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.2021)

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 protests and prokaryotes such as bacteria and certain algae also viruses are included, the scope of microbiology in 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.	After completion of the Postgraduate programme, the students of St. Mary's College will be able to
PO-1	acquire expertise knowledge in their respective disciplines and become professionals.
PO-2	pursue research / higher learning programmes.
PO-3	compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies
PO-4	develop critical / logical thinking skills and managerial skills and become locally, nationally & globally competent
PO- 5	apply their experiment and research skills to analyse and solve complex problems.
PO-6	develop themselves as a holistic person assisting in the Nation building process.
PO-7	be a lifelong learner and amenable to new ideas, actively seek out new ways of learning or understanding the world.
PO-8	1. be an empowered and economically independent woman with efficient leadership qualities in an egalitarian society through liberative education.

Programme Specific Outcome:

PSO No	Upon completion of M.Sc. Microbiology Degree Programme, the Postgraduates will be able to	PO Mapped
PSO-1	acquire in-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of Microbiology	PO - 1
PSO-2	acquire in –depth knowledge of the topics of the research conducted by the researchers.	PO - 4
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.	PO - 5
PSO-4	contribute to the generation of new scientific insights or to the innovation of new applications of microbial research.	PO – 6, 3
PSO-5	apply statistical skills	PO – 2
PSO-6	integrate and evaluate information from a variety of sources	PO – 4
PSO-7	manage resources and time.	PO – 8
PSO-8	plan, conduct and write up a programme of original research.	PO – 7

PG Course Structure

Semester-I

Subject	Course Code	Course Title	Contact hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core-I	21PMIC11	Fundamentals of Microbiology	5	4	40	60	100
Core-II	21PMIC12	Microbial Diversity and classification	5	4	40	60	100
Core-III	21PMIC13	Biochemistry	4	4	40	60	100
Core IV	21PMIC14	Microbial Physiology	4	4	40	60	100
Core Practical I	21PMICR1	Laboratory in Fundamentals of Microbiology, Microbial diversity and classification	6	3	40	60	100
Core Practical II	21PMICR2	Laboratory in Biochemistry and Microbial physiology	6	3	40	60	100
		Total	**30**	**22**			

Semester-II

Subject	Course Code	Course Title	Contact hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core- V	21PMIC21	Immunology	5	4	40	60	100
Core- VI	21PMIC22	Medical Microbiology	5	4	40	60	100
Core- VII	21PMIC23	Microbial genetics and Molecular biology	4	4	40	60	100
Core- VIII	21PMIC24	Marine Microbiology	4	4	40	60	100
Core Practical III	21PMICR3	Laboratory in Immunology and Medical Microbiology	6	3	40	60	100
Core Practical - IV	21PMICR4	Laboratory in Microbial genetics , Molecular biology and Marine Microbiology	6	3	40	60	100
		Total	**30**	**22+2**			

It is mandatory for all I PG students to attend the course through Swayam Portal. Students who pass in MOOC through portals will get extra credit. Students who fail in MOOC can appear for supplementary exam and the institution will provide the certificate. No extra credits will be given.

Semester-III

Subject	Course Code	Course Title	Contact hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core-IX	21PMIC31	Industrial and Pharmaceutical Microbiology	5	4	40	60	100
Core- X	21PMIC32	Genetic Engineering	5	4	40	60	100
Core-XI	21PMIC33	Food and Dairy Microbiology	4	4	40	60	100
Core- XII	21PMIC34	Research Methodology	4	4	40	60	100
Core Practical-V	21PMICR5	Laboratory in Industrial and Pharmaceutical Microbiology, Genetic Engineering	6	3	40	60	100
Core Practical-VI	21PMICR6	Laboratory in Food and Dairy Microbiology, Research Methodology	6	4	40	60	100
Self Study Course /MOOC	21PMISS1/ 21PMIM31	Probiotics		+2			100
		Total	**30**	**23+2**			

Semester-IV

Subject	Course Code	Course Title	Contact hours/ week	Credits	Max. Marks		
					CIA	ESE	Total
Core -XIII	21PMIC41	Environmental Microbiology	4	4	40	60	100
Core- XIV	21PMIC42	Soil and Agricultural Microbiology	4	4	40	60	100
Core -XV	21PMIC43	Applied Microbiology	4	4	40	60	100
Core Practical - VII	21PMICR7	Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology	6	3	40	60	100
Core Practical-VIII	21PMICR8	Laboratory in Applied Microbiology	6	3	40	60	100
Project	21PMIP41		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**

SEMESTER- I			
Core I - Fundamentals of Microbiology			
Course Code : 21PMIC11	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

Objectives:

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

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	analyse nutritional requirements of microbes.	5,6	Ev
CO-6	understand the techniques for isolation of pure culture of microorganisms.	1,5,6	Un

SEMESTER- I			
Core I - Fundamentals of Microbiology			
Course Code: 21PMIC11	**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 **(Self Study)** – 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 **(Self Study)** – 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. *Biology of Microorganisms.* London: Hall International Inc. 8th Edition Prentice 1997.
2. Salle, A.J. *Fundamental Principles of Bacteriology*. New Delhi: Tata McGraw – Hill Publishing Company Ltd, 7th Edition. 1996.
3. Stainer R.Y. Ingra ham J.L. Wheelis M.L. and Painter P.R. London: *General Microbiology,* Mac Millan Education Ltd 1986.
4. Tortora, Funke, Case Addison, *Microbiology – An Introduction* –Wesley Longman Inc. 7th Edition 2001.
5. Dubey R.C. and Maheswari,S. *A Text Book of Microbiology*. New Delhi: S. Chand & Co, 2003
6. Talaro K.P. and Talaro.A. *Foundations in Microbiology*. New York: WCP McGraw – Hill, 1999
7. Dubey and Maheshwari.. *A text book of Biotechnology*. Chand publications, 2006
8. Jeffrey C. Pommerville., *Alcamo's Fundamentals of Microbiology* Jones & Bartlett learning 9th edition, 2010.
9. Prescott L.M. Harley J.P. and Klein D.A *Microbiology* New York: McGraw Hill, 7th Edition, 2008.
10. Pelzar Jr. M.J.Chan E.C.S. and Kreig N.R. *Microbiology* – New York: McGraw Hill, Inc 1993.

SEMESTER I			
Core – II Microbial Diversity and Classification			
Course Code : 21PMIC12	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

Objectives:

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

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

SEMESTER I			
Core – II Microbial Diversity and Classification			
Course Code : 21PMIC12	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

Unit I: Biodiversity and Classification

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

SEMESTER I			
Core III- Biochemistry			
Course Code : 21PMIC13	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 4**

Objectives:

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

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 dna, rna structure, function, types and importance	6	Kn
CO-6	understand the functions of enzymes, coenzymes and cofactors	5,6	Un

SEMESTER I			
Core III- Biochemistry			
Course Code : 21PMIC13	**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 quarternary 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 Michaelis Menten 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 fatty acids- unsaturated, saturated fatty acids, triglycerides, saponification, sterols, cholesterol, prostaglandins, glycolipids and function of lipids.

Books for Reference :

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

SEMESTER – I			
Core – IV Microbial Physiology			
Course Code : 21PMIC14	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 4**

Objectives:

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

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 fuctions 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

SEMESTER – I			
Core – IV Microbial Physiology			
Course Code : 21PMIC14	**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 bacterirhodopsin- localization of the pigments-regulation of pigments. Anoxygenic photosynthesis-Oxygenic photosynthesis-photosynthesis in halobacteria.

Books for Reference:

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

SEMESTER – I			
Core Practical I - Laboratory in Fundamentals of Microbiology, Microbial Diversity and Classification			
Course Code: 21PMICR1	**Hrs/ Week: 6**	**Hrs/ Sem: 90**	**Credits: 3**

Objectives:

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

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	isolate and characterize bacteria by steak plate method.	2, 4 5	Un
CO-2	understand the enumeration technique for water,air and soil samples.	2, 4, 5	An
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

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

SEMESTER I			
Core Practical - II- Laboratory in Biochemistry and Microbial Physiology			
Course Code : 21PMICR2	**Hrs/Week : 6**	**Hrs/Sem: 90**	**Credits : 3**

Objectives:

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

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	conclude the procedure for lactophenol cotton blue staining and turbidity method.	4,6	An
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

SEMESTER I			
Core Practical - II- Laboratory in Biochemistry and Microbial Physiology			
Course Code : 21PMICR2	**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. H_2S 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, *Microbiology A laboratory manual*,. 9th Edition.Pearson Publication. 2011.
2. Gunasekaran. P.. *Laboratory Manual in Microbiology*. New Age International Ltd., Publishers, New Delhi. 1996
3. Jayaraman, J. *Laboratory Manual in Biochemistry*. New Delhi: Wiley Eastern Ltd.,. 1985.
4. Aneja.K.R., *Experiments in Microbiology, Plant pathology and Biotechnology.* Fourth Revised Edition. New Age International Publishers. 2007.
5. Kannan.N. *Laboratory Manual in General Microbiology*. Palani: Palani Paramount Publication, 1995.
6. Rajan.S.,Selvi Christy. R *Experimental procedure in Life sciences*. Anjanaa Book House. 2012.

SEMESTER – II			
Core – V Immunology			
Course Code : 21PMIC21	**Hrs/Week : 5**	**Hrs/Sem : 75**	**Credits : 4**

Objectives:

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

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	prioritize various applications of monoclonal antibodies and types of vaccines.	1	E v
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	improve the knowledge about various hypersensitivity reactions and transplantation immunology.	3,4	Cr
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

SEMESTER – II			
Core – V Immunology			
Course Code : 21PMIC21	**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*Immunology of infectious diseases.* USA : ASM Press,. .2002.
2. Abbas, A.K., Lichtman, A.H. and Pober, J.S.. *Cellular and Molecular Immunology.* (2nd edition). USA: WB Saunders,. 1994
3. Humphrey, J.H, and Wite, R.G. *Immunology for students of Medicine,* (5th edition) ELBS, London: 1995.
4. Weir, D.M. *Experimental Techniques in Immunology*. London : Blackwell Scientific Publishers,. 1995.
5. Donald M. Weir and John Sterward . *Immunology* (7theditoin). ELBS, London: 1993.
6. Hue Davis.. *Introductory Immunology* (1st edition). London : Chapman and Hall Publisher,. 1997.
7. Ivan M. Roit . *Essential Immunology* – London : Blackwell Scientific.Publishers,. 1998.
8. Paul .. *Fundamental Immunology,* (2nd edition). New York: Raver Press,. 1998.

9. Peter J. Delves and Ivan M. Roit (Eds). *Encyclopedia of immunology* -(2nd edition). Academic Press. 1998.
10. Ridklad, M. Aydl . *Immunology,* (2nd edition), Baltimore, Hong Kong, NMS Publication. 1995.
11. Roit, J.M., Brostaff, J.J and male, D.K. . *Immunology* (4th edition). C.V. Mosby Publisher, St. Loius. 1996.
12. Stewart Sell.. *Immunology, immunopathology and immunity*. (6th edition). USA: ASM Press,. 2001
13. Rajan, S.. *Medical microbiology,* Chennai : MJP Publishers,. 2007
14. Fathimunisa Begum.. *Monoclonal antibodies: The hopeful drugs.* Chennai: MJP Publishers,. 2008
15. Kannan, I. Immunology. Chennai: MJP Publishers, 2007.
16. Ananthanrayanan, R., and Panicker, J. *Text Book of Microbiology*. Orient longmans. 2000.

SEMESTER-II			
Core-VI Medical Microbiology			
Course Code: 21PMIC22	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits:4**

Objectives:

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

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 chemotherapic technique	4	Un
CO -6	explain the drug resistance capacity of microbes	4	Un

SEMESTER-II			
Core-VI Medical Microbiology			
Course Code: 21PMIC22	**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-(HSVI&II), Orthomyxovirus (Infleunza virus, Swine Flu) - Paramyxovirus (Measles and Mumps), Enterovirus (Poliovirus), Arbovirus- (Chikungunga 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. *Mechanism of Microbial Diseases* 2nd edition. Baltimore: Williams and Wilkins,. 1993.
2. David Greenwood, Richard CD, Slack, John Forrest Peutherer. *Medical Microbiology*. 14th edition. ELBS with Churchill Livingstone. 1992.
3. Hugo WB and Russell AD. *Pharmaceutical Microbiology* 4th edition. Oxford : Blackwell Scientific Publication,. 1989.

4. Joan Stokes E, Ridgway GL and Wren MWD. *Clinical Microbiology*, 7th edition. Edward Arnold. A division of Hodder and Stoughton. 1993.
5. Ronald M. Atlas. *Microbiology. Fundamentals and Applications*. 2nd edition, Maxwell Macmillan international editions. 1989.
6. Topley and Wilsons's. *Principles of Bacteriology, Virology and Immunity,* London: 8th edition, Vol. III Bacterial Diseases, Edward Arnold,. 1990.
7. Connie R Mahon. *Textbook of Diagnostic Microbiology*. 3rd edition. Pearson. 2010.
8. Fritz H. Kayser. *Medical microbiology*. Thieme Verlag. 2005.
9. Credric, A. Mims. *Medical microbiology*. 3rd edition. Moshy Inc. 2004.
10. Frank, Steven A. *Immunology and Evolution of Infectious Disease*. PrincetonUniversity Press. 2002.

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			
Course Code: 21PMIC23	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Objectives:

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

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

SEMESTER – II			
Core –VII Microbial Genetics and Molecular Biology			
Course Code: 21PMIC23	**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, Poly adenylation 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. *Molecular Biology*. Narosa Publishing House. 1993.
2. Avinash ., Kakoli Upadhyay MolBio - *Fundamentals of Molecular Biology* . Himalaya Publishing House. 2005.
3. Satyanarayana. U. .*Biotechnnology* – Books and Allied (P) Ltd. 2013
4. Mohan P. Arora., Gurdarshan.,Sandhu. S.*Genetics*.5th edition. Himalaya Publishing House.' 2004
5. Sambamurty.A.V.S.S . *Molecular Biology*. Narosa Publishing House. 2011.
6. Veer Bala Rastogi. *Fundamentals of Molecular Biology*. India : Ane Books. 2010
7. Jeyanthi,G.P . *Molecular Biology.* Chennai: MJP Publisher, 2009
8. Raja Pandian.K., Shanthi. S. *Molecular Biology and Microbial Genetics*. PBS Book Enterprises. 2011.

SEMESTER – II			
Core VIII -Marine Microbiology			
Course Code :21PMIC24	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits:4**

Objectives:

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.

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	explain the concept of marine pollution	2,3,4	Co
CO-6	grasp the knowledge about bioactive compounds.	2,3,4	An

SEMESTER – II			
Core VIII -Marine Microbiology			
Course Code :21PMIC24	**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 -tetradotoxin.

Books for Reference:

1. Gross, G.,.*Oceanography: A view of the Earth*. 6th edition. New Jersey: Prentice Hall Inc.,. 1993

2. McCormick, J.M. and Thiruvathaakal J.V., *Elements of Oceanography*. Philadelphia: W.B. Saunders Company,. 1976.

3. Nybakken, J.W.. *Marine Biology – An Ecological Approach*. California: Addison Weslay Longman, Inc., 477pp. 1997

4. Olivia J.Fernando. *Sea water-Properties and dynamics*, Thanjavur : Dhanesh Publications, Ponnagam,. 1999.

5. Russel. *Marine Ecology*, London and New York: Academic Press-. 1970.

6. Nelson and Smith, *Oil pollution and Marine Ecology*-Plenum press. 1973.

7. Daws, C.J.. *Marine Botany*. New York : John Wiley and Sons,. 1981.

8. Austin. B, and D.A Austin. *Bacterial Fish pathogens- Diseases of Farmed and Wild Fish.* Springer Publisher. 1999.

9. Munn and Munn. *Marine Microbiology: Ecology and Applications*. BIOS Scientific publisher. 1996.

10. Rheinheimer, G., *Aquatic Microbiology-an Ecological Approach*. Blackwell Scientific Publications. 1980.

SEMESTER II			
Core Practical III- Laboratory in Immunology and Medical Microbiology			
Course Code : 21PMICR3	**Hrs/Week : 6**	**Hrs/Sem : 90**	**Credits : 3**

Objectives:

To impart advanced practical knowledge in Immunology and Medical Microbiology.

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	test urine samples.	4	Cr
CO- 4	analyze how to perform latex agglutination and blood grouping techniques.	4,6	An
CO - 5	examine various types of bacterial pathogens like *staphylococcus aureus, escherichia coli klebsiella pneumonia.*	4	Un
CO- 6	examine stool sample .	4	An

SEMESTER II			
Core Practical III- Laboratory in Immunology and Medical Microbiology			
Course Code : 21PMICR3	**Hrs/Week : 6**	**Hrs/Sem : 90**	**Credits : 3**

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

Books for Reference:

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

SEMESTER – II			
Core Practical -IV-Laboratory in Microbial Genetics, Molecular Biology and Marine Microbiology			
Course Code : 21PMICR4	**Hrs/Week : 6**	**Hrs/Sem : 90**	**Credits : 3**

Objectives:

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

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	acquire the knowledge to identify the marine micro organisms.	1,3,4	Kn,An,Ap
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 acidity, alkalinity of marine water.	1,4,5	Kn, Ap, Ev

SEMESTER –II			
Core Practical -IV-Laboratory in Microbial Genetics, Molecular Biology and Marine Microbiology			
Course Code : 21PMICR4	**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 - *Microbiology* – A Laboratory Manual. Seventh Edition–Pearson Education, Inc. 2012
2. Gunasekaran.P. *Laboratory Manual in Microbiology.* New Delhi: New Age International (P) Ltd., Publishers,. 2007
3. Rajan.S.,Selvi Christy. R .*Experimental procedure in Life sciences*. Chennai: Anjanaa Book House, 2012
4. Aneja.K.R.. *Experiments in Microbiology, Plant pathology and Biotechnology.* 4th Revised Edition. New Age International Publishers. 2003
5. Janarthanan. S. and Vincent.S. *Practical Biotechnology*: Hyderabad : Methods and Protocols. Universities press (India) private limited,. 2007.
6. Jyoti Saxena, Mamta Baunthiyal, Indu Ravi. *Laboratory manual for Microbiology, Biochemistry and Molecular Biology*. India: Scientific Publishers, 2012.
7. Benson. Microbiological Applications – Laboratory Manual in General Microbiology. International Edition, McGraw Hill Higher Education. 2002.
8. Cappuccino.J.G.,and Sherman.N.. *Microbiology–A Laboratory Manual.* New York: Benjamin Cummins.. 1996

SEMESTER-III			
Core-IX- Industrial and Pharmaceutical Microbiology			
Course Code:21PMIC31	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Objectives:

1. To impart the professional ability and skill by increasing the global knowledge, Understanding and application in Industrial and Pharmaceutical Microbiology.
2. To empower the learners to address current and future challenges faced by the 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	Knowledge of basics and applied microbiological aspects of industries.	1	Un
CO-6	acquire the knowledge about production of various industrial and pharmaceutical products	4,5	Un

SEMESTER-III			
Core-IX- Industrial and Pharmaceutical Microbiology			
Course Code: 21PMIC31	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Unit-I- Basics of Industrial Microbiology

Historical account of microbes in industrial Microbiology; Screening, isolation, preservation and improvement of industrially important microorganisms; Strain improvement; Fermenter - principles and design - types of Fermenter, Instrumentation and control- aeration and agitation. Raw materials and media formulation for fermentation processes; Industrial Sterilization; Microbial growth kinetics in Batch, Continuous and Fed batch fermentation. Downstream processing.

Unit-II- Microbial products

Microbial production of industrially important products: Solvents (Alcohol and Acetone); Aminoacids (Glutamic acid and Lysine); Organic acids (Citric acid and Acetic acid); Enzymes (Microbial rennet, Amylase, Protease); Biopolymers (Xanthan gum and PHB); Biopreservatives (Nisin); Antibiotics - (Penicillin, Cephalosporin and Streptomycin); Vitamins (Riboflavin and Cyanocobalamin); Production of Hormones (Auxins and Gibberellins). Production of protein in bacteria and yeast (Chymosin production) – Synthetic and recombinant vaccines.

Unit-III- Bio pesticides and Bio fertilizers

Bio pesticides – history of development, production of bio pesticides from bacteria (BT), fungi (*Trichoderma viride*), virus (NPV) and their applications against different types of pathogens. Bio fertilizer – mass production of bio fertilizer (*Rhizobium*, *Azotobacte*r), quality control and field applications.

Unit-IV- Basics of Pharmaceutical Microbiology

Properties of antimicrobial agents, types of chemotherapeutic agents – Synthetic, Semi synthetic, Natural therapeutic agents. Types of antibiotics and their mode of action: antibacterial, antifungal, antiviral, antiprotozoal. Pharmaceutical Formulation (Tablets, Capsule, Oinments, Syrup, Gel), stages of pharmaceutical product development.

Unit-V- Spoilage and preservation of Pharmaceutical products

Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, sources and types of microbial contaminants, assessment of microbial contamination and spoilage. Objectives of preservation, the ideal preservative, preservative system. Antimicrobial preservatives and their properties. Preservative stability and efficacy.

Text books:

1) Dubey, R.C. *A Textbook of Biotechnol*ogy. New Delhi: S Chand and Company Limited. 4th Rev. Edition 2006.

2) Gupta, P.K. *Elements of Biotechnology.* Meerut: Rastogi Publications, 2005.

3) Jogdand, S. N. *Gene Biotechnology.* New Delhi: Himalaya publishing house. 4th Edition, 2016.

4) Reed, G Prescott and Dunn. *Industrial Microbiology.* US: Macmillan Publication. 1982.

Books for Reference:

1) Wulf Crueger. *A Text Book of Industrial Microbiology.* New Delhi: Panima Publishing Corporation. 1st edition 2000

2) Patel A.H. *Industrial Microbiology.* India: Macmillan Limited. 2017.

3) Casida L.E. *Industrial Microbiolog*y. NewYork: Eastern Limited. 1986.

SEMESTER-III			
Core-X- Genetic Engineering			
Course Code -21PMIC32	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Objectives:

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

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

Course outcomes:

C O No	**Upon completion of this course, students will be able to**	**PSO's 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	Discuss the cloning techniques and the production of transgenic materials	4	Un,An
CO -6	Understand the synthesis of genetically modified commercial products	4	Un

SEMESTER-III			
Core-X- Genetic Engineering			
Course Code -21PMIC32	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Unit – I: Gene cloning and vectors

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

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, Vitamins, Amino acids, Recombinant vaccines, Hormones, Monoclonal antibodies, Biopolymers. Genetic engineering of bio-degradative pathways – Manipulation by Transfer of plasmids and Gene alteration.

Unit – V: Cloning in plants and animals

Transgenic plant (Golden rice, Tearless onion, Colourful cauliflower, FlavrSavr Tomato) – Transgenic animal (Transgenic Fish, Transgenic Mouse, Transgenic Pig, Dolly) – GEM (Super bug) – Ethical aspects of Biotechnology

Books for Reference:

1. Burrel, M.M. *Enzymes of Molecular Biology*, Humana press. 1993.
2. Chirikjian, J.G. *Biotechnology- Theory and Techniques.*Vol.II, Jones and Burtlett Publishers. 1995.
3. Gerhardt, P., Murray, R.G., Wood, W.A., and Kreig, N.R. *Methods for General and Molecular Bacteriology*. Washington D.C: ASM Press, 1994.
4. Cafferty. Mc. J., Hoogenboom, H.R. and Chiswell, D.J. *Antibody Engineering- A Practical Approach*, Oxford University Press, 1996.
5. Lewin, B. *Genes VII*, Oxford: Oxford University Press,. 2000.
6. Murray Moo Young . *Plant Biotechnology*. Pergamon Press. 1992.
7. Radledge, C. and Kristiansen, B. *Basic Biotechnology*.2nd Edition.Cambridge University Press. 2001.
8. Das. H.K. *Text Book of Biotechnology*. New Delhi: Wiley Dreamtech India (P) Ltd., 2005.
9. Rigby. P.W.J.Ed. *Genetic Engineering*. London: 6thAcadamic press, 1987.
10. Wiseman.A. *Principles of Biotechnology*. New York: Chapman and Hall, 1983.
11. Desmond.S.T., Nicholl. *An Introduction to Genetic Engineering.* Cambridge Press. 1994.
12. Winnacker, E.L. *From Genes to Clones. Introduction to Gene technology*. New Delhi: Panima Publishing Corporation, 1st Edition. 1987.
13. Brown, T.A. *Gene Cloning – An Introduction*. Chapman and Hall, UK: 3rd Edition. 1995.
14. Glick, B.K. and Pasternik, J.J. *Molecular Biotechnology. Principles and applications of recombinant DNA.* ASM Press. 2nd Edition. 1998.
15. Mitra. *Genetic engineering*. Chennai: Published by Macmillan India Ltd., 2005.
16. Jogdand S.N . *Gene biotechnology*. Mumbai: Himalaya Publishing House, 2005.
17. Satyanarayan, *Biotechnology*. Kolkata: Books and Allied (P) Ltd., 1st edition, 2005.
18. Preeti Joshi, *Genetic engineering and its application*. Agrobios. India: 1st edition, 2002.
19. Bernad R Glick, *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. Washington, D.C: ASM Press, 3rd edition, 2003.
20. Ramawat K and Shaily Goyal, *Molecular Biology and Biotechnology*. New Delhi: S.Chand and company Ltd., 1st edition, 2010.

SEMESTER –III			
Core- XI - Food and Dairy Microbiology			
Course Code : 21PMIC33	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Objectives:

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

Course Outcome:

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

SEMESTER –III			
Core- XI-Food and Dairy Microbiology			
Course Code : 21PMIC33	**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).

Unit IV: Dairy Microbiology

Dairy Introduction – Sources of microorganisms in milk – Classification of microbes – Biochemical types, characteristics and pathology. Milk borne diseases – bacterial (Mastitis, Anthrax, Brucellosis, Diphtheria, Tetanus) and viral diseases (Food and mouth disease, Rinderpest, Cowpox, and Virus diarrhoea) 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 – microbial standard and milk grading- MBRT and Resazurin method. Good manufacturing practice, hazard analysis critical control point (HACCP) concept. BIS Laboratoryservice.

Textbook:

1. FrazierW.C., and Westhoff D.C., *Food Microbiology.* New Delhi: Tata McGraw Hill Publishing Co. Ltd,. 4th edition, 2008

Books for Reference:

1. Adams M.R., and Moss M.O., *Food Microbiology*. Cambridge: The Royal Society of chemistry, 1995.
2. Atlas. R.M., *Microbiology–Fundamentals and Applications*, MacmillianPublishing Company. 1989.
3. Banwart G.J., *Basic Food Microbiology*. NewYork: Chapman & Hall. 1989.
4. Board R.C., *A modern Introduction to food Microbiology.* Oxford: Blackwell Scientific Publication,. 1983.
5. Robinson .R.K., *Dairy Microbiology*. London: Elsevier Applied Sciences, 1990.
6. Jay J.M. *Modern Food Microbiology*. New Delhi: CBS Publishers and Distributors, 1987.

SEMESTER –III			
Core – XII Research Methodology			
Course Code : 21PMIC34	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Objectives:

1. To impart advanced level information in the subject of Research methodology.
2. 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	Estimate project writing method and to estimate Data's used in projects.	1	Ev
CO-5	Identify the journals to publish articles	1	AP
CO-6	Design article to present on seminar and the conference	5	Cr

SEMESTER –III			
Core – XII Research Methodology			
Course Code : 21PMIC34	**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 and nucleic acids – 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 HPTLC.

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

Electrophoresis –principles, factors affecting electrophoretic mobility – Agarose Gel Electrophoresis, PAGE, SDS-PAGE and Starch gel electrophoresis. Spectroscopic techniques – principles, mechanism and applications of UV –visible, Flame photometer and AAS - Estimation of cellular constituents- Sugars, amino acids and proteins.

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.

Textbooks:

1. Veerakumari L. *Bioinstrumentation*. Chennai: MJP Publishers. 2006.
2. Gurumani N. *Scientific thesis writing and Paper presentation*. Chennai: MJP Publishers. 2010.

Books for Reference:

1. Dr. Simmi Kharb. *Scientific Writing and Project management in Biotechnology*. NewDelhi: University Science Press. 2009.
2. 4 Gurumani. N. *Research Methodology for Biological Sciences*. Chennai: MJP Publishers. 2006.
3. Vijayalakshmi Ponnuraj. G. and C. Sivapragasam. *Research Methods (Tips and Techniques)*. Chennai: MJP Publishers. 2008.

SEMESTER – III			
Core Practical - V – Laboratory in Industrial and Pharmaceutical Microbiology, Genetic Engineering			
Course Code: 21PMICR5	**Hrs/week: 6**	**Hrs/Sem: 90**	**Credits: 3**

Objectives:

1. To impart advanced level practical training in Industrial, Pharmaceutical and Genetic Engineering.
2. 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	Conclude the procedure for isolation of hydrocarbon, plastic degrading micro organisms	4,6	An
CO 2	Outline kirby-bauer disc diffusion technique, minimum inhibitory concentration.	4	Un
CO 3	Recall how to perform enzyme immobilization in sodium, calcium alginate gel	2,3	Re
CO 4	Examine isolation of spontaneous and induced mutants	3	An
CO 5	Evaluate polymerase chain reaction	2	Ev
CO 6	Distinguish between transformation, conjugation and transduction	2	An

SEMESTER – III			
Core Practical - V – Laboratory in Industrial and Pharmaceutical Microbiology, Genetic Engineering			
Course Code: 21PMICR5	**Hrs/week: 6**	**Hrs/Sem: 90**	**Credits: 3**

1. Production and characterization of citric acid using *Aspergillus niger*.
2. Laboratory scale cultivation of Mushroom.
3. Ethanol production using *Saccharomyces cerevisiae*.
4. Sterility test for pharmaceutical products (any two product)
5. Assay of amylase from bacteria.
6. Cell immobilization in calcium alginate gel.
7. Isolation of antibiotic producing microorganisms.
8. Screening of antibiotic producing microorganisms.
9. Isolation of chromosomal DNA.
10. Isolation of Plasmid DNA.
11. SDS PAGE
12. Western blotting -Demonstration.
13. Southern blotting -Demonstration.
14. Restriction digestion -Demonstration.
15. Polymerase Chain Reaction -Demonstration.

Books for Reference:

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

SEMESTER -III			
Core Practical VI - Laboratory in Food and Dairy Microbiology, Research Methodology			
Course Code: 21PMICR6	**Hrs/Week:6**	**Hrs/Sem:90**	**Credits:4**

Objectives:

To impart advanced level practical training in food, dairy Microbiology and Research Methodology and 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 E.*coli* in food & beverages.	5	An
CO- 5	Examine isolation of detection & confirmation of *Salmonella, Shigella,*V*ibrio* species in food.	3	An
CO -6	Assess the isolation of microbial examination of canned foods.	3	Un

SEMESTER-III			
Core Practical VI - Laboratory in Food and Dairy Microbiology, Research Methodology			
Course Code: 21PMICR6	**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 coliforms in food &beverages.
9. Detection and determination of faecal coliforms in food &beverages.
10. Detection and determination of *E.coli* in food &beverages.
11. Detection & confirmation of *Salmonella* species in food.
12. Detection & confirmation of *Shigella* species in food.
13. Detection & confirmation of pathogenic *Vibrio* in food.
14. Estimation of molds & yeast from fruit juice.
15. Microbial examination of canned foods.
16. Preparation of buffer and determination of pH using pH meter.
17. Verification of Beer-Lambert's Law using Spectrophotometer.
18. Agarose gel electrophoresis of DNA.
19. PCR-Demonstration.
20. Visit to food and dairy industry.

Books for Reference:

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

SEMESTER- III	
Self Study Course (Optional) -Probiotics	
Course Code:21PMISS1	**Credit: +2**

Objectives:

1. 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 and to develop young students with active and creative minds in the field of microbiology.
2. 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	be acquainted with characteristics of probiotics	1,2	Kn
CO -2	can analyses the aware the probiotics organisms.	2,3,4	Ev
CO-3	differentiate the probiotics and prebiotics	1,2	Co
CO-4	explain the concept of mechanisms of probiotics	2,3,4	Un, Ap
CO-5	grasp the knowledge about prebiotics.	2,3	An
CO-6	know the wealth of the probiotics and prebiotic	2	Kn

SEMESTER- III	
Self Study Course (Optional) - Probiotics	
Course Code:21PMISS1	**Credit: +2**

Unit: I Introduction to Probiotics

Introduction and history of Probiotics, Probiotic microorganisms.

Unit : II Characteristics of Probiotics

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 gasterointestinal 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 infoods.

Books for Reference:

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

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Course Code :21PMIC41	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Objectives:

1. 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.
2. Developing young students with active and creative minds in the field of microbiology enabling the students to become entrepreneur by applying the microbial technology.
3. 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	have knowledge about the interaction between microbes and organisms at other tropic level.	1,2	Un, An
CO -2	interpret the microbiology of sewage and its treatment	2,3	Co
CO-3	explain about aero microbiology and microbial ecology	2	Un, An
CO-4	acquire basic knowledge about water purification	2	Ap
CO-5	gets knowledge about biogeochemical cycles	2,4	Co
CO-6	develop the application of biodegradation and bioremediation.	5	Ap, Cr

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Course Code :21PMIC41	**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. Basic concept of food chain, food web and energy flow. Microbial symbiosis: commensalism, mutualism, parasitism and predation with examples.

Unit II: Biogeochemical cycles

Types of biogeochemical cycles: Water cycle, gaseous cycle (Oxygen, Carbon & Nitrogen), and sedimentary cycles (Sulphur & Phosphorus). Biogeochemical cycles of micronutrients.

Unit III: Aerobiology

Air space in different layers of atmosphere, bioaerosol, assessment of air quality - sedimentation, impaction impingement, suction, and filtration. Brief account of transmission of airborne microbes (Bacteria, Virus & Fungi). Microbiology of indoor and outdoor. Allergy: causes and tests for detection of allergy.

Unit IV: Aquatic Microbiology

The aquatic ecosystem (Pond)– factors governing micro flora and their distribution in natural water. Water pollution and its sources. Role of organic pollutants in water, concepts of C-BOD, N-BOD & COD. Treatment of waste water by aerobic and anaerobic processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection).

Unit V: Advancement in Bioremediation

Concept, principle and mechanism of bioremediation, factors affecting bioremediation, types of bioremediation. Bioremediation of metals with examples. Biodegradation and biotransformation of xenbiotics including pesticides, chlorinated and nitrated aromatic compounds, phenolic compounds and polycyclic aromatic compounds.

Books for Reference:

1. Atlas,R.M and Bartha.M. *Microbial Ecology –Fundamentals and applications.* California: *Benjamin – Cummings,* Mento Park, 2003.

2. SubbaRao, N.S. *Soil Microorganisms and Plant growth*. NewDelhi Oxford and IBH Publishing Co, Pvt. Ltd, 3rdEdition, 1995.
3. Gupta,S.K. *Approaches and trends in plant disease management*. India: Scientificpublishers.Jodhpur, 5th Edition, 2014.

4. Jammaluddin et al. . *Microbes and sustainable plant productivity* India*:* Jodhpur: Scientific Publishers,. 3rdEdition, 2013.

5. G.Purohit, S.S.Kothari,P.R.andMathur. *Basic and Agricultural Biotechnology*, India: Agrobotanical Publishers Bikaner. 1993.

6. Prescott, L.M., Harley, J.P. and Helin, D.A.. *Microbiology*, , New York. McGraw Hill, 5th Edition, 2008.

7. Schlegal, H.G.. *General Microbiology*, Cambridge: Cambridge Univeristy. 7th edition, 1995.

8. Prabhakaran, G. *Introduction to Soil and Agricultural Microbiology, New Delhi:* Himalaya Publishing House. 2004.

9. George N. Agrios.. *Plant Pathology*. Academic Press. 5th Edition. 2005

10. Raina M. Maier, Ian A. Pepper and Charles Gerba. *Environmental Microbiology*. Academic Press. 2nd edition. 2009.

11. Dubey, R.C. and Maheswari, D.K.. *A text book of Microbiology*, NewDelhi: S. Chand and Company Ltd, 2013.

12. Shiva Aithal, C. *Mordern approaches in Soil,Agricultural and Environmental Microbiology*. NewDelhi: Himalaya Publishers. 2010.

13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D.. *Biology Microorganisms*, NewDelhi: Prentice Hall, 12th Edition, 2000.

14. Pelczar, M.J., Schan, E.C. and Kreig, N.R. *Microbiology – An application based approach*, NewDelhi: Tata McGraw Hill Publishing Company Limited, 5th Edition, 2010.

SEMESTER – IV			
Core – XIV- Soil and Agricultural Microbiology			
Course Code :21PMIC42	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Objectives:

1) 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.

2) To develop young students with active and creative minds in the field of microbiology

3) To enabling the students to become entrepreneur by applying the microbial technology.

4) 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 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

SEMESTER – IV			
Core – XIV- Soil and Agricultural Microbiology			
Course Code :21PMIC42	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Unit I : Microbes and soil fertility

Introduction and concepts of agricultural microbiology- soil microorganisms – bacteria (Cyanobacteria and Actinobacteria), algae, fungi, protozoans, nematodes and viruses Soil formation - Soil properties – Physical and chemical - Role of microbes in soil fertility. Soil fertility evaluation and improvement.

Unit II: Biogeochemical cycling and microbes

Biogeochemical cycles – Carbon, Phosphorus, Sulphur, Iron, Nitrogen - 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

Interrelationships between plants and microorganisms and their interactions with plants. Microbial associations in Spermosphere, Phytosphere, Rhizosphere (Mycorrhiza types and importance to agriculture) –phyllosphere (Anabaena-Azolla) -decomposition of organic Matter by microorganisms - cellulose, hemicellulose, lignin. Humus formation.

Unit IV: Plant Pathology

Plant pathogens: Bacterial – *Xanthomonas, Agrobacterium,*Fungal – *Cercospora*, *Pyricularia,* Viral – TMV, Bunchy top virus) 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 V: Bio fertilizers & **Bio pesticides**

Principles of mass production, Quality Control and Field applications - Bacterial bio fertilizer: *Rhizobium, Azotobacter- Azopirillum,*–Phosphobacteria. Algal biofertilizer - Blue green algae, Azolla.Fungal biofertilizers - Mycorrhizae – ecto and endo mycorrhiza. Biopesticides – Viral (NPV, CPV & GV), bacterial (*Bacillus thuringiensis*, *B. papillae* & *Pseudomonas* sp.), Fungal (*Beaveria* sp., *Metarrhizium* sp. & *Verticillium* sp.), Protozoan (*Mattesia* sp., *Nosema* sp., & *Lambornella* sp.)

Text books:

1. Dubey R.C. and Maheswari D.K.*A text book of Microbiology*.New Delhi:S. Chand and Company Ltd. Reprint, 2006.

2. Rangaswamy G and BagyarajD.J. *Agricultural Microbiology*. NewDelhi: Prentice-Hall of India Pvt Ltd.2nd edition, 2004.

Books for Reference:

1. Atlas R.M, and BarthaM. *Microbial Ecology –Fundamentals and applications.* California: Benjamin & Cummings, 2003.

2. Subba RaoN.S. *Soil Microorganisms and Plant growth*. New Delhi: Oxford and IBH Publishing Co, Pvt. Ltd, 3rd edition, 1995.

3. SahaT.K. *Ecology and Environmental Biology*. Kolkata: Books and Allied Pvt. Ltd., 2010.

4. Shiva Aithal, C. *Modern approaches in Soil, Agricultural and Environmental Microbiology*. New Delhi: Himalaya Publishers,.1st edition, 2010.

SEMESTER –IV			
Core XV – Applied Microbiology			
Course Code: 21PMIC43	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits:4**

Objectives:

1) 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.

2) 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 Outcomes:

C O No	Upon completion of this course, students will be able to	PSO's 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 *spirullina* production	2	Ap
CO-6	Gets knowledge about biodegradation.	4,2	Un

SEMESTER –IV			
Core XV – Applied Microbiology			
Course Code: 21PMIC43	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits:4**

Unit-I: Biofuel technology

Introduction – 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.

Unit-II: Composting technology

Historical background - Composting – methods – factors influencing - waste availability – 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.

Unit-III: Mushroom cultivation technology

Oyster, paddy, milky, button and King mushroom cultivation technology, post harvest technology.

Unit- IV: Biofertilizer and Biopesticides

Biofertilizers - *Rhizobium, Azotobacter, Cyanobacteria, Spirulina, VAM* and *Azolla* – cultivated methods, post harvest technology and single cell protein formulation.

Biopesticides – *Bacillus thuringiensis, Pseudomonas fluroscence, Trichoderma viridae, Bavaria bassiana*, Nuclear Polyhedrosis virus.

Unit-V: Biodegradation

Biodegradation of xenbiotics, cellulose, Lignin - Biodeterioration of wood, Leather ; Bioremediation – Degradation of DDT; Biomagnification, Bioaccumulation of heavy metals; Bio leaching of iron, gold and uranium, Cleanup oil spills – *Pseudomonas putida*

Books for Reference:

1. Kumar , H.D., *A textbook on Biotechnology* , New Delhi: East- west press Pvt Ltd., 2nd Edition , 1991.
2. Chatwal, G.R., *Textbook of Biotechnology*, New Delhi: Anmol Publications Pvt. Ltd., 1995.
3. Jarsa , O.P., *Environmental Biochemistry*, New Delhi, India: Sarup& Sons, Ist Edition., 2002 .
4. Prescott, L.M., Harley, J.P. and Helin,. *Microbiology*, New York: McGraw Hill, D.A. 5th Edition, 2008.

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

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Course Code : 21PMICR7	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 3**

Objectives:

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

2) 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

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Course Code : 21PMICR7	**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 phyllosphere.
5. Isolation of air borne bio-particles.
6. Determination of biological oxygen demand.
7. Determination of chemical oxygen demand.
8. Determination of Soil pH and temperature.
9. Isolation of Phosphate solubilizing bacteria & fungi
10. MPN Technique.
11. Isolation of *Rhizobium sp* from root nodules of leguminous plants.
12. Isolation of *Azotobacter sp* from soil.
13. Isolation of *Azospirillum sp* from soil.
14. Identification of Cyanobacteria from soil. (*Anabaena* and *Nostoc*).
15. Assay of bio fertilizer (Seed treatment, Seedling treatment, Soil inoculation, Measurement of root and shoot system.

Books for Reference:

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

SEMESTER –IV			
Core Practical VIII - Laboratory in Applied Microbiology			
Course Code: 21PMICR8	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits:3**

Objectives:

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.

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 *spirullina* mass production	2	Ap
CO-6	knowledge about the bio gas production from organic waste.	4,2,5	Un,Ap

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1. Preparation of Vermi bed
2. Tissue culture - mushroom.
3. Estimate protein from mushroom.
4. Estimate carbohydrate from mushroom.
5. Estimate lipid from mushroom.
6. Mass production of the Blue-Green Alga *Spirulina.*
7. Mass production of Azolla
8. Cultivation of *Spirulina platensis* in different selective media.
9. Biogas production from Cassava tubers.
10. Biogas production from organic waste.
11. Biodegradation of dye using *Pseudomonas*
12. Isolation of biodegrading bacteria from soil
13. Preparation of bio fertilizer (Demonstration)
14. Industrial visit.

Books for Reference:

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

SEMESTER - IV			
PROJECT			
Course Code: 21PMIP41	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Objectives

1. To impart advanced level information for doing a Research Project Individually and to visit to Hi-Tech Industries / Institutes

2. To develop self-confidence through paper presentation and skill based training at workshops and get acquainted to subject interviews.

Research project

To plan and design statistically, retrieve relevant literature, organize and process the data, photograph relevant observations, evaluate by statistical programme, present the project in any State/ Regional / National conference/ Seminar during the second year of the course and submit during the final semester examinations. The work has to be conducted in the Department / Collaborative organization / Institute under the guidance of the Project Supervisor. Inter-disciplinary collaborations from External Departments / Institutions can also be organized for essential areas of the Project if necessary. The method of valuation of the project report submitted by the candidate is outlined under the course project and viva-voce.

The project report should be submitted to the Head of the Course Department "One week prior" to the commencement of the practical examination in the Fourth Semester. Each student has to submit 3 copies of his / her project report for evaluation.

Industrial visit

An educational tour to leading industrial institutes should be conducted as an eye opener and to basically understand the advanced technological know-how which is a must. This exposure and orientation to Advanced Instruments / Gadgetries / On-line Process / By-product Recoveries / Involved Strategies and Implications would alleviate the level of scientific knowledge by all standards. A report pertaining to the visit of scientific learning shall be submitted for evaluation. On-Duty leave should be granted to the teachers accompanying the students. The industrial visit shall include Food, Dairy, Pharmaceutical, Biotechnological, Agricultural, Beverage and Fermentation, Enzyme Production, Solid and Liquid Waste Management, processing plants and research based organizations (Fundamental and Advanced Centers of Eminence)

Presentation of scientific findings

Each student will have to present their scientific findings of individual work (or) collaborative work in any State / Regional / National International Seminar or Symposia. Alternatively, they can attend any workshops conducted by the State / National Organizations of Scientific Recognition. Abstracts / Papers presented along with certificates will have to be produced during examination. Scientific papers published in Journals / Proceedings during his / her Master Programme will be given special weightage.

General viva - voce

The examiners shall conduct a General Viva-Voce pertaining to the core course papers as an overall component.