Central University of Punjab

M.Sc. Microbiology

(Research) (2+2)

Batch- 2025-2027

Department of Microbiology

Graduate Attributes

The graduates will have the knowledge of microbial, molecular and cellular processes and their applications, which can be utilized in multidisciplinary or multi-professional contexts for conducting research in Microbiology for the betterment of society and careers in the industry, agriculture, and applied research where the biological system is increasingly employed.

The Graduates will be effective problem solvers, be able to apply critical, creative and evidence based thinking to conceive innovative responses to the future challenges. They will have a capacity to accept and give constructive feedback, act with integrity and accept responsibility for their actions.

Course outline for 2+2 MSc in Microbiology by Research (NCrF)

Those who will pursue MSc by research needs to publish/present his/her research work in peer reviewed journal and/or National/International Conference which will be prerequisite to award MSc Microbiology (Research)

Semester – I

Course Code	Course Title	Course Type	Credit Hours			
			L	T	P	Credits
MMIC.400	Biochemistry	Core	3	0	0	3
MMIC.401	Microbiology	Core	3	0	0	3
MMIC.402	Cell and Developmental Biology	Core	3	0	0	3
MMIC.403	Molecular Genetics	Core	3	0	0	3
MMIC.404	Microbiology Practical-I	Skill Based	0	0	8	4
Discipline Elective (opt any one)						
MMIC.521	Techniques in Microbiology	Discipline elective	3	0	0	3
MMIC.535	Industrial Microbiology	Discipline elective	3	0	0	3
MMIC.536	Food and Dairy Microbiology	Discipline elective	3	0	0	3
MMIC.540	Microbial Biotechnology	Discipline elective	3	0	0	3
Total Credits						**19**
Remedial teaching			0	2	0	0

Semester – II

Course Code	Course Title	Course Type	Credit Hours			
			L	T	P	Credits
MMIC.523	Immunology	Core	3	0	0	3
MMIC.524	Molecular Biology and Recombinant DNA Technology	Core	3	0	0	3
MMIC.525	Microbial Physiology and Metabolism	Core	3	0	0	3
MMIC.526	Research Methodology and Biostatistics	Compulsory Foundation	3	0	0	3
MMIC.527	Environmental Microbiology	Compulsory Foundation	3	0	0	3
MMIC.528	Microbiology Practical- II	Skill Based	0	0	6	3
Discipline Elective (opt any one)						
MMIC.537	Medical Microbiology	Faculty research	3	0	0	3
MMIC.530	Microbial Diversity and Applied Microbiology	Faculty research	3	0	0	3
MMIC.531	Antimicrobial Resistance and Drug Discovery	Faculty research	3	0	0	3
Interdisciplinary course (IDC)						
XYZ	Choose from Interdisciplinary Course offered by other departments	Interdisciplinary Course (IDC)	2	0	0	2
MMIC.506	Basics of Microbiology	Interdisciplinary Course (IDC) for other department students	2	0	0	2
MMIC.507	Introduction to Immune system	Interdisciplinary Course (IDC) for other department students	2	0	0	2
Total Credit						**23**
Remedial teaching			0	2	0	**0**

Semester – III

S. No.	Course Code	Course Title	Course Type	L	T	P	Cr
1	MMIC.599.1	Dissertation Part-I	**Skill Based**	**0**	**0**	**40**	**20**
		Total		**0**	**0**	**40**	**20**

Semester – IV

Course Code	Course Title	Course Type	Credit Hours			
MMIC.599.2	Dissertation Part -II	Skill Based	0	0	40	20
Total Credits						**20**

L: Lectures; T: Tutorial; P: Practical; Cr: Credits, DE: Discipline Elective, DEC: Discipline Enrichment Course, VAC: Value Added Course

Post-Graduate Diploma will be awarded after the end of the first year of M.Sc. Microbiology programme

MOOCs: MOOCs may be taken up to 40% of the total credits (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match a minimum 70%. Mapping is to be done by the respective department and students may be informed accordingly.

It is mandatory for students in every PG program to complete at least one course on the SWAYAM platform accompanied by credit transfer. The students shall be responsible for payment of fees for courses on SWAYAM.

Students are encouraged to take skill-based courses on the SWAYAM PLUS platform.

Dissertation at Other Institutions: Students will have an option to carry out dissertation work in industry, national institutes, Central and State Universities. Students may also carry out dissertations in private Universities in the top 100 NIRF ranking (University Category). Each department should start efforts for roping in industries/HEIs for accepting students for dissertation/projects/internship and other academic activities for industry-academia interaction. The department may also collaborate for conducting experiments.

Group Dissertation: Group dissertation may be opted with a group consisting of a maximum of four students. These students may work using a single approach or multidisciplinary approach. Research projects can be taken up in collaboration with industry or in a group from within the discipline or across the discipline.

Examination pattern and evaluation for Masters' students

Formative Evaluation: Internal assessment shall be 25 marks using any two or more of the given methods: tests, open book examination, assignments, term paper, etc. The mid-semester test (descriptive) shall be of 25 marks including short answer and essay type. The number of questions and distribution of marks shall be decided by the teachers.

Summative Evaluation: The End semester examination (50 marks) with upto 100% descriptive type and up to 30% objective type shall be conducted at the end of the semester. The objective type shall include one-word/sentence answers, fill-in the blanks, MCQs', and matching. The descriptive type shall include short answer and essay type questions. The number of questions and distribution of marks shall be decided by the teachers. **Questions for exams and tests shall be designed to assess course learning outcomes along with focus on knowledge, understanding, application, analysis, synthesis, and evaluation.**

The evaluation for IDC, VAC and entrepreneurship, innovation and skill development courses shall include MST (50 marks) and ESE (50 marks). The pattern of examination for both MST and ESE shall be the same as ESE described above for other courses.

Evaluation of dissertation proposals in the third semester shall include 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department. The evaluation of dissertation in the fourth semester shall include 50 marks for continuous evaluation by the supervisor for regularity in work, mid-term evaluation, report of dissertation, presentation, and final viva-voce; 50 marks (50% weightage) by an external expert shall be based on report of dissertation (25 marks), presentation (10 marks), novelty/originality (5 marks) and final viva-voce (10 marks). The external expert may attend final viva-voce through offline or online mode.

Examination pattern

Core, Discipline Elective, and Compulsory Foundation Courses			IDC, VAC, and Entrepreneurship, Innovation and Skill Development Courses	
	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various methods	-	-
Mid-semester test (MST)	25	Descriptive	50	Descriptive (up to 100%) Objective (up to 30%)
End-semester exam (ESE)	50	Descriptive (up to 100%) Objective (up to 30%)	50	Descriptive (up to 100%) Objective (up to 30%)

Dissertation Proposal (Third Semester)			Dissertation (Fourth Semester)		
	Marks	Evaluation		Marks	Evaluation
Supervisor	50	Dissertation proposal and presentation	Supervisor/ co-supervisor(s)	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
HoD and senior-most	50	Dissertation proposal and	External expert	50	Report of dissertation (25), presentation (10),

faculty of the department		presentation			novelty/originality (5) and final viva-voce (10)

Marks for internship shall be given by the supervisor/internal mentor and external mentor.

Some Guidelines for Internal Assessment

1. The components/pattern of internal assessment/evaluation should be made clear to students during the semester.
2. The results of the internal assessment must be shown to the students.
3. The question papers and answers of internal assessment should be discussed in the class.
4. The internal assessment shall be transparent and student-friendly and free from personal bias or influence.

Multiple Entry Multiple Exit

At the end of the first year of M.Sc. in Microbiology, if the student want to exit the programs, for the award of Post-Graduate Diploma in MSc Microbiology, the students must complete one course of 4 credits out of the following options:

1. MOOCs courses from the list with credits equivalent to four
2. Industrial training/internship/ for a period of one month.

For the lateral entry the university wide policy will be adopted

Details of syllabus

Semester – I

L	T	P	Credits
3	0	0	3

Course Code: MMIC.400

Course Title: Biochemistry **Total Hours: 45**

Course Learning Outcomes:

Students will be able to:

CLO 1: Understand the basic chemistry that governs the living organisms: nature of bonds, importance of water, and role of buffers and concepts of bioenergetics.

CLO 2: Appraise the fundamental knowledge about various biomolecules such as proteins, carbohydrates, nucleic acids and lipids.

CLO 3: Comprehend the fundamental metabolic pathways responsible for the synthesis and degradation of biomolecules.

Course Contents

Unit/Hours	Content	Mapping with CLOs

Unit I **11 Hours**	Chemistry of Life & Bioenergetics: Ionic bonding, Ion-dipole. Covalent, H-bonds, Van der Waals interaction, Hydrophobic and hydrophilic interactions Water as a biological solvent and its role in biological processes, pH, Henderson- Hasselbalch equation, and concept of buffer, strength and range of buffer, important biological buffers. Thermodynamics, entropy, enthalpy, Gibbs free energy equation and feasibility of reaction, free energy and equilibrium constant, determination of free energy of biological oxidation reduction reactions under standard and non-standard conditions, coupled reactions. ATP and other different groups of high-energy compounds. **Exercise:** Numerical exercises for understanding the concept of pKa and buffer range, calculations of free energy and equilibrium constants, students applying and explaining thermodynamic principle in metabolism.	**CLO 1**
Unit II **12 Hours**	**Macromolecules I:** Proteins and Nucleic Acids: Proteins: Structural features of amino acids, classification of amino acids, peptide linkage: partial double bond nature, determination of primary structure of polypeptide (N-terminal, C-terminal determination, method of sequencing of peptides), structural classification of proteins, primary, secondary, tertiary, quaternary structures of proteins. Ramchandran plot. **Enzymology**-Historical perspective, General characterization and classification of enzymes, cofactor and coenzymes, Enzyme assays, the principle of enzyme catalysis and its kinetics, and Enzyme regulation. **Nature of Nucleic Acids.** Structure of purines, pyrimidine, nucleosides and nucleotides. Physicochemical properties of nucleic acids - Denaturation of nucleic acids. Hyperchromic effect and Tm. **Exercise:** Problem based learning for Determination of primary structure of proteins, N-terminal and C-terminal determination, Interpretation of Tm curve by students in the class.	**CLO 2**

Unit III **11 Hours**	**Macromolecules II: Carbohydrates, Lipids:** Carbohydrates: Monosaccharide, disaccharides, oligosaccharides and polysaccharides, concepts of epimer, isomer, starch, glycogen, chitin, cellulose. Lipids: Saturated and unsaturated fatty acids, triacylglycerol, phospholipids, sphingolipids sterols, Biological membranes. **Exercise:** Practicing nomenclature of lipid molecules according to convention, arranging them according to melting points, Recognizing aldoses, ketosis and epimers.	**CLO 2**
Unit IV **11 Hours**	**Metabolism:** Fatty acid oxidation. Biosynthesis of fatty acids, triacylglycerols and phospholipids. Catabolism of Glycogen. Amino acid catabolism-Urea Cycle Deamination and transamination reactions. *De novo* biosynthesis of purines and pyrimidines, Ribonucleotide reductase and its role in nucleic acid metabolism. **Exercise:** Numerical approaches in calculating ATP generation from the oxidation of odd and even chain fatty acids, MMIC.599.1 MSc dissertation	**CLO 3**

Suggested Reading:

1. Berg, J.M., Tymoczko, J.L., Gatto, Jr., G.J., and Stryer, L. (2023). *Biochemistry,* 10th Edition.
2. Geoffrey L. Zubay (2017). *Principles of Biochemistry by* Brown Co, USA.
3. MoatA.G., Foster J. W Spector M. P. (2002) *Microbial Physiology* John Wiley & Sons.
4. Nelson D. L. and Cox M. M. (2021) Lehninger *Principles of Biochemistry* by W. H. Freeman. 8th edition
5. White, D, Drummond J. Fuqua C (2011)*The Physiology and Biochemistry of Prokaryotes* Oxford University Press.
6. Cohen G. N. (2016) *Microbial Biochemistry* Springer.
7. Ferrier D. R. (2016) *Lippincott's Illustrated Reviews: Biochemistry* Lippincott Williams & Wilkins.
8. U.Satyanarayana,U.Chakrapani(2017) *Biochemistry,*5th Edition. Elsevier India
9. Irwin H. Segel (2010) *Biochemical Calculations* Wiley.
10. Voet.D, Voet.J.G , Pratt.C (2016) *Voet's Principles of Biochemistry ,* 5th Edition. Wiley
11. Palmer, T. Horwood E (1995) Understanding Enzymes Wiley.
12. H. Segal and Lehninger (2007) Biochemistry and Palmer Enzymology

Weblinks:

- https://epgp.inflibnet.ac.in/
- https://swayam.gov.in/

-https://lms.cup.edu.in/course/index.php?categoryid=65

Modes of transaction
-Lecture
-Problem solving
-Panel discussion
-Tutorial

L	T	P	Credits
3	0	0	3

Course Code: MMIC.401 Course Title: Microbiology

Course Learning Outcomes (CLO):
Students will be able to:

Total Hours: 45
CLO1. Describe the microbial systematics and ultrastructure of the prokaryotes as well as its significance
CLO2. Recall and define the basics of microbial growth and their application in day-to-day life.
CLO3. Classify and explain the importance of fungi with emphasis on antimicrobial resistance.
CLO4. Organize and explain the importance of algae and protozoans

Course Contents

Unit/Hours	Content	Mapping with CLOs

Unit I **12 Hours**	**History & Scope of Microbiology**: General characteristic and composition of prokaryotic and eukaryotic cells, Cell structure, different components, function and their significance in microbes. Detailed account of biogenesis and function of microbial cell structure appendages: flagella- structure, assembly and mechanism of movement; pili and fimbriae- types, structure and their role. External cell surface structures: capsule, glycocalyx, slime layer and S-layer. Overview of gram negative and gram-positive bacterial cell wall, outer membrane lipopolysaccharide (LPS). Cell wall synthesis and its inhibitors including different antibiotics. **Microbial Taxonomy:** Nomenclature, modern methods of microbial taxonomy and major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular taxonomy. Classification of Microorganisms: Haekel's three kingdom concept, Whittaker's five kingdom, Bergey's Manual of Systematic Bacteriology and their economic significance. **Exercise:** Preconception/Misconception Check, One Sentence Summary, Imagine, Group discussion about emerging pathogens (SARS- CoV-2, Ebola, Marburg etc)	**CLO 1**
Unit II 11 Hours	**Growth and cell division:** Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth. Microbial stress response to different environmental conditions. **Archaeal diversity, cell structure and model organisms:** Phylogenetic diversity and key features of different phyla. General characteristics of archaeal cell structure and comparison with eubacteria. Detailed account of model archaeal organisms: *Methanococcus, Halobacterium, Pyrococcus* and *Sulfolobus.* **Exercise:** Pyramiding /Snowball Groups, Memory Matrix, Student poll, Class quiz, self-directed learning.	**CLO 1** **CLO 2**

Unit III 12 hours	**Mechanism of Antibiotic and Resistance:** Mode of action of antibiotics and chemotherapeutic drugs: inhibitors of cell wall synthesis, Protein Synthesis, Nucleic Acid Synthesis and Metabolism, Antibiotic sensitivity assays, Antibiograms. Antibiotic resistance in bacteria-various molecular factors that contribute to the development of resistance, Monoclonal antibodies as therapeutic agents to resistance bacteria. **General features and classification of fungi**, Introduction of fungi, Reproduction in fungi, life cycle patterns, Endophytic fungi and its importance, Economic importance of fungi and yeast. **Pathogenic Fungi:** Morphological characteristics, pathogenesis and laboratory diagnosis of following pathogenic fungi: *superficial mycoses, systemic mycoses, Candida albicans; Candida auris, and Cryptococcus neoformans* **Exercise:** Asking questions, Quizzes, Presentation, unstructured interview, Students Teams.	**CLO 3**
Unit IV 10 Hours	**Algae:** Classification; reproduction and life cycles; algal toxins, algal bloom, algae as a source of antibiotics. **Protozoal Pathogens:** General description, life cycle, pathogenesis, diagnosis and treatment of and diseases caused by Protozoa- *Plasmodium spp, Trypanosoma spp, Leishmania spp, Entamoeba histolytica.* **Exercise:** Case studies, Debate, Asking questions, Objective structured practical examinations (OSPE)	**CLO 4**

Suggested Reading:

1. Pelczar, M. J., Chan, E.C.S. and Krieg, N.R. (2020). *Microbiology: Concepts and Applications*. McGraw-Hill Inc. USA.
2. Joanne Willey, Kathleen Sandman and Dorothy Wood (2023) *Prescott's Microbiology.* 12th Edition, McGraw-Hill Science, USA.
3. Tortora, G.J., Funke, B.R. and Case, C.L. (2018). *Microbiology: An Introduction.* Benjamin Cummings, USA.
4. Bauman, R.W. (2011). *Microbiology with Diseases by Body System*. Benjamin Cummings, USA.
5. Cappuccino, J.G. and Sherman, N. (2004). *Microbiology-A Laboratory Manual*. Benjamin Cummings, USA.
6. Pommerville, J.C. (2010). *Alcamo's Fundamentals of Microbiology*. Jones & Bartlett Publishers, USA.
7. Strelkauskas, A., Strelkauskas, J. and Moszyk-Strelkauskas, D. (2023).

Microbiology: A Clinical Approach. Garland Science, New York, USA.
8. James G. Cappuccino, Chad Welsh (2023) *Microbiology: A Laboratory Manual,* 11th Edition, pearson, India
9. K.R. Aneja (2022) *Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology Sixth edition* New Age Intl. Publishers Ltd. - New Delhi.
10. Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock (c 2019) *Brock Biology of Microorganisms,* 15th edition.
11. Bryce Kendrick (2017) *The Fifth Kingdom: An Introduction to Mycology*.

Web Sources:
https://lms.cup.edu.in/course/index.php?categoryid=65
-https://epgp.inflibnet.ac.in/
-https://www.biointeractive.org/classroom-resources/citric-acid-cycle

Modes of transaction
-Lecture
- Problem solving
-Panel discussion
- Group discussion

L	T	P	Credits
3	0	0	3

Total Hours: 45

Course Code: MMIC. 402
Course Title: Cell and Developmental Biology

Course Learning Outcomes:

Students will be able to:
CLO 1: Demonstrate the structure and basic components of prokaryotic and eukaryotic cells.
CLO 2: Describe the cell organelles and their related functions.
CLO 3: Apply the basic core of scientific and quantitative knowledge to enhance understanding of cell structure and function at the molecular level.
CLO 4: Explain the biological processes of cell division and signal transduction pathway.

Course Contents

Unit/Hours	Content	Mapping with CLOs

Unit I 10 Hours	**Introduction to the Cell:** Evolution of the cell. Prokaryotes and eukaryotes Cell **Membrane Structure and Function** Membrane transport of macromolecules and particles. **Structural Organization and Function of Intracellular Organelles**: Structure and function of nucleus, Ribosomes, lysosomes, peroxisomes, Golgi apparatus, endoplasmic reticulum, mitochondria and chloroplast. **Protein Secretion and Sorting:** Organelle biogenesis and protein secretion, synthesis and targeting. Intracellular traffic, vesicular traffic in the secretory pathway and protein sorting. **Exercise:** Group test reading, Debate, Brainstorming, Quiz based assessment, group discussion.	**CLO 1**
Unit II 11 Hours	**The Cytoskeleton:** The nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton. **Cell communication and cell signaling:** Cell adhesions, Cell junctions and the extracellular matrix, Cell-cell adhesion and communication, Cell matrix adhesion, Collagen the fibrous protein of the matrix, Non-collagen component of the extracellular matrix **Exercise:** Problem based learning, Muddiest Point, Crossword Puzzle, Students teaching, paper presentation on ECM and its components.,	**CLO 1** **CLO 2**

Unit III 12 Hours	**Basic Concepts of Development:** Molecular biology of basic cell functions and organism development. Germ Cells, Somatic cells and Stem cells and their applications, Totipotency, Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages, and cytoplasmic determinants. Cell regeneration, and repair. Model organisms in developmental biology (*Drosophila, C. elegans, Xenopus,* mutants, transgenics and animal cloning Fertilization, Gametogenesis, Organogenesis and Metamorphosis. Homology, Hox Genes, and Developmental Integration. Programmed Cell Death. **Exercise:** Research paper presentation, Problem based learning sessions, Class quiz.	**CLO 3**

Unit IV **12 Hours**	**Cell to cell signaling** Overview of the extracellular signaling, Identification of cell surface receptors, G-protein coupled receptors and their effectors, Second messengers, Enzyme-linked cell surface receptors, Interaction and regulation of signaling pathways. **Cell Growth and cancer**: Overview of the cell cycle and its control, the molecular mechanisms for regulating mitotic cell division, amitosis, Cell cycle control, Checkpoints in cell cycle regulation. Principles and types of Cancer. Genetics of cancer and roles of tumor suppressor and oncogenes, cancer therapy and resistance, Apoptotic pathway in cancer **Exercise:** Practical, team teaching, Quiz, Brainstorming, Presentations.	**CLO 3** **CLO 4**

Suggested Reading:

1. Bruce Alberts, Rebecca Heald , Alexander Johnson , David Morgan , Martin Raff, Keith Roberts, Peter Walter . (2022). 7th edition *Molecular Biology of the Cell*. Garland publishers, Oxford.
2. Alberts B, Hopkin K, Johnson AD *et al.* (2023) *Essential Cell Biology*, 6th Ed., W W Norton & Company.
3. Scott, F. and Gilbert, S.F. (2010). *Developmental Biology*. Sinauer Associates, Inc. USA.
4. George Plopper; David Sharp; Eric Sikorski (2015) Lewin's Cell Third edition Jones and Bartlett learning
5. Gupta, P.K. (2019). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
6. Gerald Karp, Janet Iwasa, Wallace Marshall (2019). *Karp's Cell and Molecular Biology: Concepts and Experiments*. 9th edition John Wiley &Sons. Inc. New Delhi, India.
7. De Robertis, E.D.P. and De Robertis, E.M.F. (2017). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
8. Lodish, H, Birk, A, et al. (2021) *Molecular Cell Biology*. 9th ed. WH Freeman.
9. Robert A. Weinberg (2023) The Biology of Cancer – WW Norton & Company Third edition
10. Cooper Geoffrey (2018) *The Cell: A Molecular Approach.* Eighth Edition Sinauer Associates

Web Sources:

https://lms.cup.edu.in/course/index.php?categoryid=65

https://epgp.inflibnet.ac.in/

Modes of transaction

-Lecture
- Problem solving
- Group discussion
- Self-directed learning

L	T	P	Credits
3	0	0	3

Course Code: MMIC.403

Course Title: Molecular Genetics

Total Hours: 45

Course Learning Outcomes:

Students will be able to:

CLO 1: Illustrate the basic principles of inheritance at the molecular, cellular and organism levels.

CLO 2: Elaborate the concepts of hereditary information and how they work in living organisms.

CLO 3: Demonstrate the practical skills of molecular genetic analysis of genetic diseases

CLO 4: Utilize the molecular microbial genetics and to apply them to real life situations.

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I 10 Hours	**Mendelian Principles:** Dominance, segregation, independent assortment, Allele, multiple alleles, pseudoallele, complementation tests **Extensions of Mendelian Principles:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. **Extra- Chromosomal Inheritance:** Chloroplast and Mitochondrial inheritance; Cytoplasmic inheritance. **Exercise:** Making self-pedigree tree and family history, numerical based on Mendelian laws.	**CLO 1**
Unit II 11 Hours	**Gene Mapping Methods:** Molecular markers: RAPD, RFLP, SSR, SNP, ISSR, and SCAR;Linkage maps, tetrad analysis in *Neurospora*, mapping with molecular markers, development of mapping population in plants. **Human Genetics:** Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders. **Quantitative Genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping. **Exercise:** Experiments, Panel discussion on inherited diseases.	**CLO 2** **CLO 3**

Unit III **12 Hours**	**Mutations:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal vs somatic mutants, insertional mutagenesis, applications in reverse and forward Genetics; Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications; Hardy Weinberg equilibrium. Molecular basis of spontaneous and induced mutations. **Recombination:** Site-specific, homologous, DNA transposition, retro transposition and non-homologous end joining (NHEJ). **Exercise:** Problem based learning, numerical for Hardy Weinberg equilibrium.	**CLO 3**
Unit IV **12 Hours**	**Microbial Genetics**: Microbes as tools for genetic studies. Organization of genetic material in bacteria; and viruses, Gene transfer mechanisms, F plasmid; Lambda phage: structure, genetic makeup and life cycle (lytic and lysogeny); Natural transformation and competence; Molecular basis of natural transformation – DNA uptake competence systems in gram positive and gram negative bacteria. Bacterial Conjugation- Properties of the F plasmid, F+ x F - mating, F' x F- conjugation. Transduction- Generalized and specialized transduction, virus life cycle and replication. **Exercise:** Research paper presentation, Problem based learning sessions, Class quiz.	**CLO 4**

Suggested Reading:

1. Snusted, D.P., Simmons, M. J. (2015). *Principles of Genetics*. 7th Edition, John Wiley & Sons, New York.
2. Raven P, Johnson GB, Mason KA, Losos JB, Singer SS (2014). *Biology*, 10th Edition, McGraw-Hill, USA.
3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J (2020). *An Introduction to Genetic Analysis*. 11th Edition W.H. Freeman publication, USA.
4. Larry Snyder, Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness (2014) *Molecular Genetics of Bacteria*, 4th edition; ASM Press.
5. Watson, J.D., Baker,T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2017). *Molecular Biology of the Gene*. 7th Edition, Benjamin Cummings, USA.
6. Pierce, Benjamin (2021). *Genetics Essentials: Concepts and connections*. 5th edition, Macmillan international

Web Sources:

https://lms.cup.edu.in/course/index.php?categoryid=65
https://epgp.inflibnet.ac.in/

https://www.biointeractive.org/classroom-resources/inheritance-and-mutations-singlegene-disorder
https://www.biointeractive.org/classroom-resources/analyzing- pedigrees

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
-Co-operative learning

Tools used

Videos, Google Drive

L	T	P	Credits
3	0	0	3

Course Code: MMIC.521
Course Title: Techniques in Microbiology **Total Hours: 45**

Course Learning outcomes:

CLO1: Perform and interpret chromatographic techniques for separation and analysis of biomolecules.

CLO2: Execute immunological assays to detect microbial antigens and antibodies.

CLO3: Demonstrate proficiency in cell biology techniques including microscopy, cell fractionation and centrifugation

CLO4: Integrate and interpret data from biochemical, immunological, and molecular experiments to draw scientifically valid conclusions

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I **11 Hours**	**Spectroscopy:** Basic concepts, principles and biological applications of spectroscopy: absorption spectroscopy, fluorescence spectroscopy, phosphorescence, Infrared and Raman spectroscopy, Optical Rotatory Dispersion (ORD), Circular Dichroism (CD) and Nuclear Magnetic Resonance (NMR) & Electron Spin Resonance (ESR).X-Ray Diffraction. **Chromatographic techniques:** Basics of Chromatography, Paper, Thin layer and Column chromatography; Protein purification; Liquid chromatography; Gas chromatography, Affinity Chromatography, Gel Filtration, Ion Exchange Chromatography, HPLC. **Exercise:** Visit and demonstration of NMR, GC- MS and HPLC, Classroom Opinion Polls .	**CLO 1**
Unit II **11 Hours**	**Immunological Techniques** Methods for immunoglobulin determination-quantitative and qualitative antigen and antibody reactions, agglutination-precipitation, immunocytochemistry, radioimmunoassay (RIA), Enzyme Linked Immunosorbent Assay (ELISA), immunofluorescence, Immuno-Electrophoresis, immunoblotting and Flow cytometry. **Exercise:** Learning by doing small group based exercises.	**CLO 2**

Unit III **11 Hours**	**Techniques in Cell Biology:** Types of Microscopy (phase contrast, fluorescent, electron microscopy (SEM/TEM), Scanning-probe, Atomic force and Confocal microscopy. Centrifugation: Principle and applications and types (Differential, Density Gradient, Iso-density centrifugation). Electrophoresis: Principle and types, Colony counter, Isoelectric focusing (IEF), colorimetry, turbidimetry. **Exercise:** Visit and demonstration of SEM, Confocal, practical for electrophoresis and centrifugation, Paper discussion.	**CLO 3**
Unit IV **12 Hours**	**Techniques in Molecular Biology:** Polymerase chain reaction (PCR): Principle, types and applications, PCR based markers: RAPDs, SSRs, SNPs, ISSRs, and SCARs etc. Blotting techniques: Southern, Northern, Western, Dot blotting and hybridization, DNA fingerprinting. Mutation Analyses Techniques: Restriction mapping, SSCP DNA sequencing technology. Gene expression analysis. **Exercise:** Practical and Student-generated test questions, Problem solving.	**CLO 4**

Suggested Reading:

1. Nelson D. L. and Cox M. M. (2017) Lehninger *Principles of Biochemistry* by W. H. Freeman.
2. Cohen G. N. (2014) *Microbial Biochemistry* Springer.
3. Ferrier D. R. (2016) *Lippincott's Illustrated Reviews: Biochemistry* Lippincott Williams & Wilkins.
4. Celis, J.E. (2006). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
5. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley &Sons. Inc. New Delhi, India.
6. Watson, J.D., Baker,T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2014). *Molecular Biology of the Gene*. 7th Edition, Benjamin Cummings, USA.
7. Tizard (2016). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.
8. Kindt, T. J., Osborne, B.A. and Goldsby, R.A. (2007) *Kuby Immunology*7th Edition. W.H. Freeman, USA.
9. Abbas. (2021) *Cellular and Molecular immunology*. CBS Publishers & Distributors, India.
10. Stevens C.D., (2021) *Clinical immunology & serology: A laboratory perspective*. F.A. Davis company

Web Sources:

https://www.biointeractive.org/classroom-resources

https://www.vlab.co.in

Modes of transaction

-Lecture
-Problem solving
-Panel discussion
-Tutorials
-Google Classroom

L	T	P	Credits
3	0	0	3

Course Code: MMIC.535
Course Title: Industrial Microbiology

Total Hours: 45

Course Learning Outcomes

Student will be able to:
CLO 1: Understand the principles of upstream and downstream processes in fermentation technology
CLO 2: Production and purification of Alcohol, Antibiotics, Acid and enzymes through large scale processes.
CLO 3: Apply the knowledge of industrial microbiology in large-scale production of recombinant proteins.
CLO 4: Production and purification of vitamins and microbe based products.

Course Contents

Unit/Hours	Content	Mapping with CLO1
Unit I 12 hours	**Introduction:** Scope and historical development; Sources of industrially important microbes, strain development, types of fermentation and fermenters, process optimization, and In situ Fermentation cleaning and sterilization, Types of fermentation systems; Bioreactor designs and operations. Single use bioreactor. Sterilization testing of fermenters. **Downstream processing of microbial products:** Filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane processes, drying (lyophilization and spray drying), and crystallization. **Exercise:** Case studies, industry visits,	**CLO1**

Unit II 12 hours	**Microbes in Industry:** Alcohol production- Preparation of medium, Fermentation process and recovery; Production of Malt beverages: Production of Beer- malting process, mashing process and finishing; other malt products. Production of Wine: Microbial process, wine from grapes, Fermentation Production of distilled beverages or liquors, Microbial production of organic acids- vinegar production (substrate, Microbial processing and product recovery); Citric Acid- fermentation, recovery and uses; Lactic acid-fermentation, medium and manufacturing process, recovery and uses. Exercise: Panel Discussion, Industry visits, hands-on experiments, Concept Mapping	**CLO2**

Unit III 11 hours	**Development and production of microbial products:** Organic Metabolites-Ethanol, Acetone; Citric acid, Acetic acid, Lactic acid, Amino acids; Enzymes- Amylases, Glucose Isomerase, Proteases,; Vitamins- Vitamin B12, Riboflavin, B carotene; **Antibiotics:** beta-Lactam antibiotics; Amino acid and peptide antibiotics; Carbohydrate antibiotics; Tetracycline; Nucleoside antibiotics; Aromatic antibiotics. Recombinant biomolecules and therapeutic proteins. **Exercise:** Discussions and Group Learning, Concept Mapping.	**CLO2 and CLO3**
Unit IV (10 hours)	**Application of Microbial Products:** Mushroom production Biopolymers-xanthan gum and PHA's (Bioplastics), Bioethanol, Biobutanol, Biodiesel, Biohydrogen production by using microorganisms. Biofertilizers. Single cell protein, Fermentation economics. **Exercise:** Problem based learning, Quiz, Critical Thinking, Brainstorming. Industrial visits.	**CLO 4**

Suggested Reading:

1. Cruger W and Cruger A. (2004). *Biotechnology - A Textbook of Industrial Microbiology*. Panima.
2. Nduka Okafor, Benedict C. Okeke (2018) Modern Industrial Microbiology and Biotechnology Second edition CRC Press
3. Allan Whitaker, Peter F. Stanbury, and Stephen J. Hall (2016) *Principles of Fermentation Technology.Third Edition Butterworth-Heinemann*
4. Gary Higton, Michael J. Waites, Neil L. Morgan, John S. Rockey (2001)

Industrial Microbiology: An Introduction.
5. Richard H. Baltz , Arnold L. Demain , Julian E. Davies (2010) *Manual of Industrial Microbiology and Biotechnology,* Third edition American Society for Microbiology Press
6. L.E.J.R. Casida (2019) *Industrial Microbiology* Second Edition New Age International Private Limited
7. George Stephanopoulos, Aristos A. Aristidou, Jens Nielsen (1998)*Metabolic Engineering: Principles and Methodologies* Academic Press
8. Debabrata Das, Soumya Pandit (2021) Industrial Biotechnology CRC Press

Modes of transaction:

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Group discussion

L	T	P	Credits
3	0	0	3

Course Code: MMIC.536
Course Title: Food and Dairy Microbiology

Course Learning Outcomes (CLO):

The students will be able to:

Total Hours: 45

CLO1. Describe the food borne disease caused by bacteria and fungi and explain the environmental factor responsible for food spoilage.
CLO2. Explain and assess the microbiology of different types of food and food products.
CLO3. Develop and review industrial aspects of food and dairy microbiology. CLO4. Explain about the food preservation methods, quality testing and different regulatory bodies.

Course Contents

Unit/Hours	Content	Mapping with CLOs

Unit I **11 Hours**	**History of Food Microbiology and Microbial Growth in Food:** History of Microorganisms in Food, Historical Developments, Food Preservation, Food Spoilage, Food Poisoning. Taxonomy, Role, and Significance of Microorganisms in Foods. Intrinsic and Extrinsic Parameters of Foods That Affect Microbial Growth. Implicit factors. Microbial interactions, Inorganic, organic and antibiotic additives. Physical and chemical factors influencing the destruction of microorganisms including thermal death time, Z, F and D values. **Exercise:** Training Games for Learners, Problem-solving Activities for Learners	**CLO 1**
Unit II 13 Hours	**Microorganisms in Food:** Food borne diseases- Bacterial food borne diseases- (Staphylococcal intoxication, Botulism, Salmonellosis, Shigellosis, EHEC E. coli infection, *Listeria monocytogenes* infection, *Clostridium perfringens* gastroenteritis, *Bacillus cereus* gastroenteritis; Food-borne fungi- Mycotoxins in foods. Microbial spoilage of foods: Types and causes of spoilage of cereals and cereals products, spoilage of vegetables and fruits, spoilage of meat and meat products, spoilage of fish and other sea foods, spoilage of eggs and other poultry products, spoilage of milk and milk products. **Exercise:** Quiz, Critical Thinking, Brainstorming,	**CLO 1** **CLO 2**

Unit III **11 Hours**	**Fermented Foods and Beverages:** Global dietary culture and history of traditional fermented foods and alcoholic beverages; Classification of global fermented foods and beverages. Types of fermentation: spontaneous/natural, back-slopping and starter culture. 'Ethno-microbiology' concept of fermented foods. Indian fermented food products and beverages. Fermented foods and beverages of the world. Culture dependent and culture independent methods. Health benefits of fermented foods. Application of multi omics in fermented foods and beverages. **Exercise:** Problem based learning, Quiz, Critical Thinking, Brainstorming	**CLO 3**
Unit IV **10 Hours**	**Food Preservation and Safety:** Use of High and low temperature, Control of water activity, Use of Radiations in preservation, Modified atmosphere packaging, High pressure processing, chemical preservatives and	**CLO 4**

	naturally occurring antimicrobials; Bacteriocins and their applications. Microbial testing of food, Microbiological quality standards of food and regulatory bodies: Codex Alimentarius, FDA (Food and Drug Administration), HACCP (Hazard Analysis and critical control points), FSSAI (Food Safety and Standards Authority of India). Probiotics, Prebiotics, Synbiotics, Paraprobiotics, Postbiotics. **Exercise:** Discussions and Group Learning, Concept Mapping	

Suggested Reading:

1. Ray, B. and Bhunia, A. (2013). *Fundamental Food Microbiology*, 5th revised edition. CRC press Inc.
2. Frazier, W.C. and Westhoff, D.C. (2013). *Food Microbiology.* 5th Ed. Tata McGraw Hill.
3. Doyle, M.P. and Buchanan, R.L. (2012). *Food Microbiology*, ASM Press, Washington.
4. Jay, J.M., Loessner, M.J. and Golden, D.A. (2005) *Modern Food Microbiology*, 7th ed. Springer-Verlag New York
5. Richard K. Robinson, (2002) *Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products*, Wiley-Blackwell; 3rd Edition.
6. Foster W.M (2020) Food Microbiology CBS publications
7. Doyle, M. P. and Beuchat, L. R., (2007) *Food Microbiology- Fundamentals and Frontiers*, ASM Press.
8. Elmer H. Marth, James Steele, (2001) *Applied Dairy Microbiology*, Second Edition, CRC Press.
9. Tamang, J.P., (2015) *Health Benefits of Fermented Foods and Beverages*. CRC Press.
10. Tamang, J.P., (2016) *Ethnic Fermented Foods and Alcoholic Beverages of Asia*. Springer.
11. Tamang, J.P., (2020) *Ethnic Fermented Foods and Beverages of India: Science History and Culture*. Springer.

Modes of transaction:

-Lecture

-Demonstration

-Lecture cum demonstration

-Inquiry training

-Group discussion

-Self-learning

- Field visits

Course Code: MMIC.540
Course Title: Microbial Biotechnology

Total Hours: 45

Course Learning Outcomes (CLO):
The students will be able to:

CLO1. Review and explain the use of microbes in the pharmaceutical industry. CLO2. Discuss and evaluate the role of microbial nanotechnology.
CLO3.Describe about the beneficial microbes for health and sustainable development of agriculture
CLO4. Discuss about the various regulatory practices of quality control and quality assurance

Course Contents

Unit / hours	Content	Mapping with CLOs
Unit I **10 Hours**	**Microbes in Pharmaceutical Products:** Macromolecular, cellular and synthetic drug carriers. Immobilization procedures for pharmaceutical applications. Biosensors in pharmaceuticals. Production and application of microbial enzymes in pharmaceuticals. Vaccines and adjuvant- Traditional vaccine preparations, attenuated, dead or inactivated bacteria, Attenuated and inactivated viral vaccines, Toxoids, antigen-based and other vaccine preparations. New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials. **Exercise:** Pro-Con Grids, Buzz Grou Quescussion.	**CLO 1**
Unit II 11 Hours	**Microbial Nanotechnology:** Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology. Nanobio fertilizers for Sustainable development of agriculture. **Exercise:** Quiz, Brainstorming, Problem based learning sessions, Case studies	**CLO 1** **CLO 2**

Unit III 12 Hours	**Beneficial Microbes and their applications:** Biofertilizers**-** *Rhizobium, Azospirillum, Azotobacter, Gluconacetobacter, Azorhizobium,* phosphobacteria **–** *mycorrhiza* Blue Green Algae and *Azolla***.** Mass Production of biofertilizers and composting, **Designer Microbes and Health:** Gut microbiota and diseases, approaches for engineering gut microbiota, therapeutic uses of gut microbiota, Bacteriophages in control of bacteria**.**Microbial biosensors and its applications. **Exercise:** Students seminars, Brainstorming, Case studies, Industry visits.	**CLO 3**
Unit IV 12 Hours	**Regulatory Approvals and Clinical Trials**: Good laboratory practice (GLP), Current Good Manufacturing Practice (CGMP), different phases of clinical trials, difference between biologics, biosimilar and bio-better, development of biosimilars and generic biomolecules,analysis of process economics, Design and layout of sterile product manufacturing unit, Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. **Exercise:** Problem based learning sessions, Case studies, Group discussion	**CLO 4**

Suggested Reading:

1. W. B. Hugo & A. D. Russell (2004) *Pharmaceutical Microbiology*. Blackwell Scientific Publications.
2. Frederick Kavanagh *Analytical Microbiology* Academic Press New York.
3. David C. Hooper, John S. Wolfson *Quinolinone antimicrobial agents*. ASM Washington DC.
4. Murray S.Cooper *Quality control in the Pharmaceutical Industry*. Academic Press New York.
5. H. J. Rehm & G.Reed, *Biotechnology*. VCH Publications, Germany.
6. S. P. Vyas & V.K.Dixit (2017) *Pharmaceutical Biotechnology*. CBS Publishers & Distributors, New Delhi.
7. Sydney H. Willig, Murray M. Tuckerman, William S. Hitchings, Mercel Dekker (2019) *Good Manufacturing Practices for Pharmaceuticals* New York.

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Group discussion

L	T	P	Credits
0	0	8	4

Course Code: MMIC.404
Course Title: Microbiology Practical-I **Total Hours: 120**

Learning Outcomes:
The students will be able to:

CLO1. Design, create and execute the experiments pertaining to biochemistry.
CLO2. Perform and execute the experiments pertaining to microbiology
CLO.3 Design and execute the experiments pertaining to cell biology
CLO4. Plan, and execute the experiments pertaining to genetics

Course Contents

Unit/Hours	Content	Mapping with CLOs
Part A. Biochemistry 30 Hours	1. Introduction to Good Laboratory Practices 2. Preparation of solutions, buffers, pH setting etc. 2. Quantitative estimation of proteins, sugars, total lipids and amino acids. 3. Isolation of protein from biological sample 4. Enzyme activity assays: invertase, amylase, alkaline phosphatase 5. Quantitative estimation of phenolic compounds.	**CLO 1**

Part B. Microbiology 30 Hours	1. Use of Microscope and working in a biosafety cabinet; Preparation of growth media: Liquid and Solid media 2. Staining of bacterial cultures: Simple staining, Negative Staining, Gram Staining, Acid-Fast stain, fungal staining. 3. Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on micro-organisms. 4. Preparation of microbiological media. Autotrophic media, minimal media, basic media, enriched media, enrichment media, differential media. Microbial growth studies. 5. Isolation of bacteria and fungi from different sources (soil, air, water) and determination of CFU. 6. Testing of Antibiotic sensitivity/resistance 7. Use of selective and/or differential media for isolation and identification of specific bacterial cultures. 8. Preparation of Media: Nutrient broth, Nutrient agar, plates, slants, soft agar; Pure culture technique: Streak plate, spread plate and pour plate methods. 9. Culturing methods of microbes – slant and stab cultures, tube culture, flask cultures, shake flask cultures. 10. Preparation of different types of culture media/observation. Blood Agar, Chocolate Agar, Mannitol salt agar, Blair Parker medium, MacConkey agar, Lowensten-Jension medium, Wilson Blair Bismuth sulphite medium, Biochemical media. 11. Tests for disinfectants (Phenol coefficient/RWC). 12. Biochemical tests to characterize bacterial cultures: Catalase test, Oxidase test, Methylene blue test.	**CLO 2**

Part C. Cell Biology **30 Hours**	1. Demonstration and using Microscope, meter, weighing balance and centrifuge. 2. Study of different types of prokaryotic and eukaryotic cells. 3. Using haemocytometer 4. Types of stains 5. Temporary staining for epithelial cells and blood cells. 6. Cell counting using various stains. 7. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip). 8. Study of polyploidy in onion root tip colchicine treatment. 9. Study of structure of cell organelles through electron micrographs 10. To demonstrate the presence of nucleus, mitochondria and other cell organelles using vital stains. 11. Depicting nature of cellular membranes: Osmosis, Hypertonicity, Hypotonicity, Isotonicity	**CLO 3**
Part D. Genetics **30 Hours**	1. Learning the genetic basis of blood group typing. 2. Identification of inactivated X chromosome as Barr body and drumstick 3. To demonstrate and understand the principle of Hardy-Weinberg equilibrium. Calculation of genotypic and allelic frequencies for a specific trait in a random sample. 4. Techniques for screening and isolation of bacterial cultures with specific phenotypic/genotypic characteristics. 5. Differentiating genetic variants (species/strains) using RFLP. 6. Studying *Drosophila melanogaster* as a Model organism: Identification of normal and mutant flies (*Drosophila melanogaster*), Demonstration of *Drosophila* polytene chromosomes.	**CLO 3** **CLO 4**

Modes of transaction

-Lecture cum demonstration
-Problem Solving
-Self-Learning
-Inquiry training
-Team teaching

- Experimentation

Evaluation Criteria for Practical Courses: Students are evaluated for a total of 100 marks with following distribution:

Continuous assessment- 50 Marks:

Maintaining the lab records/notebooks: 15 Marks

Surprise test/quiz/objective type test during the semester: 15 Marks Good laboratory Practices, Designing and execution of experiments: 10 Marks

Attendance during day to day practical: 10 Marks

Final Practical Examination- 50 Marks:

Minor Experiment (10 Marks), Major Experiment (to be performed, 20 Marks) and viva-voce (20 Marks)

Suggested Reading:

1. Michael J. Leboffe (2021) *A Photographic Atlas for the Microbiology laboratory*.
2. Prakash S. Bisen (2014) *Laboratory Protocols in Applied Life Sciences*. Taylor & Francis Group, LLC
3. John Harley (2016) *Laboratory Exercises in Microbiology*, 10th Edition by John Harley
4. Benson's Microbiological *Applications Lab Manual*, 2016.
5. James G. Cappuccino & Natalie Sherman (2014) *Microbiology: A Laboratory Manual,* 10th Edition.
6. Aneja KR (2014) *Laboratory Manual of Microbiology and Biotechnology*.
7. Alberts, B. Bray, D. Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the Cell.* Garland publishers, Oxford.
8. Celis, J.E. (2006). *Cell biology: A laboratory handbook,* Academic Press, UK.
9. Karp, G. (2020). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc., New Delhi, India.
10. Sawhney, S.K. and Randhir, S. (2005). *Introductory Practical Biochemistry*. Alpha Science International Ltd. New Delhi, India.

Web Sources:

- https://epgp.inflibnet.ac.in/
- https://www.vlab.co.in
- https://www.biointeractive.org/classroom-resources
- YouTube links

Semester II

L	T	P	Credits
3	0	0	3

Course Code:
MMIC.523 **Total Hours: 45**
Course Title:
Immunology

Course Learning Outcomes:
After the completion of the course students will be able to:

CLO 1: Describe the fundamental concepts and components of human immune systems using correct scientific terminologies.
CLO 2: Understand the functioning of the immune system in the context of diseases.
CLO 3: Apply the knowledge in health and disease from an immunological perspective.

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I **11 Hours**	**Immune System:** Overview of immune system; origin of Immune cells, their types and organs of immune systems; innate adaptive immunity and their components, PAMPs and PRRs. Recognition of self and non-self. Nature of antigen. Components of acquired immunity. Humoral immunity and cell mediated immunity. Immunoglobulins, basic structure, classes and subclasses, structural and functional relationships. Molecular Mechanisms of Antibody Diversity and Cellular Immunity: Organization of genes coding for constant and variable regions of heavy chains and light chains, antibody diversity & class switching. **Complement System:** Complement components, their structure and functions and mechanisms of complement activation by classical, alternative and lectin pathways. **Exercise:** Concept mapping, spontaneous quizzes, role playing	**CLO 1**

Unit II **10 Hours**	**Functions of Acquired Immunity:** Cells of acquired immunity, Th1 and Th2 responses, cytokines, chemokines, interferons, interleukins, antigen recognition-membrane receptors for antigens. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte	**CLO 1**
	Antigen (HLA) system, polymorphism, distribution variation and function. Association of MHC with disease and superantigen, recognition of antigens by T and B-cells, antigen processing, role of MHC molecules in antigen presentation and co- stimulatory signals. **Exercise:** Problem based learning, quescussion	
Unit III **12 Hours**	**Immunity and Human Diseases:** Types of hypersensitivity, features and mechanisms of immediate and delayed hypersensitivity reactions. Immunity to bacterial, fungal, viral and protozoan diseases, immunity to tumors, and allergies. Immunology of Autoimmunity, Congenital diseases and Immunodeficiencies. Recent advances for diseases like AIDS, hepatitis, cancer, SARS-CoV-2 and malaria. Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines. **Exercise:** Case studies, research paper discussion, quizzes	**CLO 2**
Unit IV **12 Hours**	**Monoclonal Antibodies and Diagnostic Immunology:** Immunotoxins production, characterization and applications in diagnosis, therapy and basic research. Antibody genes and antibody engineering chimeric and hybrid monoclonal antibodies. **Exercise:** Improved discussion, snowballing, Problem based learning	**CLO 3**

Suggested Reading:

1. Kindt, T. J., Osborne, B.A. and Goldsby, R.A. (2018). *Kuby Immunology* 8th Edition. W.H. Freeman, USA.
2. Abbas. (2017). *Cellular and Molecular immunology*. 9th Edition, CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J.R. (2004). *Immunobiology: The immune system in health and disease.* Blackwell Publishing, USA.

4. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2017). *Roitt's Essential Immunology (Series–Essentials).* Blackwell Publishers, USA.
5. Elgert K.D. (2009). *Immunology: Understanding the immune system*.
6. Paul, W.E. (2008). *Fundamental Immunology.* Raven Press, SD, USA.
7. Tizard (2008). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.
8. David K. Male, R. Stokes Peebles, Victoria Male Immunology, International Edition, 2021 9 edition Elsevier publications

Web Sources:

https://swayam.gov.in/
https://www.biointeractive.org/

Modes of transaction

-Lecture
-Inquiry training
-Panel discussion
-Problem solving
-Self-learning

L	T	P	Credits
3	0	0	3

Course Code: MMIC.524
Course Title: Molecular Biology and Recombinant DNA technology

Total Hours: 45

Course Learning Outcome

The students will be able to:

CLO1. Describe the molecular structure of DNA, RNA and their replication, damage and repair.
CLO2. Explain the basic and advanced concepts related to molecular processes in a cell and how they are related to biochemical processes in microbes and higher organisms.
CLO3. Emphasizes the concepts of central dogma of molecular biology spanning from DNA Replication, transcription and Protein Synthesis
CLO4. Propose the applications of molecular biology to societal needs with reference to medicine, industry and agriculture.

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I **12 Hours**	**Genome organization:** DNA structure, repetitive DNA, interrupted genes, Organelle DNA. **DNA replication:** Arrangement of replicons in a genome, modes of replication and keys enzymes, replication fork and priming, leading and lagging strand, elongation, termination, specific features of replication in prokaryotes and eukaryotes, action of topoisomerases, telomere maintenance and chromatin assembly, single stranded DNA replication, relationship between DNA replication and cell cycle, and DNA copy number maintenance. **Recombination and Repair of DNA:** DNA repair and recombination, DNA mismatch repair, Double Strand Break repair, recombination as a molecular biology tool, **Exercise:** Student-generated test questions, Experimental evidence, application article, Problem based learning.	**CLO 1, CLO3**
Unit II **12 Hours**	**Transcription and mRNA Processing:** Types of RNA, Prokaryotic &, eukaryotic transcription, general and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and posttranscriptional gene silencing: Initiation, Elongation & Termination of transcription, capping, polyadenylation, splicing, editing, mRNA stability, RNA interference and microarray analysis, RNA editing. **Translation:** Genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co-and post-translational modifications. **Exercise:** Asking Questions, Crossword Puzzle, Case Studies.	**CLO 2**

Unit III **10 Hours**	**Gene Regulation:** Prokaryotic – lac, trp, and gal operons, Lambda gene regulation during lysogeny and lytic cycle; Eukaryotic – yeast, higher eukaryotes, hormonal regulation of genes, epigenetic regulation. **Introduction to molecular cloning:** Enzymes, vectors and hosts used in DNA technology. Cloning, genetic manipulation and over expression of recombinant Proteins: Model organisms, genetically modified plants and animals, Creating Transgenic, Knockouts, RNAi technology, CRISPR technology. Generation of transient and stable cell lines. Overexpression of recombinant proteins in E.coli under various promoters, Mammalian cell overexpression system. **Exercise:** Real time Data interpretation for different techniques, Brainstorming, online tool for cloning, Problem Solving, Team teaching, Group Text Reading	**CLO 3**
Unit IV **11 Hours**	**Transcriptional Analysis of Gene Expression and Transcriptomics:** Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes. Enzymatic and bioluminescent reporters. Promoter analysis – deletion analysis and linker scanning analysis coupled to reporter assays, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies or 5' RACE. Transcriptome analysis by DD-PCR and EST analysis; DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expression (SAGE), RNA-seq. Yeast one and two hybrid system, DNA footprinting and chromatin immunoprecipitation and Chip-seq **Exercise:** Real time Data interpretation for different techniques, Discussions and Group Learning	**CLO 4**

Suggested Reading:

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2014). *Molecular Biology of the Gene*. 7th Edition, Benjamin Cummings, USA
2. Green, M.R., Sambrook, J. (2012). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.
3. Lodish, H, Birk, A, et al. (2016) *Molecular Cell Biology*. 8th ed. WH Freeman.
4. Nancy Craig, Rachel Green, Carol Greider, Gisela Storz, and Cynthia Wolberger (2019) Molecular Biology. Principles of Genome Function. Third Edition. Oxford

University Press
5. Michael M. Cox; Jennifer Doudna ;Michael O'Donnell (2015) Molecular Biology Principles and Practice Second Edition, WH Freeman and company
6. David P. Clark, Nanette J. Pazdernik and Michelle R. McGehee (2019) Molecular Biology: Principles and Practice Elsevier Inc. USA Robert F. Weaver (2011)Molecular Biology McGraw-Hill Education; 5th edition.
7. Jocelyn E.Krebs , Elliott S.Goldstein , Stephen T.Kilpatrick (2017) Lewin's GENES XII; 12th edition.
8. Bruce Alberts , Rebecca Heald , Alexander Johnson , David Morgan , Martin Raff, Keith Roberts, Peter Walter . (2022). 7th edition *Molecular Biology of the Cell*. Garland publishers, Oxford.
9. Gerald Karp, Janet Iwasa, Wallace Marshall (2019). *Karp's Cell and Molecular Biology: Concepts and Experiments*. 9th edition John Wiley &Sons. Inc. New Delhi, India.
10. Brown TA Gene cloning and DNA analysis an introduction 7 edition (PB 2016)

Web Sources:

-https://www.biointeractive.org/classroom-resources/bacterial-identification-virtual-lab

- https://www.youtube.com/watch?v=VgAuZ6dBOfs
- NPTEL IIT Guwahati https://youtube.com/playlist?list=PLwdnzlV3ogoW9QiY4FJXeliA6Q_fJkaDS&feature=shared

Modes of transaction

-Lecture
-Problem Solving
-Self-Directed Learning
-Inquiry training
-Co-operative learning
-Team teaching

Tools used

Study Videos, Google Classroom/Drive

L	T	P	Credits
3	0	0	3

Course Code: MMIC.525
Course Title: Microbial Physiology and Metabolism

Total Hours: 45

Course Learning Outcomes:

CLO1 - able to explain various anabolic and catabolic pathways, transport systems and the mechanisms of energy conservation in microbial metabolism

CLO2 - Illustrate the metabolic diversity exhibited by microorganisms, their thermodynamics and regulatory networks that support their survival and growth**.**
CLO3 - Grasp basic mechanisms of energy-yielding and consuming processes CLO4 - Compile the knowledge about microbial transport system, and mechanism of bacterial sporulation in a broad spectrum of micro-organism.

Course Contents

Unit/Hours	Content	Mapping with Course Learning Outcome
Unit I 10 Hours	**Bacterial Photosynthesis:** Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria**.** **Exercise:** Brainstorming, Discussions and Group Learning, Debates.	**CLO 1, CLO3**

Unit II **11 Hours**	**Bacterial Respiration:** Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in heterotrophic and chemolithotrophic bacteria. **Bacterial Anaerobic Respiration:** Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria. Catalase, superoxide dismutase, mechanism of oxygen toxicity. **Exercise:** Presentations, Debates, Quiz, Critical Thinking	**CLO 1, CLO2**

Unit III **12 Hours**	**Bacterial Permeation:** Structure and organization of membrane (Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane. Methods of diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion. Proton Motive Force, PTS, role of permeases in transport, different permeases in *E. coli*. Transport of amino acids and inorganic ions in microorganisms and their mechanisms. **Exercise:** Student-generated test questions, Classroom Opinion Polls.	**CLO 4**
Unit IV **12 Hours**	**Bacterial Sporulation:** Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation. **Bacterial Chemolithotrophy:** Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera. Oxidation of molecular hydrogen by hydrogeno-monas species. Ferrous and sulfur/sulfide oxidation by *Thiobacillus* species. **Exercise:** Concept Maps, Application Articles, Experimental evidence.	**CLO 4, CLO3**

Suggested Reading:

1. Caldwell D.R. (1995) *Microbial Physiology and Metabolism*. Brown Publishers.

2. Moat A.G., Foster J.W. and Spector M.P. (2009). Microbial Physiology, 4th edition. John Wiley and sons inc., publication.
3. Brun. Y.V. and Shimkets L.J. (2000) *Prokaryotic Development*. ASM Press.
4. Kim B.H. and Gadd G.M. (2012). Bacterial physiology and metabolism. Cambridge University Press, Cambridge.
5. Cohen, Georges N.(2014) Microbial Biochemistry Third edition Springer Netherlands
6. White, D. (2011) *The Physiology and Biochemistry of Prokaryotes*, 4th Edition, Oxford University Press
7. Madigan, Bender, Buckley, Sattley & Stahl, (2021) *Brock Biology of Microorganisms,* 16th Edition Pearson education, USA
8. Ann M. Stevens , Jayna L. Ditty , Rebecca E. Parales, Susan M. Merkel (2024) Microbial Physiology: Unity and Diversity, ASM press

Modes of transaction

-Lecture
-Problem solving
-Panel discussion
-Tutorial

L	T	P	Credits
3	0	0	3

Course Code: MMIC. 527

Course Title: Environmental Microbiology

Total Hours: 45

Course Learning Outcomes:

The students will be able to:

CLO 1: Categorize the composition of industrial waste water.

CLO 2: Enlist various approaches for microbiological treatment of waste water.

CLO 3: Discern various xenobiotic compounds generated by anthropogenic activities and learn about various microbiological approaches for bioremediation.

Course Contents

Unit/Hours	Content	Mapping with CLOs

Unit I **10 Hours**	**Characteristic and composition of industrial waste water:** General characteristics of industrial waste-water coming from sugar industries, tanneries, paper-pulp and alcohol industries, Concepts of C-BOD, N-BOD and COD, Oxygen-sag curve. Water borne risk to human health, Disinfection of drinking water with anti- microbial agents. Coliform test of potable water. **Exercise:** Concept mapping, Class discussion, spontaneous quizzes	**CLO 1**
Unit II **12 Hours**	**Microbiological approaches for waste water treatment:** Primary treatment of wastewater, treatment of industrial effluent by aerobic treatment methods; Trickling filters, and Oxidation ponds. Methods of anaerobic treatment of sludge. Bioaccumulation of heavy metal ions from industrial effluents. Removal of nitrogen and phosphorous and volatile organic matter from water. **Exercise:** Numerical exercises for BOD, COD calculation, Interpretation for oxygen sag curve	**CLO 2**
Unit III **12 Hours**	**Microbial Toxicology:** General chemistry of pollutants. Particulate matter, poly-aromatic hydrocarbons, organosulfur, organophosphorus, organohalides, organonitrogen, organometallic compounds. Fog and smog, acid rain Dose-response relationship, Determination of LD50, Effect of heavy metals, pesticides on the microbial population in air, water and soil. Ames test to determine the genotoxicity of toxicants. Mode of action of carcinogens, Microbial tolerance and resistance against heavy metals, antibiotics and pesticides. **Exercise:** Case studies, research paper discussion	**CLO 3**

Unit IV **Hours**	**Degradation of Xenobiotics:** Concepts of xenobiotics, bio-concentration and bio- magnification, Bio-transformation and biodegradation of xenobiotics like organophosphates and organohalides compounds, plastic, paints. Genetically Modified Organisms released and its environmental impact assessment and ethical issues. **Exercise:** One minute concepts, improved discussion, Quizzes	**CLO 3**

Suggested Reading:

1. Baker, K.H. And Herson D.S. (1994). *Bioremediation*. MacGraw Hill Inc. N.Y.
2. E Eldowney, S. Hardman D.J. and Waite S. (1993). Pollution: Ecology and Biotreatment Longman Scientific Technical.
3. Christian RA , Jariwala, Namrata D, Karia, GL (2023) Wastewater treatment: concepts and design approach third edition PHI Learning Private Limited
4. Lawrence, P., Wacekett, C. and Douglas Hershberger. (2014) *Biocatalysis and Biodegradation: Microbial transformation of organic compounds.* ASM Publications.
5. Christon J. Hurst (2001). *A Manual of Environmental Microbiology*. 2nd Edition. ASM Publications.
6. Ian Pepper, Charles Gerba, Terry Gentry (2014) *Environmental Microbiology* 3rd Edition; Academic Press.
7. N.S. Subba Rao. (2020). *Bio-fertilizers in Agriculture and Forestry*. CBS Publisher and Distributor.
8. Buckley R. G. (2019) Environmental Microbiology, CBS publication

Web Sources:

https://swayam.gov.in/

Modes of transaction:

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Group discussion
-Field visits

L	T	P	Credits
3	0	0	3

Course Code: MMIC.526

Course Title: Research Methodology and Biostatistics

Total Hours: 45

Course Learning Outcomes:

Student will be able to:

CLO 1: Illustrate various aspects of research methods, ethics, technical and scientific writings and literature search.

CLO 2: Develop and formulate research questions and ideas and develop skill in understating the results published in the research paper

CLO 3: Recognize the concept of biosafety, biological risks and their importance in laboratories and research.

CLO 4: Demonstrate various bioinformatics tools and techniques to analyse data and to perform the interaction studies.

CLO 5: Design, plan and execute the experimental study.

CLO 6: Utilise various tools to collect and present data.

CLO 7: Demonstrate the outcome of results using statistical approaches in testing hypotheses, analyzing experimental data and interpreting the results.

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I 10 Hours	**General Principles of Research:** Meaning and importance of research, critical thinking, formulating hypothesis and development of research plan, review of literature, interpretation of results and discussion. Scientific writing: writing synopsis, research manuscript and dissertation. Literature search and survey, e-Library, web-based literature search engines. **Exercise:** Research presentation and poster preparation. Plagiarism and open access publishing.	**CLO 1** **CLO2**
Unit II 11 Hours	**Bioethics and Biosafety:** Good Laboratory Practices, Sterilization techniques, Cell and tissue culture techniques: Plants and animals. Biosafety for human health and environment. Biosafety issues for using cloned genes in medicine, agriculture, industry, and ecoprotection. Genetic pollution, Risk/safety and Ethical considerations in rDNA and genetic engineering. CDC/DBT/ICMR guidelines for biosafety. Ethical theories, Ethical considerations during research, Ethical issues related to animal testing and human projects. Intellectual property rights (IPRs). **Exercise:** Paper discussion (research paper versus review article), case studies on patent filing.	**CLO 2** **CLO 3**

Unit III **12 Hours**	**Biostatistics:** Differences between parametric and non-parametric statistics, Univariate and multivariate analysis. Frequency distribution. Mean, Median, Mode, Probability Distribution, Standard deviation, Variation, Standard error, significance testing and levels of significance, Hypothesis testing. Measures of central tendency and dispersal, Histograms, Probability distributions (Binomial, Poisson and Normal), Sampling distribution, Kurtosis and Skewness.Statistical Tools: Student's t- test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two- way analysis of variance (ANOVA), Standard errors of regression coefficients and types of correlation coefficient. **Exercise:** Problem solving, numerical, Training Games for Learners, Student- generated test questions.	**CLO 5** **CLO 6** **CLO 7**
Unit IV **12 Hours**	**Bioinformatics:** Organization, management and analysis of biological data, use of computers in data analysis, biological databases - DNA sequence databases and protein sequence databases, BLAST, FASTA, multiple sequence alignment, primers in biology (design and types of primers) genome projects (human, *Arabidopsis* and other genome projects), NCBI, UCSC, BV-BRC and other database searches. Indian Biological Data Centre (IBDC) and its repositories: Indian Nucleotide Data Archive (INDA), Indian Proteome Databank (IPD), Indian Metabolome Data Archive (IMDA), Indian Structure Data Archive (ISDA), Indian Biological Images Archive (IBIA), Indian Crop Phenome Database (ICPD); DBT-Centre for Microbial Informatics. **Exercise:** Hands on training on bioinformatics tools, Quiz, Brainstorming.	**CLO 4**

Suggested Reading:

1. Gupta, S. (2005). *Research Methodology and Statistical Techniques.* Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C.R., Garg, G. (2019). *Research Methodology: Methods and Techniques.* 4th Edition, New Age International (p) Limited. New Delhi.
3. Fleming, D. O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
4. Rockman, H. B. (2004). *Intellectual Property Law for Engineers and Scientists*. Wiley-IEEE Press, USA.
5. Shannon, T. A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
6. Kauda J. (2012). *Research Methodology: A Project Guide for University Students*.

Samfunds literature Publications.
7. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases.* Oxford University Press, UK.
8. WHO (2005). *Laboratory Biosafety Manual*. World Health Organization.
9. Lesk, A.M. (2019). Introduction to Bioinformatics. 5th Edition, Oxford University Press, UK.
10. Ramsden, J. (2021). Bioinformatics: An Introduction (Series: Computational Biology). 4th Edition, Springer International Publishing.
11. Baxevanis, A.D. and Ouellette, B.F.F. (2005). *Bioinformatics: A Practical guide to the Analysis of Genes and Proteins*. Wiley-Interscience, USA. 12.Zvelebil, M. and Baum, J. (2007). *Understanding Bioinformatics*, Garland Science, New York, USA.
13. Mount, D. (2012). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
14. Orengo, C., Jones, D., Thornton, J. (2005). *Bioinformatics: Genes, Proteins and Computers* (Advanced Texts). Taylor and Francis Publishers**.**
15. Norman, G. and Streiner, D. (2014). *Biostatistics: The Bare Essentials*, Decker Inc. USA, 4th edition.
16. Rao Nageswara G. (2018) Biostatistics & Research Methodology, 1st Ed. PharmaMed Press
17. Samuels, M.L., Witmer, J., Schaffner, A. (2016). *Statistics for the Life Sciences*. , 5th edition, Prentice Hall publishers.
18. Emden, H.F. (2019). *Statistics for Terrified Biologists*. Blackwell Publishers.
19. Thomas, C. George (2020). *Research Methodology and Scientific Writing*. 2nd Edition. ; Ane Books pvt. Ltd.
20. Bryant, John A. & Velle, Linda LA (2019). *Introduction to bioethics*, 2nd Edition.

Web-links

- https://www.cdc.gov/
- https://www.who./
- http://dbtindia.gov.in/regulations-guidelines/regulations/biosafety- programme
- https://pubmed.ncbi.nlm.nih.gov/
- -https://www.uniprot.org-https://pubmed.ncbi.nlm.nih.gov/
- https://blast.ncbi.nlm.nih.gov/Blast.cgi
- https://scholar.google.com

Modes of transaction

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Panel discussion
-Problem solving
-Self-directed learning

L	T	P	Credits
3	0	0	3

Course Code: MMIC.537
Course Title: Medical Microbiology

Total Hours: 45

Course Learning Outcomes (CLO):

The students will be able to:

CLO1: Describe and explain the concept of various cellular processes during disease development.

CLO2: Describe and evaluate the relevance of microbes and diseases caused by pathogenic bacteria.

CLO3: Describe and explain the virus structure, pathogenesis and review the emerging viral diseases.

CLO4: Comprehend the clinical diagnostics and treatment of the different diseases caused by viruses.

Course Contents

Unit/Hours	Content	Mapping with course learning outcomes
Unit I **12 Hours**	**History and Molecular Basis of Microbial Pathogenesis:** Historical development in the field of medical microbiology, Establishment of pathogenic microorganisms: Entry, spread and tissue damage. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Biofilms and quorum sensing, Quorum quenching modulation of apoptotic processes. Bacterial secretion system and its importance: Secretion pathway, SecB secretion pathway, SRP pathway, Tat pathway. Protein secretion and types of secretory systems in Gram-negative and Gram-positive bacteria. Sortases and Injectosome. **Exercise:** Quiz, Critical Thinking, Brainstorming	**CLO 1**

Unit II **11 Hours**	**Introduction and Biology of Pathogenic Bacteria:** Important developments in medical microbiology, Morphological characteristics, pathogenesis and laboratory diagnosis including rapid methods of following pathogenic bacteria; *Staphylococcus, Streptococcus, Enterococcus, Escherichia coli, Neisseria, Klebsiella, Salmonella, Shigella, Vibrio, Campylobacter, Pseudomonas, Acinetobacter, Yersinia, Treponema, Haemophilus, Bordetella, Bacillus, Clostridium, Corynebacterium, Mycobacterium, Actinomyces, Nocardia, Fusobacterium, Listeria, Rickettsiae, Chlamydiae, Spirochetes.* Nosocomial Infections and their treatment. **Exercise:** Case Studies, Paper discussion, application Articles.	**CLO 2**

Unit III **11 Hours**	**General Virology and Pathogenesis:** Brief outline on the history and discovery of viruses, nomenclature and classification of virus, morphology and ultrastructure; Viral genomic organization, structure and replication. Prion and viroids. Viral Pandemics. **Viral infections and Pathogenesis:** Determinants of tissue tropism, penetration and uncoating, biosynthesis of genetic material, maturation, release, and transmission of infection, host defense, innate immune response and adaptive immune response. Replicative strategies employed by DNA viruses, RNA viruses. Identification of virus prototypes associated with different virus replication schemes. **Emerging Viral Diseases**: Introduction, life cycle, pathogenesis, diagnosis and treatment of Herpesvirus, Influenza virus, Hepatitis Viruses, Coronaviruses, Retroviruses and Flaviviruses. **Exercise:** Inquiry training, extempore of recent pathogenic events, Student-generated test questions	**CLO 3**
Unit IV **11 Hours**	**Oncogenic Viruses:** Oncogenic viruses, oncogenic DNA and RNA viruses, viral transformation by activation of cellular signal transduction pathways, viral transformation via cell cycle control pathways. **Diagnostic Virology:** Visualization and enumeration of virus particles, Detection of viruses: physical,	**CLO 4**

	biological, immunological and molecular methods. Serological methods. **Viruses as therapeutic agents:** Viral Chemotherapy and Vaccine, Fusion or entry inhibitors, Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors: mechanism of action and drug resistance. Recent advances in development of antiviral vaccines. **Exercise:** Case Studies, Discussions and Group learning	

Suggested Reading:

1. Atlas, R.M. (1994) Principles of Microbiology, McMillan, New York
2. Tortora, G.J., Funke, B.R. and Case, C.L. (2016). *Microbiology: An Introduction.* Benjamin Cummings, USA.
3. Madigan,M.T., Martinko, J.M., Bender, K., and Buckley, D. (2011) Brock Biology of Microorganisms, 13th Ed., Pearson Education, USA.
4. Jawetz, Melnick, & Adelberg (2016) *Medical Microbiology* by Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. Lange Publication.
5. Locht C and Simonet M, Caister (2012) *Bacterial Pathogenesis: Molecular and Cellular Mechanisms* by Academic Press.
6. Persing DH, Tenover FC, Hayden R, Leven M, Miller MB, Nolte FS, Tang YW, Belkum AAV. (2016) *Molecular Microbiology: Diagnostic Principles and Practice.* American Society for Microbiology Press.
7. Nelson KE and Williams CM (2019) *Infectious Disease Epidemiology: Theory and Practice.* Jones and Bartlett.
8. World Organization for Animal Health: "*Manual of Diagnostic Tests and Vaccines for Terrestrial Animals"* Volumes I & II, 6th Edition, 2010.
9. Rao, Juluri R, Fleming, Colin C., Moore, John E., (2006) *Molecular Diagnostics: current technology and Applications.* Horizon Bioscience, U. K.
10. Dimmock N., Easton A., Leppard K (2016) *Introduction to Modern Virology*. Blackwell Publishing.
11. Wanger, K. Hewiett M., Bloom D., Camerini D. (2007). *Basic Virology* Blackwell Publishing.
12. Cann AJ (2015) *Principles of Molecular Virology*. Elsevier Academic Press.
13. Flint S. J., L.W. Enquist, V.R. Racaniello, A.M. Skalka (2015) *Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses.* 4th edition. ASM Press.

Web Sources

https://www.cdc.gov/
https://www.who./

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
-Co-operative learning
-Team teaching

L	T	P	Credits
3	0	0	3

Course Code: MMIC.530

Course Title: Microbial Diversity and Applied Microbiology

Total Hours: 45

Course Learning Outcomes:

CLO 1: Understand the fundamentals of the concept on Microbial diversity commonly used in microbial ecology study

CLO 2: Understand the different techniques and methods commonly used in studying the microbial diversity study

CLO 3: Understand the different microbes commonly associated with foods and fermented foods and their applications

CLO 4: Learn the role of bioinformatics in microbial ecology study and the applications of microbes in health, agriculture and industry

Course Contents

Unit/Hours	Content	Mapping with CLOs

Unit I **10 Hours**	**Microbial Diversity:** Concepts and definition of microbial diversity, Microbial taxonomy and phylogeny, Microbial interactions: mutualism, commensalism, parasitism, Concepts of species richness, evenness, and ecological indices, Phylogenetic markers, Operational taxonomic units (OTUs), Amplicon sequence variants (ASVs), Microbial dark matter, Pan-genome and core-genome concepts, Average Nucleotide Identity (ANI), Polyphasic taxonomy. **Exercise:** Quiz, Critical Thinking, Brainstorming,	**CLO1**
Unit II **11 Hours**	**Techniques used in studying microbial diversity:** Traditional research methods: Plate counts, Biochemical-based techniques, Fatty acid methyl ester (FAME), Phospholipid fatty acid (PLFA), Biolog, Analytical Profile Index Identification (API); Modern molecular biology methods: Denaturant gradient gel electrophoresis/temperature gradient gel electrophoresis (DGGE/TGGE), Restriction fragment length polymorphism/ terminal restriction fragment length polymorphism (RFLP/T- RFLP), Quantitative Real-Time PCR (qPCR), Meta- Omic Approaches, High-Throughput Sequencing (HTS): 16S/18S/ITS Amplicon Sequencing and Metagenomics, Metagenome-assembled genomes (MAGs). **Exercise:** One minute concepts, improved discussion, Quizzes	**CLO2**

Unit III **12 Hours**	**Microorganisms of food and their applications:** Microbial flora of raw and processed foods, Types of fermentation: spontaneous/natural, back-slopping and starter culture. 'Ethno-microbiology' concept of fermented foods. Indian fermented food products and beverages. Fermented foods and beverages of the world. Microbiome Assembly in Fermented Foods, Beneficial microorganisms in food: Lactic acid bacteria, yeasts, molds, Starter cultures and fermented foods, Spoilage organisms and foodborne pathogens, Use of microorganisms in food preservation and biotransformation, Probiotics, prebiotics, and postbiotics: role and health benefits. **Exercise:** Case studies and hands-on experiments.	**CLO3**
Unit IV **12 Hours**	**Application of Microbial Diversity Research in Health, Environment, and Industry:** Role of bioinformatics tools in microbial prospectives and its future, Microbial resource exploration for industrial biotechnology, Environmental microbiology: bioremediation, wastewater treatment, Microbial biofertilizers and soil health, Role of microbiomes in human and animal health, Development of microbial-based products: enzymes, antibiotics, bioactive compounds, Bioprospecting from traditional fermented foods. **Exercise:** Student-generated test questions, Experimental evidence, application article, Problem based learning	**CLO4**

Suggested Reading:

1. Brown, J. W. (2014). Principles of Microbial Diversity. John Wiley & Sons.
2. Cocolin, L., & Ercolini, D. (Eds.). (2007). Molecular Techniques in the Microbial Ecology of
3. Fermented Foods. Springer Science & Business Media.
4. Louw, N. L., Lele, K., Ye, R., Edwards, C. B., & Wolfe, B. E. (2023). Microbiome assembly
5. in fermented foods. Annual Review of Microbiology, 77(1), 381-402.
6. Satyanarayana, T. (2005). Microbial Diversity: Current perspectives and potential
7. applications.
8. Verma, P., & Shah, M. P. (Eds.). (2022). Bioprospecting of microbial diversity: challenges
9. and applications in biochemical industry, agriculture and environment protection.
10. Yap, M., Ercolini, D., Álvarez-Ordóñez, A., O'Toole, P. W., O'Sullivan, O., & Cotter, P. D.
11. (2022). Next-generation food research: use of meta-omic approaches for characterizing

12. microbial communities along the food chain. Annual Review of Food Science and
13. Technology, 13(1), 361-384.
14. Zengler, K. (2008). Accessing uncultivated microorganisms: from the environment to
15. organisms and genomes and back (pp. 308-pp). Web-links

- https://www.cdc.gov/
- https://pubmed.ncbi.nlm.nih.gov/
- https://blast.ncbi.nlm.nih.gov/Blast.cgi
- https://scholar.google.com

Modes of transaction

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Panel discussion
-Problem solving
-Self-directed learning

L	T	P	Credits
3	0	0	3

Course Code: MMIC.531

Course Title: Antimicrobial resistance and Drug discovery

Total Hours: 45

Course Learning Outcomes:

Course Learning Outcomes: On the completion of this course, students will be able
CLO 1: Understand the fundamentals of antimicrobial resistance of common microbes against antibiotics.
CLO 2: Mode of transmission and spread of antimicrobial resistance, different target in microbes and mechanism of AMR.
CLO 3: Drug discovery for microbes that acquired resistance against common antibiotics, different types of drugs, clinical trial
CLO4: *In-silico* drug designing, finding new antimicrobial agents using Insilco, in-vitro and in vivo models. Molecular docking

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I **10 Hours**	**Introduction** Scope, impact, and global challenge and major classes of antibiotics. Antimicrobial Resistance (AMR) Overview, failure of antibiotic therapy, priority list pathogens related infections. **Exercise:** Research presentation and poster preparation. Plagiarism and open access publishing.	**CLO 1**

Unit II **11 Hours**	**Mechanisms of Antimicrobial Resistance**-Genetic and biochemical mechanisms (e.g., efflux pumps, enzymatic degradation, Horizontal gene transfer and mutation-driven resistance, Clinical relevance and case studies. **Exercise:** Paper discussion (research paper versus review article), case studies on patent filing.	**CLO 2**

Unit III **12 Hours**	**Principles of Drug Discovery**- Target identification and validation, Hit discovery and screening techniques. Different classes of drugs, Drug in pipeline, synthetic and natural drugs, Clinical trials, invitro and in vivo drug testing models **Exercise:** Problem solving, numerical, Training Games for Learners, Student- generated test questions.	**CLO 3**
Unit IV **12 Hours**	**Computer-Aided Drug Discovery** (CADD)-Structure-Based Drug Design, Fundamentals of Molecular Docking (Simulates how a small molecule (ligand) fits into the binding site of a target protein), Structure-based Virtual Screening, De Novo Drug Design (Designing new molecules from scratch that complement the 3D shape and chemical environment of the target), **Software**- Auto Dock, Schrödinger's Glide, GOLD, MOE, Rosetta Dock. Ligand-Based Drug Design. **Exercise:** Hands on training on bioinformatics tools, Quiz, Brainstorming.	**CLO 4**

Suggested Reading:

1) Joanne Willey, Kathleen Sandman and Dorothy Wood (2019) Prescott's Microbiology. 11th Edition, McGraw-Hill Science, USA. 3.
2) Bauman, R.W. (2011). Microbiology with Diseases by Body System. Benjamin Cummings, USA.
3) Tortora, G.J., Funke, B.R. and Case, C.L. (2018). Microbiology: An Introduction. Benjamin Cummings, USA.
4) 4. Bauman, R.W. (2011). Microbiology with Diseases by Body System. Benjamin Cummings, USA.
5) Capuccino, J.G. and Sherman, N. (2004). Microbiology-A Laboratory Manual. Benjamin Cummings, USA.
6) Edward H. Kerns and Li Di (2008) Drug-like Properties : Concepts, Structure Design and Methods from ADME to Toxicity Optimization.
7) Editors: I.W. Fong, D. Shlaes, K. Drlica. Antimicrobial Resistance in the 21st Century **(**An excellent overview of clinical implications and resistance mechanisms.**)**
8) Bacterial Resistance to Antibiotics: From Molecules to Man By Boyan B. Bonev, Pierre-Edouard Fournier

9) Mohane Selvaraj Coumar (2021), Molecular Docking: Methods, Applications, and Perspectives, Docking algorithms and scoring functions, Applications in drug discovery and target identification, Case studies using AutoDock, Glide, GOLD, etc.

Web-links

- https://www.cdc.gov/
- https://www.who./
- https://pubmed.ncbi.nlm.nih.gov/
- -https://www.uniprot.org
- https://blast.ncbi.nlm.nih.gov/Blast.cgi
- https://scholar.google.com

Modes of transaction

-Lecture
-Demonstration
-Lecture cum demonstration
-Self-directed learning

L	T	P	Credits
0	0	6	3

Course Code: MMIC.528
Course Title: Microbiology Practical-II **Total Hours: 90**

Learning Outcomes:
The students will be able to:

CLO1.Outline the basic molecular biology, cell culture and immunological techniques and correlate them with their fundamental concepts in the subject

CLO2.Assess the use of molecular biology, cell culture and immunological techniques in health and diseases,

CLO3.Elaborate the molecular biology techniques and their application to study bacterial and mammalian cells, cellular DNA, RNA, proteins along with different aspects of immune processes.

CLO4.Conduct and examine the experiments pertaining to the theory papers of environmental microbiology.

CLO5.Apply these observations and scientific ideas in the real life microbiology associated tribulations.

Course Contents Unit/Hours	**Content**	**Mapping with**

Part A. Immunology and research Methodology 30 Hours	1. To perform Total Leukocyte Count/Differential Leukocyte count of the given blood sample. 2. Separation of serum from blood. 3. To isolate mononuclear cells from peripheral blood various lysis and separation methods. 4. To analyse cell viability by dye exclusion method. 5. Media preparation for animal cell culture. 6. Growth and maintenance of cell lines. 7. Recovery of cells from monolayer: Chemical and mechanical methods. 8. To analyse cytotoxicity of a treatment in a given cell line and calculating LD50 dose. 9. Lymphocyte proliferation assay. 10. Double immunodiffusion test using specific antibody and antigen. 11. To perform immunoelectrophoresis using specific antibodies and antigen. 12. Dot Immunoblot assay (DIBA). 13. ELISA 14. Polyacrylamide gel electrophoresis and Western blotting. 15. Demonstration of Flow Cytometry. 16. Immunohistochemistry: H & E staining, Fluorescent staining,	**CLO 1** **CLO2** **CLO3**

Part B. Molecular Biology 30 Hours	1. Isolation of genomic DNA 2. DNA amplification by Polymerase Chain Reaction (PCR). 3. Ligation and E.coli transformation using chemical transformation, plating, colony selection, 4. Isolation of plasmid DNA, restriction enzyme digestion and agarose gel electrophoresis. 5. Construction of restriction map by single and double digestion, Designing DNA probe, Southern blot hybridization (demonstration only). 6. RNA isolation from biological samples. 7. cDNA synthesis and real time PCR (qPCR). 8. DNA sequencing (demonstration only). 9. NCBI BLAST search and Primer design. 10. Multiple Sequence Alignment and Phylogenetic analysis using MEGA 11. Determination of genes mapped within a specific chromosomal locus using GeneLoc integration resource and gene orthologue prediction using Ensembl. 12. Protein-protein interactions using STRING; Introduction to KEGG and Metacyc databases.	**CLO 1** **CLO2** **CLO3**

Part C. Environmental Microbiology/Microbial Physiology & Metabolism **30 Hours**	1. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids. 2. Determination of indices of pollution by measuring BOD/COD of different effluents. 3. Bacterial reduction of nitrate from ground waters 4. Isolation and purification of degradative plasmid of microbes growing in polluted environments. 5. Recovery of toxic metal ions of an industrial effluent by immobilized cells. 6. Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste]. 7. Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by *Pseudomonas* species. 8. Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds. 9. Microbial response to stress/antimicrobial agent, biofilm growth 10. Microbial dye decolorization/adsorption. 11. Isolation of Photosynthetic bacteria 12. Glucose uptake by E. coli / *Saccharomyces cerevisiae* [Active and Passive diffusion] 13. Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions in spore germination of Bacillus SP. 14. Determination of Iron Oxidation Rate of *Thiobacillus ferrooxidans*. 15. Determination of Sulfur Oxidation Rate of *Thiobacillus thiooxidans*. 16. Microbial cell permeability alteration analysis, leakage of cellular contents Estimation of calcium ions present in sporulating bacteria by EDTA method. 17. Demonstration of utilization of sugars by oxidation and fermentation techniques.	**CLO4** **CLO5**

Modes of transaction

-Lecture cum demonstration
-Problem Solving
-Self-Learning
-Inquiry training
-Experimentation

Evaluation Criteria for Practical Courses: Students are evaluated for a total of 100 marks with following distribution:

Continuous assessment- 50 Marks:

Maintaining the lab records/notebooks: 15 Marks

Surprise test/quiz/objective type test during the semester: 15 Marks

Good laboratory Practices, Designing and execution of experiments: 10 Marks
Attendance during day to day practical: 10 Marks

Final Practical Examination- 50 Marks:

Minor Experiment (10 Marks), Major Experiment (to be performed, 20 Marks) and viva-voce (20 Marks)

Suggested Reading:

1. Michael J. Leboffe (2011) *A Photographic Atlas for the Microbiology laboratory*.
2. Prakash S. Bisen (2014) *Laboratory Protocols in Applied Life Sciences*. Taylor & Francis Group, LLC
3. John Harley (2016) *Laboratory Exercises in Microbiology*, 10th Edition by John Harley Benson's Microbiological *Applications Lab Manual*, 2016.
4. James G. Cappuccino & Natalie Sherman (2014) *Microbiology: A Laboratory Manual,* 10th Edition 2014
5. Aneja KR (2014) *Laboratory Manual of Microbiology and Biotechnology*.
6. Alberts, B. Bray, D. Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the Cell.* Garland publishers, Oxford.
7. Sambrook, J., Fritish, E.F., Maniatis, T. (2000). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.
8. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.
9. Michael J. Leboffe (2011) *A Photographic Atlas for the Microbiology laboratory*.
10. *Laboratory protocols in Applied Life Sciences* (2014). Taylor & Francis Group, LLC
11. James G. Cappuccino &Natalie Sherman (2014) *Microbiology: A Laboratory Manual,* 10th Edition 2014
12. Aneja KR (2014) *Laboratory Manual of Microbiology and Biotechnology*.
13. Alberts, B. Bray, D. Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the Cell.* Garland publishers, Oxford.
14. Sambrook, J., Fritish, E.F., Maniatis, T. (2000). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.
9. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*.

CRC Press, Taylor and Francis Group, UK.

Software tools and Web Sources

BLAST, MEGA

- https://blast.ncbi.nlm.nih.gov/Blast.cgi
- https://www.vlab.co.in
- https://www.cdc.gov/
- https://www.who./

L	T	P	Credits
2	0	0	2

Course Code: MMIC.506

Course Title: Basics in Microbiology (IDC) **Total Hours: 30**

Course Learning Outcomes:

The students from different streams with a very basic knowledge and understanding of microbes, pathogens and their control will able to:
CLO 1: Impart a foundation of microbiology to the students from different backgrounds.
CLO 2: Understand the nutritional and growth requirements for different bacteria.
CLO 3: Acquire a broad understanding of different groups of microorganisms important in health, diseases and industry.
CLO 4: Outline the various methods for the control of microorganisms.

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I **7 Hours**	**Introduction to Microbiology:** Scope and history of Microbiology, Classification of Bacteria, Fungi, Protozoa, Algae, and viruses. **Basic principles and techniques used in bacterial classification.** Phylogenetic and numerical taxonomy. General characteristics, structure and classification of plant animal and bacterial viruses. **Exercise:** Spontaneous quiz on identification of microorganism based on given characteristic	**CLO 1**

Unit II **8 Hours**	**Microbial Growth, and Nutrition:** Microbial growth. Bacterial generation time. Monoauxic, Diauxic and synchronized growth curves. Factors affecting microbial growth. Principles of microbial nutrition- Chemoautotrophs, chemo-heterotrophs, photoautotrophs and photo-heterotrophs. Types of growth media, pure culture methods. Culture maintenance and preservation **Exercise:** Data Interpretation of different growth curve, classifying microorganism based on nutritional requirements	**CLO 2**
Unit III **8 Hours**	**Pathogens:** Medically important bacteria. Retroviruses, Viroids, Prions and emerging viruses such as HIV, Avian and swine flu viruses and SARS-CoV-2. Medically important fungi and protozoans. **Beneficial applications of microbes**: Human Microflora, Pre and Probiotics, Industrially important microbes. **Exercise:** Group wise discussion on therapeutic approaches against pathogenic microorganism	**CLO 3**
Unit IV **7 Hours**	**Control of Microorganism:** Control of Microorganism by physical and chemical agents. Narrow and broad-spectrum antibiotics, Mode of action of Antimicrobial agents. Antibiotic resistance mechanisms. **Exercise:** Case studies and hands-on experiments.	**CLO 4**

Suggested Reading:

1. Madigan,M.T.,Martinko, J.M., Bender, K., and Buckley, D. (2011) *Brock Biology of Microorganisms,* 13th Ed., Pearson Education, USA
2. Tauro, P., Kapoor,K.K. and Yadav, K.S. (1996). *Introduction to Microbiology*, New Age Pub., New Delhi
3. Pelczar, M.J. et al. (2020), *Microbiology- Concepts and Applications*, International Ed. McGraw Hill Publication, New York
4. Black, J.G. (2012), *Microbiology: Principles and Explorations*, 8 Sons, USA.
5. Willey, J.M., Sherwood, L., and Woolverton, C. (2013) *Prescott's Microbiology* 9th Revised Edition, McGraw Hill Higher Education, New York
6. Pommerville, J.C. (2009) *Alcamo's Fundamentals of Microbiology*, Jones and Bartlett Publishers.
7. Tortora, G.J., Funke, B.R., Case, C.L. (2016) *Microbiology -An Introduction*, Pearson education Pvt. Ltd. Singapore.
8. Talaro K.P, Chess B., (2018) *Foundations in Microbiology,* McGraw-Hill education

L	T	P	Credits
2	0	0	2

Course Code: MMIC. 507
Course Title: Introduction to Immune system (IDC)

Course Learning Outcomes:

Total Hours: **30**

The students will be able to:
CLO 1: Develop awareness about the various components of the human immune system.
CLO 2: Delineate the human immune response as it defends the host against pathogens and malignancies.
CLO 3: Examine diseases associated with deficient or abnormal immune responses.
CLO 4: Understand the immunological basis of therapeutics and diagnostics.

Course Contents

Unit/Hours	Content	Mapping with CLOs
Unit I 7 Hours	**Elements of the Immune system:** Cells, Organs, and microenvironments of the immune system. Innate and adaptive immunity, cellular and humoral immunity, inflammatory and regulatory networks and small biochemical mediators (cytokines). **Exercise:** Students teaching on phylogenetic aspects of immune system	**CLO 1**
Unit II 8 Hours	**Function of immune system:** Discriminate between self and non-self. A functional immune system confers a state of health through effective elimination of infectious agents (bacteria, viruses, fungi, and parasites) and through control of malignancies by protective immune surveillance. **Exercise:** Panel discussion about evasion mechanism employed by pathogens	**CLO 2**
Unit III 7 Hours	**Immunodeficiency and dysfunction as the basis of disease**: Immune Deficiency and Immune dysfunction. Allergies, Types of hypersensitivity reactions. Immunity to microbes (bacteria, fungi, virus and protozoans), tumors and AIDS. **Exercise:** Case studies on immune disorders, Presentations	**CLO 3**

Unit IV **8 Hours**	**Immunological Processes and Therapeutics:** Hybridoma technology and vaccine, natural, synthetic and genetic, development of vaccine. Methods for immunoglobulin determination- quantitative and qualitative antigen and antibody reactions, agglutination-precipitation, immunofluorescence ELISA and Flow cytometry. **Exercise:** Problems on data interpretation for ELISA, Flow Cytometry, antigen-antibody reactions	**CLO 4**

Suggested Reading:

1. Abbas. (2021 8). *Cellular and Molecular Immunology*. 10th Edition CBS Publishers & Distributors, India.
2. Charles, A. and Janeway, J. R. (2001). *Immunobiology: The Immune system in health and disease.* Blackwell Publishing, USA.
3. Delves, P. J., Roitt, I. M. and Seamus, J. M. (2017). *Roitt's essential immunology (Series– Essentials).*Blackwell Publishers, USA.
4. Elgert, K. D. (2009). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.
5. Kindt, T. J., Osborne, B. A. and Goldsby, R. A. (2013). *Kuby Immunology* 7th Edition. W. H. Freeman, USA.
6. Sawhney, S. K. and Randhir, S. (2005). *Introductory practical biochemistry*. Alpha Science International Ltd. New Delhi, India.
7. Tizard. (2009). *Immunology: An Introduction*. Cengage Learning, Thompson, USA

Web Sources:

https://swayam.gov.in/
https://www.biointeractive.org/

Modes of transaction

-Lecture
-Problem Solving
-Inquiry training
-Team teaching

L	T	P	Credits
0	0	40	20

Course Code: MMIC.599.1 **Total Hours: 600**

Course Title: Dissertation Part I

Course Learning Outcomes

The students will be able to:

CLO1. Organize extensive review of literature.

CLO2. Apply various search engines and websites to identify the area of their research interest.

CLO3**.** Formulate the hypothesis and work plan with scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology.

Content:
Students will prepare a research proposal based on the literature review and extensive student-supervisor interactions involving discussion, meetings and presentations. Each student will submit a research/dissertation proposal of the research work planned for MSc. dissertation with origin of research problem, literature review, hypothesis, objectives and methodology to carry out the planned research work, expected outcome and bibliography.

Students can opt for dissertation work in industry, national institutes or Universities in the top 100 NIRF ranking. Group dissertation can be opted, with a group consisting of a maximum of four students. These students may work using a single approach or multidisciplinary approach. Research projects can be taken up in collaboration with industry or in a group from within the discipline or across the discipline

Evaluation Criteria

Dissertation-One (Third Semester)		
	Marks	Evaluation
Supervisor	50	Dissertation Proposal and presentation
HoD and senior-most faculty of the department	50	Dissertation proposal and presentation

Modes of transaction

-Self-Learning
-Group discussion
-Problem solving
- Seminars
-Experimentation

Semester IV

L	T	P	Credits
0	0	40	20

Course Code: MMIC.599.2
Course Title: Dissertation Part II **Total Hours: 600**

Course Learning Outcomes:
The students will be able to:
CLO1. Organize extensive review of literature.

CLO2. Apply various search engines and websites to identify the area of their research interest.
CLO3. Formulate the hypothesis and work plan with scientifically sound (and achievable)

objectives backed by a comprehensive and detailed methodology. CLO4. Compile the data obtained from the experimental plan.
CLO5. Analyze the results in light of established scientific knowledge to arrive at cogent conclusions.
CLO6. Demonstrate their substantial research-based capabilities.

Students will carry out their research work under the supervision of a faculty member. Students will interact with the supervisor through meetings and presentations on a regular basis. After completion of the research work, students will complete the dissertation under the guidance of the supervisor. The dissertation will include literature review, hypothesis, objectives, methodology, result, discussion and bibliography.

Evaluation Criteria

Dissertation (Fourth Semester)		
	Marks	Evaluation
Supervisor	50	Continuous assessment (regularity in work, mid- term evaluation) dissertation report, presentation, final viva-voce
External expert, HoD and senior-most faculty of the department	50	Dissertation report (30), presentation (10), final viva-voce (10)

Modes of transaction

-Self-Learning
-Group discussion
- Experimentation
- Internship
- -Industrial Training