

ST. MARY'S COLLEGE (Autonomous)

(Re-accredited with 'A⁺' Grade by NAAC)

Thoothukudi-628001, Tamil Nadu

(Affiliated to Manonmaniam Sundaranar University)



Syllabus

M.Sc. Microbiology

School of Biological Sciences

Outcome Based Curriculum

(W.e.f.2019)

Preamble

Microbiology is a wide area of science that includes Bacteriology, Virology, Mycology, Phycology, Parasitology and other branches of biology. Microbiology is the study of microorganisms which are unicellular or cell cluster microscopic organisms this include eukaryotes such as Fungi and protists and prokaryotes such as bacteria and certain algae also viruses are included, the scope of microbiology is huge and have involvement in various fields such as pharmacy, medicine, clinical, research, agriculture, dairy industry, water industry, nanotechnology and chemical technology.

Vision

To make young woman as an effective science personalities through experimental scientific education.

Mission

To empower and enrich women with scientific knowledge so that they are skilled to compete in this global sphere of education as an eminent personalities.

Programme Outcome:

PO.No.	At the end of the M.Sc. Program, the students will be able to
PO-1	obtain in-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods in Science
PO-2	understand their subject areas more clearly and develop skills to critically reflect upon the theory they learn.
PO-3	adopt the scientific methods and hypothesis testing in designing and execution of experiments.
PO-4	think critically, work independently and focus in research oriented activities.
PO- 5	inculcate an ability to engage in life-long learning to improve professional competency.
PO-6	extend and understand the impact of science on society.
PO-7	apply their professional ability for entrepreneurship and self employment.
PO-8	understand and commit to professional ethics and social responsibility.

Course Structure
Semester-I

Subject	Subject code	Title of the paper	Contact hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core-I	19PMIC11	Fundamentals of Microbiology	5	4	40	60	100
Core-II	19PMIC12	Microbial Diversity and classification	5	4	40	60	100
Core-III	19PMIC13	Biochemistry	4	4	40	60	100
Core IV	19PMIC14	Microbial Physiology	4	4	40	60	100
Core Practical I	19PMICR1	Laboratory in Fundamentals of Microbiology, Microbial diversity and classification	6	3	40	60	100
Core Practical II	19PMICR2	Laboratory in Biochemistry and Microbial physiology	6	3	40	60	100
			30	22			

Semester-II

Subject	Subject code	Title of the paper	Contact hours/ week	Credit	Max. marks		
					CIA	ES E	Total
Core- V	19PMIC21	Immunology	5	4	40	60	100
Core- VI	19PMIC22	Medical Microbiology	5	4	40	60	100
Core- VII	19PMIC23	Microbial genetics and Molecular biology	4	4	40	60	100
Core- VIII	19PMIC24	Marine Microbiology	4	4	40	60	100
Core Practical III	19PMICR3	Laboratory in Immunology and Medical Microbiology	6	3	40	60	100
Core Practical -IV	19PMICR4	Laboratory in Microbial genetics , Molecular biology and Marine Microbiology	6	3	40	60	100
			30	22+2			

It is mandatory for students to complete one MOOC during the first year of study.
(19PMIM21) 2 credits

Semester-III

Subject	Subject code	Title of the paper	Contact hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core-IX	19PMIC31	Industrial and Pharmaceutical Microbiology	5	4	40	60	100
Core- X	19PMIC32	Genetic Engineering	5	4	40	60	100
Core-XI	19PMIC33	Food and Dairy Microbiology	4	4	40	60	100
Core- XII	19PMIC34	Research Methodology	4	4	40	60	100
Core Practical- V	19PMICR5	Laboratory in Industrial and Pharrmaceutical Microbiology, Genetic Engineering	6	3	40	60	100
Core Practical- VI	19PMICR6	Laboratory in Food and Dairy Microbiology, Research Methodology	6	4	40	60	100
Self Study Course /MOOC	19PMISS1/ 19PMIM31	Probiotics		+2			100
			30	23+2			

Semester-IV

Subject	Subject code	Title of the paper	Contact hours/ week	Credit	Max. Marks		
					CIA	ESE	Total
Core -XIII	19PMIC41	Environmental Microbiology	4	4	40	60	100
Core- XIV	19PMIC42	Soil and Agricultural Microbiology	4	4	40	60	100
Core -XV	19PMIC43	Applied Microbiology	4	4	40	60	100
Core Practical VII	19PMICR7	Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology	6	3	40	60	100
Core Practical- VIII	19PMICR8	Laboratory in Applied Microbiology	6	3	40	60	100
Project	19PMIP41		6	5	40	60	100
		Total	30	23			

Components	No. of Courses	Hours / Week	Credits	Extra Credits
Core	15	66	60	-
Core Practicals	8	48	25	-
Project	1	6	5	-
MOOC	1	-	-	2
Self Study / MOOC	1	-	-	2
Total	26	120	90	4

Programme Specific Outcome:

PSO No	Upon completion of M.Sc. Microbiology Degree Programme, the Post graduates will be able to
PSO-1	acquire in-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of Microbiology
PSO-2	acquire in –depth knowledge of the topics of the research conducted by the researchers.
PSO-3	obtain insight into the interface between, on the one hand, the history of Microbiology and on the other hand issues pertaining to the areas of modern technology, health and environment.
PSO-4	contribute to the generation of new scientific insights or to the innovation of new applications of microbial research.
PSO-5	apply statistical skills
PSO-6	integrate and evaluate information from a variety of sources
PSO-7	manage resources and time.
PSO-8	plan, conduct and write up a programme of original research.

SEMESTER- I			
Core I - Fundamentals of Microbiology			
Code : 19PMIC11	Hrs/ Week: 5	Hrs/ Sem: 75	Credits: 4

Vision:

To highlight the basic concepts and principles about the different aspects of microbiology and advanced level information in the subject of General Microbiology.

Mission:

To enhance the students with the basic knowledge on various techniques involved in culturing microorganisms.

Course Outcome :

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	get an idea about the historical events in microbiology.	1	Kn
CO-2	know the scope of microbiology	1,2	Kn
CO-3	know parts of microscope, type and its principle	1,2	Kn
CO-4	distinguish different methods of staining techniques	3	Un
CO-5	understand various physical and chemical means of sterilization.	1,5	Un
CO-6	know various culture media and its application	4	Kn
CO-7	analyse nutritional requirements of microbes.	5,6	Ev
CO-8	understand the techniques for isolation of pure culture of microorganisms.	1,5,6	Un

SEMESTER- I			
Core I - Fundamentals of Microbiology			
Code : 19PMIC11	Hrs/ Week: 5	Hrs/ Sem: 75	Credits: 4

Unit I - Evolution of Microbiology

Contributions of Van Leeuwenhoek, Joseph Lister, Louis Pasteur, Robert Koch, Edward Jenner, Winogradsky and Beijerinck – Further developments in Microbiology – identification, characterization and classification of microorganisms – Distinguishing characteristics between prokaryotic and eukaryotic cells – Phenotypic characters – Taxonomic characters – Distinctive characters of major groups of microorganisms – Principles of classification .

Unit II - Microscopy

Microscopy – It's principles and applications in the field of microbiology including the following; Dark field, phase contrast, fluorescence microscopy, transmission and scanning electron microscopy, confocal microscopy – colorimeter, spectrophotometer and lyophilizers – Staining methods- Gram's, acid-fast, meta chromatic granules, nuclear, capsule, flagella, silver impregnation and Giemsa staining methods.

Unit III – Sterilization and Media

Methods of sterilization: Physical and chemical agents, radiation and filtration – Indicator microorganisms for sterilization methods- Cultivation of microorganisms – Microbiological media, enrichment media, enriched media, transport media, selective media and pure culture technique – Methods of preservation and maintenance of cultures – Role of disinfectants.

Unit IV - Bacterial anatomy and growth

Bacterial anatomy, structure, properties and biosynthesis of cellular components of bacteria – Sporulation and it's mechanism – Growth and nutrition – Nutritional requirements – Autotrophs – Heterotrophs – Enrichment cultures – Growth curve – Kinetics of growth – Batch culture – Synchronous growth – Measurement of growth and enumeration of cells – Techniques of pure culture.

Unit V – Microbe - Human interaction

Microbe-Human interaction: infection and disease- Resident flora- pathogenicity and virulence. Varied pattern of infection-epidemiology- infectious diseases-recognition of an infectious disease in a population- recognition of an epidemic- the infectious disease cycle- study of disease- virulence and the mode of transmission- the emergence of new disease- control of epidemics.

Books for Reference:

1. Madigan M., T., Martinko. J.M., and Parker J., Brock TD. 1997 *Biology of Microorganisms*. 8th Edition. Prentice Hall International Inc, London.
2. Salle, A.J. 1996. *Fundamental Principles of Bacteriology*. 7th Edition Tata McGraw – Hill Publishing Company Ltd, New Delhi.
3. Stainer R.Y., Ingraham J.L., Wheelis M.L., and Painter P.R. 1986 *General Microbiology*, Mac Millan Education Ltd., London.
4. Tortora, Funke, Case Addison 2001, *Microbiology – An Introduction – 7th Edition*, Wesley Longman Inc.
5. Dubey R.C., and Maheswari, S. 2003 *A Text Book of Microbiology*. S. Chand & Co, New Delhi.
6. Talaro K.P., and Talaro. A. 1999. *Foundations in Microbiology*. WCP McGraw – Hill, New York.
7. Dubey and Maheshwari. 2006. *A text book of Biotechnology*. Chand publications
8. Jeffrey C. Pommerville., 2010, *Alcamo's Fundamentals of Microbiology* (Ninth edition). Jones & Bartlett learning.
9. Prescott L.M. Harley J.P. and Klein D.A 2008. *Microbiology* 7th Edition McGraw Hill, New York.
10. Pelzar Jr., M.J. Chan E.C.S., and Kreig N.R. 1993. *Microbiology – McGraw Hill, Inc.*, New York.

SEMESTER I			
Core – II Microbial Diversity And Classification			
Code : 19PMIC12	Hrs/ Week: 5	Hrs/ Sem: 75	Credits: 4

Vision:

To understand about the evolution of organisms on earth and variability among living organisms.

Mission:

To study about the microbial population and its habitat and about microbial communities which are excellent models for understanding biological interactions and evolutionary history.

Course Outcome:

C O No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	understand the ubiquitous nature of microbes.	1	Un
CO -2	explain the basic concept of microbial diversity and classification.	3	Re
CO -3	discuss the knowledge about the various diversification in microorganism	4	Cr
CO -4	explain the knowledge of reproduction in microbes	5	Un
CO- 5	describe genetic characters of microbes.	5	Un
CO -6	understand the general classification of microbes	4	Un
CO -7	explain the characters of protozoa	4	Un
CO -8	understand the characters of arthropod vectors	3	Un

SEMESTER I			
Core – II Microbial Diversity and Classification			
Code : 19PMIC12	Hrs/ Week: 5	Hrs/ Sem: 75	Credits: 4

Unit I: Biodiversity and Classification

Classification of microorganisms – Introduction – Haeckel's three kingdom concept – Whittaker's five kingdom concept – Three domain concept of Carl Woese basis of microbial classification, Salient features of bacteria according to Bergey's manual of determinative bacteriology. Identification of Microorganisms –phenotypic classification, phylogenetic classification, genotypic classification, taxonomic ranks – Techniques for determining microbial taxonomy & phylogeny: Classical & molecular characteristics - Genetic relationship - DNA homology -16S r RNA sequencing .

Unit II: Bacteria

General characters, Classification, nomenclature and properties. Structure and characteristics: Gram positive cocci– *Staphylococci*, *Streptococci*. Gram negative cocci– *Gonococci*. Gram positive non spore forming bacilli: aerobic – *Corynebacteria* and anaerobic- *Actinomyces*. Gram positive spore forming bacilli: aerobic- *Bacillus anthracis* and anaerobic *Clostridia*.

Unit III: Fungi and Algae

General characters, Morphology, taxonomy and classification, structure and cell differentiation of *Aspergillus sp*, *Candida sp*, *Agaricus sp*. Mycorrhiza – Ectomycorrhizae, Endomycorrhizae, Vesicular Arbuscular Mycorrhizae. Algae: Distribution, general characters, thallus and its structure, classification, nutrition and reproduction – Characters of selected groups – Blue green algae, Euglenophyta, Chrysophyta, Phaeophyta and Rhodophyta – Economic importance of algal biotechnology.

Unit IV: Virus

Classification, nomenclature and properties. Structure and characteristics of Plant virus (CaMV ,TMV) Animal virus (Adeno virus, HIV, Rhabdo virus) Insect virus (NPV,CPV) Brief outline on virion and Prions.

Unit V: Protozoa

Distinguishing characters, classification, host-parasite relationship, pathogenic mechanism, transmission, life cycle, lab diagnosis, treatment for the following: *Entamoeba sp*, *Leishmania sp*, *Giardia sp* and *Trichomonas sp*. Helminthes: Classification, lifecycle, pathogenesis, transmission, lab diagnosis treatment for Cestodes (*Taenia solium*) – Nematodes (*Ascaris lumbricoides*) – Arthropod vectors: Tick and mosquitoes.

Books for Reference:

1. Prescott L.M., Harley J.P., and Klein D.A 2008. *Microbiology* 7th Edition McGraw Hill, New York.
2. Madigan M.T., Martinko. J.M. Parker .J., and Brock T.D. 1997. *Biology of Microorganisms*. 8th Edition. Prentice Hall International Inc, London.
3. Alexopoulos, C.J., and Mims, C.W. 1979. *Introductory Mycology*, Wiley, New York.
4. Stainer R.Y., In Graham J.L., Wheelis M.L., and Painter P.R. 1986. *General Microbiology*, Macmillan Education Ltd., London.
5. Starr, M.P., Stolp, H., Truper, H.C. Balows, A., and Schlegel, H.C. 1991. *The Prokaryotes. A Hand Book of Habitats, Isolation and Identification of Bacteria*. Springer Verlag.
6. Tortora, Funke, and Case Addison (2001). *Microbiology - An Introduction* – 7th Edition Wesley Longman Inc
7. John L. Ingraham and Catherine A. Ingrahani 2000, *Introduction to Microbiology*. Books/Cole Thompson Learning, UK.
8. Talaro. K.P. and A. Talaro. 1999. *Foundations in Microbiology*. WCP McGraw-Hill, New York.
9. Jagdish Chandar (1996). *A Text Book of Medical Mycology*. Inter Print. New Delhi.
10. Powar C.B and Dagainawala H.F 2005. *General Microbiology, Volume I & II, 8th Edition*, Himalaya Publishing House, Mumbai.
11. Dubey. R.C., and Maheswari, S. 2000. *A Text Book of Microbiology* – Chand & Co, New Delhi.
12. Pelczar Jr. M.J., Chan E.C.S., and Kreig N.R. 1993. *Microbiology* – McGraw Hill, Inc., New York.
13. Salle, A.J. 1996. *Fundamental Principles of Bacteriology*. 7th edition. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
14. Holt, J.S. Kreig, N.R., Sneath, P.H.A. and Williams, S.T. 1994. *Bergey's Manual of Determinative Bacteriology*. 9th edition – Williams & Wilkins, Baltimore.

SEMESTER I			
Core III- Biochemistry			
Code : 19PMIC13	Hrs/ Week: 4	Hrs/ Sem: 60	Credits: 4

Vision:

To be recognized as a centre for excellence in biochemistry that provide an atmosphere to acquire skills in identifying the link between biological and human resources and transform it to enhance the quality of life

Mission:

To enhance the students with a broad-based knowledge in concepts and principles of biochemistry.

Course Outcome :

CO No	Upon completion of this course, students will be able to	PSO addressed	C L
CO-1	compare and contrast the structure, classification and function of the carbohydrates.	1,2	Un, Kn
CO-2	understand the structure, classification and function of lipids.	1,3	Un
CO-3	compare and contrast saturated, mono-saturated and poly-saturated fatty acids.	1	Kn
CO-4	know the structure and classification of proteins	5	Kn
CO-5	know the classification and properties of amino acids.	5	Kn
CO-6	recognize the importance of nucleic acids and its role.	6	Un
CO-7	know the dna, rna structure, function, types and importance	6	Kn
CO-8	understand the functions of enzymes, coenzymes and cofactors	5,6	Un

SEMESTER I			
Core III- Biochemistry			
Code : 19PMIC13	Hrs/ Week: 4	Hrs/ Sem: 60	Credits: 4

Unit I - Nucleic acid

Nucleic acid- structure of nitrogen bases and base pairing, structure of nucleosides, nucleotides, Ribose, Deoxyribose sugar. DNA, RNA structure, function, types and importance.

Unit II - Proteins

Proteins- classification, structure of primary, secondary, tertiary and quaternary protein, classification of amino acids, properties, peptide bond, formation and types

Unit III - Enzymes

Enzymes- concept, definition, nature, active site, properties, classification, physico-chemical properties. Factors affecting the enzyme synthesis and activity. Allosterism – Determination of MichaelisMenten constant – Factors affecting Km Value – Mode of Enzyme action (Lock and Key model and Induced fit model)- coenzymes – Cofactors – Isozymes and Inhibitors.

Unit IV - Carbohydrates

Carbohydrates- definition and classification- properties- optical and chemical structure of glucose, ring structure, Haworth and Fischer's projection, pyranose, furanose isomers, mutarotation, triose, pentose, hexose, heptose,- examples and structures, derived monosaccharide, glycosides, furanoacids, sugar, phosphates, uronic acids, sugar alcohol, disaccharides, glycosidic linkage, lactose, maltose, sucrose, oligosaccharide, trisaccharides, structure of raffinose- polysaccharide- homo polysaccharide, hetero polysaccharide structure, starch, cellulose, mucopolysaccharide, and biological significance.

Unit V - Lipids

Lipids- classification, chemistry of fattyacids- unsaturated, saturated fatty acids, triglycerides, saponification, sterols, cholesterol, prostaglandins, glycolipids and function of lipids.

Books for Reference :

1. Stryer, L. 1995. *Biochemistry*. Ed. W.H. Freeman and company, New York.
2. J.L. Jain, 1999, *Fundamental of Biochemistry*- S.Chand & company Ltd., New Delhi.
3. A.C. Deb 1999. *Concepts of Biochemistry*. (7th Edition), Books and Allied (P) Ltd., Kolkata
4. Hubert, Stryer, 1995. *Biochemistry*– Freeman and Company, New York.
5. Lehninger, 2009. *Principle of Biochemistry*. 3rd editions by Nelson and Cox (Worth)
6. A.C. Deb 1999. *Concepts of Biochemistry*. (7th Edition), Books and Allied (P) Ltd., Kolkata

SEMESTER – I			
Core – IV Microbial Physiology			
Code : 19PMIC14	Hrs/ Week: 4	Hrs/ Sem: 60	Credits: 4

Vision:

To give the students knowledge about the physiological processes of micro organisms.

Mission:

To impart advanced level information in the subject of microbial physiology.

Course outcome:

CO No	Upon completion of this course students will be able to	PSO addressed	CL
CO -1	illustrate the basic knowledge about the microbial physiology functions and its various metabolism	3	Re
CO - 2	define various components of electron transport chain and their functions.	4,3	Re
CO -3	elaborate the bacterial growth curve and the measurement of their cell growth	4	Cr
CO - 4	explain the various bacterial transport mechanisms and their secretion system	2	Un
CO - 5	discuss about various electron transport takes place under aerobic and anaerobic condition.	1,3	Cr
CO- 6	interpret the list of fermentation mechanisms for atp regeneration.	7	Un
CO -7	prioritize various aerobic and anaerobic phototrophic bacteria with examples	1,2	E v
CO - 8	know about various pigments of the photosynthetic apparatus and learn about photosynthesis in <i>halobacteria</i> bioluminescence.	2,6	K n

SEMESTER – I			
Core – IV Microbial Physiology			
Code : 19PMIC14	Hrs/ Week: 4	Hrs/ Sem: 60	Credits: 4

Unit I – Respiration and its related pathways

Definition, terminology – types - specific functions and general pattern of metabolism - anabolism Vs catabolism - metabolic pathways - linear, irreversible and branched metabolic pathways.

Aerobic respiration – glycolysis - TCA cycle, gluconeogenesis and Calvin-Benson cycle.

Unit II – Microbial growth and transport

Microbial growth- Growth curve of bacteria- Measurement of cell growth - factors affecting microbial growth: physical, chemical and biological

Bacterial Transport: Simple, passive, active transport: Symport and Antiport and Group translocation mechanisms – Role of siderophores.

Unit III- Electron transport chain

Electron transport chain: Functions and components ; NAD, NADP, FAD, FMN, Coenzyme Q, Cytochromes, Ferredoxin and Iron Sulphur protein – Mechanism of electron movement in aerobic and anaerobic organism - Chemiosmotic theory. Substrate level phosphorylation, Oxidative phosphorylation.

Electron transport under anaerobic conditions - nitrate respiration, sulphate respiration, sulphur respiration, carbonate respiration, fumarate respiration and iron respiration.

Unit IV- Fermentation

Outline mechanisms and ATP regeneration by fermentation- alcoholic fermentation by yeasts and bacteria- ethanol formation. Lactic acid fermentation- homo-fermentation, hetero-fermentation - propionic acid fermentation - formic acid fermentation – butyric acid- butanol fermentation - homo acetate fermentation- Bioluminescence.

Unit V- Photosynthesis

Aerobic and anaerobic phototropic bacteria-purple sulphur, non-sulphur purple bacteria, green sulphur bacteria and Cyanobacteria-pigments of the photosynthetic apparatus- bacterio-chlorophylls, carotenoids and bacteriorhodopsin- localization of the pigments- regulation of pigments. Anoxygenic photosynthesis-Oxygenic photosynthesis-photosynthesis in halobacteria.

Books for Reference:

1. Santhyanarayana. U. 2002. *Essentials of Biochemistry*. 1st Edition Books and Allied (P) Ltd., Kolkata
2. A.C.Deb 1999. *Concepts of Biochemistry*. 7th Edition, Books and Allied (P)Ltd., Kolkata
3. Prescott, Lansing M, Harley, John P, Klein Donald A,1999,*Microbiology*. McGraw-Hill, New York,
4. David L. Nelson. 2017. *Lehninger Principle of Biochemistry*. .7th edition.
5. Stryer, 2001. *Biochemistry* 5th edn W.H. Freeman
6. Dr.J.L.Jain, Dr.Sunjay Jain and Nitin Jain, , 2005, *Fundamentals of Biochemistry*. S.Chand Publisher, VI Edition.

SEMESTER – I			
Core Practical I - Laboratory in Fundamentals of Microbiology, Microbial Diversity and Classification			
Code: 19PMICR1	Hrs/ Week: 6	Hrs/ Sem: 90	Credits: 3

Vision:

To be recognized as a centre for excellence in Microbiology that provide an atmosphere to acquire skills in identifying the link between biological and human resources and transform it to enhance the quality of life

Mission:

To enhance the students with a broad-based knowledge in concepts and principles of fundamentals of microbiology and microbial diversity.

Course Outcome :

CO.No	Upon completion of this course, students will be able to	PSO addressed	C L
CO-1	develop bio-safety procedures in microbiology.	2	Re
CO-2	develop basic skill in aseptic techniques	2	Un
CO-3	perform various staining techniques.	3	Un
CO-4	cultivate bacteria with different cultivation techniques.	2	An
CO-5	acquainted with various sterilization techniques.	2, 4	Un
CO-6	understand various specialized techniques such as pasteurization.	2, 4	Un
CO-7	isolate and characterize bacteria by steak plate method.	2, 4 5	Un
CO-8	understand the enumeration technique for water,air and soil samples.	2, 4, 5	An

Practicals:

1. Laboratory Precautions ,Washing and cleaning of glass wares ,Biological safety cabinets
2. Hay mount to show different types of microbes
3. Hanging drop technique
4. Staining techniques - Gram's staining, Acid fast staining, Spore staining, Capsule staining
5. Preparation of culture media for micro organisms.
6. Techniques for pure culture of microorganisms by Serial dilution technique and determination of bacterial numbers.
 - i) Pour plate method.
 - ii) Streak plate method.
 - iii) Spread plate method.
7. Enumeration of bacteria – Water and soil samples
8. Microbial sampling of air
9. Cultivation of anaerobic microorganisms – Pyrogallol method.
10. a) Cultural characteristics of microorganisms.
 - b) Generic identification of unknown bacterial cultures.
 - c) Generic identification of an unknown fungi.
 - d) Isolation of yeast from grapes.
11. Growth curve (Turbidity method)
12. Cultivation and morphology of molds – Lacto phenol cotton blue staining
13. Fungal slide culture – technique

Books for Reference:

1. Cappuccino & Sherman, 2011. *Microbiology A laboratory manual*,. IX Edition. Pearson Publication
2. Kannan.N. 1995. *Laboratory Manual in General Microbiology*. Palani Paramount Publication, Palani.
3. Gunasekaran. P. 1996. *Laboratory Manual in Microbiology*. New Age International Ltd., Publishers, New Delhi.
4. Rajan.S.,Selvi Christy. R , 2012. *Experimental procedure in Life sciences*. Anjanaa Book House.
5. Aneja.K.R., 2007. *Experiments in Microbiology, Plant pathology and Biotechnology*. Fourth Revised Edition. New Age International Publishers.

SEMESTER I			
Core Practical - II- Laboratory in Biochemistry and Microbial Physiology			
Code : 19PMICR2	Hrs/Week : 6	Hrs/Sem: 90	Credits : 3

Vision:

To make the students imbibe the technical knowledge in the field of Biochemistry and Microbial physiology.

Mission:

To provide the students knowledge with various laboratory oriented techniques with advanced level informations.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	know how to verify beer's law	2	K n
CO - 2	know how to estimate lowry's method	2	K n
CO - 3	recall about how to separate amino acid by paper chromatography	1	R n
CO- 4	know how to separate amino acid by thin layer chromatography.	3	K n
CO- 5	relate the procedures and principle of carbohydrate fermentation, imvic, triple sugar ion test.	1	Re
CO- 6	recall how to perform catalase and urease test.	2,3	Re
CO- 7	conclude the procedure for lactophenol cotton blue staining and turbidity method.	4,6	An
CO- 8	explain the fungal slide culture preparation and to examine dry weight of bacteria.	1,3	Ev

SEMESTER I			
Core Practical - II- Laboratory in Biochemistry and Microbial Physiology			
Code : 19PMICR2	Hrs/Week : 6	Hrs/Sem : 90	Credits : 3

1. Principles of colorimetry -Verification of Beer's law.
2. Estimation of proteins by Lowry's method.
3. Estimation of carbohydrates by Anthrone's method.
4. Separation of amino acid by paper chromatography.
5. Separation of amino acid by thin layer chromatography.
6. Extra cellular enzymatic activities of microorganisms (Utilization of gelatin, casein, starch, lipid)
7. Carbohydrate fermentation (Glucose, Lactose, Sucrose)
8. Triple sugar iron test
9. IMViC test series
10. H₂S test
11. Urease test
12. Catalase test
13. Growth curve (Turbidity method)
14. Examination of dry weight of bacteria

Books for Reference:

1. Cappuccino & Sherman, 2011. *Microbiology A laboratory manual*,. 9th Edition. Pearson Publication
2. Gunasekaran. P. 1996. *Laboratory Manual in Microbiology*. New Age International Ltd., Publishers, New Delhi.
3. Jayaraman, J. 1985. *Laboratory Manual in Biochemistry*. Wiley Eastern Ltd., New Delhi. Aneja.K.R., 2007. *Experiments in Microbiology, Plant pathology and Biotechnology*. Fourth Revised Edition. New Age International Publishers.
4. Kannan.N. 1995. *Laboratory Manual in General Microbiology*. Palani Paramount Publication, Palani.
5. Rajan.S.,Selvi Christy. R 2012. *Experimental procedure in Life sciences*. Anjanaa Book House.
6. Sundararaj, T. 2005. *Microbiology – Laboratory Manual*. (First Edition) Publn.

SEMESTER – II			
Core – V Immunology			
Code : 19PMIC21	Hrs/Week : 5	Hrs/Sem : 75	Credits : 4

Vision:

To impart advanced level information in the study of the immune system.

Mission:

To study about the various immune responses of the human system towards the pathogens.

Course Outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	interpret the basic system of immune response.	1	Un
CO - 2	recall about the classification of various immune cells and their functions in elevating immune response.	4	R e
CO - 3	improve knowledge about the nature , functions and characteristics of antigen and antibodies involved in immune response.	3,2	C r
CO - 4	assess the detailed information about the mhc and hla.	4	Ev
CO - 5	illustrate various complement fixation pathways and their basic mechanisms.	6	U n
CO - 6	interpret the knowledge about various antigen and antibody reactions with their principle.	1	Un
CO - 7	improve the knowledge about various hypersensitivity reactions and transplantation immunology.	3,4	Cr
CO - 8	prioritize various applications of monoclonal antibodies and types of vaccines.	1	E v

SEMESTER – II			
Core – V Immunology			
Code : 19PMIC21	Hrs/Week : 5	Hrs/Sem : 75	Credits : 4

Unit: I– Basics of Immunology

History and development of immunology - Immunity: Innate & Acquired. An over view on the cells of immune system. Organs & tissues of immune system. Clonal selection theory. Immune response: HIR & CMI. Phagocytosis.

Unit: II–Immune response and its components

Antigens and antibody – structure, types and functions. Antibody diversity: isotypes, allotypes and idiotypes. Biology of T & B cell. Major Histo compatibility Complex (MHC). Human leucocyte antigen (HLA). Complement pathways: classical, alternative.

Unit: III – Applied Immunology

Agglutination. Precipitation. Complement fixation. Immunoblotting. Immuno-fluorescence. Immunodiffusion: SRID, ODD & Immnoelectrophoresis - RIEP. Flow cytometry. Radio Immuno Assay.

Unit: IV - Clinical Immunology

Hypersensitivity - immediate & delayed type. Autoimmunity. Transplantation immunology. Tumor immunology. Immuno deficiency diseases - AIDS

Unit: V -- Immunization

Monoclonal antibody: production & applications. Vaccination: types, principle & applications. Current basic immunization schedule.

Books for Reference:

1. Stefan, H. and Kaufmann, E.2002. *Immunology of infectious diseases*. ASM Press, USA.
2. Abbas, A.K., Lichtman, A.H. and Pober, J.S. 1994. *Cellular and Molecular Immunology*. (2nd edition). WB Saunders, USA.
3. Humphrey, J.H, and Wite, R.G. 1995. *Immunology for students of Medicine*, (5th edition) ELBS, London.
4. Weir, D.M. 1995. *Experimental Techniques in Immunology*. Blackwell Scientific Publishers, London.
5. Donald M. Weir and John Sterward .1993. *Immunology* (7th editoin). ELBS, London.
6. Hue Davis. 1997. *Introductory Immunology* (1st edition). Chapman and Hall Publisher, London.
7. Ivan M. Roit .1998. *Essential Immunology* – Blackwell Scientific. Publishers, London.
8. Paul .1998. *Fundamental Immunology*, (2nd edition). Raver Press, New Yoek.

9. Peter J. Delves and Ivan M. Roit (Eds). 1998. *Encyclopedia of immunology* -(2nd edition). Academic Press.
10. Ridklad, M. Aydl .1995. *Immunology*, (2nd edition), Baltimore, Hong Kong, NMS Publication.
11. Roit, J.M., Brostaff, J.J and male, D.K. .1996.*Immunology* (4th edition). C.V. Mosby Publisher, St. Loius.
12. Stewart Sell. 2001. *Immunology, immunopathology and immunity*. (6th edition). ASM Press, USA.
13. Rajan, S. 2007. *Medical microbiology*, MJP Publishers, Chennai.
14. Fathimunisa Begum. 2008. *Monoclonal antibodies: The hopeful drugs*. MJP Publishers, Chennai.
15. Kannan, I.2007. *Immunology*. MJP Publishers, Chennai.
16. Ananthanrayanan, R., and Panicker, J. 2000. *Text Book of Microbiology*. Orient longmans.
17. Wiley, Sherwood, Woolverton. 2014. *Prescott's Microbiology*. Ninth Edition. McGraw Hill International Edition.
18. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne. 2007. *Kuby Immunology*. Sixth Edition. W. H. Freeman and Company, New York.

SEMESTER-II			
Core-VI Medical Microbiology			
Code: 19PMIC22	Hrs/Week: 5	Hrs/Sem: 75	Credits:4

Vision:

A centre of excellence for training and research in medical microbiology.

Mission:

To train quality healthcare professionals carry out creative innovative and inventive research and provide reliable diagnostic services in the field of medical microbiology.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	recall the clinical microbiology concept to patient care	1	Re
CO -2	analyse the level information in the subject of medical microbiology	6	An
CO -3	illustrate the different classes of microbes	3	Un
CO -4	describe the applied microbiology aspects of clinical technique.	1	Un
CO- 5	describe the role of chemotherapeutic technique	4	Un
CO -6	explain the drug resistance capacity of microbes	4	Un
CO -7	outline the concepts of chemotherapy and its mode of action	4	Un
CO -8	explain the knowledge of mycology and parasitology	5	Un

SEMESTER-II			
Core-VI Medical Microbiology			
Code: 19PMIC22	Hrs/Week: 5	Hrs/Sem: 75	Credits:4

Unit-I : Infection and transmission

Microbial diseases - sources, route of transmission. Pathogenesis - adhesion, invasion, host cell damage, release of pathogens. Microbial virulence and virulence factors - Signs and symptoms of microbial diseases. Treatment, Prevention and control of microbial infections. Immunity of microbial diseases. Diagnosis of microbial diseases - Collection, transport, preliminary processing of clinical pathogens.

Unit- II: Bacterial diseases

Characteristics, classification, pathogenesis, pathology, diagnosis, treatment, prevention and control of diseases caused by *Staphylococci*, *Bacillus*, *Clostridium*, *Corynebacterium*, *Salmonella*, *Klebsiella*, *Vibrio*, *Pseudomonas*, *Mycobacteria*.

Unit- III: Viral diseases

Etiology, Clinical symptoms, laboratory diagnosis and treatment-Pox virus(small pox,)-Herpes virus-(HSV I&II), Orthomyxovirus (Influenza virus, Swine Flu) - Paramyxovirus (Measles and Mumps), Enterovirus (Poliovirus), Arbovirus-(Chikungunya virus, Dengue, rubella), Hepatitis virus(HAV, HBV, HCV, HDV), HIV,SARS.

Unit-IV: Mycology and Parasitology

Human mycotic infections caused by Dermatophytes, *Histoplasma*, *Cryptococcus*, *Candida*, opportunistic mycoses. Medical importance of *Entamoeba*, *Giardia*, *Taenia*, *Ascaris*, Laboratory techniques in parasitology.

Unit-V: Antimicrobial agents

Classification of antimicrobial agents, Mechanism of drug action –antibacterial (Bacteriostatic and bactericidal) antifungal and antiprotozoans. Methods of testing drug sensitivity (*in vitro* and *in vivo*), antibiotic assay in body fluids. Mechanism of drug resistance and dissemination of multi drug resistance. Probiotics as therapeutic agents.

Books for Reference:

1. Chaechter M. Medoff G. and Eisenstein BC. 1993. *Mechanism of Microbial Diseases* 2nd edition. Williams and Wilkins, Baltimore.
2. David Greenwood, Richard CD, Slack, John Forrest Peutherer. 1992. *Medical Microbiology*. 14th edition. ELBS with Churchill Livingstone.
3. Hugo WB and Russell AD. 1989. *Pharmaceutical Microbiology* 4th edition. Blackwell Scientific Publication, Oxford.

4. Joan Stokes E, Ridgway GL and Wren MWD. 1993. *Clinical Microbiology*, 7th edition. Edward Arnold. A division of Hodder and Stoughton.
5. Ronald M. Atlas. 1989. *Microbiology. Fundamentals and Applications*. 2nd edition, Maxwell Macmillan international editions.
6. Topley and Wilson's. 1990. *Principles of Bacteriology, Virology and Immunity*, 8th edition, Vol. III Bacterial Diseases, Edward Arnold, London.
7. Connie R Mahon. 2010. *Textbook of Diagnostic Microbiology*. 3rd edition. Pearson.
8. Fritz H. Kayser. 2005. *Medical microbiology*. Thieme Verlag.
9. Credic, A. Mims. 2004. *Medical microbiology*. 3rd edition. Mosby Inc.
10. Frank, Steven A. 2002. *Immunology and Evolution of Infectious Disease*. Princeton University Press.
11. Warren Levinson Ernest Jawetz 2002, *Medical Microbiology and Immunology: Examination and Board Review*, 7th Edition. McGraw-Hill/Appleton and Laye
12. Prescott L.M. Harley J.P., and Klein D.A . 2008. *Microbiology* (7th Edition) McGraw Hill, New York.
13. Pelczar Jr .M. J. Chan E.C.S. and Kreig N.R. 1993. *Microbiology*- McGraw Hill, Inc., New York.
14. Dubey R.C. and Maheswari, S. 2003. *A Text Book of Microbiology*. S. Chand & Co., New Delhi.
15. Madigan M., T., Martinko. J.M., and Parker J., Brock TD. 1997. *Biology of Microorganisms*. (8th Edition). Prentice Hall International Inc, New York.
16. Nester, E.W. Roberts, C.V. and Nester, M.T. 1995. *Microbiology, A Human perspective*. IWOA, U.S.A.
17. Stainer R.Y., Ingraham J.L., Wheelis M.L., and Painter P.R. 1986. *General Microbiology*, Macmillan Education Ltd., London.
18. Tortora, Funke, Case Addison 2001, *Microbiology – An Introduction – 7th Edition*, Wesley Longman Inc.
19. John L. Ingraham and Catherine A Ingrahani. 2000. *Introduction to Microbiology*. Books / Cole Thomas Learning, New York.

Web References:

1. <http://dmoz.org/Science/Biology/Microbiology/>
2. <http://microbiology.mtsinai.on.ca/manual/default.asp>
3. <http://cal.vet.upenn.edu/parasite/links.html>
4. <http://www.suite101.com/links.cfm/microbiology>
5. <http://www.biosci.ohio-state.edu/-zoology/parasite/home.html>

SEMESTER – II			
Core –VII Microbial Genetics and Molecular Biology			
Code: 19PMIC23	Hrs/ Week: 4	Hrs/ Sem: 60	Credit: 4

Vision

To make the students knowledgeable in the field of Microbial Genetics and Molecular Biology.

Mission

To make the students aware of the concepts of Microbial Genetics and Molecular Biology.

Course Outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	relate the genetics of microorganisms	1	Re
CO-2	recall the molecular mechanisms of microorganisms	1	Re
CO-3	explain all important topics to prepare for competitive exams	5	Un
CO-4	examine the history of molecular biology	2	An
CO-5	analyse about nucleic acids, their damage and repair mechanism	6	An
CO-6	compare all gene transfer methods	2	Ev
CO-7	interpret the central dogma of molecular biology	1	Un
CO-8	agree the concept of mutation	2	Ev

SEMESTER – II			
Core –VII Microbial Genetics and Molecular Biology			
Code: 19PMIC23	Hrs/ Week: 4	Hrs/ Sem: 60	Credit: 4

Unit I: DNA-The Genetic Engineering

Historical aspects and current concepts of Molecular Biology - Experimental evidence for Nucleic acids as genetic information carriers - DNA features: Superhelicity, linking number, topological properties – Melting of DNA - DNA replication: General principles, Experimental proof for modes of replication, proof reading – Enzymology of DNA replication.

Unit II: DNA Damage and Repair

Relationships between replication and cell cycle- Inhibitors of DNA replication (Blocking precursor synthesis, nucleotide polymerization and altering DNA structure),- DNA damage and repair – Types of DNA damage (Dimeration, oxidative damage, alkylation pyrimidine dimers) – Repair pathways : Methyl directed very short patch repair, nucleotide excision repair, base excision repair, recombinational repair and SOS repair.

Unit III: Central Dogma of Molecular Biology

Transcription in Prokaryotes - General principles, basic apparatus, types of RNA polymerases, steps in initiation, elongation and termination, inhibitors of RNA synthesis – Polycistronic and monocistronic RNAs – Control of transcription by RNA polymerases, promoter regions, sigma factors – Controlled termination: Attenuation and anti – termination– Protein synthesis: Steps, details of initiation elongation and termination, role of various factors, inhibitors – Signal hypothesis.

Regulation of gene expression: Operation concept, catabolite repression, instability of bacterial RNA, negative regulation (*E.coli*, lac operon), Positive regulation (*E.coli* ara operon) – Regulation by attenuation (trp operon). Maturation and processing of RNA: Methylation, trimming of rRNA - Capping, Polyadenylation and splicing of mRNA – Cutting and modification of tRNA.

Unit IV: Gene as a Unit of Mutation and Recombination

Mutants and mutation, mutagens, revertants, spontaneous mutation, mutant isolation, mutagenesis and it's types, suppression – Plasmids: Types, detection, transfer, replication and properties. Transposable elements – Nomenclature, classes, IS elements, Transposons – Composite structure and complex transposon structure, mechanism of transposition.

Unit V: Gene Transfer Mechanisms

Transformation modes, transformation, natural and artificial competence, DNA uptake, molecular mechanisms of transformation in *Bacillus* sp and *E.coli* recombination and genetic mapping, Bacterial conjugation – F plasmid, structure and function, origin of conjugation (Hfr and F+) Interrupted and uninterrupted mating, time map and recombination

map, conjugation in *E.coli*, colicins and col factors.

Transduction – Generalized and Specialized – Lambda phage and P1 Mechanism of gene transfer through lambda and P1 Phages – HFT and LFT lysate – Co transduction – Transduction mapping.

Books for Reference:

1. David Freifelder, George M. Malacinski. 1993. *Molecular Biology*. Narosa Publishing House.
2. Avinash ., Kakoli Upadhyay 2005. *MolBio - Fundamentals of Molecular Biology* . Himalaya Publishing House.
3. Satyanarayana. U. 2013.*Biotechnnnology* – Books and Allied (P) Ltd.
4. Mohan P. Arora., Gurdarshan.,Sandhu. S 2004.*Genetics*.5th edition. Himalaya Publishing House.'
- 5 Sambamurty.A.V.S.S 2011. *Molecular Biology*. Narosa Publishing House.
6. Veer Bala Rastogi.2010 *Fundamentals of Molecular Biology*.Ane Books India.
7. Jeyanthi,G.P 2009 *Molecular Biology*.MJP Publisher,Chennai.
8. Raja Pandian.K., Shanthi. S 2011. *Molecular Biology and Microbial Genetics*.PBS Book Enterprises

SEMESTER – II			
Core VIII -Marine Microbiology			
Code :19PMIC24	Hrs/ Week: 4	Hrs/ Sem: 60	Credits:4

Vision:

To provide the learners with the best learning experience in Marine Microbiology by providing standard education and enabling the students to become entrepreneurs and socially responsible.

Mission:

To develop young students with active and creative minds in the field of microbiology. To motivate learners to contribute to sustainable development of nation through environmental protection and social responsibility

Course Outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	describe the basic knowledge on marine ecosystem.	1	Re
CO -2	acquire the knowledge about diversity of marine ecosystem	1,2	Kn
CO-3	can analyses the aware of bio fouling and prevention.	2,3,4	Ev
CO-4	interpret the knowledge on marine microorganisms.	1,2	Ap
CO-5	determines the microbial indicator organisms.	1	Kn
CO-6	explain the concept of marine pollution	2,3,4	Co
CO-7	grasp the knowledge about bioactive compounds.	2,3,4	An
CO-8	know the wealth of the sea	2	Kn

SEMESTER – II			
Core VIII -Marine Microbiology			
Code :19PMIC24	Hrs/ Week: 4	Hrs/ Sem: 60	Credits: 4

Unit I : Marine Environment – Zonation and Biota

Classification of marine environment. – Plankton– classification (size, life, habitat) and adaptations. Physical properties: waves, tides, currents- types, causes, and their impact on marine organisms. light, temperature, pressure. Chemical properties: nutrients, (major, minor, and trace elements), salinity, pH, density, dissolved gases (oxygen, carbon-di-oxide).

Unit II: Marine Diversity

Ecology of coastal, shallow and deep sea microorganism - importance and their significance. Diversity of microorganism - Nutrient cycles- Role of microorganisms in carbon, nitrogen, phosphorous and sulphur cycles in the sea under different environments including mangroves.

Unit III: Marine Ecosystems

Estuaries, salt marshes, mangroves. Coral reef — ecology and types, species interaction, adaptations and importance. Threats and conservation of coastal ecosystems (coral reef and mangroves). Actinomycetes in the mangroves and coral environment.

Unit IV: Marine Pollution

Sources, effects and control measures of heavy metal, radioactive, oil, and thermal pollutions. Microbial indicators of pollution. Role of microbes in pollution abatement, Bio fouling. Microbial biodegradation - hydrocarbon. Bioremediation of heavy metal.

Unit V :Wealth of the sea

Living resources: Fishery products- fish meal and fish oil. Phycocolloids; agar-agar and algin. Microbial diseases diagnosis and control. Marine microorganisms as a source of biomedical resources - dinoflagellates as a source of bioactive molecules - chemistry and pharmacology of marine toxins - saxitoxin -tetrodotoxin.

Books for Reference:

1. Gross, G., 1993. *Oceanography: A view of the Earth*. 6th edition. Prentice Hall Inc., New Jersey.
2. McCormick, J.M. and Thiruvathaakal J.V., 1976. *Elements of Oceanography*. W.B. Saunders Company, Philadelphia.
3. Nybakken, J.W. 1997. *Marine Biology – An Ecological Approach*. Addison Wesley Longman, Inc. California, 477pp.
4. Olivia J.Fernando 1999. *Sea water-Properties and dynamics*, Dhanesh Publications, Ponnagam, Thanjavur

5. Russel 1970. *Marine Ecology*, Academic Press- London and New York
6. Nelson and Smith 1973, *Oil pollution and Marine Ecology*-Plenum press
7. Daws, C.J.1981. *Marine Botany* John Wiley and Sons, New York.
8. Austin. B, and D.A Austin 1999. *Bacterial Fish pathogens- Diseases of Farmed and Wild Fish*. Springer Publisher.
9. Munn and Munn 1996. *Marine Microbiology: Ecology and Applications*. BIOS Scientific publisher.
10. Rheinheimer, G., 1980 *Aquatic Microbiology-an Ecological Approach*. Blackwell Scientific Publications
11. Vijaya Ramesh, K. 2004. *Environmental Microbiology*. MJP Publishers Chennai.
12. Tait, R.V and Dipper F.A 1998. *Elements of marine ecology* - 4th edition. British Library Cataloguing in Publication Data.
13. Atlas, R.M., and Bartha.M. 2003. *Microbial ecology- Fundamentals and Applications*. Benjamin- Cummings, Menlo Park, California.
14. Grant, W.D. and Long, P.L.1981. *Environmental Microbiology*. Blackie Glasgow and London.

SEMESTER II			
Core Practical III- Laboratory in Immunology and Medical Microbiology			
Code : 19PMICR3	Hrs/Week : 6	Hrs/Sem : 90	Credits : 3

Vision:

To impart advanced practical knowledge in Immunology and Medical Microbiology.

Mission :

To perform highly specific advanced methodologies for the study of human immune system towards the pathogens.

Course Outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO- 1	demonstrate various immuno diffusion test.	5	Re
CO - 2	develop their ability to perform qualitative and quantitative assay of widal test.	6	Re
CO -3	improve their ability to perform rpr test for syphilis.	6	Un
CO- 4	analyze how to perform latex agglutination and blood grouping techniques.	4,6	An
CO - 5	examine various types of bacterial pathogens like <i>staphylococcus aureus</i> , <i>escherichia coli</i> <i>klebsiella pneumonia</i> .	4	Un
CO- 6	demonstrate antibiotic susceptibility test.	5	Ap
CO -7	test urine samples.	4	Cr
CO - 8	examine stool sample .	4	An

SEMESTER II			
Core Practical III- Laboratory in Immunology and Medical Microbiology			
Code : 19PMICR3	Hrs/Week : 6	Hrs/Sem : 90	Credits : 3

- Precipitation reaction based on immunodiffusion test
 - ODD, b. Single Radial Immunodiffusion
- WIDAL test – qualitative & quantitative assay.
- RPR test for syphilis
- Agglutination reaction with reference to blood grouping & RH typing.
- Examination of Blood cells a) Total count b) Differential count
- Latex agglutination test (ASO)
- Blood smear identification of leucocytes by Giemsa stain
- Biochemical identification of bacterial pathogens.
Following tests to be performed – TSI, Indole, MR, VP, Citrate, Urease, Catalase test for
 - Staphylococcus aureus*, *Streptococcus* sp.,
 - Escherichia coli*, *Proteus vulgaris*
- Isolation of normal flora of the skin and throat
- Urine culture and its microbiological analysis (*E.coli*)
- Isolation of enteric pathogen from stool – (*Vibrio*) .
- Antibiotic sensitivity test – Kirby Bauer method.
- Determination of minimal inhibitory concentration.
- Isolation & identification of pathogens from wound and pus.

Books for Reference:

- Practical microbiology R.C. Dubey & Maheswari, S. Chand&Co.Ltd., New Delhi, 2002.
- Kanika L. Mukherjee, 2010. *Medical Laboratory Technology – Procedure manual for routine diagnostic tests* – McGraw – Hill Publishing Co., Ltd., New Delhi. Vol.I-III.
- R.C. Dubey & Maheswari, 2007. *Practical Microbiology*. S.Chand & Co.Ltd., New Delhi
- Kannan. N. 1996. *Laboratory Manual in General Microbiology*. Palani Paramount Publication, Palani.
- Cappuccino & Sherman, 2011. *Microbiology A laboratory manual*,. IX Edition. Pearson Publication

SEMESTER – II			
Core Practical -IV-Laboratory in Microbial Genetics, Molecular Biology and Marine Microbiology			
Code : 19PMICR4	Hrs/Week : 6	Hrs/Sem : 90	Credits : 3

Vision

To impart advanced level practical training in Microbial Genetics, Molecular Biology and Marine microbiology.

Mission

To make the students skilled in the field of Microbial Genetics, Molecular Biology and Marine microbiology.

Course Outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	examine isolation of antibiotic resistant mutants.	5	An
CO- 2	examine isolation of spontaneous and induced mutants.	3	An
CO -3	assess the isolation of autotrophic mutants.	3	Ev
CO- 4	distinguish between transformation, conjugation and transduction.	2	An
CO -5	determine the marine water characteristics like total hardness, nitrite and phosphate.	1,4,5	Kn,Ev
CO -6	determine the salinity of marine water.	2,3,4,5	Kn, Ap
CO -7	determine the acidity, alkalinity of marine water.	1,4,5	Kn, Ap, Ev
CO- 8	acquire the knowledge to identify the marine micro organisms.	1,3,4	Kn,An,Ap

SEMESTER –II			
Core Practical -IV-Laboratory in Microbial Genetics, Molecular Biology and Marine Microbiology			
Code : 19PMICR4	Hrs/Week: 6	Hrs/Sem: 90	Credits: 3

1. Isolation of antibiotic resistant mutants by gradient plate technique.
2. Isolation of Spontaneous mutants.
3. Isolation of UV induced mutants.
4. Isolation of autotrophic mutants by Replica plating technique.
5. Bacterial Transformation - Demonstration.
6. Bacterial Conjugation - Demonstration.
7. Bacterial Transduction – Demonstration.
8. Isolation and enumeration of marine microbes (Bacteria, Fungi, Actinomycetes) from marine water.
9. Determination of acidity
10. Determination of salinity of sea water.
11. Determination of alkalinity of sea water.
12. Determination of total hardness of sea water.
13. Determination of nitrite of sea water.
14. Determination of phosphate of sea water.
15. Biochemical test for marine micro-organisms-IMViC

Books for Reference:

1. James G. Cappuccino and Natalie Sherman 2012 - *Microbiology – A Laboratory Manual*. Seventh Edition–Pearson Education, Inc.
2. Gunasekaran.P 2007. *Laboratory Manual in Microbiology*. New Age International (P) Ltd., Publishers, New Delhi.
3. Rajan.S.,Selvi Christy. R 2012.*Experimental procedure in Life sciences*. Anjanaa Book House, Chennai
4. Aneja.K.R. 2003. *Experiments in Microbiology, Plant pathology and Biotechnology*. 4th Revised Edition. New Age International Publishers.
5. Janarthanan. S. and Vincent.S 2007. *Practical Biotechnology: Methods and Protocols*. Universities press (India) private limited, Hyderabad.
6. Jyoti Saxena, MamtaBaunthiyal, Indu Ravi 2012. *Laboratory manual for Microbiology, Biochemistry and Molecular Biology*. Scientific Publishers, India.
7. Benson. 2002. *Microbiological Applications – Laboratory Manual in General Microbiology*. International Edition, McGraw Hill Higher Education.
8. Cappuccino.J.G.,and Sherman.N.1996. *Microbiology–A Laboratory Manual*. Benjamin Cummins. New York.

SEMESTER-III			
Core-IX- Industrial and Pharmaceutical Microbiology			
Code:19PMIC31	Hrs/Week:5	Hrs/Sem:75	Credits:4

Vision:

To impart the professional information by increasing the global knowledge, understanding, and application in industrial and pharmaceutical microbiology.

Mission:

Empower our students to address current and future challenges facing humanity using industrial and pharmaceutical microbiology.

Course outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	revise the idea about the usage of microorganisms in the field of industrial microbiology	3	An
CO -2	analyse the knowledge of various industrial and pharmaceutical products and its impacts on the society.	4	Un
CO -3	knowledgeable in industrial fermentation	3	Un
CO -4	have an insight on industrial microbiological techniques	2	Re
CO -5	understands in the field of pharmaceutical microbiology	1	Un
CO-6	knowledge of basics and applied microbiological aspects of industries.	1	Un
CO-7	acquire the knowledge about production of various industrial and pharmaceutical products	4,5	Un
CO-8	know the detail knowledge about antibiotics and production of hormones	2,3,4	Un,Ap

SEMESTER-III			
Core-IX- Industrial and Pharmaceutical Microbiology			
Code:19PMIC31	Hrs/Week:5	Hrs/Sem:75	Credits:4

Unit-I- Basics of industrial microbiology.

Screening, isolation, preservation and improvement of industrially important microorganisms; Raw materials and media design for fermentation processes; Sterilization; Development of inoculums for industrial fermentations; Types of fermentation: Batch, Continuous, dual or multiple, surface, submerged, aerobic and anaerobic.

Unit-II- Fermentation and Enzymes.

Fermenter- Design and types, Instrumentation and control-aeration and agitation .Recovery and purification of fermentation products. Enzymes and cell immobilization, Production of recombinant proteins having therapeutic and diagnostic applications: Insulin, Interferon, Somatotropin.

Unit-III- Biology of industrial microorganisms.

Biology of industrial microorganisms. Streptomyces, Yeasts (*Saccharomyces*, *Hansenula*), Spirulina and Penicillium. Mushroom cultivation. Biosensors and Biochips. Biofuels from microbial sources.

Unit-IV- Industrial products.

Alcohols (Ethanol and Butanol); Beverages (Beer and Wine); Aminoacids (Glutamic acid and Lysine); Organic acids (Citric acid and acetic acid); Production of enzymes (Protease, Amylase and Lipase); Biopolymers (Xanthan gum and PHB); Biopreservatives (Nisin).

Unit-V- Pharmaceutical products

Antibiotics- mode of action (Penicillin, Cephalosporin and Streptomycin); Vitamins (Riboflavin and Cyanocobalamin); Production of Hormones (Testosterone and Androstenedione). Vaccines (Plant- *Agrobacterium tumefaciens*, Animal – *Leptospirosis*, Microbes - DPT).

Books for Reference:

1. Wulf Crueger 2000. *A Text Book of Industrial Microbiology* 1st edition Panima Publishing Corporation, New Delhi.
2. Peter F., Stanbury., Whittaker and Hali,S.J. 1997, *Principles of Fermentation Technology* 2nd edition Pergamon Press.
- 3..Patel A.H., 1996.*Industrial Microbiology* Macmillan India Limited.
4. Prescott & Dunn 1997, *Industrial Microbiology*. CBS publishers and Distributors.
5. Casida L.E., 1986, *Industrial Microbiology*. Eastern Limited, NewYork.
6. Michael J., Waites., Neil L .Morgan, John S. Rockey and Gray Higton 2001, *Industrial Microbiology- An Introduction*, Replika press Pvt., New Delhi.
7. Purohit S.S., Kakrani H.N. Saluja. 2006 , *Pharmaceutical Biotechnology*. 2nd edition Jodhpur.
8. Satyanarayana U., 2013. *Biotechnology Books and Allied* (P) Ltd, Kolkata.

SEMESTER-III			
Core-X- Genetic Engineering			
Code -19PMIC32	Hrs/Week:5	Hrs/Sem:75	Credits:4

Vision:

To promote applicable genetics, bioengineering, and bio technological knowledge through education and state of the art technologies

Mission:

Educate students for technical competence and knowledge management in different areas of Genetic engineering.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO- 1	explain the knowledge about cloning	2	An,Un
CO -2	perceive the applications of genetic engineering in various fields	4	Un, Re
CO- 3	understands the hazardous and potential risk in releasing transgenic into environment	5	Un
CO -4	create the techniques used in genetic engineering	2	An, Re
CO -5	understands the concepts of blotting techniques and its applications	3	Un
CO -6	discuss the cloning techniques and the production of transgenic materials	4	Un,An
CO -7	understand the synthesis of genetically modified commercial products	4	Un
CO- 8	make use of enzymology in genetic engineering	1	Cr

SEMESTER-III			
Core-X- Genetic Engineering			
Code -19PMIC32	Hrs/Week:5	Hrs/Sem:75	Credits:4

Unit – I: Gene cloning and vectors

Biology of vectors – Plasmids, bacteriophages, single stranded DNA vectors, cosmids, phasmids, specialized vectors – Plant viral vectors, Animal viral vectors, Virus vectors and other plasmid vectors –Animal viral vectors – Biology of host – *Escherichia coli* , *Saccharomyces cerevisiae* Cloning strategies: Cloning of genomic DNA, cDNA cloning and screening strategies.

Unit II: Enzymology of genetic engineering

Restriction enzymes – Types - Nomenclature – Recognition sequences – Cleavage patterns. Other enzymes used in Genetic engineering – DNA Ligase, Nuclease, Alkaline phosphatase, Kinase, Reverse transcriptase, Taq DNA polymerase, Thermal transferase, DPN1 enzyme.

Unit-III: Recombinant techniques

Blotting techniques – Southern, Northern and Western Blotting – Transformation of E.coli- PCR –types and variation- RFLP – AFLP – RAPD – SSCP and VNTR- Construction of cDNA library – Molecular mapping of genome – Genetic and physical maps.

Unit- IV: Synthesis of commercial products by Recombinant microorganisms

Antibiotics, Biopolymers. Genetic engineering of bio-degradative pathways – Manipulation by Transfer of plasmids and Gene alteration.

Unit – V: Cloning in plants and animals

Transgenic plant (FlavrSavr Tomato) – Transgenic animal (Dolly) – GEM (Super bug) - Biotechnology and ethics – Biotechnology in Agriculture and Environment – Ethical aspects of Biotechnology- BT products in India and their uses– Biowarfare.

Books for Reference:

1. Burrell, M.M. 1993. *Enzymes of Molecular Biology*, Humana press.
2. Chirikjian, J.G. 1995. *Biotechnology- Theory and Techniques*. Vol.II, Jones and Burtlett Publishers.
3. Gerhardt, P., Murray, R.G., Wood, W.A., and Kreig, N.R. 1994. *Methods for General and Molecular Bacteriology*. ASM Press, Washington D.C.
4. Cafferty. Mc. J., Hoogenboom, H.R. and Chiswell, D.J. 1996. *Antibody Engineering- A Practical Approach*, Oxford University Press,
5. Lewin, B. 2000. *Genes VII*, Oxford University Press, Oxford.
6. Murray Moo Young .1992, *Plant Biotechnology*. Pergamon Press.

7. Radledge, C. and Kristiansen, B. 2001. *Basic Biotechnology*. 2nd Edition. Cambridge University Press.
8. Das. H.K. 2005. *Text Book of Biotechnology*. Wiley Dreamtech India (P) Ltd., New Delhi.
9. Rigby. P.W.J.Ed. 1987. *Genetic Engineering*. 6th Academic press, London.
10. Wiseman.A.1983. *Principles of Biotechnology*. Chapman and Hall, New York.
- Desmond.S.T., Nicholl. 1994. *An Introduction to Genetic Engineering*. Cambridge Press.
11. Winnacker, E.L. 1987. *From Genes to Clones. Introduction to Gene technology*. 1st Edition. Panima Publishing Corporation, New Delhi.
12. Brown, T.A. 1995. *Gene Cloning – An Introduction*. 3rd Edition. Chapman and Hall, UK.
13. Glick, B.K. and Pasternik, J.J. 1998. *Molecular Biotechnology. Principles and applications of recombinant DNA*. 2nd Edition. ASM Press.
14. Mitra 2005. *Genetic engineering*. Published by Macmillan India Ltd., Chennai.
15. Jogdand S.N .2005. *Gene biotechnology*. Himalaya Publishing House, Mumbai.
16. Satyanarayana 2005. *Biotechnology*. 1st edition, Books and Allied (P) Ltd., Kolkata.
17. Preeti Joshi 2002. *Genetic engineering and its application*. 1st edition, Agrobios (India).
18. Bernad R Glick 2003. *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. 3rd edition, ASM Press, Washington, D.C.
19. Ramawat K and Shaily Goyal 2010. *Molecular Biology and Biotechnology*. 1st edition, S.Chand and company Ltd., New Delhi.

SEMESTER –III			
Core- XI - Food and Dairy Microbiology			
Code : 19PMIC33	Hrs/Week: 4	Hrs/Sem: 60	Credits: 4

Vision:

To impart the advanced level knowledge in the subject of food microbiology

Mission:

Inter life science, by its specific expertise, is intended to perform promotion and consulting in all fields of microbiology, but particularly in food microbiology

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO- 1	recall the techniques in food microbiology.	1	An
CO- 2	explain the about microorganisms important in food	2,5	Un
CO -3	knowledge about the microbial contamination of food.	1,2,4	Un
CO- 4	knows about the techniques in food preservation and fermented foods	3,4,6	Re
CO -5	knowledge about beneficial and harmful aspects of microbes in dairy products	2,4,5,6	Cr
CO -6	communicate the recent techniques on good manufacturing.	2,4,5,6	Un
CO-7	grasp the quality and safety assurance in food industry and the hazard analysis and critical control point	2,3	Re, Un
CO-8	grasp microbial examinations in food	4,5	Un,Ap

SEMESTER –III			
Core- XI-Food and Dairy Microbiology			
Code : 19PMIC33	Hrs/Week: 4	Hrs/Sem: 60	Credits: 4

Unit I : Introduction to Food Microbiology:

Food as a substrate for microorganisms – Microorganisms important in food microbiology – Molds, yeasts and bacteria –General characteristics, classification and importance –Factors influencing microbial growth in food – Extrinsic and intrinsic factors (Nutrient content, pH, Redox potential, Relative humidity, temperature, gaseous atmosphere).

Unit II: Microbial contamination of foods:

Microbial contamination of foods - spoilage of food by microbes in cereals and cereal products- fruits, vegetables and its dried products- Eggs and poultry – meat- fish – canned foods.

Unit III: Food Preservation:

Principles of food preservation: Methods of food preservation – Aseptic handling, pasteurization of milk, refrigeration and freezing, dehydration, Radiation - UV, Smoking chemicals – organic acids, nitrates, nitrites, sulphur di oxide and sulphites. Food fermentation: Bread, Tempeh, Fermented dairy products (kefir, koumiss, acidophilus milk). Preservatives used for dairy products – Mode of preservation

Unit IV: Dairy Microbiology:

Dairy Introduction – Sources of microorganisms in milk – Classification of microbes – Biochemical types, characteristics and pathology. Milk bore diseases - microbial and viral diseases in cattle's – Control measures.

Unit V: Microbiological examination of foods:

Microbiological examination of foods – Estimation and examination of specific microorganisms, Bacteriological examination of milk, preservation of milk, sterilization and dehydration – microbial standard and milk grading, quality and safety assurance in food and dairy industry. Good manufacturing practice, hazard analysis and critical control point (HACCP) concept. BIS Laboratory services.

Books for Reference:

1. Adams M.R., and Moss M.O., 1995. *Food Microbiology*. The Royal Society of chemistry, Cambridge.
2. Atlas.R.M.,1989,*Microbiology–FundamentalsandApplications*,MacmillianPublishing Company.
3. Banwart G.J. 1989, *Basic Food Microbiology*. Chapman & Hall New York.
4. Board R.C. 1983, *A modern Introduction to food Microbiology* Blackwell Scientific Publication, Oxford.
5. Robinson .R.K., 1990. *Dairy Microbiology*. Elsevier Applied Sciences, London.
6. FrazierW.C., and Westhoff D.C., 2008, *Food Microbiology* 4th edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
7. Jay J.M. 1987.,*Modern Food Microbiology*. CBS Publishers and Distributors, New Delhi.

SEMESTER –III			
Core – XII Research Methodology			
Code : 19PMIC34	Hrs/Week: 4	Hrs/Sem: 60	Credits: 4

Vision:

To impart advanced level information in the subject of Research methodology.

Mission:

To show various biological techniques used in research, and study about research project, paper presentation and article publication.

Course Outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	analyse the laboratory equipment's	2	An
CO-2	evaluate the rights granted by ipr	6	Ev
CO-3	determine the process involved in centrifugation and chromatography techniques	6	Ev
CO-4	examine electrophoresis techniques	6	An
CO-5	apply research methods in biological science.	1	Ap
CO-6	estimate project writing method and to estimate data's used in projects.	1	Ev
CO-7	identify the journals to publish articles	1	AP
CO-8	design article to present on seminar and the conference	5	Cr

SEMESTER –III			
Core – XII Research Methodology			
Code : 19PMIC34	Hrs/Week: 4	Hrs/Sem: 60	Credits: 4

Unit – I: Isolation, Fractionation and Separation

Isolation, Fractionation and Separation of cellular constituents – Isolation of chloroplasts, mitochondria, nucleic acids and enzymes – homogenization –Manual, mechanical and sonication –centrifugation-centrifuges and their uses- Micro centrifuge, high speed refrigerated centrifuges, ultra centrifuges, differential and density gradient centrifugation – Chromatography –paper, thin layer-separation of amino acids and sugars-Gas liquid chromatography, HPLC and PCR –principle and applications.

Unit – II: Separation and estimation of macromolecules and other compounds

Electrophoresis –principles, factors affecting electrophoretic mobility – support medium –Agarose and polyacrylamide gels- Electrophoresis of proteins and nucleic acids-Spectroscopic techniques –UV –visible, MALDI-TOF, LC-MS and AAS-principles, Instrumentation and applications-Estimation of cellular constituents- Sugars, amino acids and proteins –Flame photometer and Bomb calorimeter- principle and applications.

Unit – III: Research and Project writing methods, Article publication

Research-definition, objectives, types and importance - Research methods in biological sciences - Research process- Literature survey – sources –scientific databases- Research report writing – Parts of Thesis and Dissertation – Presentation in seminars and conferences – Writing scientific paper – Organization of scientific paper – Importance of title – Publication in research journals – Standards of Research journals- Peer – review – impact factor – citation index – Preparation of manuscript – Proof correction – proof correction marks- method of correcting proof- Writing chapters in books – Preparation of Research proposal and funding agencies – Research fellowships.

Unit – IV: Biostatistics

Basic definitions and applications of biostatistics – Population, Sample, Data, variable, sampling. Data Collection and presentation – Types of data - methods of collection of primary and secondary data - methods of data presentation – Graphical presentation. Measures of central tendency: Mean, Median, Mode. Correlation – Positive and Negative correlation and calculation of Karl Pearson's coefficient of correlation. Regression – Linear regression and multiple linear regression - regression equation. ANOVA, one way and two way classification.

Unit – V: IPR

Introduction to Intellectual property rights, copyright, related rights, trademarks, geographical indication, industrial design, patents and protection of new varieties of plants.

Books for Reference:

1. Veerakumari. L. 2006. *Bioinstrumentation*. MJP Publishers, Chennai.
2. Gurumani. N. 2010. *Scientific thesis writing and Paper presentation*. MJP Publishers, Chennai.
3. Dr. SimmiKharb. 2009. *Scientific Writing and Project management in Biotechnology*. University Science Press, New Delhi.
- 4 Gurumani. N. 2006. *Research Methodology for Biological Sciences*. MJP Publishers, Chennai.
5. Vijayalakshmi Ponnuraj. G. and C. Sivapragasam. 2008. *Research Methods (Tips and Techniques)*. MJP Publishers, Chennai.

SEMESTER – III			
Core Practical - V – Laboratory in Industrial and Pharmaceutical Microbiology, Genetic Engineering			
Code: 19PMICR5	Hrs/week: 6	Hrs/Sem: 90	Credits: 3

Vision

To impart advanced level practical training in Industrial, Pharmaceutical and Genetic Engineering.

Mission

To make the students skilled in the field of Industrial, Pharmaceutical and Genetic Engineering.

Course Outcome:

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO 1	relate the procedures and principle of pharmaceutical products test	1	Re
CO 2	conclude the procedure for isolation of hydrocarbon, plastic degrading micro organisms	4,6	An
CO 3	outline kirby-bauer disc diffusion technique, minimum inhibitory concentration.	4	Un
CO 4	recall how to perform enzyme immobilization in sodium, calcium alginate gel	2,3	Re
CO 5	examine isolation of spontaneous and induced mutants	3	An
CO 6	evaluate polymerase chain reaction	2	Ev
CO 7	assess the isolation of autotrophic mutants	3	Ev
CO 8	distinguish between transformation, conjugation and transduction	2	An

SEMESTER – III			
Core Practical - V – Laboratory in Industrial and Pharmaceutical Microbiology, Genetic Engineering			
Code: 19PMICR5	Hrs/week: 6	Hrs/Sem: 90	Credits: 3

1. Detection of compounds using Indian pharmacopoeia (Antibiotics-Penicillin and Streptomycin)
2. Control test of pharmaceutical products (Demo)
3. Sterility test
4. Pyrogen test
5. Toxicity test
6. Carcinogenicity test
7. Mutagenicity test
8. Allergy test
9. Isolation of hydrocarbon degrading micro organisms.
10. Isolation of plastic degrading micro organisms.
11. Assay of amylase from microbes.
12. Assay of protease and cellulose from microbes.
13. Enzyme immobilization in sodium alginate gel.
14. Cell immobilization in calcium alginate gel.
15. Screening of antibody producing micro organisms.
16. Isolation of UV induced mutants.
17. Isolation of autotrophic mutants by Replica plating technique.
18. Ampicillin selection of auxotrophs.
19. Polymerase Chain Reaction - Demonstration.
20. Bacterial Transformation - Demonstration.
21. Bacterial Conjugation - Demonstration.
22. Bacterial Transduction – Demonstration.

Books for Reference:

1. James G. Cappuccino and Natalie Sherman 2012 - *Microbiology – A Laboratory Manual*. Seventh Edition – Pearson Education, Inc.
2. Gunasekaran.P 2007. *Laboratory Manual in Microbiology*. New Age International (P) Ltd., Publishers, New Delhi.
3. Rajan.S., Selvi Christy. R 2012. *Experimental procedure in Life sciences*. Anjanaa Book House, Chennai
4. Aneja.K.R (2003) - *Experiments in Microbiology, Plant pathology and Biotechnology*. 4th Revised Edition. New Age International Publishers.
5. Janarthanan. S. and Vincent.S. 2007. *Practical Biotechnology: Methods and Protocols*. Universities press (India) private limited, Hyderabad.
6. Jyoti Saxena, Mamta Baunthiyal, Indu Ravi 2012. *Laboratory manual for Microbiology, Biochemistry and Molecular Biology*. Scientific Publishers, India.
7. Sambrook and Russell. *Molecular Cloning – A Laboratory Manual*, Vol. 1,2,3. 3rd edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
8. John Vennison. S 2009. *Laboratory manual for Genetic engineering*. PHI Learning Pvt Ltd, Delhi.

SEMESTER-III			
Core Practical VI - Laboratory in Food and Dairy Microbiology, Research Methodology			
Code: 19PMICR6	Hrs/Week:6	Hrs/Sem:90	Credits:4

Vision

To impart advanced level practical training in food, dairy Microbiology and Research Methodology

Mission

To make the students skilled in the field of food, dairy Microbiology and Research Methodology.

Course Outcome:

CO NO	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	interpret the viable count of bacteria	1	Ev
CO -2	assess the quantitative analysis of milk	3	Un
CO- 3	outline the microbial examination of milk test	4	Un
CO- 4	examine isolation of detection and determination of coliforms ,faecal coliforms and <i>E.coli</i> in food & beverages.	5	An
CO- 5	examine isolation of detection & confirmation of <i>Salmonella</i> , <i>Shigella</i> , <i>Vibrio</i> species in food.	3	An
CO -6	assess the isolation of microbial examination of canned foods.	3	Un
CO -7	evaluate agarose gel electrophoresis of DNA	3	Ev
CO -8	evaluate P ^H meter, spectrophotometer	3	Ev

SEMESTER-III			
Core Practical VI - Laboratory in Food and Dairy Microbiology, Research Methodology			
Code: 19PMICR6	Hrs/Week:6	Hrs/Sem:90	Credits:4

1. Viable count of bacteria in milk.
2. Phosphatase test.
3. Microbial examination of milk by Methylene blue test
4. Microbial examination of milk by Resazurin test
5. Quantitative analysis of Milk by standard plate count method.
6. Detection of mastitis and isolation of microorganisms through the infected milk.
7. Isolation of lipolytic organism from butter.
8. Detection and determination of anaerobic mesophilic spore formers in food.
9. Detection and determination of coliforms ,faecal coliforms and *E.coli* in food & beverages.
10. Detection & confirmation of *Salmonella* species in food.
11. Detection & confirmation of *Shigella* species in food.
12. Detection & confirmation of pathogenic *Vibrio* in food.
13. Estimation of molds & yeast from fruit juice.
14. Microbial examination of canned foods.
15. Preparation of buffer and determination of pH using pH meter.
16. Verification of Beer-Lambert's Law using Spectrophotometer.
17. Agarose gel electrophoresis of DNA.
18. PCR-Demonstration.
19. Visit to food and dairy industry.

Books for Reference:

1. J.G. Cappuccino and N.Sherman 1996 *Microbiology – A lab manual* Benjamin Cummins, New York.
2. Kannan, N.1996. *Laboratory Manual in General Microbiology*. Palani Paramount Publication, Palani.
3. Jayaraman, J.1985. *Laboratory Manual in Biochemistry*. Wiley Eastern Ltd., New Delhi.
4. Plummer, D.T.1998. *An Introduction to Practical Biochemistry*. Tata McGraw-Hill. New Delhi.
5. Harley Precott. 2002. *Laboratory Exercises in Microbiology* 5th edition. The Mac Graw – Hill companies.

SEMESTER- III	
Self Study Course (Optional) -Probiotics	
Code:19PMISS1	Credit: +2

Vision:

To provide the learners with the best learning experience in Probiotics by self study education and enabling the students to become entrepreneurs and socially responsible.

Mission:

To develop young students with active and creative minds in the field of microbiology. To motivate learners to contribute to sustainable development of nation through environmental protection and social responsibility

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	recall the basic knowledge on probiotics	3	Re
CO -2	be acquainted with characteristics of probiotics	1,2	Kn
CO-3	can analyses the aware the probiotics organisms.	2,3,4	Ev
CO-4	interpret the knowledge on the roles of probiotics.	1,2	Ap
CO-5	differentiate the probiotics and prebiotics	1,2	Co
CO-6	explain the concept of mechanisms of probiotics	2,3,4	Un, Ap
CO-7	grasp the knowledge about prebiotics.	2,3	An
CO-8	know the wealth of the probiotics and prebiotic	2	Kn

SEMESTER- III	
Self Study Course (Optional) - Probiotics	
Code:19PMISS1	Credit: +2

Unit: I Probiotics:

Introduction and history of Probiotics, Probiotic microorganisms.

Unit : II Characteristics of Probiotics for selection:

Tolerance to additives, stability during storage, stability maintenance of probiotic microorganisms.

Unit: III Role of probiotics:

Role of probiotics in health and disease: prevention and treatment of gastrointestinal bacterial infection treatment of chronic urinary tract infection, antitumor and cholesterol level

Unit: IV Mechanism of probiotics:

Production of antimicrobial substances, modulation of immune system, alteration of intestinal bacterial metabolite action

Unit: V Prebiotics:

Concept, definition,criteria, types and sources of prebiotics, prebiotics and gut microflora- Prebiotics and health benefits: mineral absorption,immune response, cancer prevention, elderly health and infant health, prebiotics in foods.

Books for Reference:

1. Salminen. S and Wright , A. V. 1998. *Lactic Acid Bacteria*, Marcel Dekker
Glenn R. G. Marcel R. 2008. *Handbook of Prebiotics* CRC press
2. Lee Y K, Salminen S 2009. *Handbook of Probiotics and Prebiotics*. A John Willey and Sons Inc. Publication
3. Sandholm T. M. Saarela M. 2003. *Functional Dairy Products* CRC Woodhead Publishing .

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Code :19PMIC41	Hrs/ Week: 4	Hrs/ Sem: 60	Credit: 4

Vision:

To provide the learners with the best learning experience in Microbiology by providing standard education and enabling the students to become entrepreneurs and socially responsible.

Mission:

Developing young students with active and creative minds in the field of microbiology
 Enabling the students to become entrepreneur by applying the microbial technology
 Motivating learners to contribute to sustainable development of nation through environmental protection and social responsibility

Course Outcome:

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	recall the ecological groups of microbes	1	Re,
CO -2	have knowledge about the interaction between microbes and organisms at other tropic level.	1,2	Un, An
CO-3	interpret the microbiology of sewage and its treatment	2,3	Co
CO-4	explain about aero microbiology and microbial ecology	2	Un, An
CO-5	acquire basic knowledge about water purification	2	Ap
CO-6	gets knowledge about diversity in anoxic ecosystem.	2,4	Co
CO-7	understanding about biodegradation.	2	Sy
CO-8	develop the application of biodegradation and bioremediation.	5	Ap, Cr

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Code :19PMIC41	Hrs/ Week: 4	Hrs/ Sem: 60	Credit: 4

Unit I Microbial ecology:

Interaction between abiotic and biotic factors in an ecosystem, ecological niche, limiting factor, concept of community, fluctuation and succession. Interactions between microbes and organisms at other tropic levels: commensalism, mutualism, parasitism and predation with examples. Microbial communities: Biofilms, microbial mats and their significance.

Unit II Aerobiology:

Air space in different layers of atmosphere, bioaerosol, assessment of air quality using principles of sedimentation, impaction impingement, suction, and filtration. Brief account of transmission of airborne microbes; Microbiology of indoor and outdoor. Allergy: causes and tests for detection of allergy.

Unit III Aquatic Microbiology:

The aquatic environment - major environmental conditions influencing micro flora.. Microbiology of drinking water, water pollution, purification of water for human consumption. Assessment of microbial status in water and waste water. Wastewater characteristics, Effluent treatment processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection).

Unit IV Diversity in anoxic ecosystem:

Methanogens- reduction of carbonmonooxice- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of carbon, phosphorus, nitrogen and mercury.

Unit V Extremophiles:

The domain Archaea, acidophilic, thermophilic, and barophilic. and radiodurant microbes- mechanisms and adaptation. Halophilic- membrane variation- electron transport- Application of thermophiles and Extremophiles. Extremozymes.

Books for Reference:

1. Atlas,R.M., and Bartha.M. 2003. *Microbial Ecology –Fundamentals and applications*. Benjamin – Cummings, Mento Park, California.
2. SubbaRao, N.S.1995. *Soil Microorganisms and Plant growth*. 3rd Ed,Oxford and IBH Publishing Co, Pvt. Ltd, NewDelhi

3. Wheeler, B.E. 1976. *An introduction to Plant disease*. ELBS and John Wiley and sons, Ltd.
4. Dirk, J. Elsas, V., Trevors, T., and Wellington, E.M.H. 1997. *Modern Soil Microbiology*. Marcel Dekker INC, New York, HongKong.
5. Gupta, S.K. 2014. *Approaches and trends in plant disease management*. 5th Edition. Scientific publishers. Jodhpur, India.
6. Jammaluddin et al. 2013. *Microbes and sustainable plant productivity*. 3rd Edition. Scientific Publishers Jodhpur, India.
7. G. Purohit, S.S. Kothari, P.R. and Mathur. 1993. *Basic and Agricultural Biotechnology*, Agrobotanical Publishers (India). Bikaner.
8. Prescott, L.M., Harley, J.P. and Helin, D.A. 2008. *Microbiology*, 5th Edition, McGraw Hill, New York.
9. Schlegel, H.G. 1995. *General Microbiology*, 7th edition, Cambridge University.
10. Prabhakaran, G. 2004. *Introduction to Soil and Agricultural Microbiology*, Himalaya Publishing House.
11. George N. Agrios. 2005. *Plant Pathology*. 5th Edition. Academic Press.
12. Raina M. Maier, Ian A. Pepper and Charles Gerba. 2009. *Environmental Microbiology*. 2nd edition. Academic Press.
13. Dubey, R.C. and Maheswari, D.K. 2013. *A text book of Microbiology*, Revised S. Chand and Company Ltd, New Delhi.
14. Saha, T.K. 2010. *Ecology and Environmental Biology*, Books and Allied Pvt. Ltd. Kolkata
15. Shiva Aithal, C. 2010. *Modern approaches in Soil, Agricultural and Environmental Microbiology*. Himalaya Publishers, New Delhi.
16. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. *Biology Microorganisms*, 12th Edition, Prentice Hall, New Delhi.
17. Pelczar, M.J., Schan, E.C. and Kreig, N.R. 2010. *Microbiology – An application based approach*, 5th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.

SEMESTER – IV			
Core – XIV- Soil and Agricultural Microbiology			
Code :19PMIC42	Hrs/ Week: 4	Hrs/ Sem: 60	Credit: 4

Vision:

To provide the learners with the best learning experience in Soil and agricultural Microbiology by providing standard education and enabling the students to become entrepreneurs and socially responsible.

Mission:

Developing young students with active and creative minds in the field of microbiology
Enabling the students to become entrepreneur by applying the microbial technology. Motivating learners to contribute to sustainable development of nation through environmental protection and social responsibility

Course Outcome:

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	recall the ecological groups of microbes and properties of soil	1	Re, Un
CO -2	have knowledge about the soil fertility	1,2	Un
CO-3	recall the previous basic knowledge about nitrogen fixing	1,2	Re, Co
CO-4	explain about plant microbe interaction.	2	Un
CO-5	acquire basic knowledge about important of plant microbe interaction for different layers (rhizosphere, phyllosphere)	2	Ap, Un
CO-6	gets knowledge about recombinant microbes in agriculture.	2,4	Un, Co
CO-7	demonstrate an understanding of bio fertilizer	2	Sy
CO-8	develop the application of bio fertilizers in agricultural	5	Ap, Cr

SEMESTER – IV			
Core – XIV- Soil and Agricultural Microbiology			
Code :19PMIC42	Hrs/ Week: 4	Hrs/ Sem: 60	Credit: 4

Unit I Microbes and soil fertility:

Role of microbes in soil fertility. Decomposition of organic Matter by microorganisms - cellulose, hemicellulose, lignin, xylan and pectin. Soil fertility evaluation and improvement. Effect of pesticides on soil micro flora.

Unit II Biological nitrogen fixation(BNF):

Nitrification, denitrification; symbiotic nitrogen fixation (*Rhizobium*, *Frankia*), non-symbiotic nitrogen fixation (*Azotobacter*, *Azospirillum*); Nitrogenase enzyme, *nif* genes and molecular mechanism of nitrogen fixation. Role of nodulin genes in nodule development and symbiosis. Genetic engineering of BNF

Unit III Plant-microbial interaction:

Introduction, concepts and scope of agricultural microbiology, Interrelationships between plants and microorganisms, Rhizosphere and phyllosphere micro organisms and their interactions with plants. Plant pathogens (bacterial and fungal) Mechanisms of plant pathogenicity, symptoms of plant diseases, transmission of plant Diseases. Signaling events in pathogenesis and resistance to pathogens. Molecular basis of Plant disease control along with cultural practices, chemical and biological control.

Unit IV Biofertilizers:

Bacterial bio fertilizer: *Rhizobium*, *Azotobacter*- *Azospirillum*, *Azotobacter diazotrophicus* – Phosphobacteria. Algal fertilizer - Blue green algae, Azolla – Importance. Fungal fertilizers - Mycorrhizae – ecto and endomycorrhiza. Principles of mass production, Quality Control and Field applications.

Unit V Recombinant microbes in Agricultural:

Application of recombinant microorganisms in agriculture- Agro bacterium and virus mediated gene transfer and improvements of crops. Microorganisms and agriculture- Functions of microorganisms, Purification, fermentation and synthesis.

Books for Reference:

1. Atlas,R.M., and Bartha.M. 2003. *Microbial Ecology –Fundamentals and applications*. Benjamin – Cummings, Mento Park, California.
2. SubbaRao, N.S.1995. *Soil Microorganisms and Plant growth*. 3rd Ed,Oxford and IBH Publishing Co, Pvt. Ltd, NewDelhi

3. Wheeler, B.E. 1976. *An introduction to Plant disease*. ELBS and John Wiley and sons, Ltd.
4. Rangaswamy.g., and Bagyaraj.D.J. 1996. *Agricultural Microbiology*. Prentice-Hall of India Pvt Ltd., New Delhi.
5. Dirk, J. Elsas, V., Trevors,.T., and Wellington, E.M.H. 1997. *Modern Soil Mirobiology*. Marcel Dekker INC, New York, HongKong.
6. Gupta,S.K. 2014. *Approaches and trends in plant disease management*. 5th Edition. Scientific publishers.Jodhpur,India.
7. Jammaluddin et al. 2013. *Microbes and sustainable plant productivity*. 3rd Edition Scientific Publishers Jodhpur,India.
8. G.Purohit, S.S.Kothari,P.R.andMathur. 1993. *Basic and Agricultural Biotechnology*, Agrobotanical Publishers (India).Bikaner.
9. Prescott, L.M., Harley, J.P. and Helin, D.A. 2008. *Microbiology*, 5th Edition, McGraw Hill, New York.
10. Prabhakaran, G. 2004. *Introduction to Soil and Agricultural Microbiology*, Himalaya Publishing House.
11. George N. Agrios. 2005. *Plant Pathology*. 5th Edition. Academic Press.
12. Raina M. Maier, Ian A. Pepper and Charles Gerba. 2009. *Environmental Microbiology*. 2nd edition. Academic Press.
13. Dubey, R.C. and Maheswari, D.K. 2013. *A text book of Microbiology*, Revised S. Chand and Company Ltd, NewDelhi.
14. Atlas, R. M and Bartha, R .1998. *Microbial Ecology – Fundamentals and Applications*, 2nd edition, Wesly Longman Inc.
15. Saha, T.K. 2010. *Ecology and Environmental Biology*, Books and Allied Pvt. Ltd. Kolkat
16. Shiva Aithal, C. 2010. *Mordern approaches in Soil, Agricultural and Environmental Microbiology*. Himalaya Publishers, New Delhi.

SEMESTER –IV			
Core XV – Applied Microbiology			
Code: 19PMIC43	Hrs/Week: 4	Hrs/Sem: 60	Credits:4

Vision:

To create the ability to be multi-skilled in the field of applied microbiology with good technical and instrumentation knowledge on various concepts. And providing standard education and enabling the students to become entrepreneurs and socially responsible.

Mission:

To aware the basic knowledge about the applied microbiology and developing young students with active and creative minds in the field of applied microbiology.

Course Outcome:

CO . No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	acquire basic knowledge on applied microbiology	4	Un
CO -2	explain the basics of composting technology	4	Un
CO-3	appreciate the production of biogas technology	4	An
CO-4	grasp the fundamental knowledge about mushroom cultivation	4	Un
CO-5	acquire basic knowledge about <i>spirullina</i> production	2	Ap
CO-6	gets knowledge about biodegradation.	4,2	Un
CO-7	acquire detail knowledge about bioremediation.	2,4	Ap
CO-8	acquire the detail knowledge on bioaccumulation and bioleaching.	4,5	Un,Ap

SEMESTER –IV			
Core XV – Applied Microbiology			
Code: 19PMIC43	Hrs/Week: 4	Hrs/Sem: 60	Credits:4

Unit-I: Biofuel technology

Introduction and binary – anaerobic digestion – microbes involved – factors influencing methane – production – stages of methane generation – waste used in methanogenesis – various bioreactors used for methane generation – advantages and disadvantages. Visit in biogas production units with field demonstration.

Unit-II: Composting technology

Historical background – waste availability- factors influencing – methods – biomaturity – enrichments of compost and crop productivity. Vermiculture technologies: History – species – life cycles – methods – different types of waste suitable for vermicomposting. Utilization of vermicompost for crop production. Visit to vermicompost industries with field demonstration.

Unit-III: Mushroom cultivation technology

Bioconversion of organic wastes into protein – oyster mushroom technology, paddy mushroom, milky mushroom and button mushroom technology, post harvest technology. Mushroom farming and prospects. Visit to mushroom farms with field demonstration.

Unit- IV: Biofertilizer technology

Biology of *Spirulina* and *Azolla* – cultivated methods, post harvest technology and single cell protein formulation. Visit to *Spirulina* industries with field demonstration.

Unit-V: Biodegradation

Role of microbes in degradation. Biodegradation of xenobiotics- hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper; Factors affecting the bioremediation process, Bioremediation of toxic waste sites; Role of microbes; Bioaccumulation of heavy metals; Bio leaching of iron, gold and uranium.

Books for Reference:

1. Kumar , H.D., 1991. *A textbook on Biotechnology* , 2nd Edition , East- west press Pvt Ltd., New Delhi.
2. Chatwal, G.R., 1995. *Textbook of Biotechnology*, Anmol Publications Pvt. Ltd., New Delhi.
3. Jarsa , O.P., 2002 . *Environmental Biochemistry*, 1st Edition., Sarup& Sons, New Delhi, India.

4. Prescott, L.M., Harley, J.P. and Helin, D.A. 2008. *Microbiology*, 5th Edition, McGraw Hill, New York.
5. Raina M. Maier, Ian A. Pepper and Charles Gerba. 2009. *Environmental Microbiology*. 2nd edition. Academic Press.
6. Vonshak, A.2004. *Spirulina plantensis – physiology, cell biology and biotechnology*. Taylor and frencis, London.
7. Kawl, T.N. 1999. *Introduction to mushroom science*, oxford and IBM co., Pvt. Ltd., New Delhi.
8. Philip G. Miles, Shu- ting chang, 1997. *Mushroom biology*, world scientific, Singapore.
9. Bahl, N .1988. *Hand book on mushroom*. Oxford and IBH publishing Co.,Pvt Ltd., New Delhi.
10. Tripathi. G. 2003. *Vermiresources technology*, 1st Ed., Discovering Publication House, New Delhi.
11. Gaur, A.C., 1999. *Microbial technology for composting of Agricultural Residues by Improved Methods*, 1st Print, ICAR, New Delhi.
12. SubbaRao, N.S., 1999. *Soil Microbiology*, 4th Ed, oxford IBH publishing Co. Pvt. Ltd., New Delhi.
13. Chawla O.P. 1986. *Advances in Biogas Technology*, ICAR, New Delhi.
14. Martin Alexander 1976. *Introduction to soil Microbiology*, Wiley eastern Ltd., New Delhi.
15. LE Cassida J.R .2005. *Industrial Microbiology*. New Age International (P) Ltd., New Delhi.

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Code : 19PMICR7	Hrs/week: 6	Hrs/Sem:90	Credits: 3

Vision:

To impart skill on isolation of various microbes from Environment, soil and plant.

Mission:

To enhance advanced level laboratory training in Soil and Agricultural Microbiology and Environmental microbiology.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	test for isolation of various soil microbes	5	An
CO- 2	infer quantitative assay of microbes from air borne.	5	Ap
CO -3	interpret the preparation of bio fertilizer and its assay	4	Un
CO -4	experiment with isolation of microbes from various agro samples.	2	Un
CO- 5	interpret staining of vam	5	Un
CO -6	analyse antagonism between microorganisms	2	An
CO -7	demonstrate the isolation of phosphate solubilizing bacteria	5	Un
CO- 8	identify nitrogen fixing bacteria	5	Ap

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Code : 19PMICR7	Hrs/week: 6	Hrs/Sem:90	Credits: 3

1. Testing antagonistic activity of soil microorganisms.
2. Estimation of soil mineral contents a) pH b) nitrate c) nitrite d) sulphate e)phosphate.
3. Effect of high salt concentration on microbial growth.
4. Quantitative assay of microbes in Rhizosphere and phyllospher.
5. Isolation of air borne bioparticles.
6. Determination of biological oxygen demand.
7. Determination of chemical oxygen demand.
8. Determination of Soil pH and temperature.
9. Isolation of Phosphate solubilizing fungi.
10. Isolation of *Rhizobium sp* from root nodules of leguminous plants.
11. Isolation of *Azotobacter sp* from soil.
12. Isolation of *Azospirillum sp* from soil.
13. Identification of Cyanobacteria from soil. (*Anabaena* and *Nostoc*).
14. Assessment of VAM colonization and Staining.
15. Assay of biofertilizer (Seed treatment, Seedling treatment, Soil inoculation, Measurement of root and shoot system).

Books for Reference:

1. Jyoti Saxena, Mamta Baunthiyal, Indu Ravi. 2012. *Laboratory manual for Microbiology, Biochemistry and Molecular Biology*. Scientific Publishers, India.
2. Gunasekaran. P. 2005. *Laboratory Manual in Microbiology*. 1st edition. New Age International Ltd., Publishers, New Delhi.
3. Dubey, R.C. and Maheswari, D.K. 2002. *Practical Microbiology*. 2nd edition. Chand and Company Ltd., India.
4. Aneja K.R. 1993. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4th edition. New Age International Publishers, New Delhi.
5. Harold J. Benson, Alfred E. Brown - 2006. *Benson's Microbiological applications: Laboratory manual in General Microbiology*. International Edition, McGraw Hill Higher Education.
6. Plummer. D.T. (1998). *An Introduction to Practical Biochemistry*. Tata McGraw Hill, New Delhi.

SEMESTER –IV			
Core Practical VIII - Laboratory in Applied Microbiology			
Code: 19PMICR8	Hrs/Week: 6	Hrs/Sem: 90	Credits:3

Vision:

To provide the learners with the best learning experience in Applied Microbiology by providing standard education and enabling the students to become entrepreneurs and socially responsible.

Mission:

To develop young students with active and creative minds in the field of applied microbiology. To enable the students to become entrepreneur by applying the microbial technology. To motivate learners to contribute to sustainable development of nation through environmental protection and social responsibility

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	C L
CO-1	acquire basic knowledge on preparation of vermin bed	4	Un, Ap
CO -2	explain the maintenance of vermicomposting.	4	Un, Ap
CO-3	appreciate the production of biogas from cassava tubes.	4	Ap
CO-4	grasp the knowledge about medicinal values of mushroom.	4	Un
CO-5	acquire knowledge about <i>spirullina</i> mass production	2	Ap
CO-6	knowledge about the bio gas production from organic waste.	4,2,5	Un,Ap
CO-7	have knowledge on entrepreneurship skill	2,4	Ap
CO-8	acquire detailed knowledge about production techniques through the industrial visit.	4,5	Un,Ap

SEMESTER –IV			
Core Practical VIII -Laboratory in Applied Microbiology			
Code: 19PMICR8	Hrs/Week: 6	Hrs/Sem: 90	Credits: 3

1. Preparation of Vermi bed, Maintenance of Vermicomposting and climatic conditions.
2. Harvesting, packaging, transport and storage of Vermicomposting
3. Study of verms diseases and enemies.
4. Tissue culture- mushroom.
5. Estimate protein from mushroom.
6. Estimate carbohydrate from mushroom.
7. Estimate lipid from mushroom.
8. Mass production of the Blue-Green Alga *Spirulina*.
9. Cultivation of *Spirulina platensis* in different selective media.
10. Biogas production from Cassava tubers.
11. Biogas production from organic waste.
12. Industrial visit.

Books for Reference:

1. Satchel, J.E. 1983. *Earth worm ecology*. Chapman Hall, London.
2. Bernard Glick, Jack J. Pasternak., 2001. *Molecular Biotechnology*. ASM press Washington 2nd Edn.
3. Brown, T.A. 1999. *Gene Cloning*. 3rd Edition. Chapman and Hall Publications, USA.
4. Rajan.S., Selvi Christy. R 2012. *Experimental procedure in Life sciences*. Book House.
5. Cappuccino. J.G., and Sherman. N. 1996. *Microbiology – A Laboratory Manual*. Benjamin Cummins. New York.
6. Kannan.N. 1996. *Laboratory Manual in General Microbiology*. Palani Paramount Publication, Palani.
7. Gunasekaran.P.1996. *Laboratory Manual in Microbiology*. New Age International Ltd., Publishers, New Delhi.