxford university press.
2. Paulson, D. S. (2008). *Biostatistics and microbiology: a survival manual*. Springer Science & Business Media.

References:

1. Choudhuri S. (2014). *Bioinformatics for beginners: genes, genomes, molecular evolution, databases and analytical tools*. Elsevier.
2. Ibrahim KS., Gurusubramanian G., Zothansanga YR., Yadav RP., Kumar NS., Pandian SK., & Mohan S. (2017). *Bioinformatics-a Student's Companion*. Springer.
3. Mount, D. W. Bioinformatics: sequence and genome analysis. (2004). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor Laboratory Press
4. Singh, G. B. (2015). *Fundamentals of Bioinformatics and Computational Biology*. Springer International Publishing.
5. Rosner B. (2015). *Fundamentals of biostatistics.* Nelson Education.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO1**	**1**					
Unit 2	**CO2**			**3**			
Unit 3	**CO3**				**4**		
Unit 4	**CO4**		**2**				
Unit 5	**CO5**					**5**	
							M=3

SEMESTER IV

MIM 5422 Environmental and Agricultural Microbiology 5Hrs/4Cr

The objective of this course is to educate students on environmental and agricultural microbiology. Environmental microbiology includes ecology of microbes, biogeochemical cycles, biodegradation, bioaccumulation and bioremediation. In agricultural microbiology, comprehensive role of microbes as biofertilizers, biopesticides, plant growth promoting agents, plant pathogens will be dealt in detail.

Course Outcomes:

Upon completion of this course, students will be able to

i. Outline the host-microbe interactions and their role in environment
ii. Compile the air and soil microflora and their habitats
iii. Assess the different types of freshwater and marine microbial habitats
iv. Analyze water samples and evaluate their quality
v. Discuss the different types of microbes as biocontrol agents

I. Basics of Microbial Ecology: biosphere organization; nature, energy and nutritional flow in ecosystems; ecological interactions; biogeochemistry – atmospheric cycles – carbon, nitrogen; sedimentary cycles - water, phosphorus, sulfur; techniques - environmental sample collection and processing techniques; measurements of microbial biomass - primary production, respiration, predation and enzymatic activities.

II. Soil and Aeromicrobiology: Earth environment – soil functions, physicochemical properties, types, rock and subsurface, rock varnish, cave, deep subsurface habitats; and air – aerosol, nature and control of bioaerosols, aeromicrobiological pathway, microbial survival in the air, extramural and intramural aeromicrobiology.

III. Aquatic Microbiology: aquatic environments - microbial habitats - physical and chemical characteristics; planktonic and benthic microbes, biofilms and microbial mats; aquatic microbial lifestyles – primary and secondary production; marine environments; freshwater environments - springs, streams and rivers, lakes; others - brackish, hypersaline, subterranean waters, wetlands; extreme environments - low and high temperature, geothermal hot springs, desiccation, UV stress, aphotic environments, deep-sea hydrothermal vents, acid mine drainage system, desert carbonate cave

IV. Applied Environmental Microbiology: water quality and fecal contamination - microbial source tracking; Wastewater treatment; microbial fuel cells and Biogas, bioremediation and biodegradation – technology, biofarming; bioremediation of organic compounds and inorganic pollutants, degradation of hydrocarbons, xenobiotics, microbial weathering and biomineralization

V. Agricultural Microbiology: plant – microbe interaction - rhizosphere – mycorrhizae, nitrogen-fixing bacteria, plant growth promoting bacteria; phyllosphere associated microorganisms; interactions with pathogens; biocontrol of pests and pathogens; Biofertilizers – Vermicomposting, Agroforestry

Textbooks:

1. Pepper, I. L., Gerba, C. P., Gentry, T. J., & Maier, R. M. (Eds.). (2011). *Environmental microbiology*. Academic Press.
2. Barton, L. L., & Northup, D. E. (2011). *Microbial ecology*. Wiley-Blackwell.
3. Bagyaraj, D. J., &Rangaswami, G. (2007). *Agricultural microbiology*. PHI Learning Pvt. Ltd.

References

1. Black, J. G. (2014). *Microbiology: principles and explorations*. John Wiley & Sons.
2. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An Introduction*. Pearson.
3. Subba Rao NS. (2000). Soil Microbiology. 4th Ed. Oxford & IBH, New Delhi.

Bloom's Taxonomy		K1: Rememberin g	K2: Understandin g	K3: Applyin g	K4: Analyzin g	K5: Evaluatin g	K6: Creatin g
Unit 1	CO1	1					
Unit 2	CO2		2				
Unit 3	CO3				4		
Unit 4	CO4					5	
Unit 5	CO5					5	
							M=3.4

MIM 5224 Lab. in Environmental and Agricultural Microbiology 3Hrs/2Cr

The objective of this course is to give practical experience in understanding the principles of environmental and agricultural and veterinary microbiology. Experiments in environmental microbiology deals with the survey and monitoring of pathogens, analysis of effluents for their biochemical characters that helps in their treatments. Agricultural microbiology experiments are designed to enrich students a practical knowledge in the isolation, identification and mass production of biofertilizers and biopesticides.

Course Outcomes:

Upon completion of this course, students will be able to

i. Analyze microbial interactions
ii. Identify physico-chemical properties of soil and water samples
iii. Plan isolation and enumerationof microbial populations from soil, water and air
iv. Assess the biodegradation of selected pollutants
v. Plan isolation and enumeration of microorganisms of plant rhizosphere soil.

List of Experiments:

A. Microbial Ecology
    a. Demonstration of associative activities of bacteria: Competition and antagonism
    b. Soil biofilm
B. Soil Microbiology
    a. Winogradsky Column
    b. Determination of the soil pH and soil water content by dry-weight analysis
    c. Enumeration and examination of soil microorganisms via dilution plating and contact slide assay
    d. Isolation of saccharolytic, proteolytic and lipolyticbacteria from soil
    e. Enrichment and isolation of bacteria that decolorize dyes
    f. Adaptation of soil bacteria to metals and pesticides
C. Water Microbiology
    a. Determination of dissolved oxygen (DO), Chemical oxygen demand (COD) and Biochemical oxygen demand (BOD) of water
    b. Quantitative Analysis of Water: Coliform MPN Test and Membrane Filter Method
    c. Isolation of *Escherichia coli*bacteriophages from sewage and determining bacteriophage titers
D. Aeromicrobiology
    a. Determination of air microflora and Index of Microbial contamination of air (IMA)
E. Agricultural Microbiology
    a. Isolation and identification of *Rhizobium, Azospirillum,*phosphobacteria and *Azotobacter* from soil
    b. Observation of mycorrhizal fungi
    c. Screening for plant growth promoting traits

References:

1. Gerba, C. P., Josephson, K., & Pepper, I. L. (2011). *Environmental microbiology: A laboratory manual*. Elsevier.
2. Pollack, R. A. (2011). *Laboratory exercises in microbiology*. Wiley Global Education.
3. Aneja, K. R. (2003). *Experiments in microbiology, plant pathology and biotechnology*. New Age International.

4. Tiwari, R. P., Hoondal, G. S., &Tewari, R. (2008). *Laboratory techniques in microbiology and biotechnology*. Global Media.

Bloom's Taxonomy		**K1: Remembering**	**K2: Understanding**	**K3: Applying**	**K4: Analyzing**	**K5: Evaluating**	**K6: Creating**
Unit 1	**CO1**				**4**		
Unit 2	**CO2**			**3**			
Unit 3	**CO3**				**4**		
Unit 4	**CO4**			**3**			
Unit 5	**CO5**				**4**		
							M=3.6

MIM 5426 Food and Industrial Microbiology 5Hrs/5Cr

This course deals with the basics of food, their composition and factors responsible for spoilage. Emphasis will be given to preservative methods, their merits, contamination, preservations and spoilage of various foods. It also provides knowledge about food borne diseases. Equal importance is given to the basic concepts of fermentation, isolation, improvement of microbes, designing of media, fermenter and their types. This course also highlights the recovery of products and production of fermented foods and other products.

Course Outcomes:

Upon completion of this course, students will be able to

i. Outline the sources and components of food and their preservation techniques.
ii. Analyze the factors influencing food spoilage
iii. Apply principles of various facets of food fermentation technology
iv. Design appropriate techniques for the recovery of fermented products
v. Compare the production processes of various fermented foods

I. Food and its preservation: Classification of foods; composition of food – intrinsic and extrinsic factors; Principle methods of preservation – asepsis – removal – anaerobic conditions – Uses of high temperature and low temperature – Drying – radiation – food additives – antimicrobials – inorganic and organic and developed preservatives.

II. Contamination and spoilage of foods: Vegetables and fruits, meat and meat products, fish and other sea foods, egg and poultry, cereals and its products, milk and milk products – food borne diseases – Bacterial, fungal and viral

III. Fermentation technology: Isolation, preservation and improvement of industrially important microorganisms – formulation of media – fermenter design – control of temperature, pH and foam – Computer applications in fermenter. Types of fermenter – Batch, continuous and air lift fermenter.

IV. Downstream process: Recovery of fermented products – separation – centrifugation, chromatography, filtration and flocculation – Extraction - Purification – concentration – precipitation, ultra-filtration and reverse osmosis – Drying and Crystallization.

V. Fermented foods and other products: SCP – beverages – pickles – Sauerkraut – cheese – yogurt - bakery products - antibiotics – enzymes – organic acids – amino acids and vitamins - probiotics

Textbooks:

1. Doyle MP, Beuchat LR and TJ Montville. (2012). *Food Microbiology: Fundamentals and Frontiers*. 4th Ed. ASM Press, Washington DC.
2. Patel AH. (2012). *Industrial Microbiology*. 2nd Ed. Macmillan India Limited.

References:

1. Frazier WC and DC Westhoff. (2013). *Food Microbiology*. 4th Ed. Tata McGraw Hill, New Delhi.

Bloom's Taxonomy		K1: Rememberin g	K2: Understandin g	K3: Applyin g	K4: Analyzin g	K5: Evaluatin g	K6: Creatin g
Unit 1	CO1	1					
Unit 2	CO2				4		
Unit 3	CO3			3			
Unit 4	CO4				4		
Unit 5	CO5					5	
							M=3.4

MIM 5228 Lab. in Food and Industrial Microbiology 3Hrs/2Cr

This lab courses provides the microbial analyses and grading of various foods such as bakery foods, beverages and soft drinks, pickles, confectioneries, eggs and milk and its products. This course will train students to examine microbes from spoiled foods. Preparation of wine and immobilization technique will also be covered in this course.

Course Outcomes:

Upon completion of this course, students will be able to

i. Evaluate food products for microbial contaminants.

ii. Identify and characterize specific organisms found in spoiled food.

iii. Apply the techniques of quality assessment to grade eggs.

iv. Demonstrate the production of fermented products.

v. Assess food products by microbial screening techniques.

List of Experiments:

1. Microbial analyses of bakery products.
2. Microbial analyses of carbonated beverages and soft drinks.
3. Microbial analyses of pickles
4. Microbial analyses of confectioneries
5. Microbial examination of eggs
6. Microbial analyses of milk and milk products.
7. Grading of milk quality using Methylene Blue Reduction Test
8. Analysis of fruits and vegetable spoilage by survey method
9. Examination of microorganisms from spoiled foods
10. Production of wine by anaerobic fermentation
11. Immobilization of yeast and bacteria
12. Crowded plate technique for screening antibiotic producing microorganisms
13. Visit to food industries

Reference:

1. Cappucino R. (2017). *Microbiology – A Laboratory Manual*, 6th Ed. Benjamin/ Cumming Publication Co, California

Bloom's Taxonomy		K1: Rememberin g	K2: Understandin g	K3: Applyin g	K4: Analyzin g	K5: Evaluatin g	K6: Creatin g
Unit 1	CO1					5	
Unit 2	CO2		2				
Unit 3	CO3			3			
Unit 4	CO4					5	
Unit 5	CO5				4		
							M=3.8

MIM 5530 Vaccinology 4Hrs/5Cr

The concept of vaccines and their application have saved, and continue to save millions of people across the world from many dreaded diseases like small pox and polio. This course gives a comprehensive account of basis and purpose of vaccination tracing the origin and development of various kinds of vaccines from whole cell vaccines through DNA, edible and designer vaccines. The challenges faced by vaccinologists in developing vaccines against AIDS and tropical diseases like malaria & leprosy are given due emphasis. Fertility control and Veterinary vaccines are also included. Passive immunization with preformed antibodies, their prophylactic and therapeutic effects are also to be discussed.

Course Outcomes:

Upon completion of the course, students will be able to

i. Identify the basic concept, types of immunization and the characteristics of an ideal vaccine.
ii. Explain the evolution of diverse types of vaccines.
iii. Discuss the vaccine development strategies against AIDS, malaria & leprosy
iv. Evaluate antifertility vaccine development.
v. Compare the advantages of natural and artificial passive immunization.

1. **Introduction to vaccines**: Principles and purpose of vaccination, historical milestones, types of immunization, characteristics of an ideal vaccine, vaccine development. Factors affecting efficacy of vaccines, vaccine delivery systems – microbial- and material- based.

2. **Whole and Non whole cell vaccines:** Killed vaccines - heat, formaldehyde, radiation; live attenuated vaccines - methods of attenuation; relative merits of killed and attenuated vaccines. Macromolecules as vaccines - polysaccharides, toxoids, recombinant proteins; recombinant vector vaccines - viral and synthetic peptide vaccines and anti-idiotypic vaccines - methods of development, multivalent sub unit vaccines - micelle, liposome and ISCOM.

3. **Modern vaccines**: Recombinant vector vaccines - viral, bacterial vectors; DNA vaccines - advantages, issues; edible vaccine - advantages - selection of plant (criteria). AIDS vaccines - problems, challenges in development of vaccines, vaccines against leprosy, tuberculosis and malaria. Veterinary vaccines- Vaccines against viral, bacterial and parasitic infections in cattle, dogs and poultry; fish vaccines - vaccination methods and their relative merits.

4. **Vaccines for control of fertility:** Anti HCG vaccines - natural and synthetic; antisperm antigen vaccines. Challenges and issues.

5. **Passive immunization:** Natural passive immunization - transplacental, colostrum; artificial passive immunization - passive antibody therapy, serum therapy, monoclonal and polyclonal preparations. Human immune serum globulin, indication and precautions on use of immunoglobulin therapy.

Textbooks:

1. Talwar GP, Rao KVS and Chauhan VS. (1994). *Recombinant and synthetic vaccines*, Narosa, New Delhi

2. Plotkin, Stanley A., et al. *Plotkin's Vaccines*. Elsevier, 2018.
3. Milligan, GN. & Barrett, AD. (2014). *Vaccinology: An essential guide*. John Wiley & Sons.

References:

1. Benjamini E, Coico R and Sunshine G (2000). *Immunology a short course*. 4th Ed. Wiley-Liss Publication, NY.
2. Owen JA, Punt J and Stranford SA. (2013). *Kuby Immunology*. 7th Ed. WH Freeman and Company, New York.
3. Outteridge PM. (1985). *Veterinary Immunology*. Academic Press, London.
4. Morrow, WJW., Sheikh, NA., Schmidt, CS., & Davies, DH. (Eds.). (2012). *Vaccinology: principles and practice*. John Wiley & Sons.

Bloom's Taxonomy		K1: Rememberin g	K2: Understandin g	K3: Applyin g	K4: Analyzin g	K5: Evaluatin g	K6: Creatin g
Unit 1	CO1		2				
Unit 2	CO2			3			
Unit 3	CO3				4		
Unit 4	CO4					5	
Unit 5	CO5						6
							M=4.2

MIM 5732 **Research Project** **9Hrs/7Cr**

This course aimed at orienting students towards research methodology and to do independent research work. Students will do experiments individually after designing them by standard statistical procedures followed by critical interpretation and drawing valid conclusions. The research project is evaluated at the end of the fourth semester.

Course Outcomes:

Upon completion of the project students will be able to

i. Formulate a hypothesis to investigate on any particular issue
ii. Design a set of experiments to verify the formulate a hypothesis
iii. Compile the set of data generated by the designed experimental set up
iv. Analyze the different parameters that are studied to verify the hypothesis
v. Communicate the outcome of the analytical approach to resolve the hypothesis

Bloom's Taxonomy		K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
Unit 1	CO1		2				
Unit 2	CO2						6
Unit 3	CO3					5	
Unit 4	CO4				4		
Unit 5	CO5					5	
							M=4.5