ETHIRAJ COLLEGE FOR WOMEN
(AUTONOMOUS)
DEPARTMENT OF MICROBIOLOGY
M.Sc., APPLIED MICROBIOLOGY
SYLLABUS TO BE EFFECTIVE FROM 2021-2022

ETHIRAJ COLLEGE FOR WOMEN
(AUTONOMOUS)
CHENNAI-600 008

DEPARTMENT OF MICROBIOLOGY

SYLLABUS

CHOICE BASED CREDIT SYSTEM
OUTCOME BASED EDUCATION

(OFFERED FROM THE ACADEMIC YEAR 2021-2022)

ETHIRAJ COLLEGE FOR WOMEN
PG DEPARTMENT OF APPLIED MICROBIOLOGY
Revised Syllabus from June 2021

The Post Graduate Department of Microbiology is revising syllabus with effect from the academic year 2021-2022. PG Degree has two academic years. Every academic year is divided into two semester sessions. Each semester will have a minimum of 90 working days and each day will have 5 working hours. Teaching is organized into a modular pattern of credit courses. Credit is normally related to the number of hours a teacher teaches a particular subject. It is also related to the number of hours a student spends learning a subject or carrying out an activity.

PREAMBLE

PG Department of Microbiology submits changes and additions suggested in the curricula that are given in the ensuing pages.

- Modification of Course content in all the Core and Elective courses in accordance with emerging trends in the field of Microbiology.
- Addition of new Course and merging of courses as per the need.
- Shifting of courses between semesters to accommodate syllabus coverage.

REGULATIONS

1. ELIGIBILITY FOR ADMISSION:

Candidates for admission to the first year of the Degree of M.Sc., Applied Microbiology course shall be required to have passed the B.Sc., Degree examinations in Microbiology/ Zoology /Botany/Biotechnology under the University of Madras or as equivalent thereto by the Syndicate of the University of Madras.

2. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the Degree only if she has undergone the prescribed course of study for a period of not less than two academic years, passed the examination of all Four Semesters prescribed.

3. COURSE OF STUDY:

The Main subjects of study for Post graduate Degree shall consist of the following:

PART-I	: Core Theory, Core Practical and Project
PART-II	: Major and Non - Major Electives
PART- III	: Soft Skill
PART- IV	: Internship

4. PASSING MINIMUM:

A candidate shall be declared to have passed in each paper / practical of the main subject of study wherever prescribed, if she secures NOT LESS THAN 50% of the marks prescribed for the end semester examination.

5. CLASSIFICATION OF SUCCESSFUL CANDIDATES:

Part I, II

Successful candidates passing the examination and securing the marks (i) 60 percent and above and (ii) 50 percent in the aggregate shall be declared to have passed the examination in the first and second class respectively. Candidates who pass all the examinations (Part I, II) prescribed for the course in the FIRST APPEARANCE ITSELF ALONE are eligible for ranking.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

On obtaining a postgraduate degree the students will be able to:

PEO1-Display higher order thinking in the knowledge domain and demonstrate professional skills.

PEO2- Contribute to the advancement and application of relevant knowledge by self-directed learning.

PEO3-Extend and integrate knowledge and skills to design and develop novel products and explore innovative solutions to national and international goals of development.

PEO4-Exercise management skills and develop social interactions in a responsive, ethical and constructive way to meet global standards of excellence in all spheres of activity.

PEO5-Strive for social and economic equity based on the need for gender parity and ecological sustainability.

PROGRAMME OUTCOMES (PO)

PO1 - To acquire advanced conceptual knowledge and comprehensive understanding of the fundamental principles in respective discipline.

PO2 - To apply knowledge and critically evaluate the concepts and scientific developments to take up any challenge.

PO3- To visualize and work on laboratory multidisciplinary tasks related to current research in the fields of Mathematical, Physical and Life Sciences.

PO4 -To acquire research-based knowledge and design methods to conduct investigations of complex problems in research/ Industrial field and achieve employability/self-employment.

PO5- To communicate effective ideas verbally in English, leading to Entrepreneurship ventures such as consultancy and training.

PO6- Employ innovative and environment friendly methods, novel ideas to solve complex and challenging societal and environmental issues.

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO1-Analyse the fundamental concepts and biodiversity of microorganisms, enabling critical thinking in different fields of Microbiology.

PSO2 - Demonstrate the importance of immunity, pathogenesis, cultivation, diagnosis and control of pathogens through therapeutics and prophylaxis in various Health and Pharmaceutical domains.

PSO3 - Evaluate and Identify the needs, potentials and impact of microorganisms relevant to food, soil and agriculture, ensuring environmental conservation and food safety.

PSO4 - Design appropriate strategies in bioprocessing and fermentation technology, with emphasis on industrial production of biomass and their products.

PSO5 - Apply the concepts of Genomics and Proteomics through analytical, molecular and *in silico* techniques for the betterment of society.

PSO6 - Examine the significance of research using statistical tools and communicate the findings in research forums.

PSO7 – Ensure biosafety and bioethics for social responsibility, environmental sensitization and obtain Intellectual Property Rights for various research findings.

PSO8 - Apply computing, communicative and entrepreneurial skills for employability and lifelong learning.

PROGRAMME PROFILE-M.SC., APPLIED MICROBIOLOGY

	PART	COURSE CODE	TITLE OF THE PAPER	CREDITS	HOURS/ WK	TOTAL HOURS	CA	SE	TOTAL
I	CORE I	16SP21/1C/GMP	General Microbiology and Microbial Physiology	4	5	75	40	60	100
	CORE II	16SP21/1C/CBY	Cell Biology	4	5	75	40	60	100
	CORE III	16SP21/1C/SSA	Soil Fertility and Sustainable Agriculture	4	5	75	40	60	100
	CORE ELECTIVE I	16SP21/1E1/BST	Biostatistics	3	3	45	40	60	100
	SOFT SKILL			2	2	30	-	50	50
	CORE PRACTICAL I	16SP21/2C/PR1	General Microbiology and Microbial Physiology	-	5	75	-	-	-
	CORE PRACTICAL II	16SP21/2C/PR2	Medical Microbiology	- **17 Credits**	5 **30 Hrs**	75	-	-	-
II	CORE IV	16SP21/2C/MMY	Medical Microbiology	4	5	75	40	60	100
	CORE V	16SP21/2C/IPM	Industrial and Pharmaceutical Microbiology	4	4	60	40	60	100
	CORE ELECTIVE II	16SP21/2E2/MIG	Microbial Genetics	3	3	60	40	60	100
	CORE ELECTIVE III	16SP21/2E3/RMY	Research Methodology	3	3	45	40	60	100
	EXTRA DISCIPLINARY ELECTIVE I	16SP21/2E/VMB	Vermitechnology and Applied Mushroom Biology	3	4	60	40	60	100
	SOFT SKILL			2	2	30	-	50	50
	CORE PRACTICAL I	16SP21/2C/PR1	General Microbiology and Microbial Physiology	4	4	60	40	60	100
	CORE PRACTICAL I1	16SP21/2C/PR2	Medical Microbiology	4 **27 Credits**	5 **30 Hrs**	75	40	60	100
	Total Credits of I and II Semester = 44								

SEM	CORE/ ELECTIVE	COURSE CODE	TITLE OF THE PAPER	CREDITS	HOURS /WK	TOTAL HOURS	CA	SE	TOTAL
III	CORE VI	16SP21/3C/ILY	Immunology	4	5	75	40	60	100
	CORE VII	16SP21/3C/MEM	Microbial Ecology and Environmental Microbiology	4	4	60	40	60	100
	CORE ELECTIVE IV	16SP21/3E4/EPM/ 16SP21/3E4/ABS	Epidemiology of Infectious Diseases and Public Health Microbiology/ Analytical Techniques for Biological Sciences	3	3	45	40	60	100
	NON-MAJOR ELECTIVE II	16SP21/3E/GOH	Creative Gardening and Ornamental Horticulture	3	4	60	40	60	100
	SOFT SKILL	16SP21/3S/BCG	Basic Computing	2	2	30	-	50	50
	CORE PRACTICAL III	16SP21/4C/PR3	Immunology and Molecular Biology	-	4	60	-	-	-
	CORE PRACTICAL V	16SP21/4C/PR4	Environmental Microbiology	-	4	60	-	-	-
	CORE PRACTICAL V	16SP21/4C/PR5	Food and Industrial Microbiology	-	4 **30 Hrs**	60	-	-	-
	INTERNSHIP*			2 **18 Credits**					
	SELF STUDY PAPER **		Life Sciences for Competitive Examinations	2			100		100
IV	CORE VIII	16SP21/4C/MBY	Molecular Biology and Recombinant DNA Technology	4	5	75	40	60	100
	CORE IX	16SP21/4C/FDY	Food and Dairy Microbiology	4	4	60	40	60	100
	CORE X	16SP21/4C/PRO	Project	4	4	60	40	60	100
	CORE ELECTIVE V	16SP21/4E5/BIF 16SP21/4E5/GAP	Bioinformatics / Genomics and Proteomics	3	3	45	40	60	100
	SOFT SKILL	16SP21/4S/WES	Women Entrepreneurship Development	2	2	30	40	60	100
	CORE PRACTICAL III	16SP21/4C/PR3	Immunology and Molecular Biology	4	4	60	40	60	100
	CORE PRACTICAL IV	16SP21/4C/PR4	Environmental Microbiology	4	4	60	40	60	100
	CORE PRACTICAL V	16SP21/4C/PR5	Food and Industrial Microbiology	4 **29 Credits**	4 **30 Hrs**	60	40	60	100
	***Internship will be carried out during summer vacation of the II semester **Self-Study Paper for Advanced Learners (Students with distinction in first and second semester) Total credits of III and IV semester=47+2 Total credits=91 + 2**								

STRUCTURE OF SOFT SKILL PAPERS

SEMESTER	CODE	COURSE TITLE
I	Soft Skill	
II	Soft Skill	
III	16SP21/3S/BCG	Basic Computing
IV	16SP21/4S/WES	Entrepreneurship Development

EVALUATION PATTERN FOR CONTINUOUS ASSESSMENT

INTERNAL VALUATION BY COURSE TEACHER/S

CORE/ELECTIVE/PROJECT-THEORYPAPERS

S.NO	COMPONENT	TIME	MAX.MARKS	CA MARK
1	Test I	2 Hrs	50 Marks (To Be Converted to 10)	10
2	Test II	2 Hrs	50 Marks (To Be Converted to 10)	10
3	Assignment/Seminar/Field Visit			10
4	Participatory Learning			10
	Total			40

CORE/ELECTIVE-PRACTICAL PAPERS

S.NO	COMPONENT	TIME	MAX.MARKS	CAMARK
1	Test I	2 Hrs	50 Marks (To Be Converted to 10)	10
2	Test II	2 Hrs	50 Marks (To Be Converted to 10)	10
3	Maintenance Of Observation/Record			10
4	Participatory Learning			10
	Total			40

PROJECT

S.NO	COMPONENT	TIME	MAX.MARKS	CAMARK
1	Presentation I	2 Hrs	50 Marks (To Be Converted to 10)	10
2	Presentation II	2 Hrs	50 Marks (To Be Converted to 10)	10
3	Table Work			10
4	Participatory Learning			10
	Total			40

CA QUESTION PAPER PATTERN

Knowledge Level	Section	Word Limit	Marks	Total
K2	A – 3 x 2 Marks	50	6	50
K2, K3	B – 3 x 8 Marks	500	24	
K2, K3, K4	C – 1 x 20 Marks	1500	20	

RUBRICS FOR CONTINUOUS ASSESSMENT

Assignment	Content/originality/Presentation/Schematic Representation and Diagram/Bibliography
Seminar	Organisation/Subject Knowledge/Visual Aids/Confidence level/Presentation-Communication and Language
Field Visit	Participation/Preparation/Attitude/Leadership
Participation	Answering Questions/Clearing Doubts/Participating in Group Discussions/Regular Attendance
Case Study	Finding the Problem/Analysis/Solution/Justification
Problem Solving	Understanding Concepts/Formula and Variable Identification/Logical Sequence/Answer
Group Discussion	Preparation/Situation Analysis/Relationship Management/Information Exchange/Delivery Skills
Flipped/Blended Learning	Preparation/Information Exchange/ Group interaction/Clearing doubts

END SEMESTER EVALUATION PATTERN

THEORY PAPERS

SEMSTER I/II/III/IV

DOUBLE VALUATION BY INTERNAL EXAMINER AND EXTERNAL EXAMINER
MAXIMUM MARKS: 100 TO BE CONVERTED TO 60

PASSING MARKS: 50

PRACTICAL PAPERS

SEMSTER II/IV

DOUBLE VALUATION BY INTERNAL EXAMINER AND EXTERNAL EXAMINER

MAXIMUM MARKS: 100 TO BE CONVERTED TO 60
PASSING MARKS: 50

SOFT SKILLS PAPERS

SEMESTERI/II/III/IV

SINGLE VALUATION BY COURSE TEACHER

MAXIMUM MARKS: 50
PASSING MARKS: 25

PROJECT PAPER

SEMESTERIV

DOUBLE VALUATION BY INTERNAL EXAMINER AND EXTERNAL EXAMINER

DISSERTATION: 40
VIVA: 20
MAXIMUM MARKS: 100
PASSING MARKS: 50

INTERNSHIP

21-day Internship after I year during summer vacation –Mandatory.

SELF STUDY PAPER

SEMESTER II AND III

SINGLE VALUATION BY COURSE TEACHER

MAXIMUM MARKS: 100

PASSING MARKS: 50

SEMESTER I COURSE PROFILE-PROGRAMME OF STUDY

COURSE CODE	TITLE OF THE PAPER	CREDITS	HOURS /WK	TOTAL HOURS	L-T-P	CA	SA	TOTAL
16SP21/1C/GMP	General Microbiology and Microbial Physiology	4	5	75	4-1-0	40	60	100
16SP21/1C/CBY	Cell Biology	4	5	75	4-1-0	40	60	100
16SP21/1C/SSA	Soil Fertility and Sustainable Agriculture	4	5	75	4-1-0	40	60	100
16SP21/1E1/BST	Biostatistics	3	3	45	2-1-0	40	60	100
PG21/1S/PEW	Personality Enrichment for Women	2	2	30				
16SP21/2C/PR1	General Microbiology and Microbial Physiology	-	5	75	0-0-4	40	60	100
16SP21/2C/PR2	Medical Microbiology	-	5	75	0-0-4	40	60	100
	TOTAL CREDITS	**17**						

SEMESTER I

GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

TOTAL HOURS: 75 **COURSE CODE: 16SP21/1C/GMP**
CREDITS: 4 **LT P: 4 1 0**

COURSE OBJECTIVES:

1. Impart basic knowledge about the History of Microbiology and Classification of Microorganisms.
2. Throw light on principles and working of different microscopes.
3. Discuss the important properties and functions of enzymes.
4. Impart the fundamentals and importance of biosynthetic pathways.
5. Provide insights on sterilization and antibiotics.

COURSE OUTLINE:

UNIT I **15 Hours**

History of Microbiology, Whittaker's Five Kingdom concept, Eight Kingdom concept and Three domain Concept. Overview of Bergey's Classification. Phenetic, Phylogenetic and Genotypic Classification. Numerical Taxonomy-Similarity Matrix, Dendrograms. Microbial Nutrition - Nutritional requirements -Nutritional Types of bacteria. Nutrient transport mechanisms and Iron uptake. Staining - Classification of Stains with examples. Microbial growth - Growth Media and its type - Cultivation of Bacteria - Aerobic and Anaerobic methods - Growth curve and Measurement of Growth - Cell Number, Cell Mass and Metabolic activity. Batch, Continuous, Synchronous and Asynchronous cultures, Factors affecting growth. Preservation of Microbial cultures.

UNIT II **15 Hours**

Microscopy - Principle, Working and Application -Bright field, Dark field, Phase contrast, Differential Interference contrast, Fluorescence Microscopy - FRET and Confocal Microscopy, Transmission and Scanning Electron microscopy - Specimen preparation - Negative staining, Shadow casting, Freeze fracture methods and Image processing methods.

UNIT III **15 Hours**

Enzymes - properties, functions and regulation. Mechanism of ATP synthesis - Substrate level Phosphorylation - Embden-Meyerhof pathway, Entner-Doudoroff pathway, Pentose Phosphate pathway, Phosphoketolase pathway, Fermentation. Oxidative Phosphorylation - Tricarboxylic Acid cycle, Electron Transport chain, Chemiosmosis. Photophosphorylation - Cyclic and Non-cyclic. Calvin-Benson cycle.

UNIT IV **15 Hours**

Brief account of Biosynthetic pathways - Peptidoglycan synthesis, Amino acids, Nucleic acids, Phospholipids. Metabolism of lipids - β oxidation, Fatty acid biosynthesis and Methanogenesis. Anaerobic respiration. Bioluminescence- Process and Applications

UNIT V **15 Hours**

Sterilization - Physical and Chemical Methods- High temperature - Moist heat and Dry heat, Radiation and Filtration. Disinfection methods - Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals, Dyes, Detergents, Quaternary Ammonium compounds, Aldehydes and Gaseous agents. Quality control of Sterilization methods. Antibiotics Classification and Mechanism of action. Antibacterial sensitivity testing methods and Quality control. Mechanisms of Drug resistance and antibiotic policy, CLSI guidelines, EUCAST.

RECOMMENDED TEXT BOOKS:

1. Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th edn., Mc Graw – Hill, New York.
2. Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th edn., McGraw-Hill International edition.
3. Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th edn., A La Carte Pearson.
4. Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th edn., McGraw Hill Inc. New York.
5. Boyd, R.F. (1998). General Microbiology, 2nd edn., Times Mirror, Mosby College Publishing, St Louis.

REFERENCES:

1. Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5th edn., MacMillan Press Ltd.

2. Tortora, G.J., Funke, B.R. and, Case, C.L (2013). Microbiology-An Introduction, 11th edn., Benjamin Cummings.
3. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5thhedn., McGraw Hill Publications.
4. Wheelis M, (2007). Principles of Modern Microbiology, 1st edn., Jones and Bartlett Publishers, Inc.
5. Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). Brock - Biology of Microorganisms, 13thedn., Benjamin-Cummings Pub Co.

JOURNALS:

1. Journal of Applied Microbiology.
2. Journal of Pure and Applied Microbiology.

E-LEARNING RESOURCES:

1. https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
2. https://www.keyence.com/ss/products/microscope/bz-x/study/principle/structure.jsp
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/#
4. https://bio.libretexts.org/@go/page/9188
5. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/
6. https://www.lamission.edu/lifesciences/lecturenote/mic20/Chap06Growth.pdf
7. https://www.britannica.com/science/photosynthesis

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Analyze the basics concepts of microorganisms its classification. Demonstrate nutritional requirement, modes of nutrient transport and cultivation of bacteria.
CO 2	Apply the knowledge acquired on different microscopes, working principles for visualization and study of structural features of microorganisms.
CO 3	Compare various metabolic pathways and discuss the properties and functions of enzymes. Analyze methods of energy generation in bacteria.
CO 4	Illustrate various biosynthetic pathways and discuss the importance of these processes in relationship with environment
CO 5	Apply methods of physical and chemical sterilization in Microbiology. Evaluate antibiotics and their modes of action.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	2	3	3	3	2	3	2
CO 2	3	2	3	2	2	3	2	2
CO 3	3	3	3	3	2	2	3	2
CO 4	2	3	3	2	2	2	3	2
CO 5	1	2	2	2	2	2	3	2
Average	**2**	**2.4**	**2.8**	**2.4**	2.4	**2.2**	**2.8**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Online Teaching, e-content, Practical Learning, Group Discussion, Assignment, Quiz and Seminars, Online games and Quizzes.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

CELL BIOLOGY

TOTAL HOURS: 75 **COURSE CODE: 16SP21/1C/CBY**
CREDITS: 4 **LT P: 4 1 0**

COURSE OBJECTIVES:

1. Explain prokaryotic cell structure and organization.
2. Impart knowledge on eukaryotic cell structure and function.
3. Summarize the importance of organelles involved in transport of molecules.
4. Illustrate the cell signaling molecules and their pathways.
5. Discuss the significant aspects of cell cycle and cancer Biology.

COURSE OUTLINE:

UNITI **15 Hours**

Cell Organization-Prokaryotic cell structure - Cell Wall, Membrane, Capsule, Flagella, Inclusion Bodies and Spores. Differences between Prokaryotic and Eukaryotic cells.

UNITII **15 Hours**

Eukaryotic Cell Structure and Organization - Plasma membrane - Structure and transport of small molecules-Cell Wall, Extra cellular matrix and Cell matrix interactions, Cell - Cell Interactions-Adhesion junctions, Tight junctions ,Gap junctions and Plasmodesmata. Mitochondria, Chloroplasts and Peroxisomes. Cytoskeleton - Structure, types and functions of Intermediate filaments, Micro filaments, Actin binding proteins microtubules. Nucleus - Nuclear envelope, Nuclear pore complex and Nuclear lamina. chromatin - Molecular organization and Nucleolus.

UNIT III **15 Hours**

Protein Sorting and Transport - Ribosomes, Endoplasmic Reticulum-Structure, function and transport from ER to Golgi complex targeting and insertion of proteins in the ER, Protein folding, Processing and Quality control in ER, smooth ER and Lipid synthesis, export of Proteins and Lipids. Golgi apparatus-Organization, Protein glycosylation, Sorting Protein sorting and Targeting of Vesicles and Export from Golgi apparatus, Lysosomes.

UNIT IV **15 Hours**

Cell Signaling - Signaling molecules - Extracellular Messengers and Intracellular messengers - functions of Cell surface receptors - G Protein coupled receptors, Insulin receptors. Pathways of Intracellular Signal transduction – Cyclic AMP pathway, Cyclic GMP, and Ras – MAP kinase pathway. Signaling network - Feedback and Cross talk - Network of Signal transduction.

UNIT V **15 Hours**

Eukaryotic cell cycle and its Regulation - Mitosis and Meiosis. Cancer Biology - Development of Cancer, causes, properties and types - Programmed cell death. Stem cells - Embryonic stem cell, Induced pluripotent stem cells.

RECOMMENDED TEXT BOOKS:

1. Pelczar. M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7thedn., Mc Graw – Hill, New York.
2. Watson J.D., Gann A., Baker T.A., Levine M., Bell S.P and Losick.R. (2014). Molecular Biology of the Gene. 7thedn., Pearson.
3. Karp G.(2010). Cell and Molecular Biology: Concepts and Experiments. 6thedn., John Wiley & Sons. Inc.

REFERENCES:

1. Hardin J, Bertoni G and Kleinsmith L.J.(2010). Becker's World of the Cell. 8thedn., Pearson.
2. Willey J., Sherwood L., and Woolverton C. J. (2017). Prescott's Microbiology. 10thedn., McGraw-Hill International edition.
3. Krebs JE, Goldstein ES and Kilpatrick ST (2014). Lewin Genes XI. Jones and Bartlett Learning LLC.
4. De Robertis, EDP and De Robertis EMF.(2006).Cell and Molecular Biology. 8th edn., Lipincott Williams and Wilkins, Philadelphia.
5. Cooper, G.M. and Hausman, R.E.(2009).TheCell:AMolecularApproach.5th edn., ASM Press & Sunderland, Washington ,D.C.; Sinauer Associates, MA.

JOURNALS:

1. Journal of Microbiology
2. Journal of Cell Biology

E-LEARNING RESOURCES:

1. https://www.ncbi.nlm.nih.gov/books/NBK9963/
2. https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/changes-in-signal-transduction-pathways/a/intracellular-signal-transduction
3. https://www.ibiology.org/cell-biology/protein-sorting/
4. https://www.nature.com/scitable/topicpage/eukaryotic-cells-14023963/
5. https://www.easybiologyclass.com/bacterial-endospore-definition-characteristics-structure-and-its-formation/
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4700099/

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Apply the knowledge on prokaryotic structural organization.
CO 2	Analyze the importance of eukaryotic structure and function.
CO 3	Evaluate the role of protein sorting and its transport to right destination.
CO 4	Elucidate the significance of cell communication and its pathways.
CO 5	Assess the concepts of cell growth and division and the important concepts on cancer biology.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	2	3	2	2	2	2	2
CO 2	3	2	2	2	3	2	2	2
CO 3	1	2	2	2	2	2	2	3
CO 4	2	3	2	2	2	2	2	3
CO 5	2	2	2	2	2	2	2	2
Average	**2.2**	**2.2**	**2.2**	**2**	**2.2**	**2**	**2**	**2.4**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Flipped Learning, Online Teaching, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning and Seminar, Interactive classes, Online games and Quizzes.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

SOIL FERTILITY AND SUSTAINABLE AGRICULTURE

TOTAL HOURS: 75 **COURSE CODE: 16SP21/1C/SSA**
CREDITS: 4 **LT P: 4 1 0**

COURSE OBJECTIVES:

1. Demonstrate the role of soil microorganisms and analyze the methods for studying soil microbial communities.
2. Analyze the process of organic matter decomposition and nitrogen fixation.
3. Discuss the benefits resulting from interactions of soil microbes.
4. Outline the process of plant pathogenesis and plant defence mechanisms.
5. Describe the symptoms and control of plant disease and discuss integrated plant disease Management.

COURSE OUTLINE:

UNIT I **10 Hours**

Features of soil microhabitat, Diversity and functions of soil microbial communities, Methods for assessing Microbial diversity - Culture dependent (Dilution plating and CLPP) and Culture independent methods - Phospholipid fatty acid analysis (PLFA) – Fatty acid signatures, rRNA analysis, FISH. Parameters of Soil microbiological activity – Basal Respiration and Fluorescein diacetate hydrolysis

UNIT II **10 Hours**

Organic matter decomposition – Sources, Process and microbes involved, Soil organic Matter (SOM) – Components, Humus, C:N ratio. Biological Nitrogen fixation- Chemistry and Genetics of BNF, N_2 fixing microorganisms and Quantification methods. Engineering *nif* genes. Microbial transformation of Carbon, Nitrogen and Phosphorus.

UNIT III **15 Hours**

Microbial Interactions - Mutualism, Commensalism, Amensalism, Synergism, Competition, Rhizosphere- Rhizosphere effect, Mycorrhizae – Types, Endophytes, PGPR- PGPR traits, Biofertilizers – Types, benefits, mass production, Formulations and applications.

UNIT IV **10 Hours**

History of Phytopathology and Major epidemics, Disease cycle of Plant pathogens, Types of disease symptoms, Structural and Inducible biochemical defenses - Systemic Acquired Resistance (SAR), pathogenesis related (PR) proteins, Plantibodies, Phenolics, Phytoalexins.

UNIT V **15 Hours**

Etiological agent, Symptoms, Epidemiology and Control of Late blight of Potato, Black Stem rust of Wheat, Wilt of Tomato, Angular Leaf Spot of cotton, Leaf blight of Paddy, Rice Tungro, Potato Spindle Tuber, Integrated Plant Disease Management, Biopesticides.

RECOMMENDED TEXT BOOKS:

1. Subbarao.N.S. (2005). Soil microorganisms and Plant Growth. 4th edn., Oxford and IBH Publishing Pvt Ltd.
2. Agrios, G. (2005). Plant Pathology, 5th edn., Reed Elsevier India Private Limited, New Delhi, India.
3. Subbarao.N.S.(1995). Biofertilizers in Agriculture and Forestry, 3rd edn., Oxford and IBH PublishingCo. Pvt Ltd.

REFERENCES:

1. Rangaswami G. (2005). *Diseases of Crop Plants in India*. 4th edn., Prentice Hall of India Pvt. Ltd., New Delhi.
2. Ogram A, Castro H, Chauhan A. **(**2007). Methods of Soil Microbial Community Analysis, p 652-662. *In* Hurst C, Crawford R, Garland J, Lipson D, Mills A, Stetzenbach L (ed), Manual of Environmental Microbiology, 3rd edn., ASM Press, Washington, DC. doi: 10.1128/9781555815882.ch53.
3. Mukesh Meena, Dubey, M. K., Prashant Swapnil, Andleeb Zehra, Shalini Singh, Punam Kumari, Upadhyay, R. S. Advances in PGPR research (Eds**)** Singh, H. B., Sarma, B. K., Keswani, CDOI10.1079/9781786390325.0000.
4. Paul, E.A. and Clark, F.E, (1996).Soil Microbiology and Biochemistry. 2nd edn., Academic Press, London.
5. Atlas R. M and Bartha R. (1998). Microbial Ecology Fundamentals and Applications 3rd edn., Benjamin Cummings. Redwood City .CA

WEB RESOURCES:

1. plantpath.cornell.edu/labs/enelson/PDFs/Hill_et_al_2000.pdf
2. http://hs.umt.edu/dbs/labs/holben/documents/publications/Ramsey%20PLFA%20CLPP%20Pedobiologia%202006.pdf
3. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2389.2005.00781.x
4. https://www.agriculturejournals.cz/publicFiles/52808.pdf
5. https://scielo.isciii.es/pdf/im/v8n1/revision2.pdf

JOURNALS:

1.Indian Journal of Agricultural Research.
2.Journal of Plant Pathology and Microbiology.

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Analyze the diversity and functions of soil microorganisms and methods to assess soil microbiological activity and diversity.
CO 2	Evaluate soil organic matter decomposition and biological nitrogen fixation
CO 3	Infer the outcomes of interactions among microbes and evaluate the benefits of microbe-plant communion.
CO 4	Summarize the disease cycle of plant pathogens and plant defence mechanisms against pathogens.
CO 5	Illustrate the etiology, symptoms and treatment of plant diseases and interpret integrated plant disease management.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	2	3	1	2	2	2	2
CO 2	3	1	3	1	1	3	2	2
CO 3	3	3	3	3	3	2	3	3
CO 4	3	2	3	2	3	2	2	2
CO 5	2	3	2	2	2	2	3	2
Average	**2.8**	**2.2**	**2.8**	**1.8**	**2.2**	**2.2**	**2.4**	**2.2**

TEACHING METHODOLOGY

Lecture by Chalk and Board, Online Teaching, e-content, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

BIOSTATISTICS
(For Applied Microbiology students)

TEACHING HOURS: 45 **COURSE CODE: 16SP21/1E1/BST**
CREDITS: 3 **LTP: 3 0 0**

COURSE OBJECTIVES:

1. Demonstrate the importance of biostatistics, sampling types and representation of data.
2. Illustration on methods used for measuring central tendency and dispersion.
3. Discuss Probability theory and its applications in solving biological problems.
4. Explain Correlation, regression and hypothesis testing methods.
5. Identify appropriate method for analysis of variance and understand statistical packages.

COURSE OUTLINE:

UNIT I **10 Hours**

Introduction to Biostatistics, basic concepts and applications in Research. Data Collection and Analysis, Types of Data. Sampling -Designs and Types. Representation of Data- Tabulation, Frequency distribution, Diagrams and Graphs.

UNIT II **10 Hours**

Measures of Central tendency – Mean, Median and Mode, Deciles and Percentiles. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of Variation and Standard error. Measure of Skewness and Kurtosis. Computation of Mean and Standard Deviation using Excel.

UNIT III **8 Hours**

Probability: Random experiment, Events, Sample space, Mutually exclusive events, Independent and dependent events, Addition and Multiplication theorems of Probability, Random Variables (Discrete and Continuous), Probability Distributions-Binomial, Poisson and Normal Distributions.

UNIT IV **7 Hours**

Correlation - Types, Methods, Coefficient of Correlation. Regression - Equations, Regression lines. Testing of Hypothesis -Null Hypothesis, Alternate Hypothesis, Type I and Type II Errors. Tests of Significance- Chi-Square test, Student t test and Z score.

UNIT V **10 Hours**

Analysis of variance- ANOVA-One-way classification and Two-way classification CRD, RBD, LSD, Duncan's Multiple Range Test (DMR) and least significant difference. Statistical treatment of Proportion data (MPN, toxicity testing and immunization schedule) and Count data (Bacterial colony count and radioactivity count). Features of Statistical software like R programming and its applications in Data analysis.

RECOMMENDED TEXT BOOKS:

1. Rastogi V.B. (2011). Fundamental of Biostatistics, 2nd edn., Ane books Pvt.Ltd.
2. Gupta S.P. (2021). Statistical methods, 46th edn., Sultan Chand & Sons Publisher, New Delhi.
3. C.R. Kothari and Gaurav Garg (2014). Research Methodology-Methods and techniques, 2nd edn., New age publication.

REFERENCE BOOKS:

1. Rosner B. (2016). Fundamentals of Biostatistics,8thedn., Cengage Learning USA.
2. Pagano M. and Gauvreau K. (2018). Principles of Biostatistics 2nd edn., CRC press.
3. Zar, J.H. (2008). Biostatistical analysis. 4thedn., Pearson education Inc. New Jersey.
4. Daniel, W.W. (1999). Biostatistics: A foundation for analysis in health sciences. 7th edn., John Wiley & Sons, New York.
5. N. Gurumani. (2009). An Introduction to Biostatistics, 2ndedn., MJP publishers.

JOURNALS:

1. International Journal of Biostatistics.
2. Journal of the Royal statistical society.

E LEARNING RESOURCES:

1. https://www.hopkinsmedicine.org/gim/research/method/biostat.html
2. https://statistics.laerd.com/statistical-guides/measures-central-tendency-mean-mode-median.php
3. https://www.researchgate.net/publication/282576221_Proofs_in_Biostatistics_and_Probability
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC374386/
5. http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704_HypothesisTesting-ANOVA/BS704_HypothesisTesting-Anova_print.html

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Apply knowledge of data collection and presentation of data in various fields of Microbiology
CO 2	Assess and implement central tendency, deviation and error in the data collected during research
CO 3	Apply the knowledge of probability theory and its applications in research data analysis
CO 4	Use the methods of calculating correlation, regression in research data analysis and test the hypothesis to solve simple problems from biological sciences
CO 5	Elucidate the methods of analysis of variance in research and usage of statistical packages

MAPPING - COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	2	2	2	2	3	2	2
CO 2	2	2	2	2	2	3	2	2
CO 3	1	1	1	1	2	3	2	2
CO 4	2	2	2	2	1	3	2	2
CO 5	2	2	2	2	2	3	2	2
Average	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**3**	**2**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Online Teaching, Flipped Learning, e-content, Problem Solving, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

SEMESTER II COURSE PROFILE-PROGRAMME OF STUDY

COURSE CODE	TITLE OF THE PAPER	CREDITS	HRS /WK	TOTAL HOURS	L-T-P	CA	SA	TOTAL
16SP21/2C/MMY	Medical Microbiology	4	5	75	3-1-0	40	60	100
16SP21/2C/IPM	Industrial and Pharmaceutical Microbiology	4	4	60	3-1-0	40	60	100
16SP21/2E2/MIG	Microbial Genetics	3	3	45	2-1-0	40	60	100
16SP21/2E3/RMY	Research Methodology	3	3	45	2-1-0	40	60	100
16SP21/2E/VMB	Vermitechnology and Applied Mushroom Biology	3	4	60	3-1-0	40	60	100
Soft skill		2	2	30		40	60	100
16SP21/2C/PR1	General Microbiology and Microbial Physiology	4	4	60	0-0-4	40	60	100
16SP21/2C/PR2	Medical Microbiology	4	5	75	0-0-4	40	60	100
	TOTAL CREDITS	**27+2**						

SEMESTER II
MEDICAL MICROBIOLOGY

TOTAL HOURS: 75 **COURSE CODE: 16SP21/2C/MMY**
CREDITS: 4 **LTP: 3 2 0**

COURSE OBJECTIVES:

1. Impart knowledge on host parasite interactions and important bacterial infections.
2. Equip the students with knowledge on the diverse viral infections, their laboratory diagnosis and treatment methods.
3. Provide in-depth knowledge on superficial, systemic and opportunistic infections caused by fungi.
4. Explain the role of protozoans and helminths as infectious agents.
5. Provide insights on collection, processing of specimen and laboratory diagnosis of pathogenic bacteria.

COURSE OUTLINE:

UNIT I **15 Hours**

An overview of Host parasite relationship. Bacteriology- Gram Positive- *Staphylococcus aureus, Streptococcus pyogenes* and *Clostridium tetani*. Gram Negative- *Neisseria gonorrhoeae, Vibrio cholerae* and *Helicobacter pylori*. Slow growers and Non-cultivable bacteria- *Mycobacterium* sp- tubercle and leprae bacilli, MAIS complex. Spirochetes- *Treponema pallidum*.

UNIT II **15 Hours**

Virology- DNA virus –Herpes (HHV1,2 and 3) and HBV. RNA viruses-Polio and Coxsackie, HIV, Rabies, Influenza, Mumps, Measles, Rubella and SARS COV 2. Oncogenic viruses- Human Papillomavirus, Epstein Barr virus and HCV. Arthropod borne infections- Dengue and Chickungunya.

UNIT III **15 Hours**

Mycology- Agents of Superficial Mycoses- *Malassezia furfur* and Dermatophytes- *Trichophyton, Epidermophyton* and *Microsporum*. Subcutaneous- Eumycetoma, *Sporothrix*.

Systemic mycoses - *Histoplasma capsulatum*. Differential diagnosis from other systemic fungi. Opportunistic mycoses- *Candida*, *Cryptococcus*.

UNIT IV **15 Hours**

Parasitology-Protozoa-*Entamoeba, Toxoplasma, Trichomonas, Leishmania donovani Trypanosoma, Plasmodium* and *Cryptosporidium*. Helminths-*Taenia, Enterobius, Schistosoma, Ascaris, Ancylostoma* and *Wuchereria.*

UNIT V **15 Hours**

Diagnostic Microbiology- Collection, Transport and Processing of Specimens for pathogen identification. Sensitivity vs specificity, false positives and false negatives. Antimicrobial agents for effective control of infections. Biomedical Waste management- Safe disposal of infectious waste.

RECOMMENDED TEXTBOOKS:

1. Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology. 19th edn., Lange Medical Publications, U.S.A.
2. Ananthanarayanan,R. and Panicker,C.K.J. (2017). Textbook of Microbiology. 10th edn., Orient Longman.
3. Chander, J. (2009). A Text book of Medical Mycology. 3rd edn., Mehta publishers. New Delhi.
4. Chatterjee (2009). Medical Parasitology. 13th edn., CBS Publishers, New Delhi.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th edn., Elsevier, Mosby Saunders.
6. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartney Practical Medical Microbiology. 14thedn., Churchill Livingston.

REFERENCE BOOKS:

1. Greeenwood D., Slack R.C.B and Peutherer J.F. (1992). Medical Microbiology. 14thedn., ELBS, Churchill Livingston.
2. Parija S. C. (1996). Text Book of Medical Parasitology.4th edn., Orient Longman, All India Publishers & Distributors.
3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22ndedn., Cambridge University Press.
4. Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. 4th edn., Mc Graw Hill, New York.
5. Fisher, F. and Cook, N.B. (1998). Fundamentals of Diagnostic Mycology. 1st edn., W.B. Saunders Company, Pennsylavania.
6. Topley and Wilson's. (1998). Principles of Bacteriology.9th edn., Edward Arnold, London.

JOURNALS:

1. Indian Journal of Medical Microbiology.
2. Diagnostic Microbiology and Infectious disease.

E-LEARNING RESOURCES:

1. https://www.sciencedirect.com/topics/immunology-and-microbiology/virulence-factors
2. http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-95742015000500034
3. https://journals.lww.com/revmedmicrobiol/Fulltext/2001/01000/Infections_due_to_anaerobic_bacteria_and_the_role.1.aspx
4. https://academic.oup.com/cid/article/33/6/834/329873
5. https://www.dovepress.com/antibiotic-resistance-a-rundown-of-a-global-crisis-peer-reviewed-fulltext-article-IDR#
6. https://www.healthcare.uiowa.edu/path_handbook/Appendix/Micro/micro_spec_collection.html.
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4001330/
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5620758/
9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5508608/
10. https://accessmedicine.mhmedical.com/content.aspx?bookid=1130&sectionid=79739575
11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4731227/
12. https://www.intechopen.com/books/current-issues-in-molecular-virology-viral-genetics-and-biotechnological-applications/vaccines-and-antiviral-agents

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Analyze the etiological agents of bacterial diseases and implement appropriate diagnostic methods.
CO 2	Apply the knowledge of viral diseases and pathogenesis in identification and control.
CO 3	Differentiate pathogenic and opportunistic fungi diagnose them.
CO 4	Adopt control measures for preventing parasitic diseases.
CO 5	Detect microbes from clinical specimens and follow biosafety protocols for effective hospital waste disposal and deploy antibiotic control policy in management of drug resistance.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	3	1	2	2	2	2	2
CO 2	3	3	2	2	2	2	2	2
CO 3	3	3	2	2	2	2	2	2
CO 4	3	3	2	2	2	2	2	2
CO 5	2	3	3	2	2	3	3	2
Average	**2.8**	**3**	**2**	**2**	**2**	**2**	**2.2**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Flipped Learning, e-content, Online Teaching, Problem Solving, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY

TEACHING HOURS: 60 **COURSE CODE: 16SP21/2C/IPM**
CREDITS: 3 **LTP: 3 1 0**

COURSE OBJECTIVES:

1. Describe the stages in Industrial Fermentation processes.
2. Explain the Construction, Design and Operation of Fermenter.
3. Provide insights on Downstream process and importance of fermentation economics.
4. Illustrate the Principles of Pharmaceutical Microbiology.
5. Introduce the concepts of Industrial production of Microbial products.

COURSE CONTENT:

UNIT I **10 Hours**

Introduction to industrial microbiology: Sources of industrially important microbes (GRAS), Criteria for selection and strategies for Strain development, maintenance and containment of recombinant organisms, types of Fermentation processes- Batch, Fed batch and Continuous Culture kinetics, Inoculum development – Bacteria, Yeast and Mycelium and recent developments in fermentation technology.

UNIT II **10 Hours**

Basic features, design, components of a typical fermentor and bioreactor, different types of fermentor. Instrumentation and control of fermentation parameters. Fermentation Media – formulation strategies- Sources of Carbon and Nitrogen, Vitamins and Minerals; Role of buffers, precursors, Inducer and Inhibitors. Sterilization of Air, Equipment and medium- Batch sterilization and Continuous Sterilization, Concept and derivation of Del factor. Aeration and Agitation- concepts of Newtonian and Non-Newtonian fluids, Plastic fluids, Apparent viscosities and Antifoam agents. Scale up and Scale down process.

UNIT III **15 Hours**

Principle and methods of Down-Stream Processing- Choice of recovery process, Biomass separation from Fermentation Media- Precipitation, Filtration, Centrifugation, Cell disruption for Intracellular products, Solvent extraction and Recovery, Chromatography, Membrane processes, drying, Crystallization and Whole broth processing. Fermentation economics:

Guidelines for a successful Economically viable fermentation process, Market potential of the products, Cost break down of various stages in the processes development including Effluent treatment.

UNIT IV **10 Hours**

Introduction to Pharmaceutical Microbiology-Microbiological spoilage, Prevention and Preservation of Pharmaceutical products. Sterility testing of Pharmaceutical products and Quality assurance- GMP, QC of Raw materials and Microbiological assays. Formulation of Biotechnological Products, Drug Delivery, Concept of Pharmacokinetics and Pharmacogenomics. Government regulations and Ethical issues involved in Microbial products.

UNIT V **15 Hours**

Important industrial and Pharmaceutical products- Amino acids- Glutamic acid and Lysine, Enzymes-Amylase, Protease and Pectinase, SCP-Baker's yeast, Solvents -Ethanol and Butanol, Alcoholic beverages – Wine and Beer, Vitamins- Cyanocobalamin and Riboflavin, Antibiotics- (Penicillin, Streptomycin and Tetracycline), Vaccines (Tetanus and Corona), Recombinant products (Hepatitis vaccine and insulin), Biopreservatives (Nisin) and Microbial transformation of Steroids.

RECOMMENDED TEXT BOOKS:

1. Stanbury, P. F., Whitaker, A., and Hall, S.T. (2017). Principles of Fermentation Technology 3rd edn., Pergamon press.
2. Reed,G. (2004). Prescott and Dunn's Industrial Microbiology, 4th edn., CBS publication and distributors.
3. Patel A.H (2012). Industrial Microbiology. 2nd edn., Mac Millan India Pvt Ltd.

REFERENCE BOOKS:

1. Cruger, W., Anneliese, C and Aneja, K.R. (2017). Biotechnology-A textbook of Industrial Microbiology, 3rd edn., Medtech publisher.
2. Stephen P Denyer, Norman A Hodges, Sean P. Gorman and Brendan F Gilmore (2011). Hugo &Russell's Pharmaceutical Microbiology, 8th edn., Wiley Blackwell.
3. Sivakumar, P.K., Joe, M.M and Sukesh, K. (2010). An introduction to Industrial Microbiology, 1st edn., S.Chand and Company Ltd, New Delhi.
4. Peppler, H.J. and Pearl Man, D. (1979). Fermentation Technology, Vol 1 & 2, 2nd edn., Academic Press, London.
5. E1-Mansi, E.M.T., Bryce, C.F.A., Demain, A.L. and Allman,A.R. (2007). Fermentation Microbiology and Biotechnology, 2nd edn., CRC press, Taylor and Francis Group.

JOURNALS:

1. Journal of Industrial Microbiology and Biotechnology.
2. Journal of International pharmaceutical research.

E -LEARNING RESOURCES:

1. http://www.biologydiscussion.com/microbiology-2/microorganisms-microbiology-2/role-of-microorganisms-in-industrial-processes-microbiology/84754
2. https://www.biologydiscussion.com/industrial-microbiology-2/fermentor-bioreactor-history-design-and-its-construction/55756
3. http://www.biologydiscussion.com/biotechnology/downstream-processing/stages-in-downstream-processing-5-stages/10160
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3969074/
5. https://sciencesamhita.com/industrial-products-from-microbes/

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Illustrate knowledge on basics and different stages in Industrial fermentation process.
CO 2	Apply theoretical knowledge on design, construction and working of different types of fermenters and medium formulation on an industrial scale.
CO 3	Outline the stages in downstream process, effluent treatment and fermentation economics.
CO 4	Gain knowledge about pharmaceutical microbiology, Sterility testing of pharmaceutical products and quality assurance.
CO 5	Adopt the processes of primary and secondary metabolite production using biological systems with certain examples

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO7	PSO8
CO 1	2	1	2	3	1	2	1	1
CO 2	2	1	1	3	2	2	2	1
CO 3	2	1	2	3	2	2	2	2
CO 4	2	3	2	3	2	2	2	3
CO 5	2	3	3	3	2	2	2	2
Average	**2**	**1.8**	**2**	**3**	**1.8**	**2**	**1.8**	**1.8**

KEY: STRONGLY CORELATED-3 MODERATELY CORELATED-2 WEAKLY CORELATED-1 NO CORELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Online Teaching, Flipped Learning, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

MICROBIAL GENETICS

TOTAL HOURS: 45 **COURSE CODE: 16SP21/2E2/MIG**

CREDITS: 3 **L T P: 2 1 0**

COURSE OBJECTIVES:

1. Provide a deeper knowledge in structure, replication and repairing mechanisms of DNA.
2. Illustrate the significance and functions of RNA.
3. Distinguish the types and importance of Mutations.
4. Discuss the gene regulation mechanisms in prokaryotes and eukaryotes.
5. Explain different types of gene transfer mechanisms.

COURSE OUTLINE:

UNIT I **10 Hours**

Organization of genetic material – Law of DNA constancy, C-value, C-value Paradox, Genome size, Karyotype and Idiogram, Chromosome banding pattern. Composition and Structure of Eukaryotic and Prokaryotic genome. Topology of DNA, Super helicity of DNA, Cot curves, linking number. Replication in Prokaryotes – Models of DNA replication – Replisome, Unidirectional and Bidirectional replication, Rolling circle replication. Enzymes involved in replication. DNA Methylation, Repetitive and Non- repetitive DNA sequence. Replication in Eukaryotes. Repair of DNA damage- Mismatch repair, Photoreactivation, Excision repair, SOS, recombination repair.

UNIT II **10 Hours**

Structural features of RNA (rRNA, tRNA, mRNA) and Polycistronic and Monocistronic RNA. Transcription, Post transcriptional modification, Maturation and Splicing of RNA Transcripts and Catalytic RNA. Genetic code and Wobble hypothesis. Protein synthesis and Inhibitors of Protein synthesis. Post translational modification. An overview of Protein sorting and Transport.

UNIT III **9 Hours**

Mutation, mutants and mutagenesis -Spontaneous and Induced mutation, Different types of Mutants, Molecular basis of mutagenesis. Transposon mutagenesis, S site directed Mutagenesis and Environmental Mutagenesis. Mutagenic Chemicals and Radiations and their Mechanisms of actions – EMS, MMS, acridines, NTG, Hydroxylamine -Mutagenic Radiations -UV and gamma rays, Importance of Mutation. Mutation Toxicity Testing.

UNIT IV **8 Hours**

Transcriptional regulation in Prokaryotes (Inducible and Repressor system, Positive and Negative regulation) Operon concept-lac and trp Operons. Viral and Phage genetics-Genomic organization and Genetic significance of M13, SV 40, Hep B, H1-N1, Retroviruses. Lytic and Lysogenic cycles of lambda phage. Fungal genetics-Yeast (*Saccharomyces cerevisiae*), Neurospora genomes as genetic model systems. Cytoplasmic inheritance and biochemical mutants.

UNIT V **8 Hours**

Gene Transfer Mechanisms – Conjugation-Discovery, Mechanism, Hfr and F' strains, Interrupted Mating Technique and Time of entry mapping. Transduction-Generalized Transduction, Specialized Transduction, LFT & HFT lysates, Mapping by Recombination and co-transduction of markers, Transformation-Discovery, Mechanism of natural competence. and Transposition-Insertion Sequences, Composite and Non-composite Transposons, Replicative and Non replicative transposition. Legitimate and Illegitimate recombination. Overview of Bacterial Genetic map.

RECOMMENDED TEXT BOOKS:

1. Friedfelder D. (1990). Microbial Genetics, 2nd edn., Navosa publishing house, India
2. Gardner E.J and Snusted D.P (1991). Principles of Genetics, 8th edn., John Wiley and sons Inc.
3. Peter Paolella, Introduction to Molecular biology, 4th edn., International edition, McGraw-Hill.

REFERENCE BOOKS:

1. Hays W. (1985). The Genetics of Bacteria and Viruses. 2nd edn., Blackwell Scientific Publishers, Oxford.
2. Synder L and Chapness W. (1997). 3rd edn., Molecular genetics of bacteria. ASM Press Washington-D.C.
3. Russell P.J. (2010). Genetics in Molecular approach, 3rd edn., Pearson New International edn.
4. Strachan, T. and Read, A. P. (1996). 1st edn., Human Molecular Genetics, Bios Scientific Publishers, U.K.
5. Benjamin Lewin. (1997). Genes VII. 7th edn., Oxford University Press, London, UK.

JOURNALS:

1. Journal of Microbiology and Biotechnology.
2. Research Journal of Biotechnology.

E-LEARNING RESOURCES:

1. https://mmg.natsci.msu.edu/
2. https://geneticgenie.org
3. https://www.nestgrp.com/molbiol.shtml4
4. https://www2.le.ac.uk
5. https://openstax.org/details/books/microbiology

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Analyze the significance of genetic material.
CO 2	Illustrate the types of RNA and protein synthesis machinery
CO 3	Analyze the impact of mutation and its repair mechanism.
CO 4	Identifying and distinguishing genetic regulatory mechanisms.
CO 5	Summarise gene transfer mechanisms for experimental study.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	3	2	3	2	3	2	1
CO 2	3	3	2	3	2	3	2	2
CO 3	2	3	3	3	3	3	3	2
CO 4	3	3	3	3	3	1	3	2
CO 5	2	2	3	2	3	3	3	3
Average	**2.6**	**2.8**	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Computing problems, LCD Classes, Online Teaching, Group Discussion, Quiz, Peer Learning

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

RESEARCH METHODOLOGY

TOTAL HOURS: 45 **COURSE CODE: 16SP21/2E3/RMY**
CREDITS: 3 **LTP: 3 1 0**

COURSE OBJECTIVES:

1. Designing a study and learning bioethics.
2. Applying advance techniques.
3. Exploring research and identifying steps involved.
4. Learn the Art of report and thesis writing.
5. Provide insights on importance of scientific communication, ethical issues in research, plagiarism and IPR.

COURSE OUTLINE:

UNIT I **9 Hours**

Research methodology, research approach. Definition, sampling design and types. Fundamentals of bioethics. Committee on Publication ethics. Ethical issues related to publishing, Data fudging, plagiarism and self-plagiarism, software to detect plagiarism. Data collection and analysis pertaining to ICMR standards.

UNIT II **8 Hours**

Basic concepts of Journals and Publication of Research or Review papers.Criterion for best journals- ISSN, ISBN, Citation Index - Science Citation Index (SCI), Impact factor (SJIF and RJIF), SJR indicator, h-index, g-index, Citescore.WOS, SCOPUS THOMPSON REUTERS, Google Scholar, UGC CARE journals.

UNIT III **9 Hours**

Objectives of research- problem identification and formulation, Approaches, design-exploratory descriptive and experimental, steps and criteria of good research.

UNIT IV **9 Hours**

Writing the Research report-Title, Authors, Address, Abstract, Keywords, Introduction, Review of Literature, Materials and Methods, Results, Discussion, Summary, Acknowledgement and Bibliography. Research report- Tables, Figures and Formatting.

Difference between Dissertation writing and Journal writing. Importance of scientific communication- Types and modes of Scientific communications.

UNIT V **10 Hours**

Journals in Microbiology, impact factor of journals, when and where to publish. Intellectual property rights-types, patents, copy rights, trade marks, design rights, geographical indications - importance of IPR - patentable and non patentables - patenting life - legal protection of inventions - world intellectual property organization (WIPO). IPR in India and abroad.

RECOMMENDED TEXT BOOKS:

1. N. Gurumani. (2006). Research Methodology for Biological Sciences, 1st edn., MJP Publisher.
2. Boyer R.F. (2002).Modern Experimental Biochemistry 3rd edn., Pearson Education.
3. Sharma,K.R. (2002). Research methodology, 1st edn., National Publishing House.

REFERENCE BOOKS:

1. Anderson J.B. and Poole M. (2011). Assignment and Thesis Writing, 4th edn., Wiley India Private Limited.
2. Kothari C.R. and Garg G. (2004). Research Methodology: Methods and Techniques, 2ndedn., New Age International Publishers.
3. Ahuja V.K. (2017).Laws Relating to Intellectual Property Rights, 2nd edn., Lexis Nexis.
4. Goel D. and Parashar S. (2013). IPR, Biosafety and Bioethics, 1st edn., Pearson Education in South Asia.
5. Day, R.A. (1988). How to write and publish a scientific paper, 3rd edn., Oryx Press.

JOURNALS:

1. Journal of Biomedical Instrumentation and Applications.
2. Indian Journal of Applied Research.

E-LEARNING RESOURCES:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5206469/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2757927/
3. https://www.aresearchguide.com/write-a-report.html
4. https://www.wipo.int/about-ip/en/

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Demonstrate the basic concepts of bioethics.
CO 2	Apply knowledge about journals and paper publications.
CO 3	Analyze the basic concepts of publication and research.
CO 4	Utilize the Art of report and thesis writing for scientific communication.
CO 5	Demonstrate the importance of scientific communication, ethical issues in research, plagiarism and IPR.

MAPPING OF COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	3	3	3	2	2	2	2
CO 2	2	3	3	3	2	2	2	2
CO 3	3	3	3	3	2	2	2	2
CO 4	2	2	2	2	2	2	2	3
CO 5	3	2	2	2	2	2	2	3
Average	**2.4**	**2.6**	**2.6**	**2.6**	**2**	**2**	**2**	**2.4**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:
Lecture by Chalk and Board, Flipped Learning, Online Teaching, e-content, Problem Solving, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

Non-Major Elective
VERMITECHNOLOGY AND APPLIED MUSHROOM BIOLOGY
(For other department students)

TOTAL HOURS: 60 **COURSE CODE: 16SP21/2E/VMB**
CREDITS: 3 **L T P: 3 1 0**

COURSE OBJECTIVES:

1. Classify and compare the characteristics of earthworm species and waste materials needed for vermicomposting.
2. Describe the process and benefits of vermicomposting.
3. Differentiate edible and poisonous mushrooms and their effects.
4. Outline the process of mushroom cultivation.
5. Analyze the pathological damage on mushrooms and outline the post-harvest practices.

COURSE OUTLINE:

UNIT I **15 Hours**

Vermicomposting- Definition and scope of vermicomposting. Characteristics, Structureand Types of Earthworm species. Different Stages of development in Earthworm- Cocoon, hatching, Juvenile and Adult. Requirements for Vermicomposting- Physical, Chemical and Biological. Vermiculture- Methods and Application. Enemies of Vermicomposting- Vermiweed and its implications. Differentiation of Composting from Vermicomposting.

UNIT II **10 Hours**

Process of Vermicomposting- Selection of species, Collection methods and Preservation of Earthworms. Production methods- Bed and Pit method – Harvesting methods – Storage and Transportation of Earthworms. Nutrient content of Vermicompost. Application of Vermicompost in Agriculture- Benefits to Soil and Plants. Vermiwash – Production, Composition and its uses.

UNIT III **10 Hours**

Definition and Importance of Mushroom Cultivation. General Characteristics, Types, Structure and Life cycle of Mushrooms. Edible and Poisonous mushrooms. Mycetismus- Cause, Symptoms and Treatment. Nutritional aspects of edible mushrooms -Fats, Carbohydrates, Proteins, Vitamins and Minerals - Medicinal value of Mushrooms.

UNIT IV **15 Hours**

Cultivation techniques of Paddy Straw Mushroom and White button mushroom. Steps involved in cultivation - Pure Culture preparation- Media preparation - Common Media used- Methods - Spore print and Tissue culture. Spawn preparation - Master Spawn and Planting spawn. Composting - Long, short and Bulk pasteurization Methods. Filling, Spawning and its types, Spawn run, Casing -Casing mixture, Treatment and Application. Cropping and Harvest of Mushrooms.

UNIT V **10 Hours**

Postharvest Techniques – Storage, Packaging, Transport and Preservation of Mushrooms (Long term and short term). Genetic improvement methods of Mushroom. Management of Mushroom pests: Mushroom Flies,Mushroom Mites, Springtail, Beetles, Mushroom Nematodes-Myceliophagous Nematodes and Saprophagous Nematodes, Fungal Competitors. Diseases of Mushroom – Bacterial (Bacterial blotch, mummy disease) Fungal (Dry bubble, Wet bubble, Cobweb disease) and Viral.

RECOMMENDED TEXT BOOKS:

1. L.S. Ranganathan. (2006). Vermibiotechnology: From soil health to human health, 1st edn., Agrobios Publication, India.
2. Singh and Singh. (2005). Modern Mushroom cultivation, 1stedn., Agrobiose publishers.India.
3. Dubey and Maheshwari. (2007). A textbook of biotechnology, 1st edn.,S.Chand and company.

REFERENCE BOOKS:

1. Kannaiyan. (1999). Cultivation of Edible Mushrooms. 1st edn., TNAU Publication.
2. Ismail, S.A. (1997). Vermicology-The Biology of Earthworm.1st edn., Orient longman.
3. Russell S. (2003).Essential Guide to Cultivating Mushrooms. 1st edn., Storey Publishing LLC
4. Tiwari SC and Kapoor P. (2018). Mushroom-The art of Cultivation. 1st edn., Mittal Publications.
5. Edwards CA, Arancon NQ Sherman RL. (2011).Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1st edn., CRC Press.

JOURNALS:

1. Research & Reviews: Journal of Agriculture and Allied Sciences.
2. Annals of Biology.

E-LEARNING RESOURCES:

1. https://static.vikaspedia.in/media/files_en/agriculture/farm-based-enterprises/vermicompost-production-and-practices.pdf
2. https://www.earthwormsoc.org.uk/lifecycle
3. https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Mushroom.html
4. https://agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/
5. https://www.slideshare.net/VikasTiwari166/diseases-and-insect-pests-of-mushroom

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Distinguish the types of earthworms and feed needed for vermicomposting.
CO 2	Differentiate various methods of vermicomposting and its benefits to soil and plants.
CO 3	Assess the nutrient and medicinal value of edible mushrooms and analyse effects of mushroom poisoning
CO 4	Apply the various methods of cultivation of button and oyster mushrooms for small-scale industries.
CO 5	Assess the loss of productivity in mushroom yield due to pests and diseases and analyse the post-harvest practices.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	3	2	2	1	1	1	3
CO 2	2	3	3	3	2	2	2	3
CO 3	2	3	2	1	2	2	2	3
CO 4	2	1	2	3	1	2	2	3
CO 5	2	3	2	1	2	1	1	3
Average	**2**	**2.6**	**2.2**	**2**	**1.6**	**1.6**	**1.6**	**3**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, LCD, e-Content, Videos, Group Discussion,Quiz/ Seminar/ Assignment, Online Teaching.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

PRACTICALS

GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

TOTAL HOURS: 120 **COURSE CODE: 16SP21/2C/PR1**
CREDITS 4 **L T P: 0 0 4**

COURSE OBJECTIVES:

1. Demonstrate the general sterilization techniques followed in a Microbiological Laboratory and its quality control with emphasis on biosafety measures.
2. Illustrate the use of microscopes in identifying microbes, determining their size by micrometry and demonstrate the morphology by various staining techniques.
3. Measure bacterial growth, identify optimal growth parameters, cultivate bacteria, and perform antibiotic sensitivity.

COURSE OUTLINE:

1. Microbiology Good Laboratory Practices and Biosafety.
2. Glassware, Equipment, Media and Chemicals Maintenance.
3. Sterilization - Physical agents- Moist heat, Dry heat, Filtration.
4. Sterilization- Chemical agents-
   a) Phenol Coefficient method.
   b) Agar Plate Sensitivity method.
5. Quality Control of Sterilization - Physical, Chemical - Indicator strips. Biological – spore strips.
6. Calibration of Micrometer and measurement of Microbial size.
7. Observation of Algae by Wet Mount.
8. Demonstration of motility of bacteria by Hanging Drop Method.
9. Staining methods - Preparation of stains - Gram staining, Acid fast staining, Negative staining, positive staining, metachromatic granule staining and Spore staining.
10. Preparation of Solid, Liquid and Semi-solid media.
11. Pure culture technique- Streak Plate, Pour Plate and Spread Plate techniques.
12. Preservation of bacterial cultures by various techniques.
13. Demonstrations of Fungi by LPCB mount and Slide culture technique.
14. Anaerobic Culture of bacteria-Gaspak System.
15. Measurement of bacterial growth- by direct count and turbidity method.

16. Effect of temperature on Microbial growth and determination of thermal death point.
17. Effect of heavy metals on bacteria- Oligodynamic action.
18. Effect of pH on microorganisms.
19. Effect of UV radiation on microorganisms.
20. Chemotherapeutic agents- Kirby-Bauer method and Synergistic effect of drug combination.

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Apply sterilization, sanitation and disinfection methods with proper quality control in microbiology laboratories for effective use and disposal of microbes
CO 2	Employ microscopes and staining techniques appropriately in determining the shape, size and other attributes of microbes
CO 3	Formulate the parameters for optimal growth of bacteria and ways to combat them using proper antibiotic control techniques

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	2	2	2	2	2	3	3
CO 2	3	2	2	2	2	2	3	3
CO 3	3	3	2	2	2	2	3	3
Average	**3**	**2.3**	**2**	**2**	**2**	**2**	**3**	**3**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:
Demonstration and experimentation.

QUESTION PAPER PATTERN:
Time: 9 Hours (3 hours, 3 days) **Max. Marks: 60**

Major- 25 marks
Minor-15 marks
Spotters - 5 x 2 =10 marks
Record – 5 marks
Viva- voce- 5 marks

PRACTICALS
MEDICAL MICROBIOLOGY

TOTAL HOURS: 150 **COURSE CODE: 16SP21/2C/PR2**
CREDITS: 4 **LTP: 005**

COURSE OBJECTIVES:

1. Discuss the importance and role of normal flora and pathogenic microbes.
2. Provide hands on exposure to processing of clinical specimens and laboratory diagnosis of microorganisms using different techniques.
3. Develop diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases

COURSE OUTLINE:

BACTERIOLOGY

1. Collection and transport of clinical specimens- Use of transport media and enrichment media in recovery of pathogens.
2. Direct examinations – wet films for feces, staining for Pus, Sputum, Throat / Ear/Nasal /Wound swabs.
3. Isolation and identification biochemical identification test for the respective Bacteria- *Staphyloccocus, Streptococcus, E.coli, Klebsiella, Pseudomonas, Proteus, Salmonella, Shigella.*
4. Processing of clinical samples for bacterial identification- Urine- Calibrated loop method, CLED agar. ii) Feces, iii) Pus and iv) Throat swab.
5. Rapid Identification of bacteria- Use of API Strips
6. Antibiotic Sensitivity Tests — Disc Diffusion – Stokes method, Kirby Bauer method and E - test.
7. MBC and MIC techniques – Agar and broth dilution methods.
8. Determination of Antibiotic resistance
   i) Beta-Lactamase activity- Acidometric method, Iodometric method.
   ii) MRSA- Cefoxitin and Oxacillin
   iii) ESBL-Double disc synergy test

VIROLOGY

1. Isolation and characterization of Bacteriophage from natural resources.
2. Phage titration.
3. Inoculation of Virus into Chick Embryo – CAM and yolk Sac.
4. Observation of Viral inclusions and CPE-stained smears.
5. Detection of viral infections by ELISA.
6. Screening of antiviral agents for cytotoxicity- MTT assay

MYCOLOGY

7. KOH observation of Skin, Hair and Nail scrapings for fungi, Woods Lamp Examination.
8. Preparation of fungal media- SDA/ Corn Meal Agar- Cultural and Microscopic characteristics of Mucor, *Rhizopus, Aspergillus, Penicillium, Candida,* Dermatophytes, *Fusarium, Curvularia.*
9. Cellophane tape preparation and Slide Culture -LPCB mount, Chlamydospore formation on CMA.
10. Detection of *Candida albicans*- Germ tube test. Sugar Assimilation and Fermentation.

PARASITOLOGY

11. Examination of Parasites in Clinical specimens – ova / cysts in feaces - Direct and Concentration methods –Formal Ether and Zinc sulphate methods, Saturated Salt Solution Method.
12. Blood smear examination of Malarial Parasites –Leishman's stain.

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Isolate and identify bacterial pathogens from clinical specimens through biochemical and antimicrobial sensitivity testing procedures.
CO 2	Utilize practical skills for virus cultivation procedures using embryonated eggs and apply the scientific methods in identifying viruses from clinical samples.
CO 3	Analyze the role of microorganisms in a range of diseases and apply cultivation and identification methods for fungi and parasites.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO NUMBER	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO 1	3	3	3	3	2	2	2	2
CO 2	3	3	2	3	2	2	2	2
CO 3	3	3	3	3	2	3	2	2
Average	**3**	**3**	**2.6**	**3**	**2**	**2.3**	**2**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:
Demonstration and experimentation.

QUESTION PAPER PATTERN:

Time: 9 Hours (3 hours, 3 days) **Max. Marks: 60**

Major- 25 marks
Minor-15 marks
Spotters- 5 x 2 =10 marks
Record - 5 marks
Viva - voce- 5 marks

SEMESTER III COURSE PROFILE-PROGRAMME OF STUDY

COURSE CODE	TITLE OF THE PAPER	CREDITS	HRS/ WK	TOTAL HOURS	L-T-P	CA	SA	TOTAL
16SP21/3C/ILY	Immunology	4	5	75	3-1-0	40	60	100
16SP21/3C/MEM	Microbial Ecology and Environmental Microbiology	4	4	60	3-1-0	40	60	100
16SP21/3E4/EPM/ 16SP21/3E4/ABS	Epidemiology of Infectious Diseases and Public Health Microbiology/ Analytical Techniques for Biological Sciences	3	3	45	2-1-0	40	60	100
16SP21/3E/GOH	Creative Gardening and Ornamental Horticulture	3	4	60	3-1-0	40	60	100
16SP21/3S/BCG	Basic Computing	2	2	30	1-1-0			
16SP21/4C/PR3	Immunology and Molecular Biology	-	4	60	0-0-4	40	60	100
16SP21/4C/PR4	Environmental Microbiology	-	4	60	0-0-4	40	60	100
16SP21/4C/PR5	Food and Industrial Microbiology	-	4	60	0-0-4	40	60	100
Self-Study Paper	Life Sciences for Competitive Examinations	2						
Internship		2						
	TOTAL CREDITS	**16+4**						

SEMESTER III

IMMUNOLOGY

TOTAL HOURS: 75 **COURSE CODE: 16SP21/3C/ILY**
CREDITS: 4 **LTP: 3 1 0**

COURSE OBJECTIVES:

1. Introduce basic concepts in Immunology.
2. Provide insights to the Human Defense Mechanisms against Infections.
3. Study various applications of Immunological Techniques.
4. Discuss the importance of Immunity, Immune Response and Vaccines.
5. Illustrate the mechanisms of Autoimmune, Immunodeficiency Disorders.

COURSE CONTENT:

UNIT I **10 Hours**

Introduction - History, Scope of Immunology and Recent development. Cells of Immune system - Lymphoid lineage and Myeloid lineage. Hematopoiesis. Lymphoid Organs. T cell receptors, B cell receptors and other specific receptors. Inflammation. Lymphocyte Trafficking.

UNIT II **15 Hours**

Antigens and Antibodies – Antigens - Factors Influencing Antigenicity, Epitopes, Haptens, Superantigen, Mitogen, Adjuvants. Sequestered antigens. Antibodies - Structure, Types and Functions. Theories of antibody production and class switching. Production of Monoclonal and Polyclonal antibodies. Antigen Antibody Interactions - Agglutination and Precipitation reactions. Principles and Applications of RIA, ELISA, ELISpot, Immunofluorescence, Nephlometry, FACS analysis. Immunohistochemistry.

UNIT III **15 Hours**

Infection and Immunity. Introduction and Classification of immunity - Innate and Acquired. Factors involved in Immunity. Complement - Salient features, Complement activation - Classical pathway and Properdin pathway, Biological functions of Complement system. Host Parasite Relationship. Immune response - Humoral and Cell mediated, Cytokines and Cytokine Storm. Evasion of Immune defense. MHC - Definition, Structure, Types, Function

and MHC restriction. HLA typing and its Application in Organ Transplantation. Transplantation immunology - Types of Graft, Host vs Graft rejection, graft vs host rejection, Prevention of Graft Rejection.

UNIT IV **10 Hours**

Immunoprophylaxis. Active and Passive Immunization. Latest Immunization schedule. Vaccines – Introduction and types. Recent vaccines. Hypersensitivity– Introduction, types and Treatment. Skin test - Scratch, Intradermal and Patch tests. Immunosuppressive Drugs.

UNIT V **10Hours**

Autoimmune Diseases. Types - Cell Mediated, Organ specific Immune inflammatory, Humoral Mediated. Treatment of Autoimmune diseases. Immunodeficiency disorders. Immunotolerance and anergy. Tumour immunology - Properties, Causes, Diagnosis. Immunomodulation and Interferons. Immunotherapy.

RECOMMENDED TEXT BOOKS:

1. Kuby, J. (2006). Immunology 2nd edn., H.W.Freeman and company. New York.
2. Janeway C, Travers P, Walport M, Sholmchik M. (2004). Immunobiology6th edn., Gerald Science
3. Roitt R.I.M.(2001). EssentialImmunology.10th edn., Blackwell Scientific Publishers.

REFERENCEBOOKS:

1. Stites D.P.,Abba I.Terr, Parslow T.G.(1997). Medical Immunology. 9thedn., Prentice-Hall Inc.
2. Tizard, R.I. (2000). Immunology- An Introduction. 4thedn., Saunders College Publishing, Philadelphia.
3. Nairn, R., & Helbert, M. (2006). Immunology for Medical Students. 2nd edn., Mosby International limited.
4. Humphrey, J.H. and White, R.G. (1995). Immunology for Students of Medicine, 5th edn., ELBS, London
5. Ananthanarayanan, R, & Panicker,C.K.J. (2013). Textbook of Microbiology,10th edn., Orient Longman.

JOURNALS:

1. Indian Journal of Experimental Biology.
2. Journal of Clinical Immunology.

E-LEARNING RESOURCES:

1. https://www.ncbi.nlm.nih.gov › pmc › articles › PMC2581910
2.https://microbiologybook.org/mayer/ab-ag-rx.htm
3. https://www.ebi.ac.uk/interpro/potm/2005_2/Page2.htm
4. https://www.nejm.org/medical-research/autoimmune-disease
5. https://www.webmd.com>cancer
6. https://www.healthline.com>health
7. https://www.webmd.com>skin-test

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Analyze cells and organs of immune system and its role in types of immunity
CO 2	Evaluate the reactions between various antigens and antibodies and apply the knowledge in diagnosing diseases and disorders
CO 3	Analyze the concepts and factors influencing immunity, HLA typing and its applications and compare the role of MHC in graft rejection in transplantation and plan appropriate strategies
CO 4	Employ the principles of immunity for vaccine development and analyse types of hypersensitivity reactions
CO 5	Evaluate autoimmune and immune deficiency disorders and apply immunotherapy in modulating oncogenesis.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	3	2	2	2	2	3	2
CO 2	2	3	3	2	2	2	3	2
CO 3	2	3	2	2	2	2	2	2
CO 4	2	3	2	2	2	2	2	2
CO 5	2	2	2	2	2	2	2	2
Average	**2**	**2.8**	**2.2**	**2**	**2**	**2**	**2.4**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by chalk and Board, Flipped Learning, Online Teaching, e-content, Problem Solving, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

MICROBIAL ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

TOTAL HOURS: 60 **COURSE CODE: 16SP21/3C/MEM**
CREDITS: 4 **LTP: 3 1 0**

COURSE OBJECTIVES:

1. To learn the concepts of microbial ecology.
2. Illustrate the characteristic features of microbes in extreme environmental condition.
3. Analysis of potable and sewage water treatment process.
4. Discuss the ability of microorganisms to produce food, fuel and mitigate environmental pollution.
5. Explain the Air borne infection and its control.

COURSE OUTLINE:

UNIT I **10 Hours**

Microbial Ecology- Concepts and Dynamics of Ecosystem. Definition and scope of Microbial Ecology. Important Historical events. Contribution of Martinus Beijerinck and Sergei Winogradsky to the field of Microbial Ecology. Winogradsky's column. Rumen Microbiology-Bacteria, Fungi and Protozoans. Microbes in Aquatic environment.Water borne pathogen.

UNIT II **15 Hours**

Extremophiles - Archeal biodiversity. Extreme habitat - Characterization of Microbes - Geothermal Hot springs, Deep Sea Hydrothermal Vents, Acid Mine drainage, Desiccation and UV Stressed areas. Acidophiles, Alkaliphiles and Halophiles. Commercial uses of Extremophiles - Bioremediation -Addition of microbes or DNA , Addition of Oxygen and other gases, Addition of nutrients, Microbes in Space.

UNIT III **10 Hours**

Microbiology of Potable water - Definition and scope. Municipal Water treatment - Screening Techniques, Aeration, Sedimentation, Coagulation, Flocculation and Sand filters. Sewage Treatment Process - Primary Treatment Process-screening and straining, Grit removal, Sedimentation, Flotation, Coagulation and Flocculation, Secondary treatment process –Aerobic, Anaerobic and Tertiary treatment- Disinfection. Disposal of Sewage Sludge.. Indicators of Feacal Contamination. Microbiological Examination of Water quality - Multiple tube test, Membrane Filtration Technique, Advantages and Disadvantages. Aquatic Microbes-Food for the Future.

UNIT IV **10 Hours**

Utilization of Solid Waste as Food, Feed and Fuel- Composting, Vermicomposting, Biogas production, Single Cell Proteins. Biodegradation of Xenobiotics - Recalcitrant Halocarbons, Recalcitrant TNTs, PCBs and Synthetic polymers.Biodegradation of Hydrocarbons. Biodeterioration of Textiles and Leather. Pollution Control Bodies and Environmental laws in India.

UNIT V **15 Hours**

Microbiology of Air- Aeroallergens and aeroallergies. Aerosols - Types and nature of Bio-Aerosols, Droplets, Droplet nuclei and infectious dust. Air borne transmission of Microbes. Assessment of Microbial quality of Air - Settlement under Gravity, Filtration Technique, Centrifugation, Impingement in Solid and Liquid, Air Sanitation, Air borne pathogens - Bacterial, Fungal, Viral and Protozoan. Control of Bio- aerosol.

RECOMMENDED TEXT BOOKS:

1. Atlas R. M and Bartha R. (1992). Microbial Ecology Fundamentals and Applications, 3rd edn., Benjamin & Cummings Redwood City, CA.
2. Subbarao.N.S. (1993). Biofertilizers in Agriculture and Forestry, 3rd edn., Oxford and IBH Publishing co. Pvt Ltd.
3. Dubey and Maheshwari. (2007). A textbook of Biotechnology, 4th edn., S. Chand and company.

REFERENCE BOOKS:

1. Rheinheimer. G. (1980). Aquatic Microbiology 2nd edn., John Wiley and Son, London.
2. SubbaRao.N.S. (2005). Soil microorganisms andPlant Growth. 4thedn., Oxford and IBH Publishing Pvt Ltd
3. Daniel, C.J. (1996). Environmental Aspects of Microbiology, 1stedn., Bright Sun Publications.
4. Maier RM, Pepper IL, Gerba CP (2008). Environmental Microbiology, 2ndedn., Academic Press
5. Buckley RG. (2016). Environmental Microbiology 1stedn., CBS Publishing.

JOURNALS:

1. Nature Environment and Pollution Technology.
2. Journal of Environmental Sciences.

E -LEARNING RESOURCES:

1. https://academic.oup.com/femsec/article/93/5/fix044/3098413
2. http://www.fao.org/3/t0551e/t0551e05.htm
3. www.environmentshumail.blogspot.in/
4. https://serc.carleton.edu/microbelife/index.html
5. https://sfams.onlinelibrary.wiley.com

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Understand basic concepts within the field of microbial ecology and environmental microbiology
CO 2	Analyze and categorize the crucial role of microbes in extreme physical conditions
CO 3	Appraise the microbial processes involved in the treatment of liquid wastes and potable water treatment
CO 4	Demonstrate utility of microbes in bio-fuel production and biodegradation of Xenobiotics
CO 5	Assess the survival and spread of microbes in the atmosphere

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	1	2	2	1	1	1	1	1
CO 2	3	2	2	2	2	2	1	1
CO 3	2	2	3	3	1	1	3	3
CO 4	3	3	3	3	2	2	1	2
CO 5	3	3	3	2	2	2	3	1
Average	**2.4**	**2.4**	**2.6**	**2.2**	**1.6**	**1.6**	**1.8**	**1.6**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

1. Lecture by Chalk and Board, LCD, Online Teaching, Flipped Learning, e-Content, Videos, Group discussion, Quiz/ Seminar/ Assignment.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

EPIDEMIOLOGY OF INFECTIOUS DISEASES AND PUBLIC HEALTH MICROBIOLOGY

TOTAL HOURS: 45 **COURSE CODE: 16SP21/3E4/EPM**
CREDITS: 4 **LTP: 2 1 0**

COURSE OBJECTIVES:

1. Impart fundamental knowledge on determinants of infectious diseases and the role of Microbiome in controlling them.
2. Teach Disease surveillance methods and investigate outbreaks.
3. Equip the students with knowledge on hospital acquired infections and their control.
4. Provide insights on factors and analysis of emerging and reemerging infections.
5. Explain biochemical and molecular typing methods in epidemiology.

COURSE OUTLINE:

UNIT I **5 Hours**

Infectious diseases Epidemiology- Determinants of Infectious diseases- Epidemiologic Triad- Agent factors, Host factors and Environmental factors. Transmission basics- Chain of infection, Portal of entry, Modes of transmission-Direct and indirect. Stages of infectious diseases. Role of Reservoirs and carriers in Disease transmission. Human Microbiome and its role.

UNIT II **10 Hours**

Dynamics of infections with respect to Population- Sporadic, Endemic, Epidemic, Pandemic. Measuring disease frequency- Prevalence, Incidence-Index case, Basic reproductive number (R0) Morbidity, and Mortality. Pattern of Epidemics. Infectious Disease Surveillance-Goals, Methods and Innovative Technologies in Surveillance-GIS. Analytical Epidemiology- Experimental and Observational- Cohort, Case controlled and Cross-sectional studies. Outbreak investigation- Epidemic, Outbreak, Cluster. Steps involved in investigation. Infection Control programs of India.

UNIT III **10 Hours**

Hospital acquired infections-Factors, Infection sites, Mechanisms, Role of Multidrug resistant pathogens, Mechanisms of Antimicrobial resistance - Multidrug Efflux pumps, Extended Spectrum β-lactamases (ESBL). Role of *Pseudomonas*, *Acinetobacter*, *Clostridium difficile* HBV, HCV, Rotavirus, *Cryptosporidium* and *Aspergillus* in Nosocomial infections. Prevention and Management of nosocomial infections.

UNIT IV **10 Hours**

Epidemiology of Zoonosis- Factors, Routes of transmission, list of Bacterial, Viral, Parasitic and Fungal Zoonotic agents, Control of Zoonosis. Emerging and Re-emerging Infections- Mechanism of emergence of new Pathogens, Microbial change and Adaptation, Horizontal gene transfer, Pathogenicity islands and Role of integrons. Role of Covid-19, Ebola, MDR-TB, Malaria, Mucoromycosis in Emerging and Re-emerging infections.

UNIT V **10 Hours**

Biochemical and Immunological tools in Epidemiology- Biotyping, Serotyping, Phage typing, FAME (Fatty acid methyl ester analysis), Curie Point PyMS(Pyrolysis Mass spectrometry), Protein profiling, Multilocus enzyme Electrophoresis (MLEE); Molecular typing: RFLP, RAPD, 16S-23S IGS, ARDRA(Amplified ribosomal DNA (rDNA) restriction analysis), rep (REP, ERIC, BOX)-PCR, PFGE, VNTR, SNP, Genome sequencing and Microarray.

RECOMMENDED TEXTBOOKS:

1. Dicker R, Coronado F, Koo D, Parrish R.G. (2012). Principles of Epidemiology in Public Health Practice, 3rdedn., CDC.
2. Burt Gerstman B. (2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology, 3rdedn., Wiley Blackwell.
3. Greenwood D., Slack R.C.B and Peutherer J.F. (1992). Medical Microbiology. 14thedn., ELBS, Churchill Livingston.
4. Jawetz, E., Melnick, J.L. and Adelberg, E.A. (1997). Review of Medical Microbiology 9thedn., Lange Medical Publications, U.S.A.

REFERENCE BOOKS:

1. Bhopal R.S. (2016). Concepts of Epidemiology- An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. 3rd edn., Oxford University Press, New York
2. David D. Celentano, Moyses Szklo (2015). Gordis Epidemiology 6th edn., Elseiver, USA.

3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries. - Part 2 2nd edn., Cambridge University Press.
4. Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. 4th edn., Mc Graw Hill, New York.
5. Topley W.W. C.,Wilson G.S., Parker M.T and Collier (1998). Principles of Bacteriology.9th edn., Edward Arnold, London.

JOURNAL:

1. Journal of Epidemiology and Community Health.
2. Epidemiology: Open access.

E-LEARNING RESOURCES:

1. https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en
2. https://hal.archives-ouvertes.fr/hal-00902711/document
3. https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7187955/
5. https://www.nhp.gov.in/outbreak-investigation_pg#:~:text=Investigating%20an%20outbreak%2Fepidemic%20is,and%20prevent%20the%20spread%20of
6. https://www.who.int/diseasecontrol_emergencies/publications/idhe_2009_london_outbreaks.pdf
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7150340/
8. https://www.paho.org/english/sha/be_v21n2-outbreak.htm
9. https://www.cdc.gov/csels/dsepd/ss1978/index.html

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Acquire knowledge on factors of disease transmission and learn the importance of normal flora.
CO 2	Apply surveillance methods of infectious outbreaks and investigate them.
CO 3	Analyse the mechanism and principles of hospital acquired infections.
CO 4	Implement control measures for emerging and reemerging infections.
CO 5	Devise appropriate typing methods for infectious diseases.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	3	3	1	1	2	2	2	2
CO 2	3	3	2	2	2	2	2	2
CO 3	3	3	2	3	2	2	2	2
CO 4	3	3	2	2	2	2	2	2
CO 5	2	3	3	2	2	3	3	2
Average	**2.8**	**3**	**2**	**2**	**2**	**2**	**2.2**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Flipped Learning, e-content, Online Teaching, Problem Solving, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

ANALYTICAL TECHNIQUES FOR BIOLOGICAL SCIENCES

TOTAL HOURS: 45 **COURSE CODE: 16SP21/3E4/ABS**
CREDITS: 3 **LTP: 2 1 0**

COURSE OBJECTIVES:

1. Learn principles and applications of types of spectrophotometry
2. Explain principles and applications of types of centrifuges, chromatography and electrophoretic techniques and PCR
3. Learn the principle and applications of electron microscopy
4. Explain the principle, applications and uses of automated microbiological detection systems
5. Discuss principles of Scintillation counter, biosensors and microbial identification systems.

COURSE OUTLINE:

UNIT I **10 Hours**

Principles of Analytical instrumentation –Techniques and applications of Colorimetry and Spectrophotometry- Beer lamberts Law, Turbidimetry, UV-Vis Spectroscopy, Fourier Transform Infrared Spectroscopy, Fluorescence spectroscopy, NMR spectroscopy, Mass Spectroscopy, Circular Dichroism and Optical Rotatory Dispersion (ORD).

UNIT II **8 Hours**

Centrifugation- Basic Principles, Instrumentation, types of Centrifuges and Methods of Centrifugation. Chromatography- Principles and types- Column, Thin layer, Paper, Adsorption, Gas liquid, Ion Exchange, Affinity, HPLC and HPTLC. Electrophoretic techniques- Native, SDS and 2D. Gel Documentation system. PCR principle and applications.

UNIT III **9 Hours**

Electron Microscopy-Scanning and Transmission Microscopes. Microtome- Principle and Applications, Different fixation and Staining techniques for Electron Microscope, Freeze etch and Freeze fracture methods for Electron Microscope, Image processing methods in Microscopy. Flow Cytometry and Immunofluorescence Microscopy. Detection of molecules in Living cells – FISH and GISH.

UNIT IV **8 Hours**

Automated Microbiological Detection system – API Phenotyping System, AST Automated Microbiology System, VITEK 2 Automated Identification System, VITEK MS MALDI – TOF MS System - Principle, Parts, Applications and Uses.

UNIT V **10 Hours**

Detection and Measurement of Radioactivity - Liquid and Solid Scintillation counters. Molecular Imaging of Radioactive material and Safety guidelines. Biosensors - Definition, Components of Biosensors, Types-Electrochemical, Enzyme, Environmental Biosensors and Application of Biosensors.

RECOMMENDED TEXT BOOKS:

1. Boyer R.F. (2002) Modern Experimental Biochemistry,3rd edn., Pearson Education.
2. Veerakumari L. (2015) Bioinstrumentation,1st edn., MJP Publishers.
3. Palanivelu,P. (2004). Analytical Biochemistry and Separation Techniques- A laboratory manual for B.Sc and M.Sc students, 3rdedn., Twenty First Century Publications.

REFERENCE BOOKS:

1. Wilson K., Walker J., Clokie S and Hofmann A. (2018) Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 8thedn., Cambridge University Press.
2. Webster, J.G. (2004) Bioinstrumentation, 1st edn., John Wiley & Sons (Asia) Pvt.Ltd.

JOURNALS:

1. Journal of Biomedical Instrumentation and Applications.
2. Indian Journal of Applied Research.

E-LEARNING RESOURCES:

1. https://www.researchgate.net/publication/285688809_Spectrophotometry_Biochemical_ Applications
2. https://www.nature.com>articles
3. https://ncbi.nlm.nih.gov/pmc/articles/
4. http://www.biomerieux-usa.com
5. http://www.americanpharmaceuticalreview.com

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Apply the principles and applications of types of spectrometry to various fields of research
CO 2	Demonstrate the applications of types of centrifuges, chromatography and electrophoretic techniques and PCR for purification of biological substances
CO 3	Apply the principle and techniques of electron microscopy to study the details about living cells
CO 4	Use the principle, applications and uses of automated microbial identification systems in research
CO 5	Utilize the applications radioactive materials and biosensors in detection

MAPPING OF COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	3	3	3	2	2	2	2
CO 2	2	3	3	3	2	2	2	2
CO 3	3	3	3	3	2	2	2	2
CO 4	2	2	2	2	2	2	2	3
CO 5	3	2	2	2	2	2	2	3
Average	**2.4**	**2.6**	**2.6**	**2.6**	**2**	**2**	**2**	**2.4**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Flipped Learning, Online Teaching, e-content, Problem Solving, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

NON MAJOR ELECTIVE
CREATIVE GARDENING AND ORNAMENTAL HORTICULTURE
(For other Department Students)

TOTAL HOURS: 60 **COURSECODE: 16SP21/3E/GOH**
CREDITS: 3 **L T P: 3 1 0**

COURSE OBJECTIVES:

1. Describe the types, features and styles of gardens.
2. Explain the plant propagation techniques employed in gardening
3. Demonstrate the techniques of Lawn making, Bonsai and terrarium
4. Classify and summarize the plant species used in gardening.
5. Apply the principles of landscaping in home/indoor or container gardening.

COURSE CONTENT:

UNIT I **10 Hours**

Scope and introduction to gardening. History of Gardening in India, Importance of Garden. Types of Gardens, Features of a Commercial Garden, Styles of Garden – Persian, Italian, French, Mughal and English Garden.

UNIT II **15 Hours**

Methods of Planting and Maintenance of Flowerbed, Hedges, Topiary, Water Garden, Paved Garden. Methods of Plant propagation- Seed, Cutting, Grafting and Layering -Advantages and Disadvantages.

UNIT III **15 Hours**

Lawn making- Types of grasses- methods of Planting - Maintenance. Introduction to Bonsai Training, Pruning and Wiring. Introduction to Terrarium technique. Nursery practices for Roses.

UNIT IV **10 Hours**

Different types of Plant Species suitable for Commercial and Home gardening. Definition, Classification, Planting and maintenance of Annuals, Trees, Shrubs, Climbers and Creepers.

UNIT V **10 Hours**

Principles of landscape designing, Landscape designing of Public places. Indoor Gardening – Types, Requirements, Indoor plants, Containers, Potting mixtures, Potting and Repotting. Care, Principles and Styles of Flower Arrangement.

RECOMMENDED TEXT BOOKS:

1. Sheela,V.L. (2011).Horticulture, 1st edn., MJP Publishers.
2. Randhawa and Amitabha (1998), Floriculture in India. 1st edn., Allied Publishers.
3. Alan. T (1985). Green House Gardener, 1st edn., Marshall Cavendish Books.

REFERENCE BOOKS:

1. Flemer William. (1972). Nature's guide to successful gardening and landscaping, 1st edn., Crowell publications.

2. Ann Reilly. (1990). Home Landscaper, 1st edn., Home Planners.
3. Black and Decker. (1993). Landscape design and construction,1st edn., Random House, Canada.
4. Patrick Taylor. (1998). The Oxford Companion to the Garden,2nd edn., Oxford University Press.
5. Kumar, N. (2010). Introduction to Horticulture. 1st edn., Oxford and ibh Publishers.

JOURNALS:

1. Journal of Horticulture.
2. Horticultural Plant Journal.

E- RESOURCES:

1. https://www.agriculturenigeria.com/manuals/research/articles/an-introduction-to-home-gardening/
2. http://www.hillagric.ac.in/edu/coa/horticulture/lecture/Types%20of%20Gardens%20[Compatibility%20Mode]%20pdf.pdf
3. https://www.plantcelltechnology.com/blog/seven-methods-of-plant-propagation/
4. https://www.popularmechanics.com/home/lawn-garden/how-to/a9093/build-a-terrarium-in-6-steps-15574536/
5. https://www.agrifarming.in/indoor-gardening-beginners-guide

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Recall the features and styles of garden.
CO 2	Differentiate the methods of plant propagation and summarize the planting methods of flower bed, hedges, topiary, water garden and paved garden
CO 3	Illustrate the techniques of Lawn making, Bonsai and Terrarium
CO 4	Distinguish between annuals, perennials, climbers, shrubs and trees and infer the methods of cultivation.
CO 5	Interpret the principles of landscape designing and describe the types of indoor gardening

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	1	1	3	1	1	2	2	1
CO 2	2	2	2	2	2	2	3	3
CO 3	1	1	2	1	2	2	3	2
CO 4	2	2	2	2	1	2	2	2
CO 5	2	2	2	1	1	3	2	3
Average	**1.6**	**1.6**	**2.2**	**1.4**	**1.4**	**2.4**	**2.4**	**2.2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Chalk and Board,Online Teaching, Assignment, Quiz, Seminar and Garden diagrammatical representations.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

SOFT SKILL
BASIC COMPUTING

TOTAL HOURS: 30 **COURSE CODE: 16SP21/3S/BCG**
CREDITS: 2 **LTP: 1 1 0**

COURSE OBJECTIVES:

1. Learn basic mathematics required for competitive exams.
2. Impart logical reasoning and quantitative aptitude.
3. Provide knowledge to challenge the competitive examinations.

COURSE CONTENT:

UNIT I **10 Hours**

BODMAS. Arithmetic and Geometric Progression. Factorization, Fractions and Decimals. Simple equations, Lines and Angles, Triangles and Congruence of triangles. Area and perimeter. Algebraic expressions.

UNIT II **10 Hours**

Ratio and proportion. Direct and inverse proportions. Exponents and power. Squares and square roots, cubes and cube roots. Linear equations. Comparing quantities. Percentage. Profit and Loss. Mensuration. Surface area and Volumes.

UNIT III **10 Hours**

Time and distance. Distance and Velocity. Time. Calendar. Number series. Alphabet series. Alphabet and Number codes. Set operations - Union and Intersect. Logical Reasoning – Verbal and Non-verbal.

RECOMMENDED TEXT BOOKS:

1. Prakashan K. (2014). Text Book of Quickest Mathematics: Quantitative Aptitude & Numerical Ability Useful for All Competitive Exams, 5th edn., Kiran Prakashan.
2. Singh S. (2017). UGC NET Paper, 2nd edn.,Tata McGraw Hill Education.

REFERENCE BOOKS:

1.Tiwari G. N. and Dimri N. (2016).Fundamentals of Basic Mathematical Tools NotionPress, Inc.

2. Agarwal R.S. (2018). A Modern Approach to Verbal and Nonverbal Reasoning. S.Chand Publications.

JOURNALS:

1. The Journal of Indian Mathematical Society.
2. Mathematical Reviews.

E- LEARNING RESOURCES:

1.https://www.mathsisfun.com/decimal-fraction-percentage.html
2.https://www.test-preparation.ca/metric-conversion-practice-questions/
3. https://www.javatpoint.com/reasoning
4. https://www.indiabix.com/aptitude/questions-and-answers/
5.https://www.sanfoundry.com/discrete-mathematics-mcqs-set-operations/

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Outline the basic concepts and formulae in Mathematics
CO 2	Compute metric conversions and apply them in various practical circumstances.
CO 3	Appraise various patterns of logical reasoning and aptitude-based questions which forms the important criteria in competitive examinations.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	1	2	3	2	1	3	2	3
CO 2	1	2	3	2	1	3	2	3
CO 3	3	3	3	2	2	3	2	3
Average	**1.6**	**2.3**	**3**	**2**	**1.3**	**3**	**2**	**3**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:
Lecture by chalk and talk, Computing problems, LCD Classes, OHP, Group Discussion, Quiz, Peer Learning.

QUESTION PAPER PATTERN:
Time: 2 Hours Max. Marks: 50
50 Objective type questions 50x 1= 50 marks

SELF-STUDY PAPER
LIFE SCIENCES FOR COMPETITIVE EXAMINATIONS

COURSE CODE: **CREDITS: 2**

COURSE OBJECTIVES:

1. Impart knowledge on Morphology of plants and animals
2. Explain the concepts of animal Physiology.
3. Discuss in-depth about Genetics, types of ecosystems and their importance.
4. Outline the major drivers in biodiversity and various conservation approaches.
5. Introduce basic concepts of evolution and biological clock.

COURSE CONTENT:

UNIT I

Morphology of Plant and animals- Anatomy of flowering plants, Structural Organization in animals. Levels of organization - Tissues, Organs andSystems and Comparative Anatomy. Gametogenesis, Fertilization, Embryogenesis of Plants and Animals, Seed germination. Post Embryonic development- Larva formation and Metamorphosis. Sex Determination.Plant Physiology- Photosynthesis- C3, C4 and CAM cycle, Photorespiration, Nitrate and Ammonium Assimilation.

UNIT II

Animal Physiology- Heart structure and functions-Myogenic Heart and Cardiac cycle, ECG reading, Blood pressure and Volume regulation. Anatomy of Brain and Spinal cord, Action potentials and Neural coordination. Organs of Vision, Hearing and Touch. Hormones and its role in Animal Physiology.Physiology of Digestion and Assimilation. Excretory Organs of Animalia, Mechanism and Regulation of Excretion.

UNIT III

Inheritance Biology- Mendelian Genetics and its extension, Extra Chromosomal Inheritance, Linkage and Gene mapping, Karyotyping, Genetic Disorders and Pedigree analysis.Ecology - Biomes, Habitat, Niche, Species Interactions, Population Growth curve- k and r selected Species, Community Ecology- Succession. Ecosystem- Terrestrial and Aquatic.

UNIT IV

Biodiversity and Conservation- Status, Monitoring and Documentation- Methods of Estimating Population Density of Animals and Plants. Major drivers of Biodiversity change; Rare, endangered Species. Biodiversity Management approaches. Indian case studies on Conservation/Management strategy (Project Tiger, Biosphere Reserves).

UNIT V

Evolution- Theories- Darwinism, Lamarckism, Oparin Haldane. Paleontological, Embryological and Molecular evidences. Hardy Weinberg's Law. Speciation; Allopatricity and Sympatricity. Adaptive radiation and Convergent evolution; Sexual selection; Co-evolution. Altruism, Biological clocks, Migration and Parental care.

RECOMMENDED TEXT BOOKS:

1. Russell P.J, (2010). Genetics-a molecular approach, 3rd edn., Benjamin Cummings.
2. Atlas R. M and Bartha R. (1992). Microbial Ecology Fundamentals and Applications, 3rd edn., Benjamin & Cummings Redwood City .CA
3. Lincoln Taiz and Eduardo Zeiger (2010). Plant physiology, 5th edn., SinauerAssociates Inc.
4. Scott F. Gilbert (2016). Developmental biology, 11th edn., Sinauer Associates Inc.
5. Rastogi S.C. (2007). Essentials of animal physiology, New age publisher.

REFERENCE BOOKS:

1. Chapman J.L (1998). Ecology: Principles and applications, 2nd edn., Cambridge University Press.
2. Michel Loreau, Shahid Naeem and Pablo Inchausti (2004). Biodiversity and Ecosystem functioning- synthesis and perspectives, 2nd edn., Oxford university press.
3. Pierre Pontarotti (2018). Origin and Evolution of biodiversity, 1st edn., Springer.
4. Ray F.Evert and Susan E. Eichhorn (2012). Ravens biology of plants, W.H Freeman & Co.
5. James Bidlack, Shelley Jansky and Kinsley Stern (2013). Stern's Introductory Plant biology, 13th edn., McGraw Hill Education.
6. Lewis Wolpert, CherylTicle and Alfonso Martinez-Arias (2018). Principles of development, 5th edn., Oxford University Press.
7. Richard Jurd (1997). Instant Notes in Animal Physiology, 2nd edn., Taylor and Francis.

JOURNALS:

1. Biodiversity and Conservation.
2. Journal of Plant Physiology.
3. Journal of Animal Physiology and animal nutrition

E - LEARNING RESOURCES:

1. https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_ (Wakim_and_Grewal)/08%3A_Inheritance/8.3%3A_Genetics_of_Inheritance.
2. https://www.livescience.com/474-controversy-evolution-works.html.
3. http://www.careerpoint.ac.in/download/smp_sample/Botany_Plant%20morphology.pdf.
4. https://www.sciencedirect.com/journal/plant-physiology-and-biochemistry
5. https://qbi.uq.edu.au/brain/brain-anatomy/central-nervous-system-brain-and-spinal-cord
6. https://www.onlinebiologynotes.com/physiology-of-digestion/
7. https://www.sciencedirect.com/agricultural-and-biological-sciences/animal-physiology

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Compare the morphology and levels of organization in plants and animals, and analyse the physiology of Plants
CO 2	Illustrate the structure and anatomy of Animals across different phyla and appreciate their Physiology
CO 3	Assess and implement the information on inheritance biology in various fields. Outline fundamentals of ecology and ecosystem types
CO 4	Use information on biodiversity and conservation of endangered species
CO 5	Appraise various theories on evolution, migration and parental care

QUESTION PAPER PATTERN:

Time: 3 Hours Max. Marks: 100

50 Objective type questions 50x 2= 100 marks

SEMESTER IV COURSE PROFILE-PROGRAMME OF STUDY

COURSE CODE	TITLE OF THE PAPER	CREDITS	HRS/ WK	TOTAL HOURS	L-T-P	CA	SA	TOTAL
16SP21/4C/MBY	Molecular Biology and Recombinant DNA Technology	4	5	75	3-1-0	40	60	100
16SP21/4C/FDY	Food and Dairy Microbiology	4	4	60	3-1-0	40	60	100
16SP21/4C/PRO	Project	4	4	60		40	60	100
16SP21/4E5/BIF/ 16SP21/4E5/GAP	Bioinformatics/ Genomics and Proteomics	3	3	45	2-1-0	40	60	100
16SP21/4S/WES	Women Entrepreneurship Development	2	2	30	1-1-0	40	60	100
16SP21/4C/PR3	Immunology and Molecular Biology	4	4	60	0-0-4	40	60	100
16SP21/4C/PR4	Environmental Microbiology	4	4	60	0-0-4	40	60	100
16SP21/4C/PR5	Food and Industrial Microbiology	4	4	60	0-0-4	40	60	100
	TOTAL CREDITS	**29**						

SEMESTER- IV

MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

TOTAL HOURS: 75 **COURSECODE: 16SP21/4C/MBY**
CREDITS: 4 **LTP: 3 1 0**

COURSE OBJECTIVES:

1. Provide basic concepts in classification and structure of proteins, lipids and carbohydrates.
2. Explain the application of various gene cloning vectors
3. Provide in depth knowledge in artificial gene transfer mechanisms and selection of Recombinants
4. Discuss the importance of various molecular techniques and their importance in Forensic science.
5. Learn the wide applications of genetic engineering in various fields.

COURSE OUTLINE

UNIT I **10 Hours**

Proteins: Structural Classification of Proteins -Primary, Secondary, Tertiary, Quaternary Structures of Proteins. Ramachandran plot. Lipid Composition of Microorganisms - Common types of Membrane Lipids: Phospholipids, Cholesterol, Glycolipids, Archaeal Lipids, Ganglioside, Cerebroside, Sphingomyelin, Triacylglycerols, Arachidonic acid, Properties. Carbohydrates - Structure, Properties and uses of Different classes of Carbohydrates. Monosaccharides- Glucose, Galactose and Fructose. Disaccharides- Sucrose, Lactose and Maltose. Sugar Polyols - Sorbitol, Mannitol and Erythritol. Oligosaccharides - Raffinose, Stachyose and Maltodextrin. Polysaccharides - Amylose, Glycogen, Cellulose.

Unit II **10 Hours**

Gene cloning. Isolation of DNA - Bacteria, Phage, Plasmid, Plant and Animal DNA. DNA Modifying enzymes and their Applications: Restriction Endonucleases, DNA Polymerases, DNA Ligases, Reverse Transcriptase, Terminal Deoxynucleotidyl transferase, Kinases and Phosphatases, Topoisomerases and Methylases. Use of Linkers and Adaptors. Cloning Vectors -Plasmids - Nomenclature**,** General Properties of Plasmids- Replication, Copy

number, Host range and Incompatibility. Structure and uses of Natural and Artificial plasmids. pBR322, pUC vectors. Plasmids encoding Metal Resistance and Plasmids for Degradation of Recalcitrant compounds (PAH, PCB). λ Phages, M13 Phage. Cosmids, Phagemids. Artificial Chromosomes -YAC and BAC, Baculovirus Based Vectors. Shuttle Vectors.

Unit III **10 Hours**

Transformation. Artificial Techniques - Calcium chloride Induction, Electroporation, microinjection, Biolistic method, Liposome and Viral-mediated Delivery, *Agrobacterium* - Mediated delivery. Methods of Selection of Recombinants- *E. coli* and yeast genomic and cDNA libraries - Construction and Screening.

Unit IV **15 Hours**

An Overview of Applications of Genetic Engineering – Production of Recombinant Proteins in Prokaryotes and Eukaryotic cells. Recombinant Pharmaceuticals- Vaccines, Growth Hormones, Insulin, Blood products. Agriculture- Transgenic plants, Antisense technology. RNAi, siRNA and miRNA. Transgenic Animals. Research and Therapy- Transposons in Drosophila, Transgenes in Mice, ATryn in goat and Green Fluorescent Protein (GFP) in mammals. Pollution control- Zebrafish. Conservation- European Rabbits and Passenger Pigeons. Commercial applications - Transgenesis in Livestocks. Medicine- Gene therapy for Inherited disorder.

Unit V **15 Hours**

Molecular techniques - Colony and Plaque Hybridization Probes. Gene Probes - Reporter Genes. Southern, Northern, Western Blotting and Dot & Slot Blot Techniques. PCR- Hot Start, Nested, RT- PCR, Real Time, Multiplex PCR. DNA Finger Printing, RFLP and RAPD. CRISPR and its Applications. DNA Analysis in Forensic Science.

RECOMMENDED TEXT BOOKS:

1. Brown T. A. (1995). Gene Cloning, 4th edn., Chapman and Hall.
2. Russell P.J, (2010). Genetics-a molecular approach, 3rdedn., Benjamin Cummings.
3. Bernard R. Glick and Jack J. Pasternak (1998). Molecular Biotechnology,3rdedn., ASM Press, Washington, D.C.

REFERENCE BOOKS:

1. Nelson, D.L and Cox, M.M. (2008). Leininger Principles of Biochemistry, 5thedn., W.H. Freeman and Company.
2. Watson, J. D., Gilman, M and Witkoweski, J. (1992). Recombinant DNA, 2ndedn., Scientific Books.
3. Old R. W. and Primrose S. B. (1989). Principles of Gene Manipulation, 4thedn., Black well Scientific Publications, London.
4. Frifelder D. (1995) Molecular Biology, 4thedn., Narosa Publishing House, New Delhi.
5. Glover, D.M. (1984) Gene Cloning: The Mechanism of DNA Manipulatio, 2ndedn., Chapmanand Hall, London.

JOURNALS:

1. Journal of Molecular Biology.
2. Indian Journal of Biotechnology.

E-LEARNING RESOURCES:

1. https://www.molbiotools.com/usefullinks.html
2. https://geneticgenie.org3.
3. https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5
4. https://www2.mrc-lmb.cam.ac.uk/
5. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Identify the importance of proteins, lipids, carbohydrates and properties of plasmids in rDNA technology
CO 2	Analyze the role of Vectors in Gene Cloning Techniques.
CO 3	Apply and analyze the principles of selection, construction, screening of recombinants and application of artificial transformation techniques.
CO 4	Illustratively assess the Molecular Techniques for DNA and Protein analysis
CO 5	Adopt the application of Genetic Engineering in the field of Agriculture and medicine towards scientific research with illustrations.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 8
CO 1	2	2	2	3	2	2	1	1
CO 2	2	2	2	3	3	3	2	2
CO 3	2	3	3	3	3	3	3	2
CO 4	3	3	3	3	3	3	3	3
CO 5	2	3	3	3	3	3	3	3
Average	**2.2**	**2.6**	**2.6**	**3**	**2.8**	**2.8**	**2.4**	**2.2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Computing problems, LCD Classes, Online Teaching, Group Discussion, Quiz, Peer Learning

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

FOOD AND DAIRY MICROBIOLOGY

TOTAL HOURS: 60 **COURSE CODE: 16SP21/4C/FDY**
CREDITS: 4 **LTP: 3 1 0**

COURSE OBJECTIVES:

1. Distinguish the intrinsic and extrinsic factors of growth of microbes in food and illustrate the various food preservation techniques
2. Describe the causes of spoilage of different types of food and plan the methods for detecting the causative microbes of food spoilage
3. Detect and interpret the food borne infections, intoxications and prevent food borne outbreaks
4. Demonstrate the basic tests of food quality and production of fermented milk foods at large scale level
5. Implement quality control and represent the standards in food production

COURSE OUTLINE:

UNIT I **10 Hours**

Introduction to Food Microbiology - Factors (Extrinsic and Intrinsic) affecting Microbial Growth in food. Microorganisms in Food - Bacteria and Fungi. Determination of Microorganisms in food. Principles of Preservation - Asepsis, High Temperature, Low Temperature, Drying and Food Additives. Novel processing Technologies of Food Preservation –Principles and Applications of High Pressure processing, Cold Plasma and Pulsed Electric Field.

UNIT II **15 Hours**

Spoilage of Food,Vegetables, Fruits, Sugar products, Fish and Other Sea foods, Meat and Meat products. Spoilage of Canned food.Detection methods used for food identifying food borne pathogens -Culture, Microscopic, and Sampling Method for detecting microbes, Modified and Conventional Automated methods, Immunological methods, DNA based methods. Food Packaging materials, Properties and Benefits.

UNIT III **10 Hours**

Food Borne Infections and Food Poisoning - *Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Listeria.* Nematodes, Protozoa, Algae, Fungi and Viruses. Food Borne outbreaks in India.

UNIT IV **10 Hours**

Microbiology of Milk-Microbes in Milk, Milk borne Infections. Fermentation of Milk-Souring, Lactic Acid Fermentation, Colour and flavours, Gassy fermentation and proteolysis. Quality Control Tests – Phosphatase, Resazurin and Reductase Tests. Microbiology of Fermented Milk products. Production of Cheese, Yogurt, Buttermilk, Kumis, Kefir, Acidophilus Milk and Probiotics. An overview of Nutraceuticals and Functional Foods.

UNIT V **15 Hours**

Good Hygiene Practices, Sanitation in manufacture and retail trade; Food control agencies and their regulations, Hazard analysis and critical control points (HACCP); GMP, Plant sanitation-employees' health standard, waste treatment, disposal, quality control. Bureau of Indian standards. FSSAI- an overview, Food laws and standards in India (FSS). Recent trends and development in Food Technologies in India. Codex Alimentarius Commission-Codex India, National Codex Committee of India.

RECOMMENDED TEXT BOOKS:

1. Frazier, W.C., &West off, D.C. (1988). Food Microbiology 4thedn., Tata McGraw Hill Publishing Company Ltd. New York
2. Jay J.M. (2005). Modern Food Microbiology 4thedn., CBS Publishers and Distributors., New Delhi
3. Prescott and Dunn (1982). Industrial Microbiology 4thedn., CBS Publishers and Distributors.

REFERENCES:

1. Robinson R. K. (2000). Dairy Microbiology, 3rdedn., Elsevier Applied Science, London.
2. Adams M.R, and Moss M.D. (2005). Food Microbiology,4thedn., New Age International Pvt. Ltd., Publishers. First edition.
3. Banwarst. G.J. (2003). Basic Food Microbiology 2nd edn., CBS Publishers and distributors.
4. Hobbs, B.C. and Roberts, D. (1968). Food Poisoning and Food Hygiene,7thedn., Edward Arnold: London.
5. Vijaya R. K. (2004). Food Microbiology,1stedn., MJP Publishers, Chennai.

JOURNALS:

1. International Journal of Food Microbiology.
2. Indian Journal of Microbiology and Research.

E-LEARNING RESOURCES:

1. https://academic.oup.com/bioscience/article/65/8/758/240222
2. https://www.fda.gov/food/laboratory-methods-food/bam-food-samplingpreparation-sample-homogenate
3. https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-A_review
4. https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/download
5. https://www.uoguelph.ca/foodscience/book/export/html/2002
6. https://www.fda.gov/food
7. https://www.food-safety.com/articles/2497-an-overview-of-novel-processing-technologies-for-the-food-industry
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257668/

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Apply the role of microorganisms, various preservation techniques, and assess the growth factors of food pathogens in food industry.
CO 2	Evaluate food contamination and spoilage, detect food pathogens based on physical, chemical and immunological methods and choose appropriate preservative techniques for food.
CO 3	Identify and analyse the role of pathogens in food borne infections and food poisoning and create awareness towards food borne outbreaks in India.
CO 4	Assess the techniques in checking Milk quality, fermentation of milk and to perform production of fermented milk foods at large scale level
CO 5	Plan hygiene and sanitation protocol, apply Hazard analysis, Food laws and standards for good quality in food production

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO 1	3	3	3	2	1	2	2	2
CO 2	3	3	3	2	3	2	2	2
CO 3	3	3	3	1	1	3	2	2
CO 4	3	2	3	3	1	2	2	3
CO 5	1	2	3	3	2	1	3	3
Average	**2.6**	**2.6**	**3**	**2.2**	**1.6**	**2**	**2.2**	**2.4**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Flipped Learning, Online Teaching, e-content, Problem Solving, Group Discussion, Case Studies, Assignment, Quiz, Peer Learning and Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

BIOINFORMATICS

TEACHING HOURS: 45 COURSE CODE: 16SP21/4E5/BIF
CREDITS: 3 L T P: 2 1 0

COURSE OBJECTIVES:

1. Apply computational based solutions for biological perspectives.
2. Explain basics and uses of internet and biological databases.
3. Demonstrate the use of tools for parsing and retrieving sequences and structures from appropriate databases and predicting genes.
4. Equip with the necessary inputs for alignment of sequences for homology studies, evolutionary significance and their scoring functions with special emphasis on drug designing.
5. Analyse prokaryotic and eukaryotic genome using cloning, sequencing strategies and preparation of gene libraries
6. Impart in-depth knowledge on microarray and applications of Bioinformatics.

COURSE OUTLINE:

UNIT I **9 Hours**

Introduction to Bioinformatics and Computational Biology. Basics of Internet- Internet Protocol (TCP/IP), Worldwide web (WWW), File transfer protocol (FTP), HTML, HTTP, Telnet and URL. Major Bioinformatics Resources NCBI, EXPASY, EBI- Biological Data Base- Nucleic acid sequence databases- GenBank, EMBL, DDBJ, Protein sequence databases- SWISS-PROT, TrEMBL, PIR and Uniprot. Structure Database- PDB, Genome Databases at NCBI, EBI, TIGR, SANGER.

UNIT II **9 Hours**

Basic Concepts of Sequences Similarity, Identity and Homology. Similarity Searching- Dot Matrix Analysis, Dynamic Programming. Scoring matrices: PAM and BLOSUM. Introduction to Sequence Alignment- Pair Wise Alignments- BLAST and FASTA. Multiple Alignment- CLUSTAL and T-coffee for Analysis.

UNIT III **9 Hours**

Detection of Conserved Protein Motifs. Introduction to Phylogenetics - Rooted vs Unrooted tree, Distance Based Trees UPGMA trees, Neighbour Joining trees and Bootstrapping,Phylogenetic Analysis Software -Phylip. Basics of Drug Designing- Lipinski's rule of five, Ligand and Target Selection, Drug Designing Tools.

UNIT IV **9 Hours**

Whole genome analysis – Hierarchical sequencing and Shot gun sequencing. Conventional (Sanger's and Gilbert) Automated Sequencing and Modern DNA Sequencing Methods. Databases of Medical Informatics: VISTA, OPEN EMR, OPEN EHR

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UNIT V **9 Hours**

Micro array – Principle, Types and Applications. Applications of Bioinformatics- Pharmaceutical Industry, Immunology, Agriculture, Forestry, Chemiinformatics in Biology, Geoinformatics.

RECOMMENDED TEXT BOOKS:

1. Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics, 1st edn., Addision Wesley Longman Limited, England.
2. Mount D.W. (2013).Bioinformatics sequence and genome analysis, 2nd edn., CBS Publishers, New Delhi.
3. Xiong J. (2011). Essential bioinformatics,1st edn., First south Indian Edition, Cambridge University Press.

REFERENCE BOOKS:

1. Paul G. Higgs and Teresa K. Attwood. (2005).Bioinformatics and Molecular Evolution, Blackwell publishing, First Indian Reprint.
2. A.M. Lesk. (2017). Introduction to Bioinformatics, 1st edn., Oxford University Press India.
3. S.C. Rastogi, N. Mendiratla and P.Rastogi. (2013). Bioinformatics methods and applications- Genomics, Proteomics and Drug Discovery, 1st edn., Prentice Hall India.
4. Andreas D. Baxevanis, B. F. Francis Ouellette. (2012). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 3rd edn., Wiley and Sons.
5. Harshawardhan P.Bal. (2006). Bioinformatics Principles and Applications,1st edn., Tata McGraw-Hill Publishing Company Limited.

JOURNALS:

1. In Silico Biology.
2. BMC bioinformatics.

E-LEARNING RESOURCES:

1. https://www.ncbi.nlm.nih.gov/home/tutorials/
2. http://cef-cfr.ca/uploads/Membres/Yangetal.pdf
3. https://www.ebi.ac.uk/Tools/msa/clustalo/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1978274/
5. http://dn3g20un7godm.cloudfront.net/2011/AM11SA/93.pdf
6. http://www.premierbiosoft.com/tech_notes/microarray.html
7. https://academic.oup.com/chromsci/article/55/2/182/2333796
8. http://ab.inf.uni-tuebingen.de/teaching/ws09/bioinformatics-i/10-sequencing.pdf

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Effectively use internet in biological database searching, communicating biological data by depositing, storing and retrieving sequences and structures.
CO 2	Analyse and identify genes and proteins from a set of sequences using appropriate bioinformatic tools
CO 3	Apply the evolutionary relatedness in predicting structure, function of biomolecules, metabolism and to Perform insilico drug designing,
CO 4	Use the knowledge to prepare, store and analyse gene libraries for whole genome analysis and sequencing
CO 5	Illustrate importance of microarray and applying Bioinformatics in several fields for benefit of the society.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	1	1	1	1	2	2	2	3
CO 2	2	2	2	1	3	2	1	3
CO 3	3	3	3	2	3	2	3	2
CO 4	2	2	2	2	3	2	2	2
CO 5	2	3	2	2	3	2	3	2
Average	**2**	**2.2**	**2**	**1.6**	**2.8**	**2**	**2.2**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Flipped Learning,e-content, Problem Solving, Group Discussion, learning with tools or bioinformatics software, Assignment, Quiz, Peer Learning, Online Teaching, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

GENOMICS AND PROTEOMICS

TEACHING HOURS: 45 COURSE CODE: 16SP21/4E5/GAP
CREDITS: 3 L T P: 2 1 0

COURSE OBJECTIVES:

1. Impart basics and applications of Genomics.
2. Teach gene prediction, functional analysis and comparative genomics.
3. Train the students on tools and methods in protein structure prediction.
4. Provide insights on protein analysing techniques.
5. Equip the students with applications of Genomics and Proteomics.

COURSE OUTLINE:

UNIT I **9 Hours**

Genomics-Genome evolution, organization- an overview. Genome sequencing Strategies- Hierarchial and Shot gun sequencing. Methods of preparing Genomic DNA. Genome Mapping- Genetic and Physical maps, Assembly- Reads, Contigs, Scaffolds. Methods to Bridge gaps. Genome and Nucleotide databases, first complete Genome Sequence and Human Genome project.

UNIT II **9 Hours**

Genome Annotation- Challenges in Annotating Prokaryotic and Eukaryotic genomes, Open reading Frame. Gene prediction in Prokaryotes and Eukaryotes. DNA sequencing methods- Sanger's, Automated methods, Next Generation Sequencing techniques. NGS file formats. Comparative genomics-Basic Concepts and tools- BLAST2, MegaBlast algorithms, PipMaker, and Vista. Phylogenetic analysis- Methods, Tools and Statistical significance.

UNIT III **9 Hours**

Protein Classification - Helix, Strand, Loop, Coils. SCOP and CATH. Protein Databases, Protein Motifs and Domain prediction. Protein Structure prediction Computational methods- Secondary Structure Prediction, Transmembrane and Globular proteins-Chou Fasman, GOR method, Neural Network and HMM. Tertiary Structure Prediction- Homology Modelling and Threading.

UNIT IV **9 Hours**

Proteomics- Extracting Proteins from Biological samples, Proteome Characterization techniques- 1D and 2D Gel electrophoresis, DIGE. Mass Spectrometry- MALDI-TOF Analyzers, ESI Tandem MS Instrument, Tandem Mass Analyzers, The Triple Quadrupole Mass Analyzer, The Ion Trap Mass Analyzer, Q-TOF. Peptide Mass Finger Printing and Post Translational Modifications. Protein Protein interaction assays - Two-hybrid methods, TAP/ GFP tags, Phage Display.

UNIT V **9 Hours**

EST, SNP and its Applications. SAGE, Microarray Analysis- Principle, Types and Applications. Microarray Databases. Role of omics in Medicine, Agriculture and Industries. Bioinformatics in Synthetic biology.

RECOMMENDED TEXT BOOKS:

1. Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics, 1st edn., AddisonWesley Longman Limited, England.
2. Mount D.W. (2013).Bioinformatics sequence and genome analysis, 2nd edn., CBS Publishers, New Delhi.
3. Xiong J. (2011). Essential bioinformatics, First South Indian edn., Cambridge University Press.

REFERENCE BOOKS:

1. Paul G. Higgs and Teresa K. Attwood. (2005).Bioinformatics and Molecular Evolution, Blackwell publishing, First Indian Reprint.
2. Lesk. A.M. (2017). Introduction to Bioinformatics, 1st edn., Oxford University Press India.
3. Rastogi S.C, Mendiratla.N and P.Rastogi.(2013). Bioinformatics methods and applications- Genomics, Proteomics and Drug Discovery, 1st edn., Prentice Hall India.
4. Andreas D. Baxevanis, B. F. and Francis Ouellette. (2012). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edn., Wiley and Sons.
5. Pevsner, Jonathan. (2003). Bioinformatics and Functional Genomics, 3rd edn., Wiley Publishing. 10.1002/9780470451496
6. Thangadurai, D and Sangeetha.J. (2015). Genomics and Proteomics: Principles, Technologies, and Applications, 1stedn., Apple Academic Press.

JOURNALS:

1. In Silico Biology.
2. BMC Bioinformatics.

E-LEARNING RESOURCES:

1. https://nptel.ac.in/courses/102/104/102104056/
2. https://microbenotes.com/next-generation-sequencing-ngs/
3. https://www.nature.com/articles/s41580-019-0163-x.pdf
4. https://www.thermofisher.com/in/en/home/life-science/protein-biology/protein-biology-learning-center/protein-biology-resource-library/pierce-protein-methods/overview-protein-protein-interaction-analysis.html
5. https://academic.oup.com/chromsci/article/55/2/182/2333796
6. http://dx.doi.org/10.1002/bies.20070
7. http://14.139.189.27/ngsdat19/downloads/PPT_Blessy_NGS_Data_formats_and_QC.pdf
8. https://www.thermofisher.com/au/en/home/life-science/protein-biology/protein-biology-learning-center/protein-biology-resource-library/pierce-protein-methods/overview-mass-spectrometry.html
9. https://www.genome.gov/human-genome-project

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Effectively use basics of genome prediction algorithms and tools.
CO 2	Predict genes and analyse them for comparative and phylogenetic genomics.
CO 3	Apply the proteomic tools and software in protein structure prediction.
CO 4	Differentiate wet lab protein analysing methods with insilico methods and apply them for applications in biology.
CO 5	Devise appropriate omics strategy in Bioinformatics for benefit of the society.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO7	PSO8
CO 1	1	2	1	1	3	2	2	3
CO 2	2	2	2	2	3	2	1	3
CO 3	3	3	3	2	3	2	2	2
CO 4	2	2	2	3	3	2	2	2
CO 5	2	3	2	2	3	2	3	2
Average	**2**	**2.4**	**2**	**2**	**3**	**2**	**2**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Flipped Learning, e-content, Online Teaching, Problem Solving, Group Discussion, Learning with tools or bioinformatic software, Assignment, Quiz, Peer Learning, Seminar.

QUESTION PAPER PATTERN:

Knowledge Level	Section	Word Limit	Marks	Total
K2	**A-10x2 marks (Compulsory)**(2 Questions from Each Unit)	50	20	100
K2, K3	**B-5x8 marks (Answer any Five questions out of seven) (**One to be taken from each unit. Remaining 2 questions can be from any 2 units)	500	40	
K2, K3, K4	**C-2 x20 marks (Answer any Two questions out of four)** (one question each from any four units)	1500	40	

SOFT SKILL
WOMEN ENTREPRENEURSHIP DEVELOPMENT

TOTAL HOURS: 30 **COURSE CODE: 16SP21/4S/WES**
CREDITS: 2 **LTP: 1 1 0**

COURSE OBJECTIVES:

1. To familiarize the students with the concept and overview of entrepreneurship with a view to enhance entrepreneurial talent.
2. To impart knowledge on the basics of entrepreneurial skills and competencies.
3. Analyse self and improve the personality.
4. Gain knowledge about Women Entrepreneurship.
5. Analyse the opportunities and get equipped in setting up small scale units.

COURSE OUTLINE:

UNIT I **10 Hours**

Introduction to Entrepreneurship, Development of Entrepreneurial Skills, Introduction to Various form of Business Organization-Sole Proprietorship, Partnership, Corporations, Co-operative, Franchise and Limited Liability company. Importance of Computer literacy and Basic Knowledge of Computers- Creation of company Profile; Website Logo design, Software for Billing - Tally, E- filing of various tax returns-GST. Role of E-commerce in Business.

UNIT II **10 Hours**

Importance of communication skills in running an Enterprise-Business Presentations, Group discussion, Personal Selling and Negotiation. Tips for making good Impression- Dress, Hair style, Hand bags, Shoes and Posture. Women Entrepreneurship-need and problems faced by Women entrepreneurs.

UNIT III **10 Hours**

Overview of Small, Medium & Large Industries. Financial assistance by different Agencies-MSME, Small Scale Industries (SSI). Import and Export Licensing Procedures in India.

RECOMMENDED TEXT BOOKS:

1. Ramachandran (2008). Entrepreneurship Development, 1st edn., Mc Graw Hill.
2. Hisrich, Robert D., Michael Peters and Dean Shepherded (2017). Entrepreneurship, 10th edn., TataMc Graw Hill, ND.
3. Barringer, Brace R., and R., Duane Ireland (2019). Entrepreneurship, 6th edn., Pearson Prentice Hall, New Jersey (USA).

REFERENCES BOOKS:

1. Léo-Paul Dana (2013). World Encyclopedia of Entrepreneurship, 1st edn., Edward Elgar.
2. Lall, Madhurima, and Shikha Sahai (2008).Entrepreneurship, 2nd edn., Excel Book, New Delhi.
3. Charantimath and Poornima (2018).Entrepreneurship Development and Small Business Enterprises, 3rd edn., Pearson Education, New Delhi.
4. Byrd Megginson (2007). Small Business Management An Entrepreneur's Guidebook, 7th Edn., McGraw Hill.
5. Lowe R & S Mariott (2006). Enterprise: Entrepreneurship & Innovation, 1st edn., Burlington, Butterworth Heinemann.

JOURNALS:

1. International Journal of Entrepreneurship.
2. International Journal of Entrepreneurship and small Business.
3.Prabandhan-Indian Journal of Management.

E- LEARNING RESOURCES:

1. https://www.yourarticlelibrary.com/entrepreneur/entrepreneurship-characteristicsimportance-types-and-functions-of-entrepreneurship/5228
2. https://www.aiu.ac.in/documents/AIU_Publications/Reimagining%20Indian%20Universities/17.Employability%20and%20Entrepreneurship%20Issues%20and%20Challenges%20for%20Indian%20Universities%20By%20K%20Siva%20Rama%20Krishna,%20VC,%20Gandhi%20Institute%20Of%20Technology%20and%20Management%20Visakhapatnam.pdf
3. https://www.riinvestinstitute.org/uploads/files/2017/November/10/Womens_Entrepreneurship1510307815.pdf
4. https://www.dcmsme.gov.in/ssiindia/census/highlights.htm
5. https://smallbusiness.chron.com/similarities-sole-proprietorship-franchise-22821.html

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Develop the entrepreneurial mind-set further in terms of acquiring a business focus, creative thinking and risk-taking ability.
CO 2	Outline the needs and critically assess the Pros and Cons of Women Entrepreneurship. Practise effective communication and presentation skills
CO 3	Employ necessary inputs to start a small scale business

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO7	PSO8
CO 1	2	2	3	3	3	3	2	3
CO 2	2	2	3	3	3	3	3	3
CO 3	3	2	3	3	3	3	3	3
Average	**2.3**	**2**	**3**	**3**	**3**	**3**	**2.6**	**3**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:

Lecture by Chalk and Board, Computing problems, LCD Classes, Online Teaching, Group Discussion, Quiz, Peer Learning.

QUESTION PAPER PATTERN:

Time: 2 Hours Max. Marks: 50
Section A- Answer any 10 questions (out of 12 questions) 10 x 5 = 50 marks

PRACTICALS
IMMUNOLOGY AND MOLECULAR BIOLOGY

TOTAL HOURS: 120 **COURSE CODE: 16SP21/4C/PR3**
CREDITS: 4 **LTP: 0 0 4**

COURSE OBJECTIVES:

1. Learn various immunological techniques.

2. Provide foundation in experimental microbial genetics.

3. Apply the knowledge of immunological and molecular techniques in clinical diagnosis.

COURSE OUTLINE:

1. Blood collection, Serum and Plasma separation.

2. RBC, WBC, Differential Count, ESR.

3. Separation of Lymphocytes from Peripheral Blood by Density Gradient Centrifugation.

4. Purification of Antibodies by Ammonium Sulfate Precipitation.

5. Latex agglutination – RF, ASO, CRP.

6. WIDAL - Slide and Tube test.

7. RPR Test.

8. Haemagglutination – TPHA, ABO blood grouping.

9. Precipitation – SRID, ODD, Immunoelectrophoresis. Staining of Precipitation lines.

10. Serum Electrophoresis.

11. Coomb's test.

12. Estimation of DNA by diphenylamine method.

13. Determination of Tm value of DNA.

14. Find the Normality and Molarity of the given solution.

16. Isolation of Plasmid DNA.

17. Isolation of Chromosomal DNA.

18. Isolation of RNA.

19. Restriction Digestion of DNA and Ligation of Digested DNA fragments.

20. Transformation.

21. Replica Plate Technique.

22.Separation of Proteins by Column Chromatography.

23. Separation of Proteins by SDS PAGE.

24. Western blot.

25. PCR.

26. ELISpot Assay.

27. DOT BLOT Test.

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Interpret Immunological tests for diagnostic purposes
CO 2	Undertake novel research with techniques like DNA extraction, gel electrophoresis and gene transfer mechanisms
CO 3	Skillfully analyze the purpose of immunological and molecular techniques in clinical diagnosis to enhance job skills

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO 1	2	3	3	3	3	2	2	2
CO 2	2	3	3	3	3	3	2	2
CO 3	2	3	3	3	3	3	2	3
Average	**2**	**3**	**3**	**3**	**3**	**2.6**	**2**	**2.3**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:
Demonstration and experimentation.

QUESTION PAPER PATTERN:
Time : 9 Hours (3 hours, 3 days) **Max. Marks: 60**

Major- 25 marks
Minor-15 marks
Spotters- 5 x 2 =10 marks
Record – 5 marks
Viva- voce- 5 marks

ENVIRONMENTAL MICROBIOLOGY

TOTAL HOURS: 120 **COURSECODE:16SP21/4C/PR4**
CREDITS: 4 **LTP: 0 0 4**

COURSE OBJECTIVES:

1. Estimation and analysis of Pathogenic Microorganisms in air, water and soil
2. Testing the quality of soil for the presence of Nitrogen fixing organisms, Phosphate solubilizers and other bio fertilizers
3. Determination of soil enzymes, phyllosphere microorganisms and study bio manure

COURSE OUTLINE:

1. Water analysis-Multiple Tube Test:
   a. Presumptive test. b. Confirmed test.c. Completed test
2. Membrane filtration technique.
3. Estimation of BOD of the sewage sample.
4. Enumeration of bacteria and fungi from air – Air sampler.
5. Isolation of *Rhizobium Sp*. from nodules.
6. Isolation of *Azotobacter Sp*. from soil.
7. Isolation of *AzospirillumSp* from soil
8. Isolation of *Frankia Sp* from soil.
9. Isolation of Phosphate solubilisers from soil.
10. Preparation of Biofertilizer and testing the efficiency of prepared biofertilizer
11. R:S ratio of soil microbes.
12. Estimation of soil enzymes- urease and phosphatase.
13. Study of phylloplane microflora by leaf impression method.
14. Isolation of cellulose degrading bacteria.
15. Isolation of phenol degrading organisms from soil.
16. Isolation of pesticide degrading bacteria from soil.
17. Preparation of a vermicompost.
18. Isolation of VAM fungi from soil.
19. Winogradsky's column.
20. Isolation of plant pathogen - *Alternaria* sp.,
21. Cultivation of edible mushroom from solid waste.

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO 1	Analyze the beneficial microbes in soil, water and air.
CO 2	Examine and identify Pathogenic Microorganisms in water and apply their implications to the society.
CO 3	Assess the role of Microorganisms and their enzymes in the preparation of Bio-manure and isolation and study planr pathogens

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	2	2	2	2
CO 2	2	2	2	2	2	2
CO 3	2	2	2	2	2	2
Average	**2.3**	**2.3**	**2**	**2**	**2**	**2**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:
Demonstration and Experimentation.

QUESTION PAPER PATTERN:

Time: 9 Hours (3 hours, 3 days) **Max. Marks: 60**

Major- 25 marks
Minor-15 marks
Spotters- 5 x 2 =10 marks
Record – 5 marks
Viva- voce- 5 marks

PRACTICALS
FOOD AND INDUSTRIAL MICROBIOLOGY

TOTAL HOURS: 120 **COURSE CODE: 16SP21/4C/PR5**
CREDITS: 4 **LTP: 0 0 4**

COURSE OBJECTIVES:

1. Prepare and do sterility check for industrially important products.
2. Detect, interpret and discuss about the food borne infections and intoxications.
3. Analyse and demonstrate the basic tests of food quality and production of fermented dairy foods.
4. Develop related products to Food, Beverage and Pharmaceutical industries.

COURSE OUTLINE:

1. Isolation and identification of Bacterial and fungal pathogens from spoiled food.
2. Direct microscopic examination and standard plate count of milk.
3. Isolation of lactic acid bacteria from probiotic foods.
4. Methylene blue reductase test.
5. Phosphatase test
6. Resazurin test.
7. Sterility testing of injectables.
8. Isolation of antibiotic producer by crowded plate technique and bioassay of penicillin.
9. Wine production.
10. Production of Beer from cereals.
11. Preparation of Sauerkraut.
12. Cheese production.
13. Quality Assessment and Analysis of packaged foods: Milk, Juice, Yogurt (ISI standards).
14. Analysis of packaged drinking water.
15. Separation of amino acids by ion exchange chromatography.
16. Comparison of amylase activity of *Aspergillus* culture grown in liquid medium and on solid substrate.
17. Immobilization of enzyme in calcium alginate beads and qualitative and quantitative estimation of activity.
18. Visit to Food / Beverage Industry.

COURSE OUTCOME:

CO NUMBER	CO STATEMENT
CO1	Employ quality control methods on milk and dairy products
CO2	Check Food samples and assess the quality of food
CO3	Demonstrate entrepreneurial skill in production of products related to Food, Beverage and Pharmaceutical Industry.

MAPPING - COURSE OUTCOME WITH PROGRAM SPECIFIC OUTCOME:

CO / PSO	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO 1	2	3	3	3	2	2	3	2
CO 2	3	3	3	3	2	2	3	2
CO 3	2	2	3	3	2	2	2	3
Average	**2.3**	**2.6**	**3**	**3**	**2**	**2**	**2.6**	**2.3**

KEY: STRONGLY CORRELATED-3, MODERATELY CORRELATED-2, WEAKLY CORRELATED-1, NO CORRELATION-0

TEACHING METHODOLOGY:
Demonstration and experimentation.

QUESTION PAPER PATTERN:
Time : 9 Hours (3 hours, 3 days) **Max. Marks: 60**

Major- 25 marks
Minor-15 marks
Spotters- 5 x 2 =10 marks
Record – 5 marks
Viva- voce- 5 marks