CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

NATIONALLY ACCREDITED (III CYCLE) WITH "A" GRADE BY NAAC

TIRUCHIRAPPALLI – 18

PG & RESEARCH DEPARTMENT OF MICROBIOLOGY

SYLLABUS FOR

M.Sc., MICROBIOLOGY

2020-2022

PROGRAMME EDUCATIONAL OBJECTIVES

- The Masters in Microbiology programme will address the increasing need for skilled scientific manpower with an understanding of research ethics
- The laboratory training in addition to theory is included to prepare them for careers in the industry, agriculture, and applied research where biological system is increasingly employed
- The objective of this programme is to benefit the society by adding skilled scientific workforce across the country and the globe

PROGRAMME OUTCOME

1. Students will be able to acquire, articulate, retain and apply specialized language and knowledge relevant to microbiology
2. Students will acquire and demonstrate competency in laboratory safety including accurately reporting observations and analysis
3. Students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely
4. Students will inculcate involvement in Research and internship activity
5. Graduates develop a broad range of scientific knowledge to meet the current and future expectation of industries at the national and global level

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)
TIRUCHIRAPPALLI-620018
M.Sc., Microbiology Course Structure under CBCS
(For the candidates admitted from the academic year 2020-2021 onwards)

Sem.	Course	Title	Course code	Inst./ Hours/ Week	Credit	Exam Hours	Marks		Total
							Int.	Ext.	
I	Core Course – I(CC)	Essentials of Microbiology	19PMB1CC1	6	4	3	25	75	100
	Core Course – II(CC)	Biological macromolecules	19PMB1CC2	6	4	3	25	75	100
	Core Course – III (CC)	Virology	19PMB1CC3	5	4	3	25	75	100
	Core Course – IV (CC)	Microbial Ecology	19PMB1CC4	5	4	3	25	75	100
	Core Practical –I (CP)	Essentials of Microbiology, Virology, Biological Macromolecules and Microbial Ecology Practicals	19PMB1CC1P	8	4	3	40	60	100
			TOTAL	**30**	**20**	**-**	**-**	**-**	**500**
II	Core Course –V (CC)	Microbial Metabolism	19PMB2CC5	6	5	3	25	75	100
	Core Course – VI(CC)	Immunology	19PMB2CC6	6	5	3	25	75	100
	Core Practical–II (CP)	Microbial Metabolism and Immunology Practicals	19PMB2CC2P	8	4	3	40	60	100
	Elective Course – I	(A) Microbial Techniques (B) Organic Farming (C) Microbial Cytology	19PMB2EC1A 19PMB2EC1B 19PMB2EC1C	5	5	3	25	75	100
	Elective Course – II	(A) Biofertilizer Technology (B) Public Health Microbiology (C) Marine Microbiology	19PMB2EC2A 19PMB2EC2B 19PMB2EC2C	5	5	3	25	75	100
	Extra Credit Course	Swayam Online Course	To be fixed later	As per UGC Recommendation					
			TOTAL	30	24	-	-	-	500

III	Core Course– VII(CC)	Industrial Microbiology	19PMB3CC7	6	5	3	25	75	100
	Core Course – VII(CC)	Clinical Microbiology	19PMB3CC8	6	5	3	25	75	100
	Core Practical– III(CP)	Industrial Microbiology and Clinical Microbiology Practicals	19PMB3CC3P	8	4	3	40	60	100
	Elective Course– III(EC)	A. Microbiology for Competitive Examination	20PMB3EC3A	5	5	2	-	100	100
		B. Food Adulteration C. Biomedical Laboratory Technology	19PMB3EC3B 19PMB3EC3C	5	5	3	25	75	100
	Elective Course– IV(EC)	A. Recombinant DNA Technology B. Microbes in Solid Waste Management C. Microbial Nanotechnology	19PMB3EC4A 19PMB3EC4B 19PMB3EC4C	5	5	3	25	75	100
	Extra Credit Course	Swayam Online Course	To be fixed later	As per UGC Recommendation					
			TOTAL	**30**	**24**	**-**	**-**	**-**	**500**
IV	Core Course – IX(CC)	Microbial Biotechnology	19PMB4CC9	5	5	3	25	75	100
	Core Course – X (CC)	Molecular Biology& Microbial Genetics	19PMB4CC10	5	5	3	25	75	100
	Elective Course-V(EC)	(A) Bio informatics &Biostatistics (B) Entrepreneurial Microbiology (c) Molecular taxonomy and phylogeny	19PMB4EC5A 19PMB4EC5B 19PMB4EC5C	5	4	3	25	75	100
	Core Practicals-IV(CP)	Microbial Biotechnology, Molecular Biology& Microbial Genetics-Practicals	19PMB4CC4P	8	4	3	40	60	100
	Project		19PMB4PW	7	4	-	-	-	100
			TOTAL	**30**	**22**	**-**	**-**	**-**	**500**
			GRAND TOTAL	**120**	**90**	**-**	**-**	**-**	**2000**

CORE COURSE I (CC)
ESSENTIALS OF MICROBIOLOGY

Semester I	Internal Marks : 25	External Marks : 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB1CC1	**Essentials of Microbiology**	**Core**	**90**	**-**	**6**	**4**

Preamble: To enable the students to understand the basic knowledge in Microbiology.

Course Outcome

COs	CO Statement	Knowledge Level
CO1	Determine the scope of Microbiology	K4
CO2	Differentiate the types of Microscopy	K4
CO3	Assess the morphological features of Eukaryotic Cell	K5
CO4	Generalize view of Prokaryotic Cell Structure	K6
CO5	Develop the cultivation methods of microbes	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**S**	**S**	**M**	**M**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**M**	**S**	**M**	**S**
CO4	**S**	**M**	**M**	**M**	**M**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

Unit I: History of Microbiology (18 Hours)

History and Scope of Microbiology – Generation theory – Contribution of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, Winogradsky, Waksman and John Tyndall. Classification of microorganisms - Haeckel's three kingdom concept, Whittaker's five kingdom concept, Carl Woes three domain system, Bacterial classification (outline) according to Bergey's manual of systemic Bacteriology.

Unit II: Microscopy (18 Hours)

Light Microscopy – Bright field, Dark field, Phase contrast, Fluorescent and

Polarization microscopes, Electron Microscopy – TEM & SEM,Atomic absorption Microscopy, Confocal Microscopy – Principles and applications.

Unit III: Cell Structure of Prokaryotes (18 Hours)

Morphological types, Cell wall of Gram negative, Gram positive bacteria and halophiles. Cell wall synthesis. Capsule composition and function. Cell membranes in Eubacteria, archaebacteria and cyanobacteria, Cell membrane functions. Periplasmicspace. Structure and function of flagella, cilia and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Reserve food materials – polyhydroxybutyrate, polyphosphates, cyanophycin and sulphur inclusions. General account on Mycolpasma.

Unit IV: Cell Structure of Eukaryotes(18 Hours)

General characteristics, Classification, Structure and Reproduction of Algae: Chlorophyta (Green algae), Diatoms, Rhodophyta (Red algae), Fungi: Cell wall – chemical composition and functions, membranes and their functions, nutritional strategies of fungi. Structure and life cycle of fungi Ascomycetes (Aspergillus), Zygomycetes (Mucor), Basidiomycetes (Agaricus). Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification, Cultivation and Purification assay of virus and Protozoa.

Unit V: Microbial Growth Measurements (18 Hours)

Microbial growth - culture media - isolation of pure culture. Growth curve: Diauxy - continuous culture – chemostat – turbidostat - synchronized growth. Measurement of microbial growth – Total cell count method - viable cell count method and biomass determination - dry weight – wet weight – protein – Kjeldhal nitrogen – chlorophyll. Growth phases – kinetics – asynchronous – synchronous - batch – continuous culture. Factors affecting growth (pH, salinity, temperature, light, etc). Microbial growth control - Physical and chemical methods – sterilization and disinfection. Maintenance and preservation of microorganism.

Text Books

S. No	Author	Title	Publisher	Year
1	Atlas, R.A. and Bartha, R	Microbial Ecology, Fundamentals and Application	Benjamin Cummings, New York	2000
2	Pelczar, M.J., Schan, E.C. and Kreig, N.R.	Microbiology – An application based approach, Fifth Edition,	Tata McGraw Hill Publishing Company Limited, New Delhi.	2010.
3	Stanier, R., Lingraham, Y., Wheelis, M.L. and	General Microbiology, Fifth Edition	Macmillan, London	2011.

	Painter, R.P.,			
4	Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D	Biology Microorganisms, Twelth Edition	Prentice Hall, New Jerry	2012
5	Dubey, R.C. and Maheswari, D.K. S.	A text book of Microbiology, Revised	Chand and Company Ltd, New Delhi	2013

Reference Books

S. No	Author	Title	Publisher	Year
1	Brendan Wren (Editor), Nick Dorrell	Functional Microbial Genomics (Volume 33) (Methods in Microbiology)	Academic Press, UK.	2002
2	Tortora G.J., Funke, B.R.and Case, C.L	Microbiology Ninth Edition,	Dorling Kindersely (India) Pvt. Ltd., Noida	2009
3	Stryer, L. W.H.	Biochemistry, Seventh Edition	Freeman and Company, New York.	2010.
4	Mark Wheelis	Principles of Modern Microbiology	Jones & Bartlett India Pvt. Ltd., New Delhi.	2010
5	Prescott, L.M., Harley, J.P. and Helin, D.A.	Microbiology, Fifth Edition	McGraw Hill, New York.	2017.

CORE COURSE II (CC)

BIOLOGICAL MACROMOLECULES

Semester I	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB1CC2	**Biological Macromolecules**	**Core**	**90**	**-**	**6**	**4**

Preamble: To provide knowledge about cell and its function, to understand the metabolic pathways of various macromolecules.

COs	CO Statement	Knowledge Level
CO1	Classification of cell and its structure in prokaryotes and eukaryotes	K4
CO2	Analyze the chemical nature and function of biological macromolecules	K4
CO3	Explain the concepts of metabolism with detailed pathways	K5
CO4	Elaborate the basic concepts of enzyme and its catalysis	K6
CO5	Discuss the concepts of thermodynamics and biological buffers	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**M**	**M**	**M**	**S**
CO2	**S**	**M**	**S**	**M**	**M**
CO3	**S**	**M**	**M**	**M**	**S**
CO4	**S**	**M**	**S**	**M**	**S**
CO5	**S**	**M**	**S**	**M**	**S**

S-Strong; M-Medium; L-Low

Unit I: Cellular organization (18 Hours)

Composition of living matter. Cellular organization and functions of intracellular organelles of bacteria, animal and plant cell. Various specialized components of microorganisms and their structure and function.

Unit II: Enzymes (18 Hours)

Enzymes as biocatalysts, enzyme classification, specificity, active site,

mechanism of enzyme action, regulation of enzyme activity. Enzyme kinetics: Michaelis – Menton equation for simple enzymes. Enzyme inhibition, isozymes.

Unit III: Biological macromolecules and their biosynthesis (18 Hours)

Structural features and chemistry of macromolecules. Nucleic acid - properties, biosynthesis of purines and pyrimidines - Structure of DNA and RNA. Proteins - classification - aminoacids - primary-secondary-tertiary - quaternary and three dimensional structure of proteins. Carbohydrates - mono, di, oligo and polysaccharides. Lipids and biomolecules: Fatty acids, properties, -oxidation - biosynthesis of cholesterol.

Unit IV: Bioenergetics (18 Hours)

Bioenergetics and strategy of metabolism - flow of energy through biosphere, strategy of energy production in the cell. Oxidation - reduction reactions, coupled reactions and group transfer. Biological energy transducers. ATP production, structural features of biomembranes, transport, free energy and spontaneity of reaction, G, G°, G' and equilibrium. Basic concepts of acids, base, pH and buffers.

Unit V: Concepts of metabolism (18 Hours)

Cell metabolism - catabolic principles and break down of carbohydrates, lipids, proteins and nucleic acids - vitamins and their role as coenzymes.

Text Books

S. No	Author	Title	Publisher	Year
1	Christopher K Mathews and Van Holde KE.	Biochemistry. 2nd edition.	The Benjamin/ Cummings publishing company, Inc	1996.
2	Freifelder D	Molecular Biology, II Edition	Narosa Publishing House, New Delhi	1996
3	Jeremy M Berg, John L Tymoczko and Lubert stryer.	Biochemistry.5th edition.	W.H.Freeman and company, Newyork	2002

Reference Books

S. No	Author	Title	Publisher	Year
1	David E Metzler and Carol M Metzler	Biochemistry -The chemical reactions of living cells- Vol1and2.2nd edition.	Harcourt/Academic press, Newyork	2001

2	Lehninger, Albert L, David L Nelson and Michael M Cox.	Lehninger Principles of Biochemistry. New York:	Worth Publishers.	2000.
3	Stryer L Berg JM and Tymoczko JL	Biochemistry. 5th edition. New York:	W.H. Freeman.	2002.
4	Thomas M Devlin. A.	Textbook of Biochemistry with clinical correlations, 5th edition.	John Wiley and sons, Inc., publication, Newyork	2002.
5	Rafi MD	Textbook of Biochemistry for medical students, 2nd edition	Universities Press, (India) Pvt. Ltd, Hyderabad, India	2014

CORE COURSE III (CC)
VIROLOGY

Semester I	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB1CC3	**Virology**	**Core**	**75**	**-**	**5**	**4**

Objective: The course is designed to develop the student with enough knowledge about general account of viruses, bacteriophages, plant, animal and human viral diseases. To train up the student in gaining knowledge about instrumentation relevant to virology

COs	CO Statement	Knowledge Level
CO1	Simplified view of viruses	K4
CO2	Test for antigen & antibody reactions	K4
CO3	Compared views of Bacteriophages.	K5
CO4	Predict the structure pathogenesis and control of plant viruses.	K6
CO5	Compiled views of animal viruses	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**M**
CO2	**S**	**M**	**S**	**S**	**M**
CO3	**S**	**M**	**S**	**M**	**S**
CO4	**S**	**S**	**S**	**M**	**M**
CO5	**S**	**S**	**S**	**M**	**M**

S- Strong; M-Medium; L-Low

Unit I : General Virology (15 Hours)

Brief outline on discovery of viruses, nomenclature and classification of viruses; Distinctive properties of viruses; morphology & ultrastructure. Capsids and their arrangements - types of envelopes and their composition-viral genome, their types and structures. Virus related agents (viroids, Virusoids, prions and Satellite viruses).

Unit II : General Methods of Diagnosis and Serology (15 Hours)

Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures.

Primary & secondary cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems. Serological methods – Haemagglutination & HAI; complement fixation; Immuno fluorescence methods, ELISA and Radio immunoassays. Assay of viruses – physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy). Infective assay (plaque method, end point method) – Infectivity assay of plant viruses.

Unit III : Bacterial Viruses (15 Hours)

Bacteriophage - structural organization - one step growth curve - life cycle - Lytic and Lysogenic, Classification, Morphological groups - virulent dsDNA phage, ssDNA phage, phage lambda, Temperate and Transposable phage, Phage Mu, M13, T4, P1, Bacteriophage typing, Phage therapy (bacteriophage therapy), - burst size; lysogenic cycle. Brief details on M13, Mu, T4, Lambda and P1.

Unit IV : Plant Viruses (15 Hours)

Classification and nomenclature; effects of viruses on plants; Common virus diseases of plants - Tobamo virus group, Potex virus, Poty virus, Tymo virus, Tomato spotted wilt, Cauliflower mosaic virus, Potato leaf roll virus, Rice tungro virus, Mosaic disease of sugarcane; Transmission of plant viruses with vectors - insects, nematodes, fungi - without vectors (contact, seed and pollens). control measures of plant viruses-generation of virus-free planting material; vector control.

Unit V : Animal Viruses (15 Hours)

Classification and nomenclature of animal human viruses. Epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA Viruses - Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV, SARS, Influenza, Oncogenic viruses. DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses. Viral vaccines (including DNA Vaccines with examples) interferons, and antiviral drugs.

Text Books

S. No	Author	Title	Publisher	Year
1	Flint, S.J., Enquist, L.W., Krung, R. Racaniello, VR. and Skalka, A.M.	Principles of Virology, Molecular Biology, pathogenesis and control	ASM Press, Washinton D.C.	2000
2	Roger Hull. Mathews'	Plant Virology, 4th edition,	Academic press- A Harcourt Science and technology company, New York	2002
3	Baishali C, Sumanta K Dutta, PatraLekha RC and Ranjita S	Topley and Wilson's: Principles of bacteriology, Virology and immunity. 11th edition, vol 4	Edward Arnold London.	2005

4	Dimmock NJ and Primerose SB.	Introduction to modern virology. 6th edition.	Blackwell scientific publication, Oxford, London.	2007
4	John Carter and Venetia Saunders	Virology: Principles and applications, 2nd Edition	John wiley and son's publishers, USA	2013

Reference Books

S. No	Author	Title	Publisher	Year
1	Roger Hull	Mathews' Plant Virology.(4thEdition).	Academic press-A Harcourt Science and technology company, Newyork.	2002
2	Maureen A Harrison and Ian F Rae	. General techniques of cell cultures, Cambridge	University Press, England.	2010
3	Nayudu MV.	Plant viruses	Tata Mc Graw Hill education, US.	2008
4	Villarreal LP.	Viruses and the Evolution of Life	ASM Press, Washington DC	2005
5	Alan J. Cann. 2015.	Principles of Molecular Virology. 6th edition,	Academic press, California.	2015

CORE COURSE- V (CC)
MICROBIAL ECOLOGY

Semester I	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB1CC4	**Microbial Ecology**	**Core**	**75**	**-**	**5**	**4**

Preamble: To create awareness on evolutionary relationship of ecosystem and its interactions. To understand the concepts of community ecology and strategies for biodiversity conservation.

COs	CO Statement	Knowledge Level
CO1	Examine basic concept of ecosystem	K4
CO2	Determine the microorganisms and their natural habitats	K4
CO3	Evaluate environmental pollution	K5
CO4	Diagnose waste management system	K5
CO5	Extend the biodiversity and its conservation	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**M**	**S**
CO2	**S**	**S**	**M**	**S**	**M**
CO3	**M**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**M**	**S**
CO5	**S**	**M**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

UNIT I: Ecological concepts (15 Hours)

History, significance, principle, scope and development of microbial ecology. Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Biological Interactions: Microbe–Microbe Interactions, Microbe–Plant Interactions, Microbe–Animal Interactions. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its

measurement; edges and ecotones. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit II: Microorganisms & their natural habitats (15 Hours)

Ecosystem – structure and functions. Abiotic and biotic components. Energy flow, food chain, food web, ecological pyramids and types. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats. Atmosphere: Stratification of the Atmosphere, Aeromicroflora, dispersal of Microbes. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Biogeochemical cycles- types.

Unit III: Ecological pollution (15 Hours)

Environmental pollution-Air pollution: Sources and classification of major air pollutants; Noise pollution- concept and effects. Soil pollution: sources and types of soil and water pollutants; effect of pollutants on soil health and productivity; Radioactive pollutants, their lifetime and disposal; Water pollution: major sources and types of water pollutants; pollution in fresh and marine water bodies. Climate change: Global warming and green house effects, sources and sinks of green house gases, Acid rain. Global environmental change; adaptation and mitigation strategies of climate change, global dimming, carbon sequestration and clean development mechanism.

Unit IV :Waste management(15 Hours)

Waste management- Solid and liquid wastes. Physical, chemical and biological properties of wastes; Effluent treatment- sewage and other agro-industrial wastes; Biomagnification and its impact on loss of biodiversity. Biodegradation and Bioconversion of organic wastes; Microbiological and public health aspects of waste disposal; heavy metal contamination of environments, source and sinks of heavy metals.

Unit V: Biodiversity and conservation ecology (15 Hours)

Biodiversity- concepts, levels and types; strategies for biodiversity conservation. Biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Principles of conservation- *in-situ* and *ex-situ*. Major approaches to management. Indian case studies on conservation/management strategy. National and global conservation measures. Biodiversity hot spots in India and world.

Text Books

S. No	Author	Title	Publisher	Year
1	Joseph C Daniel	Environment Aspects of Microbiology. 1st Edition,	Bright sun Publications, Chennai	1999
2	Vaun Mc Arthur	Microbial Ecology – An Evolutionary approach	Elsievier publications, Academic press.	2009

3	Pelczar, M.J., Schan, E.C. and Kreig, N.R	Microbiology – An application based approach, Fifth Edition	Tata McGraw Hill Publishing Company Limited, New Delhi	2010
4	Saha, T.K	Ecology and Environmental Biology	Books and Allied Pvt. Ltd. Kolkata.	2010
5	Dubey, R.C. and Maheswari, D.K.	A text book of Microbiology Revised	S. Chand and Company Ltd, New Delhi	2013

Reference Books

S. No	Author	Title	Publisher	Year
1	Atlas, R.A. and Bartha, R. 2000.,	Microbial Ecology, Fundamentals and Application	Benjamin Cummings, New York.	2000
2	Tortora G.J., Funke, B.R. and Case, C.L.	Microbiology, 9th Edition,	Dorling Kindersely (India) Pvt. Ltd., Noida	2009
3	Nduka Okafor.	Environmental Microbiology of Aquatic and Waste Systems.	Springer Dordrecht Heidelberg London New York	2011
4	Ian Pepper Charles Gerba Terry Gentry.	Environmental Microbiology.3rd Edition.	Academic press. USA.	2014.
5	Prescott, L.M., Harley, J.P. and Helin, D.A.	Microbiology, 10th Edition	McGraw Hill, New York.	2017

CORE PRACTICAL –I
ESSENTIALS OF MICROBIOLOGY, BIOLOGICAL MACROMOLECULES, VIROLOGY AND MICROBIAL ECOLOGY PRACTICALS

Semester I	**Internal Marks: 40**	**External Marks: 60**				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB1CC1P	**Essentials of Microbiology, Virology, Biological Macromolecules and Microbial Ecology Practicals**	**Core Practical**	**60**	**8**	**-**	**4**

Preamble: To impart knowledge about bacterial morphology, phage identification and estimation of nucleic acids

CO Number	**CO Statement**	**Knowledge Level**
CO1	Determine the sterilization mehods .	K4
CO2	Examine the bacterial morphology	K4
CO3	Evaluvate bacteriophage	K5
CO4	Critique knowledge about buffer preparation	K5
CO5	Measure the Use of chromatography	K5

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**S**	**S**	**M**	**M**	**S**
CO2	**S**	**S**	**M**	**M**	**M**
CO3	**M**	**M**	**S**	**M**	**M**
CO4	**S**	**M**	**M**	**S**	**S**
CO5	**M**	**M**	**M**	**M**	**M**

S- Strong; M-Medium; L-Low

I. Essentials of Microbiology (15 Hours)

1. Principle and methods of sterilization
2. Preparation of media: nutrient broth, nutrient agar plate, soft agar.
3.Pure culture techniques: streak plate, spread plate and pour plate.
4. Motility determination – Hanging drop method.
5. Isolation and enumeration of bacteria from different environmental samples.
6. Enumeration of bacteria - viable count (plate count) and total count (Haemocytometer count)

7. Direct microscopic observation of fungal spores and mycelium
8. Staining method: simple, negative, Gram's staining and spore staining.
9. Fungal slide culture.
10. Measurement of growth rate and generation time by turbidometry method.

II. Biological macromolecules (15 Hours)

1. Preparation of buffer (Tris, phosphate, acetate buffer)
2. Determination of (H+)ion concentration
3. Verification of Beer-Lambert's law using coloured solution
4. Preparation of standard graph for the following and estimating the concentration in a microbial sample
    i) Glucose -Anthrone method,
    ii) Bovine serum albumin (Lowry's method) and
    iii) Nucleic acid - DNA (diphenylamine method), RNA (Orcinol method).
5. Separation of amino acids by paper chromatography and identification of amino acid.
6. Separation of proteins by PAGE, SDS - PAGE - Demonstration.

III. Virology (15Hours)

1. Isolation of Bacteriophages from natural resources
2. Phage titration – T4 phage
3. Animal tissue culture- chick embryo, fibroblast and egg yolk culture preparation
4. Mechanical transmission of Plant Viruses

IV. Microbial Ecology (15 Hours)

1. Analysis of soil physicochemical properties
2. Isolation of microbes (bacteria & fungi) from soil
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Isolation of *Rhizobium* from root nodules of legumes
5. Isolation of *Azotobacter/Azospirillum* from soil
6. Isolation of phosphate solubilizers from soil

Reference Books

S. No	Author	Title	Publisher	Year
1	Wilson K and Walker J.	Practical biochemistry, 5th edition	Cambridge University Press, London	2000
2	Aneja KR.	Experiments in Microbiology: Plant Pathology and Tissue Culture	Wishwa Prakashan, New Delhi	2003
3	Keith Wilson and John Walker	Principles and Techniques of Practical Biochemistry. 4th edition	Cambridge University press, Britain	2005
4	Harry W. Seeley JR, Paul J Van Demark and John J Lee	Microbes in Action – A Laboratory Manual of Microbiology	.. W.H. Freeman and Company, New York.	2007
5	Thangaraj M and Santhana Krishnan P.	Practical Manual on Microbial inoculants	Centre of advanced studies in agricultural University, TNAU, Coimbatore.	2008
6	Nizhny Novgorod.	Laboratory manual on Biochemistry	Publishing House of Nizhny Novgorod State medical academy	2008
7	Shawn O' Farrell and Ryan T Ranallo.	Experiments in Biochemistry: A Hands on Approach-A manual for the undergraduate laboratory	Thomson Learning, Inc.,Australia	2010
8	Cappuccino JG and Sherman N.	Microbiology – A Laboratory Manual. 7th Edition	Dorling Kindersley (India) Pvt. Ltd., New Delhi.	2012
9	Kanika Sharma.,.	Manual of Microbiology – Tools and Techniques. 2nd Edition	Ane Books Pvt. Ltd., New Delhi	2012
10	Gunasekaran P., 2018	Laboratory Manual in Microbiology	New Age International Pvt. Ltd. Publishers, New Delhi.	2018

CORE COURSE –V (CC)
MICROBIAL METABOLISM

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2CC5	**Microbial Metabolism**	**Core**	**90**	**-**	**6**	**5**

Preamble : To understand the growth, enzymology and physiological processes of microbes.

COs	CO Statement	Knowledge Level
CO1	Select view of cell structure and functions	K3
CO2	Explain about carbon assimilation	K3
CO3	Analyze the growth phases of microbial populations	K4
CO4	Criticize about microbial pigments and	K5
CO5	Assess about spore structure and functions	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**S**	**S**	**M**	**M**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**M**	**M**	**M**	**M**
CO4	**S**	**M**	**M**	**M**	**M**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

Unit I: Bacterial Growth (18 Hours)

Phases of growth, Growth kinetics - batch culture, continuous culture and synchronous culture - induction of synchrony. Factors affecting growth - nutrition, aeration, temperature and pH. Physiological adaptation to extreme environmental conditions. Nutritional types and metabolic diversity - types based on carbon, energy and electron sources. Bioenergetics: Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and biological oxidation reduction reactions.

Unit II: Enzymes (18 Hours)

Purifications of enzyme, kinetics of single substrate enzyme catalyzed reaction. Kinetics of reversible inhibitions enzyme catalyzed reactions, King Altman approach to derive – two substrate enzyme catalyzed reactions and its types. Concept of allosterism, positive and negative co-operativity, models (Monad, Wyamann and Changuax and Koshland, Nemethy

and Filmer model), examples and significance of allosteric enzymes

Unit III: Bacterial Photosynthesis (18 Hours)

Energy consideration in photosynthesis, light and dark reaction, electron carriers in photosynthesis, Organization of photosystem I and II, cyclic and non-cyclic flow of electrons. Membrane Transport: Solute transport across membranes: Passive diffusion, active transport using P and F type ATPases, Ion mediated transport, transport of ions across membranes (ion pumps).

Unit IV: Nitrogen metabolism (18 Hours)

Nitrogen cycle - ammonification, nitrification, denitrification and nitrogen fixation. Nitrogenase enzyme, physiology of nitrogen fixation in symbiotic and free living bacteria. Genetics of nitrogen fixation, acetylene reduction assay. Transamination and deamination.

Unit V: Microbial stress responses (18 Hours)

Osmotic stress and osmoregulation; Aerobic to anaerobic transitions; Oxidative stress; pH stress and acid tolerance; Thermal stress and heat shock response; Nutrient stress and starvation stress. Fermentative pathways. Alcoholic, lactic acid, formic, mixed, propionic, butyric, butanol, butanediol fermentation.

Text Books

S. No	Author	Title	Publisher	Year
1	Moat, A.G. and Foster, W.,	Microbial Physiology, Fourth Edition	John Wiley and Sons, New York	2002.
2	Nelson D. L. and Cox M. M.	Lehninger's Principles of Biochemistry, Fourth edition	W. H. Freeman & Co. New York	2005
3	Deb, A.C..,	Fundamentals of Biochemistry	New Central Book Agency Pvt. Ltd., Kolkata.	2006
4	Srivastava, M.L.	Microbial Biochemistry	Narosa Publishing House, New Delhi	2008
5	Stryer, L	Biochemistry, Seventh Edition	W.H. Freeman and Company, New York.	2010
6	Satyanarayana, U. and Chakrapani, U..	Biochemistry, Fourth Edition	Book and Allied Pvt. Ltd., Kolkata	2013

Reference Books

S. No	Author	Title	Publisher	Year
1	Geoffrey	Biochemistry, 4th Ed	W. C. Brown, New York	1998
2	White David.	Physiology and Biochemistry of Prokaryotes. 2nd Ed	Oxford University Press, New York. 14. Zubay	2000
3	Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D..,	Biology Microorganisms, Twelth Edition	Prentice Hall, New Jerry	2000
4	Berg Jeremy, Tymoczko John, Stryer Lubert	Biochemistry 4th Ed,	W. H. Freeman, New York	2001
5	Metzler David E. (2001)	Biochemistry: The chemical Reactions of Living Cells, Volume 1&2,	Academic Press California	2001
6	Donald Voet and Judith G. Voet	Biochemistry. Third Edition	John Wiley and Sons, Inc. New York	2011

CORE COURSE –VI (CC)
IMMUNOLOGY

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2CC6	**Immunology**	**Core**	**90**	**-**	**6**	**5**

Preamble: The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease as well as acquire a generalized view on antigen-antibody reactions, hypersensitivity reactions & transplantation immunology.

COs	CO Statement	Knowledge Level
CO1	Functions of Immune system	**K4**
CO2	List the various types of Immunoglobulin	**K4**
CO3	Compared view of antigen & antibody reactions	**K5**
CO4	Explain the Hypersensitivity reactions	**K5**
CO5	Constructive view of transplantation immunology	**K6**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**M**	**M**	**S**	**M**
CO2	**S**	**M**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**

S- Strong; M-Medium; L-Low

Unit I : Immune System and immunity (18 Hours)

History of immunology; innate and acquired immunity. Cells and organs involved in immune system – T-cells, B-cells, lymphoid organ, spleen and bone marrow. Haematopoiesis. Antigenic properties, T and B cell epitopes, chimeric peptides, macrophages, antigen-processing cells, eosinophils, neutrophils, mast cells and natural killer cells; immune responses– cell mediated and humoral, clonal selection and nature of immune response.

Unit II: Antigen and antibodies (18 Hours)

Types, structure and properties of antigens, Haptens; adjuvant - antigen specificity. Immunoglobulins – structure, types and subtypes, properties, primary and secondary responses, Antibody diversity. Complement system – Structure, components, properties and functions, complement fixation and complement pathways, biological consequences. Inflammation-effector mechanisms.

Unit III: Antigen-Antibody reactions (18 Hours)

Agglutination, precipitation, Immuno electrophoresis, immunofluorescence, ELISA, RIA; Flow cytometry, Montaux test. Applications of these methods in diagnosis of microbial

infections, autoimmunity mechanisms, altered antigens, systemic lupus erythematosus, Graves‟s diseases, rheumatoid arthritis, myasthenia gravis, multiple sclerosis. Immunodeficiency-phagocytic, humoral, CMI, combined HLA association.

Unit IV: Hypersensitivity reactions (18 Hours)

Allergy, Type I- Anaphylaxis; Type II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity. Symptoms and Immunological methods of diagnosis of hypersensitive reactions. Lymphokines and cytokines – Assay methods. Immunological tolerance and modulation.

Unit V: Transplantation Immunology (18 Hours)

Graft versus host reactions. Structure and functions of MHC and the HLA systems. Gene regulation and Ir-genes; HLA and tissue transplantation – Tissue typing methods for transplantations in humans; graft versus host reaction and rejection. Tumor immunology: tumor specific antigens, Immune response to tumors, immuno diagnosis of tumors – detection of tumor markers – alphafoetal proteins, carcinoembryonic antigen, Cancer therapeutics. Immunization: types of vaccines and its application. Edible vaccines. Production of Polyclonal and monoclonal antibodies.

Text Books

S. No	Author	Title	Publisher	Year
1	Roitt, I.M.	Essential of Immunology, 7th Edition.	Elsievier.	2006
2	Rao, C. V	Immunology, Second Edition	Narosa Publishing House. New Delhi	2013
3	Singh R.P	Immunology and Medical Microbiology.2 nd edt	Kalyani Publishers, New Delhi	2015

Reference Books

S. No	Author	Title	Publisher	Year
1	Murphy K, Travers P, Walport M.	Janeway's Immunobiology. 7th edition	Garland Science Publishers, New York	2008
2	Peakman M, and Vergani D	Basic and Clinical Immunology. 2nd edition	Churchill Livingstone Publishers, Edinberg	2009
3	Richard C and Geiffrey S.	Immunology. 6th edition.	Wiley Blackwell Publication	2009
4	Jenni Punt, Sharon A Stranford Patricia P Jones, Janis Kuby.	Kuby immunology	W.H. Freeman New York:	2013
5	Abul K. Abbas & Andrew H. H. Lichtman& Shiv Pillai.	Basic Immunology, Functions and Disorders of the Immune System. 5th Edition	Elsevier	2015
6	Richard Coico and Geoffrey Sunshine.	Immunology: A Short Course, 7th Edition	Wiley-Blackwell	2015

CORE PRACTICAL–II
MICROBIAL METABOLISM AND IMMUNOLOGY PRACTICALS

Semester II	Internal Marks: 40	External Marks: 60				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2CC2P	**Microbial Metabolism and Immunology Practicals**	**Core Practical**	**60**	**8**	**-**	**4**

Preamble: To impart knowledge about immunological techniques.

COs	CO Statement	Knowledge Level
CO1	Analyze the Growth nature of *E. coli*	K4
CO2	Asses the fermentation stratigies	K5
CO3	Evaluate on blood groups, Rh typing	K5
CO4	Determine WBC & RBC counting.	K5
CO5	Compiled view of Serological techniques	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**M**	**S**	**S**	**S**	**S**
CO3	**M**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

I. MICROBIAL METABOLISM (30 Hours)

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on growth of *E. coli.*
4. Effect of pH on growth of *E. coli.*
5. Demonstration of alcoholic fermentation.
6. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

II. IMMUNOLOGY (30 Hours)

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.

4. Separation of serum from the blood sample.
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immune electrophoresis.

Reference Books

S. No	Author	Title	Publisher	Year
1	Moat, A.G. and Foster, W.,	Microbial Physiology, Fourth Edition	John Wiley and Sons, New York	2002.
2	Reddy SR and Reddy SM.	Microbial Physiology	Scientific Publishers India	2005
3	Delves P, Martin S, Burton D, Roitt IM.	Roitt's Essential Immunology.11th edition	Wiley Blackwell Scientific Publication, Oxford	2006
4	Abbas AK, Lichtman AH	Cellular and Molecular Immunology. 6th edition	Pillai Saunders Publication, Philadelphia	2007
5	Goldsby RA, Kindt TJ, Osborne BA.	Kuby's Immunology. 6th edition	W.H. Freeman and Company, New York	2007
6	Murphy K, Travers P, Walport M.	Janeway's Immunobiology. 7th edition	Garland Science Publishers, New York	2008
7	Peakman M, and Vergani D	Basic and Clinical Immunology. 2nd edition	Churchill Livingstone Publishers, Edinberg	2009
8	Richard C and Geiffrey S.	Immunology. 6th edition.	Wiley Blackwell Publication	2009
9	Willey JM, Sherwood LM, and Woolverton CJ.	Prescott's Microbiology. 9th edition.	McGraw Hill Higher Education	2013
10	Madigan MT, and Martinko JM	Brock Biology of Microorganisms. 14th edition.	Prentice Hall International Inc	2014

ELECTIVE COURSE-I (EC)
MICROBIAL TECHNIQUES

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credit**
19PMB2EC1A	**Microbial Techniques**	**Elective**	**75**	**-**	**5**	**5**

Preamble: To educate the students with the basic principles of microbial techniques so as to develop their research aptitude and career prospects

COs	CO Statement	Knowledge Level
CO1	List the various of microscopic techniques.	K4
CO2	Analyze the spectroscopic & Spectrophotometer methods	K4
CO3	Explain the chromatographic techniques.	K5
CO4	Create the knowledge about electrophoresis & its applications.	K6
CO5	Discuss the need for molecular techniques.	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**M**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**M**	**M**
CO5	**S**	**S**	**S**	**M**	**M**

S- Strong; M-Medium; L-Low

UNIT I: Microscopy (15 Hours)

Basic principles and application of Bright Field, Phase contrast, Polarization, Confocal laser, Fluorescence, Scanning Electron microscope & Transmission Electron Microscope (SEM & TEM) and Radio Microscopy.

UNIT II : Spectroscopy & Spectrophotometry (15 Hours)

Basic concepts, Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD), Fluorescence spectroscopy, Infrared spectroscopy, Fourier-transform infrared spectroscopy (FTIR), Nuclear Magnetic Resonance spectroscopy (NMR). Beer-Lambert's Law and its use in determination of protein/ nucleic acid concentration. UV/Visible spectrophotometry.

UNIT III: Chromatographic techniques (15 Hours)

Basic Principles and application of Bioautography, Gel filtration chromatography, Ion-exchange chromatography, Affinity chromatography, Gas chromatography, High Performance Liquid chromatography.

UNIT IV: Electrophoresis (15 Hours)

Basic concepts, Gel Electrophoresis- Agarose and acrylamide (native, denaturingand gradient), Isoelectric focusing, 2D Electrophoresis and Immuno electrophoresis.

UNIT V: Radiography & Molecular techniques (15 Hours)

Basic principles and application of Autoradiography, Liquid scintillation counting, phosphor imaging, IRMA. PCR, DNA Sequencing (Sanger's method), Blotting (Southern, Western, Northern) Techniques, DNA Finger printing, RFLP, RAPD and AFLP application.

Text Books

S. No	Author	Title	Publisher	Year
1	Chatwal G and Anand	Instrumental Methods of Chemical Analysis	Himalaya Publishing House, Mumbai	1989
2	Bajpai PK	Biological Instrumentation and Methodology. Revised edition	S.Chand&Co.Ltd, New Delhi.	2010
3	Dr. Kishore R. Pawar, Dr. Ashok E	Biological Techniques	Nirali Prakashan	2017
4	Ananta Swargiary	Biological Tools & Techniques (A textbook for UG/PG students of Life Sciences)	Kalyani Publishers, New Delhi	2018

Reference Books

S. No	Author	Title	Publisher	Year
1	H.H. Willard, L.L. Merritt Jr	Instrumental Methods of Analysis. 7 th Edition	CBS Publishers and Distributors	2012
2	Pavia And Lampman,	Introduction To Spectroscopy, 5Th Edition	Cengage Learning	2015
3	Reiner Westermeirer	Electrophoresis in Practice: Guide to Methods and Applications of DNA and Protein Separations	Wiley	2016
4	Paul Ekpo and Godwin Michel	Introduction to Biological Techniques: Approaches for Effective Applications	Wiley	2018

ELECTIVE COURSE –I (EC)
ORGANIC FARMING

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2EC1B	**Organic Farming**	**Elective**	**75**	**-**	**5**	**5**

Objectives: This course aims at sensitizing the need and generating knowledge and skill on various organic farming practices, so as to equip the learners carrying out organic agricultural production and management.

COs	CO Statement	Knowledge Level
CO1	Analyze the origin and importance of organic farming	K4
CO2	Explain the scope of organic farming	K5
CO3	Criticize the methodology practiced in organic farming	K5
CO4	Develop an idea about biocontrol agents in crop protection	K6
CO5	Construct the strategies for the commercialization of organic products	K6

Mapping with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**S**	**M**	**M**	**M**
CO2	**M**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**M**	**S**	**M**	**S**
CO5	**S**	**S**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

Unit I: Organic Farming Concepts (15 Hours)

Introduction, concept and development of organic farming. Principles and Types of organic farming. Benefits and Need for organic farming. Biodynamic farming.

Unit II: Scope & Requirements (15 Hours)

Scope of organic farming; Conventional farming v/s Organic farming. Requirements for organic farming. Integrated organic farming management system.

Unit III: Methods & managements (15 Hours)

Green manuring- Composting- principles, stages, types and factors, Composting methods - Vermicomposting, Organic amendments and sludges. Biofertilizers - methods of application, advantages and disadvantages. Propagation-seed, planting materials and seed treatments, Water management - drip irrigation - rain water harvesting.

Unit IV: Plant protection (15 Hours)

Plant protection- biopesticides, - biocontrol agents, Weed management- preventive practices, biological control of weeds, mechanical control, Standards for organic inputs, crop rotation- inter cropping, Bio Pesticides - agniastra, neemastra - mode of application- advantages. Mulching- Pruning.

Unit V: Seed conservation and marketing (15 Hours)

Seed conservation- techniques- seed bank. Farm inspection and certification- Quality analysis of organic foods - Standards of organic food - Preparation and Marketing of Organic products

Text Books

S. No	Author	Title	Publisher	Year
1	Joanne M Willey,Kathleen MSandman and Dorothy H Wood	Prescotts microbiology	McGraw-Hill Education	2019
2	Unni M R and SabuThomas	Organic Farming Global Perspectives and Methods	Woodhead publishing	2018
3	AmitavaRakshit and H B Singh	ABC of Organic Farming	Jain Brothers	2018
4	Reddy S R	Principles of Organic Farming	Kalyani Publisher	2017

Reference Books

S. No	Author	Title	Publisher	Year
1	Bansal M	Basics of Organic Farming	CBS publishers and Distributors Pvt.Ltd.	2020
2	Janet Wilson	Composting: Sustainable and Low- Cost Techniques for Beginners	Drip Digital Publisher	2020
3	DebabrataBiswas, Shirley A. Micallef	Safety and Practice for Organic Food	Academic press Elsevier Science	2019
4	Rhonda Sherman	The Worm Farmer's Handbook	Chelsea Green Publishing Company	2018
5	Vinaya Kumar Sethi	Organic farming and bio-fertilizers	Discovery publishing house Pvt. Ltd.	2018

ELECTIVE COURSE I – (EC)
MICROBIAL CYTOLOGY

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2EC1C	**Microbial Cytology**	**Elective**	**75**	**-**	**5**	**5**

Objectives:
To introduce basics in prokaryotic and eukaryotic cell structure.

COs	CO Statement	Knowledge Level
CO1	Assess the main principles of cell theory	K5
CO2	Determine the Prokaryotic cell	K4
CO3	Evaluate the Structure and functions of eukaryotic cell	K5
CO4	Generalize view of cell division	K6
CO5	Examine Microbial cell communication	K4

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**M**	**S**	**S**	**M**
CO2	**S**	**S**	**M**	**M**	**S**
CO3	**M**	**S**	**M**	**S**	**S**
CO4	**S**	**M**	**S**	**S**	**M**
CO5	**M**	**S**	**S**	**M**	**S**

S- Strong; M-Medium; L-Low

Unit I : History of microbial cytology (15 Hours)

History of microbial cytology, Cell – definition and general concepts, Main principles of the cell theory, cell as basic unit of life, broad classification of cell types - prokaryotic and eukaryotic cells and their similarities and differences.

Unit II: Structure and functions of prokaryotic cell (15 Hours)

Structure and functions of prokaryotic cell –Outer flagella, surface layers, cell wall, Cytosol and other organelles, Chromosome and extra chromosomal DNA.

Unit III: Structure and functions of eukaryotic cell (15 Hours)

Structure and functions of eukaryotic cell - Cytosol, Nucleus, Chloroplast, Organelles of Vesicular trafficking system, endoplasmic reticulum (rough and smooth endoplasmic reticulum), Golgi bodies, lysosomes, microbodies.

Unit IV: Eukaryotic cell cycle (15 Hours)

Eukaryotic cell cycle – Role of cell cycle and Control of cell cycle. Cell division – Mitosis and Meiosis.

Unit V: Microbial Cell Communication (15 Hours)

Microbial Cell Communication – overview- types of cell signaling- signal molecules – Signal amplification- receptor types –quorum sensing.

Text Books

S. No	Author	Title	Publisher	Year
1.	Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B.	Biology in Focus	Pearson Education	2014
2.	Karp G., Iwasa J. and Masall W	Karp's Cell and Molecular Biology	John Wiley and Sons	2015
3.	Veerma P.S. and Agarwal V.K.	Cell Biology	Paperback, S. Chand and Company Ltd	2016
4.	Hardin J. and Bertoni G.	Becker's World of the Cell	Pearson Education Ltd	2017
5	Kumar P. and Mina U.	Life Sciences: Fundamentals and Practice	Pathfinder Publication	2018

Reference Books

S. No	Author	Title	Publisher	Year
1.	Mason K.A., Losos J.B. and Singer S.R	Raven and Johnson's Biology	Mc Graw Hill publications	2011
2.	Alberts B., Johnson B., Lewis J., Morgan D., Raff M., Roberts K. and Walter P	Molecular biology of cell	Taylor and Francis	2015
3.	Challoner J	The Cell: A visual tour of the building block of life	The University of Chicago Press and Ivy Press Ltd	2015
4.	Cooper G.M. and Hausman R.E.	The Cell – A Molecular Approach	Sinauer Associates Inc	2016
5.	Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P.	Essential Cell Biology	Norton & Company	2018

ELECTIVE COURSE II– (EC)

BIOFERTILIZER TECHNOLOGY

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2EC2A	**Biofertilizer Technology**	**Elective**	**75**	**-**	**5**	**5**

Preamble: The aim of the course is to make the student to know the importance of biofertilizers in agriculture and about the field applications and production technologies

COs	CO Statement	Knowledge Level
CO1	Explain the concept of biofertilizers and its significance in plant growth	K5
CO2	Perceive the knowledge about biofertilizer production methods	K5
CO3	Elaborate the production methods of microbes used as biofertilizers	K6
CO4	Discuss about the application methods of produced biofertilizers	K6
CO5	Create the knowledge about biocontrol agents and its applications	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**M**	**M**	**M**	**S**
CO2	**S**	**M**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**M**	**S**	**M**	**S**
CO5	**S**	**M**	**M**	**M**	**S**

S-Strong; M-Medium; L-Low

Unit-I: Biofertilizer (15 Hours)

Biofertilizer-Introduction, History, Classification of biofertilizer- basis on Nitrogen, Phosphorous and Potash providing microbes. Plant Growth Promoting Rhizobacteria (PGPR) - introduction, characters and importance. Significance of biofertilizers.

Unit II: Biofertilizer formulation (15 Hours)

Strain, strain selection methods- Screening methods of efficient strain, quality control analysis. Biofertilizer formulation- carrier based, liquid based. Biofertilizer production methods- Preparation of mother inoculums, pre-starter culture, starter culture.

Unit III: Production of Biofertilizer (15 Hours)

Introduction, characters and production technology- *Rhizobium, Azotobacter, Azospirillum, Acetobacter,* Phosphobacteria and potash bacteria- *Frateuria* sp.

Unit IV: Application Methods of Biofertilizer (15 Hours)

Introduction, characters and production technology- Frankia, Cyanobacteria, *Azolla-anabaena,* AM and VAM fungi and its types. Application methods of biofertilizers- seed treatment, seedling root dip, soil application- sowing, trip irrigation. Advantages of biofertilizers, limitations of biofertilizers.

Unit –V: Biocontrol agents (15 Hours)

Introduction and characters of Biocontrol agents-*Pseudomonas, Trichoderma.* Bioinsecticides-*Bacillus thuringiensis, Verticillium, Beauveria, Metarhizium.* Industrial visit and field visit.

Reference Books:

S. No	Author	Title	Publisher	Year
1	Kannaiyan S., 2002	Biotechnology of biofertilizers	Narosa publishing house, New Delhi.	2002
2	Mukerji KG, Manoharachary C and Chamola BP	Techniques in Mycorrhizal studies	Kluwer Academic Publishers	2002
3	Kannaiyan S	Biotechnology of biofertilizers, CHIPS, Texas. 5th edition	McGraw Hill, New York	2003
4	Kannaiyan S and Kumar K	Azolla bio fertilizers for sustainable rice production	Daya publishing house, Delhi.	2005
5	Dinesh K Maheswari	Bacteria in Agrobiology	Springer Heidelberg, New York	2012
6	Mahendra K Rai	The Hand book microbial biofertilizers. 9th edition.	Haworth press, Inc. New York	2015

ELECTIVE COURSE –II (EC)
PUBLIC HEALTH MICROBIOLOGY

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2EC2B	**Public Health Microbiology**	**Elective**	**75**	**-**	**5**	**5**

Preamble : This course deals with the microbes related to public health and to gain the knowledge about the diagnosis and treatment methods for various microbial infections.

COs	CO Statement	Knowledge Level
CO1	Examine basic ideas about microbial association	K4
CO2	Diagnose the various airborne disease	K4
CO3	Determine the water borne diseases and its control	K4
CO4	Evaluate the role of microorganisms in food	K5
CO5	Extend the diagnosis hospital acquired infections	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**M**	**M**
CO2	**S**	**M**	**S**	**S**	**M**
CO3	**S**	**M**	**S**	**M**	**M**
CO4	**S**	**M**	**M**	**M**	**M**
CO5	**M**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

Unit I: Introduction to public health (15 Hours)

Definition, scope, concept and importance of public health microbiology – roles of microbiologist in public health – microbial association of water, air and soil.

Unit – II Air borne infections (15 Hours)

Air and its composition – indoor air – outdoor air – air borne diseases (bacterial, fungal and viral) – methods of enumeration of microorganisms in air – air sanitation.

Unit – III Water borne infections (15 Hours)

Kinds of water – water borne diseases (viral, bacterial, protozoan) – methods of enumeration of microorganisms in water – indicator organism – water treatment control of water borne diseases.

Unit – IV Food borne diseases (15 Hours)

Definition and importance of food hygiene – types (spoilage of meat and its products, milk and dairy product, fish and fish products and eggs) – role of microorganisms in food spoilage and poisoning – food borne diseases – types of food borne diseases – food poisoning – food borne infection.

Unit – V Hospital acquired infection (15 Hours)

Prophylactic immunization – disposal of infective hospital and laboratory materials – monitoring of sanitation in community – techniques used for the diagnosis of hospital acquired infection.

Reference Books:

S. No	Author	Title	Publisher	Year
1	Brownson, R.C., Baker, E.A., Leet T.L. and Follespie K.N	Evidence Based Public Health	Oxford University Press.	2003
2	Ghimire P. and Parajuli K.	A Text Book of Microbiology	Vidhyarthi Pustak Bhandar Publication, Kathmandu	2005
3	Jay J.M., Loessner, M.J. and Golden D.A.	Modern Food Microbiology, 7th Edn.	Springer	2005
4	Engelkirk P.G. and Duben-Engelkirk J.	Burton's Microbiology for the Health Sciences, 10th Edn.	Wolters Kluwer Health	2015
5	Park K.	Parks Text Book of Preventive and Social Medicine,	Banarsidas Bhanot Publishers	2017

ELECTIVE COURSES– II (EC)
MARINE MICROBIOLOGY

Semester II	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB2EC2C	**Marine Microbiology**	**Elective**	**75**	**-**	**5**	**5**

Objectives:

This deals with the study of microorganisms in sea environment including their biodiversity, ecology and biogeochemistry.

Course Outcome

COs	CO Statement	Knowledge level
CO1	Determine marine microbes and kingdom concepts	K4
CO2	Distinguish the Role of microbes in sea water habitats	K4
CO3	Assess Biogeochemical processes in marine systems	K5
CO4	Expand the application of marine microbial products	K6
CO5	Develop Biodegradation methods for marine pollutants	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**M**	**M**	**M**	**M**
CO2	**S**	**S**	**M**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**M**	**S**	**S**	**S**	**M**
CO5	**M**	**M**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

Unit-I Marine Microbes (15 Hours)

Introduction to marine microbes, importance, Classification - Haeckel's three kingdom, Whittaker's five kingdom, Carl Woese three domain concepts. Extremophiles – biotechnological applications.

Unit II : Marine Habitats (15 Hours)

Role of microbes in sea water habitats- coastal, intertidal, estuaries, shores, salt marsh, mangrove, lagoon, coral reef, deep sea, hydrothermal vents. Marine flora & fauna: Phytoplankton-Zooplankton- habitats and ecosystem- Sea weeds, Sea grasses, Kelp forest and uses.

Unit III: Marine Biogeochemistry (15 Hours)

Seawater- Physical & chemical properties.Composition of sea water and brakish water. Ocean acidification- sedimentation. Biogeochemical processes in marine systems- carbon, nitrogen, oxygen, sulfur and phosphorous cycle.

Unit IV: Marine Microbial Products (15 Hours)

Marine microbes – application -Marine hydrocolloids (Agar, Agarose, Carrageenanand Alginate), Antifouling coating- production, Marine drugs-bioactive compounds, Nutraceutical– functional foods.

Unit V: Marine Pollution (15 Hours)

Biodegradation and bioremediation of marine pollutants: Sources of marine pollution-domestic, industrial and agricultural discharges- oil pollution-thermal and radioactive pollution. Biofouling- biofilm formation- related microbes- control & prevention methods.

Reference Books

S. No	Author	Title	Publisher	Year
1	Hunter-Cevera, J Karl, D. and Buckley, M	Marine Microbial Diversity: the key to Earth's habitability	American Academy of Microbiology	2005
2	Susan Libes	Introduction to Marine Biogeochemistry.	Academic press publications Elsevier, 2nd edition. USA	2009
3	Colin Munn	Marine microbiology: ecology & applications, 2nd edition	Garland Science	2011
4	Meller, C. B. and Wheeler, P. A	Biological Oceanography, 2nd Edition	Wiley-Blackwell Publishers	2012
5	Se-Kwon Kim	Marine Microbiology: Bioactive Compounds and Biotechnological Applications.	Wiley-VCH VerleyGMbH& Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany	2013
6	Jeffrey S. Levinton.,.	Marine Biology – Function, Biodiversity Ecology, 4th edition.	Oxford University Press, New York.	2014

CORE COURSE-VII

INDUSTRIAL MICROBIOLOGY

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3CC7	**Industrial Microbiology**	**Core**	**75**	**-**	**6**	**5**

Preamble: To train the students on Industrial Microbiology so as to develop them for employment in Microbial Industry. To learn the screening of industrial strains, fermenters, media, fermentation process and downstream process.

Course Outcome:

COs	CO Statement	Knowledge level
CO 1	List the Concept and History of Strain development	K1
CO 2	State the Fermentor and Fermentation media	K2
CO 3	Explain the Fermentation Products	K2
CO 4	Describe the Production of Pharmaeutical Products	K2
CO 5	Prepare the Production and Purification Industrial Important Microbial Products.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**S**	**M**	**M**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**M**	**M**
CO4	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**

S- Strong; M-Medium; L-Low

Unit I (15 Hours)

Bioreactor / Fermenter - Introduction, Definition. Types - Batch, Fed-Batch, Continous. Solid substrate fermentation, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static, Submerged and agitated fermentation). Operation of Bioreactors, Physico-chemical standards used in bioreactors, limitations of bioreactors, Principles of Fermentation Technology, stages of fermentation processes. Growth Kinetics, Thermal death kinetics. Advantages & disadvantages of solid substrate & liquid fermentations.

Unit II (15Hours)

Strain- Strain selection, Strain development, Methods , Preservation of strains, maintenance and strain improvement by mutation of gene transfer. Media formulation, Sterilization. Criteria for good Medium, Medium requirements for fermentation processes, Carbon Nitrogen, Minerals, Vitamins & other complex nutrients, Oxygen requirements, Design of various commercial media for Industrial fermentation- Medium optimization methods- Quality control Analysis**.**

Unit III (15 Hours)

Downstream processing – extraction,Separation techniques. concentration, recovery &purification techniques. Chromatography-Ion Exchange, Molecular Sieve, Affinity, HPLC, HPTLC, GC,GC-MS, Distillation, Fluid Extraction & Electrodialysis, Centrifugation, Sonification Techniques.

Unit IV (15Hours)

Enzyme technology –Genetic engineering & Protein engineering of enzymes, Immobilized cells and enzymes (Ca-alginate beads, polyacrylamide), industrial applications of immobilized enzymes. Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid, α-amylase, protease penicillin, tetracycline and vitamin B12, Production of herbal drugs. SCP, Beer, Wine and Yoghurt.

UNITV (15Hours)

Biological fuel generation – Biogas Production- Biodiesel, ethanol Bioelectricity, hydrogen from Biomass. Biotechnology in specific medical & industrial applications - Retting of jute, microbial process for immunization (Production of monoclonal antibodies), Deterioration of paper, textiles, painted surfaces and their prevention, Biofilms, microbial biopolymers, biosurfactants. RSM & Optimization of Media.

Text Books:

S.No	Author	Title	Publisher	Year
1.	Subhash Chand & Satish Chandra Jain	Fermentation Biotechnology: Industrial Perspectives	All India Biotech Association	1999
2.	James E. Bailey and David F. Ollis	Biochemical Engineering fundamentals	Tata Mcgrae Hill	2005
3.	Casida LE	Industrial Microbiology	New Age International Private Limited	2019
4.	Stanbury P.F.A. Whitaker and S.J. Hall	Principles of fermentation techniques	Elsevier	2017
5.	Crueger W and Crueger A	Biotechnology: A Test Book of Industrial Microbiology	Medtech	2017
6.	Patel AH	Industrial Microbiology	Laxmi Publication	2011

Reference Books:

S.No	Author	Title	Publisher	Year
1.	Michael L. Shuler and FikretKargi	Bioprocess Engineering: Basic Concepts	Pearson Education India	2015
2.	Agarwal AK and PradeepParihar	Industrial Microbiology	AGROBIOS	2012
3.	Doran	Bioprocess Engineering Principles	Elsevier	2012
4.	Richard H. Baltz, Arnold L. Demain and Julian E. Davies	Manual of Industrial Microbiology and Biotechnology	American Society for Microbiology	2010
5.	Prescott and Dunns	Industrial microbiology	CBS	2004

Web Links

1. https://www.youtube.com/watch?v=emUoAVOBGec
2. https://www.youtube.com/watch?v=eXEpiarmYkY
3. https://www.youtube.com/watch?v=Tdb0N_PMpEI
4. https://www.youtube.com/watch?v=opfPTm3z0rE
5. https://www.youtube.com/watch?v=YT34E_DJH24
6. https://www.youtube.com/watch?v=Uut1cUs6GpA
7. https://www.youtube.com/watch?v=RUoAmns7NiQ
8. https://www.youtube.com/watch?v=fL0CN_iyylA
9. https://www.youtube.com/watch?v=uOWS6q9HQGk
10. https://www.youtube.com/watch?v=D8jfLf_bODs

CORE COURSE-VIII

CLINICAL MICROBIOLOGY

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3CC8	**Clinical Microbiology**	**Core**	**90**	**-**	**6**	**5**

Preamble: To impart and explain the students with the advanced knowledge of the characteristics of clinically important pathogenic organisms with the focus on the pathogenesis, lab diagnosis, prophylaxis, and treatment of the disease.

Course Outcome:

On the successful completion of the course, students will be able to

COs	CO Statement	Knowledge level
CO1	Describe and Classify the various pathogens.	K3
CO2	Diagnose the various bacterial pathogens	K4
CO3	Examine and differentiate the various fungal infections	K4
CO4	Analyse various human viral diseases.	K6
CO5	Examine and Categorize different types of parasitic diseases	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**L**	**M**	**L**	**S**	**S**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**M**	**M**	**M**

S- Strong; M-Medium; L-Low

Unit I : (18 hours)

Historical development and Scope of clinical microbiology, classification, isolation and identification of pathogenic bacteria, clinically important fungi, Protozoa and viruses. Normal microbial flora of the human body: normal flora of skin,eye, throat, gastrointestinal tract and urogenital tract - Diagnosis Process of Sample collection, Transport and examinations of the Specimens. Zoonotic and Nosocomial infections.

Unit II :(20 hours)

Clinical Bacteriology- infections associated with Gram positive bacteria – *Bacillus anthracis, Clostridium, Pneumococcus, Corynebacterium, Streptococci* and *Staphylococci*. Infections associated with Gram negative bacteria – *Salmonella, Shigella, Vibrio, Escherichia, Haemophillus*. Pathogenesis, lab diagnosis and treatment of Tuberculosis, leprosy and Syphilis.

Unit III: (18 Hours)

Clinical Mycology- Etiology, Lab diagnosis, pathogenesis and treatment of superficial Dermatophytes– *Trichophyton, Microsporum* and *Epidermophtan (Tinea)*. Systemic – Candidiasis, Cryptococosis, Blastomycosis and Histoplasmosis. Opportunistic, systemic mycoses – Aspergillosis.

Unit IV :(18 Hours)

Clinical Parasitology- Etilogy, clinical diagnosis of protozoans- *Entamoeba histolytica, Giardia lamblia, Leishmania, Plasmodium.* Nematodes – *Wucheria bancrofti, Trichonella, Trichuris*. Cestodes – *Taenia, Echinococcus.* Trematodes – *Schistosoma*.

Unit V :(16 Hours)

Chemotherapy – Mechanism of action of antibiotics, Mechanism of development of antibiotics resistance. Alternatives to antibiotics (Probiotics, Prebiotics, Synbiotics and Post biotics). Vaccines – Live attenuated, Recombinant, Subunit and Edible vaccines. Interferons.

Text Books

S. No	Author	Title	Publisher	Year
1	David Greenwood, Richard CB Slack and John Peutherer	Medical Microbiology, 16th edition	Church Hill Living stone Publication.	2002
2	Ananthanarayanan R and Jeyaram Panicker CK..	Textbook of Medical Parasitology. 5th Ed	Medical publisher, Pvt Ltd., New Delhi	2004
3	Chatterjee KD	Parasitology, 13th Edition.	CBS Publishers	2009
4	Parija S.C.,	Medical Parasitology: Protozoology and Helminthology, 4th Edition.	All India Publishers and Distributors, New Delhi.	2013
5	Arora D.R., Brijbala.,.	Medical Parasitology, 5th Edition	Amit Book company Pvt Ltd., New Delhi.	2018

Reference Books

S. No	Author	Title	Publisher	Year
1	Moselio Schaechter, Cary Englebreg, N. Barry I Einsenstein, Gerald medoff.	Mechanisms of microbial disease, 3rd edition	Lippincott Williams & Wilkins,	1999
2	Jawetz, Melnickand and Adelberg	Medical Microbiology, 22nd edition	McGraw HillMedical Publication division.	2001
3	Ananthanarayanan R and JeyaramPanicker CK.	Textbook of Microbiology. 9th Ed.	University Press.	2013
4	Martha Polich., Mi Keala Olsen., amd Kris Lefebvre	Chemotherapy and biotherapy guidelines and Recommendations for Practice. 4th Edition.	Oncology Nursing Society	2014.
5	Baveja CP., Baveja V	Medical Parasitology	Arya Publication	2017

WEBLINKS:

1. https://www.cdc.gov/tb/education/corecurr/pdf/chapter2.pdf
2. http://apps.searo.who.int/PDS_DOCS/B5123.pdf
3. http://loyce2008.free.fr/Microbiologie/-%20Micro%20-%20Gillespie%20Hawkey%20-%20Principles%20And%20Practice%20Of%20Clinical%20Bacteriology%202Nd%20Ed.pdf

ELECTIVE COURSE- III
MICROBIOLOGY FOR COMPETITIVE EXAMINATIONS

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
20PMB3EC3A	**Microbiology for Competitive Examinations**	**Elective**	**75**	**-**	**5**	**5**

Preamble: This course provides a multidisciplinary forum for the discussion of all aspects of microbiology which helps to develop and impart knowledge for the students to appear in the competitive examination.

Course Outcome:

COs	CO Statement	Knowledge level
CO1	Explain the taxonomy principles and concepts	K5
CO2	Understanding the basics of inheritance Biology	K2
CO3	Extend the Knowledge about microbes in Agriculture	K2
CO4	Understand the basic concepts of cell development and its impacts	K5
CO5	Expand the knowledge about Bio-nano-informatics	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**M**	**M**	**M**	**S**
CO2	**S**	**M**	**S**	**M**	**M**
CO3	**S**	**S**	**M**	**M**	**S**
CO4	**S**	**M**	**M**	**S**	**M**
CO5	**S**	**M**	**M**	**M**	**M**

S- Strong; M-Medium; L-Low

Unit I: Microbial Taxonomy (15 Hours)

Taxonomy - Principles and methods, Concepts of species and hierarchical taxa. Levels of structural organization- Unicellular, colonial and multicellular forms; Taxa & Species concepts- Traditional, typological, evolutionary, biological, phylogenetic concepts. Phylogenetic (among species) versus Tokogenetic (within species) relationships. Taxonomic rank and names. Types of taxonomy- chemotaxonomy, numerical taxonomy and polyphasic taxonomy. Phylogenetic analysis and evolutionary relationship among taxa. Application in

Taxonomy and phylogeny, Comparative genomics.

Unit II: Inheritance Biology (15 Hours)

Mendelian principles, Concept of gene , Gene mapping, Human genetics - Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Polygenic inheritance, heritability and its measurements, QTL mapping. Structural and numerical alterations of chromosomes - Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination Homologous and non-homologous recombination including transposition

Unit III: Agricultural Microbiology (15 Hours)

Biogeochemical cycles -Nitrogen, Carbon, Phosphorous, Sulphur, Iron and their importance. Microbial association with plants-Phyllosphere, Rhizosphere, Mycorrhizae, Nitrogen fixing organism –symbiosis, asymbiosis, associate symbiosis – phosphate solubilizers. Application of biofertilizers in agriculture. Biology of nitrogen fixation – genes and regulations in Rhizobium. Bacterial, viral and fungal plant pathogens. Disadvantages of chemical pesticides. Microbial pesticides- types, mechanisms, advantages and limitations.

Unit IV: Developmental Biology (15 Hours)

Basic concepts of cell development, Gametogenesis, Spermatogenesis and Oogenesis in mammals, outline of experimental embryology, Morphogenesis and organogenesis in *Drosophila*. Metamorphosis, Regeneration and Human development

Unit V: Bio-Nano-Informatics (15 Hours)

Introduction to Bioinformatics-Applications of Bionanotechnology - Drug and gene delivery –protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays. Nanomedicines, Antibacterial activities of nanoparticles. Nanotechnology in agriculture. Toxicology in nanoparticles – Dosimetry. Nanotherapy for cancer treatment. Nanoscience in India – Nanoscience education abroad – Looking at ethics and society.

Text Books

S. No	Author	Title	Publisher	Year
1	Smith, Sally E., and David J	Mycorrhizal Symbiosis	Academic Print	2010
2	Chattopadhyay. S	An Introduction to Developmental Biology	Books and Allied (P) Ltd, Kolkata	2016
3	Chattopadhyay K.K..	Introduction to Nanoscience and Nanotechnology	K.K.. Publisher: Prentice Hall India Learning Private Limited	2019

Reference Books

S. No	Author	Title	Publisher	Year
1	Barnes Michael R.	Bioinformatics for Geneticists	Wiley India	2018
2	D. Peter Snustad and Michael J. Simmons	Principles of Genetics	Wiley Publisher	2015
3	Hartl, Daniel L.	Genetics : analysis of genes and genomes	Burlington, Massachusetts : Jones & Bartlett Learning	2019
4	Gilbert, Scott's	Developmental biology	Sinauer Association, Inc., Publishers	2014
5	M. A. Shah and K. A. Shah	Nanotechnology	Wiley	2019

WEB LINKS:

1. https://doi.org/10.1111/j.1095-8312.1949.tb00525.x.
2. https://www.discoverlife.org/png/taxonomic_principles.pdf
3. https://lms.biotecnika.org/unit/unit-9-a-principles-methods-of-taxonomy/
4. https://en.wikipedia.org/wiki/Agricultural_microbiology
5. http://agritech.tnau.ac.in/ta/org_farm/orgfarm_biofertilizers.html
6. https://www.worldscientific.com/worldscibooks/10.1142/7364
7. http://www.imedpub.com/journal-nanoscience-nanotechnology-research/
8. https://benthamscience.com/journals/nanoscience-and-nanotechnology-asia/

ELECTIVE COURSE- III

FOOD ADULTERATION

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3EC3B	**Food Adulteration**	**Elective**	**75**	**-**	**5**	**5**

Preamble: To explain the students about the impacts of food adulteration and enhance the advanced knowledge about deduction methods for common adulterations.

Course Outcome:

COs	CO Statement	Knowledge level
CO1	Predict the properties of Biomolecules	K3
CO2	Determine the common food contaminants	K4
CO3	Critique knowledge about microbial food poisoning	K4
CO4	Compare various regulations of food safety agencies	K5
CO5	Expand about food preservation methods	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**L**	**M**	**L**	**S**	**S**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**M**	**M**	**M**

S- Strong; M-Medium; L-Low

Unit I: (15 Hours)

Properties, functions, sources of Carbohydrates, Proteins, Lipids, Fat soluble vitamins (A, D, E, K) and water soluble vitamins (B complex, vitamin C): occurrence, chemistry, daily requirements.

Unit II: (15 Hours)

Microbial contaminants of foods with special reference to spoilage of: Cereals, Sugar and sugar products-, Fruits and vegetables- Meat and meat products- Egg and poultry, Milk and milk products- Canned food spoilage- types and causes.

Unit III: (15 Hours)

Brief introduction to types of microbes responsible for the spoilage of foods i.Bacteria ii.Virus iii. Protozoa iv. Yeast v. Fungi. Food intoxication.

Unit IV: (15 Hours)

Detection of common food adulterants in various Food. HACCP, GMP, role of FDA, Agmark, ISI. Concept of sanitation and hygienic production of food.

Unit V: (15 Hours)

Basic principles of food preservation- Asepsis, removal of microorganisms and antibiotic conditions. Preservation using high temperature, canning, TDT, heat resistance of micro-organisms and spores. Low temperature freezing: Growth of microorganisms at low temperature. Drying (dehydration) - Methods, factors in control of drying treatment of food before and after. Chemical preservations.

Text Books

S. No	Author	Title	Publisher	Year
1	M.R. Adams and M.O. Moss	Food Microbiology	New Age International (P) Ltd., New Delhi	2005
2	James M. Jay	Modern Food Microbiology, 4th Edition	CBS Publishers and Distributors, New Delhi	2005
3	Vijaya Ramesh K	Food Microbiology	MJP Publishers, Chennai	2007

Reference Books

S. No	Author	Title	Publisher	Year
1	Adams Tamine	Probiotic Dairy Products	Blackwell Publishing, USA	2005.
2	James G. Cappuccino and Natalie Sherman, Microbiology – A Laboratory Manual	Microbiology – A Laboratory Manual,	Pearson Education Publishers, USA	2008

WEBLINKS:

1. http://vikaspedia.in/health/health-campaigns/beware-of-adulteration/methods-for-detection-of-common-adulterants-in-food
2. http://tnschools.gov.in/media/textbooks/XII_Std_Food_Service_Management_EM_Combined_02.03.2019.pdf

ELECTIVE COURSE- III
BIOMEDICAL LABORATORY TECHNOLOGY

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3EC3C	**Biomedical Laboratory Technology**	**Elective**	**75**	**-**	**5**	**5**

Preamble: To impart and explain the students with the advanced knowledge on the diagnosis of medically important human microbial pathogens by sample collection, transport, diagnosis etc.

Course Outcome:

COs	CO Statement	Knowledge level
CO1	Predict the laboratory safety measures.	K3
CO2	Determine the uses of laboratory equipments	K4
CO3	Critique knowledge about sample collection	K4
CO4	Critique thinking of reagent preparation	K5
CO5	Expand about organ function and infection	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**L**	**M**	**L**	**S**	**S**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**M**	**M**	**M**

S- Strong; M-Medium; L-Low

Unit I : (15 Hours)

Introduction to Clinical laboratory Basic laboratory principles - Code of conduct of medical laboratory personnel The use of the laboratory - Basic laboratory principles - Code of conduct of medical laboratory personnel -Organization of clinical laboratory and role of medical laboratory technician - Safety measures - Medical laboratory professional and professionalism in laboratory workers - clinic borne infection and personnel hygiene.

Unit II: (15 Hours)

Common Laboratory Equipment's Incubator, Hot Air Oven, Water Bath - Anaerobic Jar, Centrifuge, Autoclave -Microscope - Fundamentals of Microscopy, Resolution & Magnification, Light Microscopy, Electron Microscopy- Glassware – Description of Glassware, its use, handling and care.

Unit III:(15 Hours)

Basic Steps for Drawing A Blood Specimen Requirement of Blood Collection - Blood collection - Phlebotomy - Sampling errors - Collection and preservation of biological fluids - Anticoagulants - Preservation of samples - Chemical preservatives - Process of analysing the specimens - The laboratory report.

Unit IV:(15 Hours)

Preparation of Reagents & Quality control Buffer and pH- Preparation of reagents : Normal , per cent and Molar solution - normal saline -Methods of measuring liquids- Clinical Laboratory records- Modern Laboratory set up - Quality control: Accuracy, Precision, and Reference values.

Unit V:(15 Hours)

Evaluation of organ function test Function of liver in health and disease: Jaundice, Hepatitis; liver function test. Assessment and clinical manifestation of renal, hepatic, pancreatic, gastric & intestinal function, enzyme of pancreatic origin and biliary tract, test of myocardial infarction.

Text Books

S. No	Author	Title	Publisher	Year
1	Jochei and Kolhatkar	Medical laboratory science theory and practice	Tata McGraw-Hill, New Delhi	2002
2	Kanai L. Mukherjee	Medical laboratory technology Vol.1	Tata McGraw Hill.	2007
3	Vasudevan D. &SreeKumari S	Text Book of Bio Chemistry for Medical Students	Jaypee Brothers, New Delhi	2016

Reference Books

S. No	Author	Title	Publisher	Year
1	Gradwohls,. (ed) Ales C. Sonnenwirth and leonardjarret,	Clinical laboratory methods and diagnosis.	M.D.B.I., New Delhi	2000
2	Fischbach	Manual of lab and diagnostic tests	Lippincott Williams Wilkins, New York	2005
3	Teitz	Clinical Chemistry.	W.B. Saunders Company Harcourt (India) Private Limited New Delhi	2012
4	U. Satyanarayan	Biochemistry	Books and Allied (P) Ltd. Kolkata-India	2017

WEB LINK:

1. https://chemistrynotesinfo.com/basic-laboratory-principles-and-procedure/
2. http://teachertech.rice.edu/Participants/louviere/vms/science/labequipment.html
3. http://www.biotechnologynotes.com/laboratory/preparation-of-buffers-and-solutions-laboratory-biotechnology-2/1120

ELECTIVE COURSE- IV
RECOMBINANT DNA TECHNOLOGY

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3EC4A	**Recombinant DNA Technology**	**Elective**	**75**	**-**	**5**	**5**

Preamble: To acquaint the students to the versatile tools and techniques employed in recombinant DNA technology. The student will achieve a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in basic and applied fields of life science researches.

Course Outcome:

COs	CO Statement	Knowledge level
CO1	Understand the steps in recombinant DNA/RNA modifying enzymes	K2
CO2	Infer the features of various types of gene cloning vectors	K4
CO3	Analyze the gene cloning strategies in recombinant DNA	K4
CO4	Explain the techniques involved in genetic engineering	K5
CO5	Discuss the problem solving aspect of recombinant technology	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**M**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**S**	**S**	**S**

S-Strong; M-Medium; L-Low

UNIT I: (15 Hours)

Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases – DNA polymerases - Ligases – Gene transfer techniques: electroporation, microinjection, protoplast fusion and microparticle bombardment – Screening for recombinants: Direct: Insertional inactivation, plaque phenotype and indirect methods:

Immunochemical detection, nucleic acid hybridization, Dot and Colony Blotting. Methods of DNA cloning. Construction and applications of Genomic DNA and cDNA libraries.

UNIT II: (15 Hours)

Cloning Vectors – properties - types of vectors – plasmids – host range and incompatibility – plasmids vectors for cloning in *E. coli* (pBR322 and derivatives, pUC vectors and pGEM3Z) - Vectors constructed based on bacteriophages (M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – animal and plant vectors – expression vectors: *E. coli lac* and T7 phage promoter based vectors - shuttle vectors - Expression of foreign genes in bacteria, animal, plant, algae and fungi – merits and demerits.

UNIT III:(15 Hours)

Gene cloning: Steps - Isolation and purification of nucleic acids (genomic DNA, RNA and Plasmids) – Methods of handling and quantification of DNA and RNA. Linkers, adapters, insertional inactivation, directional cloning, homopolymer tailing. Analyses of DNA/ RNA and proteins: Agarose Gel and SDS – PAGE - Blotting – types of blotting – Southern, Northern and Western Blotting. Methods of gene transfer techniques in plants and animals (Agrobacterium mediated, electroporation and particle gun, liposome, PEG).

UNIT IV: (15 Hours)

Characterization of cloned DNA: Polymerase chain reaction (PCR) – Principles, types and their applications. Restriction mapping - restriction fragment length polymorphism (RFLP) - DNA sequencing: Primer walking, Chemical method: Maxam and Gilbert method, Sanger's method: traditional (dideoxy) and automated sequencing methods. Pyrosequencing – DNA chips and microarray, Ligation based sequencing (SOLiD sequencing), Ion semiconductor sequencing, Chromosome walking.

UNIT V: (15 Hours)

Microbial biotechnology: Genetic manipulation, Engineering microbes for the production of antibiotics and enzymes, Engineering microbes for the production of insulin, growth hormones, monoclonal antibodies, Engineering microbes for clearing oil spills. Gene therapy methods, Gene target0069ng and silencing, Gene therapy in the treatment of inherited disorders and infectious diseases, Challenges and future of gene therapy

Text Books

S. No	Author	Title	Publisher	Year
1	Primrose S.B., Twyman RM..	Principles of Gene Manipulation and Genomics, 7th Edition:	Blackwell Science	2006
2	Howe, C. J.	Gene Cloning and Manipulation	Cambridge University Press	2007
3	Primrose S. B., & Twyman, R..	Principles of Gene Manipulation and Genomics:	Wiley. com	2009

4	Monika Jain	Recombinant DNA Technology: A Textbook	Narosa	2011
5	Chaudhuri, Keya	Recombinant DNA Technology	TERI, New Dehli	2013

Reference Books

S. No	Author	Title	Publisher	Year
1	Brown, T. John	Gene Cloning and DNA Analysis: An Introduction	Wiley & Sons	2010.
2	Bernard R. Glick and Jack J. Pasternak, Cheryl L. Patten	Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th ed.	ASM Press	2010
3	Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick.	Lewin's genes X. 1Oth ed		2011
4	Brown TA	Genomes, 2nd Ed.	John Wiley and sons	2012
5	Snyder, L., Peters, J. E., Henkin, T.M., and Champness, W	Molecular Genetics of Bacteria, 4th ed	American Society of Microbiology	2013

WEB LINK:

1. https://books.google.co.in › books
2. http://nptel.ac.in/courses/102103013/
3. http://www.lsic.ucla.edu/ls3/tutorials/gene_cloning.htm

PEDAGOGY

Power point presentation, Group Discussion, Seminar, Quiz, Assignment, Brain Stroming Activity.

ELECTIVE COURSE- IV

MICROBES IN SOLID WASTE MANAGEMENT

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3EC4B	**Microbes in Solid waste Management**	**Elective**	**75**	**-**	**5**	**5**

Preamble: The student will acquire a sound knowledge on solid waste management system allows them to innovatively apply their knowledge to control the pollution effectively and allow them to initiate new technique for solid waste handling and enhance their interest in the new avenue in biological researches.

Course Outcome:

On the successful completion of the course, students will be able to

COs	CO Statement	Knowledge level
CO1	Understand the Types of Wastes	K2
CO2	Analyze the methods of different waste collection	K4
CO3	Classify the nuclear wastes	K4
CO4	Explain the techniques involved in biomedical wastes management	K5
CO5	Discuss the problem solving of hazardous wastes	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**M**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**S**	**S**	**S**

S-Strong; M-Medium; L-Low

Unit I:(15 Hours)

Definition - Sources and types of solid waste- composition and its determinants of Solid waste-factors influencing generation-quantity assessment of solid wastes-methods of sampling and characterization.

Unit II:(15 Hours)

Collection: Collection of Solid waste – collection services and equipment, factors affecting collection. Transfer: types – Transport means and methods, selection of location, types & design requirements, operāt̄ion & maintenance.

Unit III:(15 Hours)

Characteristics – Types – Nuclear waste – Uranium mining and processing – Power reactors – Refinery and fuel fabrication wastes – spent fuel– Management of nuclear wastes –

Decommissioning of Nuclear power reactors– Health and environmental effects.

Unit IV:(15 Hours)

Biomedical wastes – Types – Management and handling – control of biomedical wastes Chemical wastes – Sources – Domestic and Industrial - Inorganic pollutants – Environmental effects – Need for control – Treatment and disposal techniques –Physical, chemical and biological processes – Health and environmental effects.

Unit V:(15 Hours)

Recovery of Resources, conversion products and energy recovery – recoverable materials – processing and recovery systems – incineration and Land fill method. Identifying a hazardous waste – methods – Quantities of hazardous waste generated – Components of a hazardous waste management plan – Hazardous waste minimization – Disposal practices in Indian Industries – Future challenges.

Text Books

S.No	Author	Title	Publisher	Year
1.	Maulin P Shah, Gaurav Saxena and Vineet Kumar	Bioremediation for Environmental Sustainability	Elsevier Science	2020
2.	Tobias Richards and Mohammad J Taherzadeh	Resource Recovery to Approach Zero Municipal Waste	CRC Press	2018
3.	Kumar S	Integrated Waste Management Volume II	Intech Publishers	2016
4.	AmmaiyappanSelvam, Rao Y Surampalli, R D Tyagi and Jonathan W Wong	Sustainable Solid Waste Management	American Society of Civil Engineers	2016
5.	M N V Prasad	Bioremediation and Bioeconomy	Elsevier Science	2015

Reference Books

S.No	Authors Name	Title of the Books	Publishers Name	Year
1.	Devin J Sapsford, Lynne E Macaskie and Will M Mayes	Resource recovery from wastes towards a circular economy	Royal Society of Chemistry	2019
2.	Ashok Pandey, Jonathan Wong, Kim Bolton and Mohammad Taherzadeh	Sustainable resource recovery and zero waste approaches	Elsevier Science	2019

3.	Abhilash, HossainMd Anawar and Vladimir Strezov	Sustainable and economic waste management resource recovery technique	CRC Press	2019
4.	Charles R Rhyner, Leander J Schwartz, Robert B Wenger and Mary G Kohrell	Waste management and resource recovery	All India Publishers and Distributors	2017
5.	By Zhao Youcai and Lou Ziyang	Pollution Control and Resource Recovery Municipal Solid Wastes at Landfill	Elsevier Science	2016

WEBLINKS

1. https://en.wikipedia.org/wiki/Waste_management
2. http://www.houstontx.gov/solidwaste/
3. https://www.unc.edu/courses/2009spring/.../SolidWasteIndiaReview2008.pdf
4. https://www.cyen.org/innovaeditor/assets/Solid%20waste%20management.pdf
5. http://www.ilo.org/oshenc/part-vii/environmental-pollution-control/item/514-%20solidwaste-management-and-recycling

PEDAGOGY

Power point presentation, Group Discussion, Seminar, Quiz, Assignment, Brain Stroming Activity

ELECTIVE COURSE- IV
MICROBIAL NANOTECHNOLOGY

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3EC4C	**Microbial Nanotechnology**	**Elective**	**75**	**-**	**5**	**5**

Preamble: The most important objectives that are frequently found in nanobiology involve applying nanotools to relevant medical/ biological problems and refining these applications. Microbes are playing an important role in the synthesis of nanoparticles. This syllabus would enlighten the students to understand basic concepts and application of nanotechnology.

Course Outcome:

C COs	CO Statement	Knowledge level
CO1	Define the basics of bionanotechnology	K1
CO2	Acquire the knowledge about microbial nanotechnology	K1
CO3	Critique knowledge about characterization of nanoparticles	K4
CO4	Explain the application of nanoparticles	K5
CO5	Expand about merits and demerits of nanoparticles	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**M**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**M**	**L**	**M**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**M**	**M**	**M**

S- Strong; M-Medium; L-Low

Unit I: (15 Hours)

Introduction to bionanotechnology - Milestones in History – bionanotechnology – concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, bionanotechnology, nanobiomaterials, biocompatibility, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles, nanosensors. Biotechnology to bionanotechnology, natural bionanomachines.Current status of bionanotechnology.

Unit II: (15 Hours)

Microbial nanotechnology –Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology. Preparation of nanobiomaterials – Polymeric scaffolds collagen, Elastins: Mucopolysaccharides, proteoglycans, cellulose and derivates; Dextrans; Alginates; Pectins; Chitin.

Unit III: (15 Hours)

Types of nanoparticles and methods of characterization - Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization of nanoparticles – UV-Vis spectroscopy, particle size analyzer, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD.

Unit IV: (15 Hours)

Applications of bionanotechnology - Drug and gene delivery – protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays. Nanomedicines, Antibacterial activities of nanoparticles. Nanotechnology in agriculture. Toxicology in nanoparticles – Dosimetry. Nanotherapy for cancer treatment – Interior artery expansions – Replacing joints with better stuff. - Radioactive tuberene cages in Nuclear medicine.

Unit V: (15 Hours)

Merits and demerits of nanoparticles – drug targeting, protein detection, MRI, development of green chemistry – commercial viability of nanoparticles. Cleaning the air with Nanotechnology – Nanotechnology for water treatment. Microbial nanoparticles. Nanocarbon ball as deodorizer in ferment process. Biomotors for engineered devices. Possible harm from Nanomaterials. Nanoscience in India – Nanoscience education abroad – Looking at ethics and society. Disadvantages – pollution and health risks associated with nanoparticles.

Text Books

S.No	Authors	Title	Publishers	Year
1	Parthasarathy, B.K	Introduction to Nanotechnology	Isha Publication	2007
2.	Elisabeth Papazoglou and Aravind Parthasarathy.	Bionanotechnology	Morgan& Claypool Publishers	2007
3.	. T. Pradeep	NANO: The Essentials: Understanding Nanoscience and Nanotechnology	McGraw Hill Education Publisher	2017
4.	Risal Singh Shipra Mital Gupta	Introduction to Nanotechnology	Oxford University Press.	2018
5.	.Chattopadhyay K.K..	Introduction to Nanoscience and Nanotechnology	Prentice Hall India Learning Private Limited.	2019

Reference Books

S.No	Authors	Title	Publishers	Year
1.	Joseph M. Irudayaraj	Biomedical Nanosensors, 1 edition	Publisher: Jenny Stanford Publishing	2012
2.	Shubra Singh M.S. Ramachandra Rao.	Nanoscience and Nanotechnology: Fundamentals of Frontiers	Wiley	2013 .
3.	Chattopadhyay K.K	Introduction to Nanoscience and Nanotechnology	Prentice Hall India Learning Private Limited	2019.
4.	.M. A. Shah and K. A. Shah.	Nanotechnology	Wiley; Second edition.	2019 .
5.	. N. Sriraam..	Biomedical and Clinical Engineering for Healthcare Advancement, 1 edition	Business Science Reference	2019

WEB LINKS:

1. https://www.ncbi.nlm.nih.gov/pubmed/17947022
2. https://www.springeropen.com/p/nano
3. https://www.worldscientific.com/worldscibooks/10.1142/7364
4. http://www.imedpub.com/journal-nanoscience-nanotechnology-research/
   https://benthamscience.com/journals/nanoscience-and-nanotechnology-asia/

PEDAGOGY

Power point presentations, Group Discussion, Seminar, Quiz, Assignment, Brain Storming activity.

CORE PRACTICALS - III
INDUSTRIAL MICROBIOLOGY AND CLINICAL MICROBIOLOGY PRACTICAL

Semester III	Internal Marks: 40	External Marks: 60				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB3CC3P	**Industrial Microbiology and Clinical Microbiology Practicals**	**Core Practical**	**60**	**8**	**-**	**5**

Preamble: The main objective of this course is to understand the basic skills applied in Fermentation Biology and build a foundation for more advanced studies in Industrial Microbiology and also to study the Clinical Specimens and their diagnostic methods.

Course Outcome:

On the successful completion of the course, students will be able to

CO Number	CO Statement	nowledge level
CO1	ganized view of Industrially important Microbes and their growth nature	K3
CO2	Critique knowledge about Production and Estimation of Microbial Products	K4
CO3	lculate the Microbial Product recovery	K6
CO4	Explain the techniques involved in Clinical Specimen collection	K5
CO5	Discuss the Isolation and Identification of Pathogens from Clinical specimens	K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**M**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**M**	**L**	**M**
CO4	**S**	**M**	**S**	**S**	**S**
CO5	**S**	**M**	**S**	**S**	**S**

S- Strong; M-Medium; L-Low

I.INDUSTRIAL MICROBIOLOGY (30 Hours)

1. Isolation of Industrially Important Microorganisms from Natural Resources
2. Calculation of Bacterial Growth Curve
3. Calculation of Thermal Death Point and Thermal Death Time of a Microbial Sample
4. Protoplasmic Fusion – PEG Method

Organic acids

5. Production and Estimation of Acetic acid
6. Production and Estimation of Citric acid

Fermentation

7. Production and Analysis of Ethanol – Submerged Fermentation
8. Wine Production
9. Estimation of Sugar, Acid and Alcohol in Wine.

Enzymes and Vitamins

10. Production and Analysis of Amylase and Protease
11. Immobilization of Enzymes and Yeast Cells using Sodium Alginate
12. Biosynthesis of Vitamin B12 using Microorganism.

Product Recovery

13. Compound Separation using Column Chromatography - Demonstration
14. Amino acid Separation by Paper Chromatography
15. Compound Separation using Thin Layer Chromatography

II. CLINICAL MICROBIOLOGY (30 Hours)

1. Collection, Coding and Transport of Clinical Specimens for Microbiological Examinations
2. Isolation and Identification of Upper Respiratory Tract Bacterial Pathogen – *Streptococcus pyogenes.*
3. Isolation and Identification of Lower Respiratory Tract Bacterial Pathogen – *Pseudomonas aeuroginosa* .
4. Isolation and Identification of Gastrointestinal Bacterial Pathogens –*Salmonellaspp*, *Shigella spp* and *Vibrio spp.*
5. Isolation and Identification of Urinary Tract Pathogens – *E. coli* and *Klebsiella pnemoniae*
6. Isolation and Identification of Bacterial Pathogen Causing Enteric Fever – *Salmonella typhi*, S. *paratyphi* A and B
7. Antibiotic Susceptibility test – Disc Diffusion Method (Kirby –Bauer)
8. Determination of MIC of any one Antibiotic against any one Bacterial Species. Examination of Blood Smears for *Plasmodium spp*.
9. Examination of Faeces for Parasites

Reference Books:

S.No.	Author	Title	Publisher	Year
1	Mackie and McCartney (2006).,.	Practical Medical Microbiology, 14th edition	South Asia Edition	2006
2	Stanbury PF, Whitaker A and Hall SJ.	Principles of Fermentation Technology. 2 nd edition	Elsevier Science Ltd	2006
3	Betty A Forbes, Daniel F Sahm and Alice S Weiss feld	Bailey and Scott's Diagnostic Microbiology, 12th edition	Mosby Elsevier.	2007
4	Patel AH	Industrial Microbiology	Laxmi Publication	2011
5	Rajan S	Manual for Medical Laboratory Technology	Anajanaa Book House, Chennai	2012
6	Casida LE	Industrial Microbiology	New Age International Private Limited	2019
7	Stanbury P.F.A. Whitaker and S.J. Hall	Principles of fermentation techniques	Elsevier	2017
8	Crueger W and Crueger A	Biotechnology: A Text Book of Industrial Microbiology	Medtech	2017

CORE COURSE – IX (CC)
MICROBIAL BIOTECHNOLOGY

Semester III	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB4CC9	**Microbial Biotechnology**	**Core**	**75**	**-**	**5**	**5**

Preamble: To impart and explain the students with the advanced knowledge on the screening of biotechnologically important microbes by genetic engineering methods and its applications in industry.

Course Outcome

COs	CO Statement	Knowledge level
CO1	Understand the primary and secondary screening of microbes.	K4
CO2	Determine the applications of microbes	K4
CO3	Explain about biocontrol agents and its mode of action	K6
CO4	Elaborate the industrial production and preservation techniques	K6
CO5	Expand about functions of IPR& Biosafety	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**L**	**M**	**L**	**S**	**S**
CO2	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**M**	**M**	**M**

S- Strong; M-Medium; L-Low

Unit I: (15 Hours)

History and Concepts of Biotechnology, Primary and secondary metabolites, Genetic engineering of microbes to improve production of enzymes, antibiotics, amino acids, lipids, steroids, organic acid, toxins etc. Introduction to the use of microbes in environmental applications, Bioremediation, Biofertilizers, Bioaugemntation, Bioemulsifiers, Biosurfactants, Leaching of ores, Biopolymers and Bioplastics.

Unit II: (15 Hours)

Application of Microbes in Biotechnology: Entomo pathogenic microbes- *Beauveria bassiana Metarhizium anisopliae*, paecilomyces sp, *Bacillus thuringiensis* - Application and Mode of action. Biocontrol agents- *Trichoderma viride*, *Pseudomonas fluorescens*. Microbial pesticides; Application of plant biotechnology in crop protection, herbicide tolerant and insect resistant transgenic plants.

Unit III: (17 Hours)

History and Importance of Biocontrol agents-parasites, predators, probiotics and insect pathogens. Ecological, biological, taxonomic, legal, ethical and economic aspects of biological control. Principles and procedures of using exotic biocontrol agents. Utilization of natural biocontrol agents: conservation, habitat management and augmentation. Mass multiplication techniques and economics. Effective evaluation techniques, Biocontrol organizations in World and India. Successful cases of biological control of pests.

Unit IV: (13 Hours)

Industrial production: Fermenter designs and types. Control of fermentation process - batch, feed batch and continuous. Upstream and downstream processing in fermentation industry. Production of single cell proteins and hormones. Phyco remediation. Microbiology of raw and processed foods. Fermented food – Vinegar, Wine sauerkraut, Pickles, Cheese, and Yogurt, Ethanol, Citric acid, Amino acids, Vitamins, Antibiotics. Food preservation, contamination and spoilage, food-borne illness and intoxication.

Unit V: (15 Hours)

IPR, Biosafety & Bioethics: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS. Bio safety- concept and issues, rational vs subjective, perceptions of risk and benefits of biosafety. Bioethics: Concepts; Philosophical considerations; Bioweapons; Emerging issues: Challenges to Public Policy – To Regulate or not to regulate; improving public understanding of biotechnology products to correct misconceptions and Biodiversity act.

Text Books

S.No	Author	Title	Publisher	Year
1.	Prakash Kumar Sarangi & Sonil Nanda	Biotechnology for Sustainable Energy and Products	I.K. International Publishing House Pvt. Ltd	2019

2.	Rup Lal	An Introduction to Biotechnology	I.K. International Publishing House Pvt. Ltd	2016
3.	Dr. Rita Singh and Dr. S.K. Ghosh	Industrial Biotechnology	Gvph-Publishers	2016
4.	S. C. Bhatia	Textbook of Biotechnology	Atlantic Publishers	2015
5.	R C Dubey	Textbook of Biotechnology	S.Chand Publishing,	2015

Reference Books

S.No	Author	Title	Publisher	Year
1.	William J. Thieman , Michael A. Palladino .	Introduction to Biotechnology (What's New in Biology),	Pearson Publications	2018
2.	N. Dane Scott.	Food, Genetic Engineering and Philosophy of Technology	Hardcover, Springer;	2018
3.	Fernandes	Comprehensive Biotechnology,	M. Moo Young, Pergamon Press, UK	2016
4.	Mahendra K Rai	Hand book microbial biofertilizers	The Haworth press, Inc. New York.	2015
5.	Ashim K. Chakravarty.	Introduction to Biotechnology	4Oxford University Press	2015

Web References

1. https://blackopscool.blogspot.com/2018/10/download-industrial-biotechnology-pdf.html
2. https://www.researchgate.net/publication/311576484_Industrial_Biotechnology_An_Overview
3. https://onlinelibrary.wiley.com/doi/book/10.1002/9783527807833
4. https://stuvera.com/biotechnology-books-pdf/
5. https://content.kopykitab.com/eReader.html

Pedagogy

Power point presentation, Seminar, Assignment and Quiz.

CORE COURSE –X (CC)

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Semester IV	Internal Marks: 25	External Marks: 75				
Course code	**Course Title**	**Category**	**L**	**P**	**T**	**Credits**
19PMB4CC10	**Molecular Biology and Microbial Genetics**	**Core**	**75**	**-**	**5**	**5**

Preamble: To gain the basic knowledge on genetic material, nucleic acids, central dogma of molecular biology and DNA repair mechanisms. To develop an in-depth knowledge on gene expression and variations involved with the regulation of gene expression in prokaryotic system

Course Outcome:

COs	CO Statement	Knowledge level
CO1	Understand the basics of molecular biology	K2
CO2	Analyze central dogma of molecular biology	K4
CO3	Interpret nucleotide sequence change and repair mechanism	K4
CO4	Explain the significance of vectors and bacterial genetics	K5
CO5	Discuss gene expression and transposons	K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**M**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**S**	**S**	**S**

S-Strong; M-Medium; L-Low

Unit I: Chemical Composition & Replication of Nucleic acid (15 hours)

Discovery of DNA, Molecular basis of DNA as genetic material, Structure and forms of DNA, Properties of DNA (denaturation, renaturation, melting curve and hyperchromicity), Replication of DNA- semi conservative mode, Meselson - Stahl experiment. Enzymology of DNA replication, Molecular basis of DNA replication, Types of replication - circular and theta. Structure of RNA - replication -types of RNA: tRNA, mRNA, rRNA and siRNA. Introduction to PNA (Peptide Nucleic Acid).

Unit II: Transcription and Translation (15 hours)

Transcription - Initiation, Elongation and Termination; Transcriptional factors, Transcription in Eukaryotes, alternative splicing, mRNA transport and Post – transcriptional modifications. Translation - Basic features of genetic code, Wobble concept, prokaryotic and eukaryotic ribosomes, RNA polymerase types and decoding system. Protein synthesis - initiation, elongation and termination, inhibitors of protein synthesis.Post-translational modification of proteins, Translational control.

Unit-III: Mutation, DNA Damage & Repair Mechanism (15 hours)

Mutation & its types, Mutagens: Types, Physical mutagens, DNA reactive chemicals, base analogs, intercalating agents, metals and biological agents. DNA damages: Deamination, methylation, alkylation, UV damage, DNA repair pathways: mismatch repair, Nucleotide and Base excision repair, recombinational repair, SOS inducible repair, pyrimidine dimers and alkylation induced damage.

Unit IV: Plasmids and Bacterial Genetics (15 hours)

Plasmids - properties, types and replication. Gene transfer mechanisms- Bacterial transformation (detection of transformation, development of competence, mechanism of transformation, transfection); conjugation-effective contact and pilli in conjugation, F-factor, the conjugal transfer process; high frequency recombination (Hfr) strains; formation of F prime (F’); transduction – generalized transduction; abortive transduction; specialized transduction. Sex duction.

Unit V: Regulation of Gene Expression and Transposable Elements (15 hours)

Operon systems: Lactose operon - induction & repression; Tryptophan operon - repression & attenuation; Arabinose operon. Transposons: Structure, genetic organization and mechanism of transposition of transposable elements (Tn5, Tn3, Bacteriophage μ), Sleeping beauty transposon system. Retrotransposons, Conjugative and Mobilizable transposons. Assays of transposition. Importance of transposable elements in horizontal transfer of genes and evolution.

Text Books

S.No	Author	Title	Publisher	Year
1.	Krishnaiah G.R.	Microbial Genetics & Molecular Biology (1st edition)	Blue Rose Publisher	2019
2.	Verma P. S. and Agarwal A. K.	Cell Biology, Genetics, Molecular Biology, Evolution and Ecology	S. Chand Publishing	2018
3.	Primrose S.B. and Twyman R.M	Principles of Gene Manipulation and Genomics (8th edition)	Wiley-Blackwell Publisher	2016
4.	Gerald Karp, Janet Iwasa, Wallace Marshall	Karp's Cell and Molecular Biology: Concept and Experiments (8th edition)	Wiley Publisher	2015
5.	David Freifelder, John E. Cronan and Stanley R Maloy	Microbial Genetics (2nd edition)	Jones & Bartlett Publishers	2014

Reference Books

S.No	Author	Title	Publisher	Year
1.	Hartl, Daniel L.	Genetics: Analysis of genes and genomes. (9th Edition)	Jones & Bartlett Learning	2019
2.	Peter Snustad D and Michael J. Simmons	Principles of Genetics (7^{th} Edition)	Wiley	2015
3.	Bruce Alberts, Alexander D. Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter	Molecular Biology of the Cell (6^{th} Edition)	Garland Science, W. W. Norton &Company	2014
4.	Krebs J. E., Kilpatrick T. and Goldstein E. S.	Lewins Genes IX	Viva Books Pvt Ltd.	2014
5.	Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness	Molecular Genetics of Bacteria (4th Edition)	ASM Press	2014

Web links

1.https://books.google.co.in › books

2. http://www.freebookcentre.net/Biology/Molecular-Biology-Books.html

3.http://www.freebookcentre.net/medical_text_books_journals/genetics_ebooks_online_texts_download.html

4. https://www.nature.com/scitable/ebooks/

5. http://www.digitalbookindex.org/_search/search010biolmolecularcellbiologya.asp

Pedagogy

Power point presentations, Group Discussion, Seminar, Quiz, Assignment, Brain Storming activity

ELECTIVE COURSE- V(EC)

(A) BIOINFORMATICS AND BIOSTATISTICS

Semester IV	Internal Marks: 25	ExternalMarks:75				
Course code	**Course Title**	**category**	**L**	**P**	**T**	**credit**
19PMB4EC5A	**Bioinformatics and Biostatistics**	**Elective**	**75**	**-**	**5**	**4**

Preamble: The important objective of this course is to enable the students to understand scope and popular databases of bioinformatics and methods of biostatistics. This syllabus gives a broad account of sequence alignment and approaches to drug discovery using bioinformatics techniques.

Course Outcome

COs	CO Statement	Knowledge level
CO1	Understand scope and popular databases of bioinformatics	K4
CO2	Explain sequence alignment methods	K5
CO3	Explain drug development using bioinformatics	K5
CO4	Compute the measures of central tendency	K4
CO5	Examine the various large sample testing of hypothesis	K4

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**M**	**M**
CO2	**S**	**M**	**S**	**M**	**M**
CO3	**S**	**S**	**S**	**M**	**M**
CO4	**S**	**S**	**S**	**M**	**M**
CO5	**S**	**S**	**S**	**S**	**S**

S- Strong; M-Medium; L-Low

Unit I: (**16 Hours)**

Important contributions - aims and tasks of bioinformatics - applications of bioinformatics - challenges and opportunities . Computer - types , servers and operating system, internet basics - HTML. Biological databases- primary , composite and secondary - Nucleic acid database, Protein database sequence. Structure databases, bibliographic databases - specialized genomic resources.

Unit II : (**14 hours)**

Sequence analysis of biological data - significance and Types of sequence alignment - pairwise alignments (FASTA & BLAST) - Models - Global, Local, End space free alignment and gap penalty. Multiple sequence alignment - methods, ClustalW.

Unit III :**13 hours**

Bioinformatics in drug development: Discovering a drug - target identification and validation- identifying the lead compound - optimization of lead compound - chemical libraries. Cheminformatics and pharmaco informatics. NGS.

Unit IV :16 hours

Measures of central tendency- Mean, Median and Mode- Standard Deviation- Correlation Analysis- Regression Analysis.

Unit V:16 hours

Hypothesis Testing and Large sample tests- Population and sample- Estimation Theory- Testing of hypothesis- Test of significance of mean- Test of significance of difference between two means- Test of significance for difference between of two standard deviations- Test of significance for single proportion- Test of significance of difference between two sample for large samples- ANOVA one way classification and two-way classification.

Text books

S.No	Author	Title	Publisher	Year
1.	R. Amjesh and S.S. Vinochandra	Bioinformatics for Beginners	Lamber Academic Publishing	2019
2.	C.S.V. Murthy	Bioinformatics	Himalaya Publishing House	2016
3.	Keith and M.Jonathan	Bioinformatics (Volume I) - Data,	Springer	2017

		sequence analysis and evolution		
4.	P.N. Arora& P.K. Malhan	Biostatistics	Himalaya Publishing House	2012
5.	K. Subramanian & A. Santha	Statistics for Management	Scitech publications	2012

Reference books

S.No	Author	Title	Publisher	Year
1.	K.G. Srinivasa, G.M. Siddesh and S.R. Manisekhar	Statistical Modelling and machine leaning principles for bioinformatics techniques, tools and applications (Algorithms for intelligent systems)	Springer publications	2020
2.	Noor Ahmad Shaik	Essentials of bioinformatics In silico life sciences medicine	Kindle Edition	2019
3.	William T. Loging	Bioinformatics and computational biology in drug discovery and	Cambrindge University press	2016
4.	R.S.N. Pillai&V.Bagavathi	Statistics Theory and Practice	S.Chand	2016
5.	Bernard Rosner	Fundamentals of Biostatistics	Lengage learning	2006

Web links

1. https://en.wikipedia.org/wiki/Sequence_alignment
2. https://www.technologynetworks.com/drug-discovery/articles/target-identification-validation-in-drug-discovery-312290
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3058157
4. https://en.wikipedia.org/wiki/Sequence_database
5. https://saylordotorg.github.io/text_introductory-statistics/s12-02-large-sample-tests-for-a-

popul.html
6. https://www.analyticsvidhya.com/blog/2017/03/conditional-probability-bayes-theorem/

Pedagogy

Power point presentation, Seminar, Assignment and Quiz

ELECTIVE COURSE- V (EC)
(B) ENTREPRENEURIAL MICROBIOLOGY

Semester IV	Internal Marks: 25	ExternalMarks:75				
Course code	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**
19PMB4EC5B	**Entrepreneurial Microbiology**	**Elective**	**75**	**5**	**-**	**4**

Preamble: Understanding important concepts of entrepreneurship & basic requirements for establishing a bio-based startup and company.

Course Outcome

COs	CO Statement	Knowledge level
CO1	Outline study of Entrepreneurial Microbiology	K1
CO2	Explain the composting process & biofertilizer production	K2
CO3	Prepare and formulate microbial metabolites	K2
CO4	Compile on types of fermented foods	K3
CO5	Relate on various mushroom production	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**M**	**S**	**S**
CO3	**S**	**M**	**S**	**M**	**S**
CO4	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

Unit I: (15 Hours)

Entrepreneur development activity, Institutes involved, Government contributions to entrepreurs & risk assessment. Structure & start-up of a Bio-based technology Company. New Product Development. Intellectual Property Principles in microbial technologies. Understanding of Government policies: Ethical and Other Legal Issues in microbial products.

Unit II: (15 Hours)

Composting, Vermicompost & biogas production. Steps in mass production of bacterial biofertilizers *Rhizobium, Azotobacter, Azospirillum*– quality guidelines for biofertilizers. Mass production of blue green algae (SCP-Health benefits) and micro algae for fuels. Industrial products from micro algae & seaweed.

Unit III: (15 Hours)

Microbial Metabolites: Primary and secondary metabolites, Production of citric acid, acetic acid, amino acids and vitamins by microbial cultures using sucrose and molasses; Production of extracellular enzymes; Ethanol production using immobilized yeast culture. Production of antibiotics and pigments from microbes.

Unit IV: (15 Hours)

Fermented beverages- production of different types of wine and beer; Fermented foods of vegetables and fruits- sauerkraut, pickles, Kimchi; Cereal and legume based fermented products bread, Soya Sauce, Koji, Tempeh, Miso, Natto, Tofu; Fermented Dairy Products Buttermilk; Yogurt (probiotics, prebiotics, synbiotics); Acidophilus Milk; Bifidus Milk, Bulgarian milk; Kefir; Kumiss; Cheeses.

Unit V: (15 Hours)

Mushroom cultivation – Preparation of mother spawn, bed spawn. Preparation of bed- *Agaricus* sps, *Calocybe* sps, *Pleurotus* sps, *Volvariella* sps. Maintenance of mushroom shed, post harvesting technology-long term & short term storage. Mushroom recipes- soups, biryani, powder, pakoda. Marketing strategies.

Text Books:

S. No	Author	Title	Publisher	Year
1.	Charles Bamford	Entrepreneurship	McGraw Hill	2019
2.	William C Frazier, Dennis C Westhoff	Food Microbiology	McGraw Hill	2018
3.	Dr. Awani kr. Singh	Handbook of Microbial Bertilizers	Agrotech press	2018
4.	Madigan M.T, Bender K.S, Buckley D.H, Sattley W.M. and Stahl D.A.	Brock Biology of Microorganisms	Pearson Education	2017
5.	Ram Prasad	Environmental Microbiology	I K International Publishing house, Delhi	2016

Reference Books:

S. No	Author	Title	Publisher	Year
1.	James M. Jay, Martin J. Loessner, David A. Golden	Modern Food Microbiology	Springer	2020
2.	Amita Jain	Essentials of Microbiology	Elsevier	2019
3.	Vinita Katiyar & Anubha Joshi	Microbial Research- An Overview	I K International Publishing house, Delhi	2018
4.	Ananthanarayan& Paniker	Textbok of microbiology	Orient Blackswan	2018
5.	Dr. CD Thapa, Dr. V. Prakasam, Sh. Mohinder Singh	Mushroom culture	ICAR	2016

WEB LINKS

1. https://www.ikbooks.com/subject/life-sciences/microbiology/145
2. https://www.ikbooks.com/books/book/earth-environmental-sciences/environmental-microbiology/9789384588526/
3. https://www.ikbooks.com/books/book/life-sciences/agriculture/potential-microorganisms-sustainable-agriculture/9788190746205/
4. https://www.amazon.in/Food-Microbiology-William-C-Frazier/dp/1259062511
5. https://www.agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/
6. https://www.researchgate.net/publication/41584156_Brock_Biology_of_Microorganisms_11th_edn_Michael_T_Madigan_John_M_Martinko_eds
7. https://www.elsevier.com/books/essentials-of-microbiology-for-nurses-1st-edition/kannan/978-81-312-4454-8
8. https://www.amazon.in/Management-Entrepreneurship-N-V-R-Naidu/dp/8190675788

PEDAGOGY

Power point presentations, Group Discussion, Seminar, Quiz, Assignments.

ELECTIVE COURSE- V (EC)
(C) MOLECULAR TAXONOMY AND PHYLOGENY

Semester IV	Internal Marks: 25	ExternalMarks:75				
Subject code	**Course Title**	**Category**	**L**	**P**	**T**	**Credit**
19PMB4EC5C	**Molecular taxonomy and Phylogeny**	**Elective**	**75**	**-**	**5**	**4**

Preamble: This course focuses on a key component of systematics and the inference of phylogenesis that show how species or genes are related to one another. The students will get wide knowledge in the molecular taxonomy levels and phylogenetics.

Course Outcome:

Cos	CO Statement	Knowledge level
CO1	Determine the methods of taxonomy	K4
CO2	Critique the levels of structural organization	K4
CO3	Evaluate the taxa and phylogenetic concepts	K5
CO4	Generalize the gene regulations and genetic map	K6
CO5	Compile &analysephylogenetics	K6

Mapping with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**S**	**M**	**M**	**M**
CO2	**S**	**M**	**M**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**

Strong –S, Medium- M, Low-L

Unit I: (15 Hours)

Taxonomy - Principles and methods, Concepts of species and hierarchical taxa, biological nomenclature, classical and quantititative methods of taxonomy of plants, animals and microorganisms.

Unit II : (15 Hours)

Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy. Outline classification of plants, animals and microorganisms: Important criteria used for classification in each taxon.

Unit III: (15 Hours)

Traditional, typological, evolutionary, biological, phylogenetic concepts.Phylogenetic (among species) versus Tokogenetic (within species) relationships.Classical genetics, Mendelian genetics, population genetics. Recombination, heterozygosity, polymorphism.Hybridization. Lateral transfer. Phenetic analysis. Gene trees vs. species trees.

Unit IV: (15 Hours)

DNA finger printing- importance of 16s rRNA, 18s rRNA, ITS sequencing in mitochondrial DNA. DNA bar coding. PCR and its types, RFLP, RAPD, DGGC, TGGC, STRR, LTR, Automated DNA sequencing; Linkage and pedigree analysis; Construction of genetic maps; Scoring Matrix, Pair wise sequence alignments, Multiple sequence alignments.

Unit V: (15 Hours)

Phylogenetic analysis and evolutionary relationship among taxa. DNA-based phylogenetic trees- Phylogeny of various microbes- Bacteria, Archaea and Eukarya– Application of Taxonomy and Phylogeny, Conventional Classification of Taxonomy, Comparative genomics.

Text Books

S.No	Author	Title	Publisher	Year
1.	Joanne M Willey; Kathleen M Sandman; Dorothy H Wood	Prescott's microbiology	McGraw-Hill Education	2019
2.	Asheesh Shanker	Bioinformatics: Sequences, Structures, Phylogeny	Springer	2018
3.	Barnes Michael R.	Bioinformatics For Geneticists	Wiley India.	2018

4.	Paul M. Selzer, Richard J. Marhöfer, Oliver Koch.	Applied Bioinformatics: An Introduction.	Springer	2018
5.	Randall T. Schuh	Biological Systematics: Principles and Applications	Cornell University Press	2017

References Books

S.No	Author	Title	Publisher	Year
1.	Gerald Karp, Janet Iwasa, Wallace Marshall	Karp's Cell and Molecular Biology,	Wiley publishers	2020
2.	Zhipeng Cai, Pavel Skums, Min Li	Bioinformatics Research and Applications	Springer	2019
4.	Robert Brooker	Genetics: Analysis and Principles	McGraw-Hill Education	2017
5.	Austin Balfour	Principles of Plant and Animal Taxonomy	Syrawood Publishing House	2016

WEB LINKS

1. http://www.deduveinstitute.be/~opperd/private/phenetics.html

2.https://socratic.org/questions/what-is-molecular-taxonomy

3.http://bio1510.biology.gatech.edu/module-4-genes-and-genomes/4-7-gene-regulation/

4.https://www.ebi.ac.uk/training/online/course/introduction-phylogenetics/what-phylogenetics

5.http://www.scienceandculture-isna.org/20081213.htm

6.http://www.pmbio.icbm.de/lehre/ws1011/vlphys/vlphys-07.pdf

7. http://www1.biologie.uni-hamburg.de/bonline/library/micro229/terry/229sp00/lectures/taxonomy.html

PEDAGOGY

Power point presentation, Group Discussion, Seminar, Quiz, Assignment

CORE PRACTICALS- IV (CP)

MICROBIAL BIOTECHNOLOGY, MOLECULAR BIOLOGY& MICROBIAL GENETICS- PRACTICALS

Semester IV	Internal Marks: 40	ExternalMarks:60				
Course code	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**
19PMB4CC4P	**Microbial Biotechnology, Molecular Biology& Microbial Genetics- Practicals**	**Practical**	**60**	**-**	**8**	**4**

Preamble:

- To enable the Students to understand the Basic Knowledge in Microbial Biotechnology and Molecular Biology and Microbial genetics.
- To understand the production process Applications of Microbial products.
- To acquire a Skills about the various Techniques in Recombinant DNA Technology.
- To gain the brief Knowledge about Protein separation.

Course Outcome:

COs	CO Statement	Knowledge level
CO1	Predict the application of Immobilization	K3
CO2	Determine the Commercial production methods of Microbial Products	K4
CO3	Compare the genomic and plasmid DNA separation methods	K5
CO4	Expand the knowledge about PCR, Restriction digestion and ligation of DNA	K6
CO5	Critique knowledge about protein Separation method	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**M**	**S**	**S**	**S**
CO2	**S**	**M**	**S**	**S**	**M**
CO3	**S**	**S**	**M**	**S**	**S**
CO4	**S**	**S**	**S**	**M**	**M**
CO5	**S**	**M**	**S**	**S**	**S**

S- Strong; M-Medium; L-Low

Microbial Biotechnology: 20 Hours

1. Immobilization of whole Yeast cells/ Enzyme by suitable method and determination of stability of Immobilized Enzyme.
2. Production of Organic acids - Citric acid and Glutamic acid
3. Production of Extracellular Enzymes – Amylase and Protease
4. Separation of Bio compounds –Paper Chromatography and Column Chromatography
5. Ethanol Production using Immobilized and free living Yeast Culture

Molecular Biology & Microbial Genetics: 40 hours

1. Isolation of Antibiotic Resistant Microbes
2. Isolation of Mutants by Spontaneous Mutation – Gradient plate technique
3. Isolation of Auxotrophic and Antibiotic Resistant Mutants by Physical and Chemical Mutagens
4. Competent Cell Preparation and Bacterial Transformation
5. Generalized Transduction in *E.coli*
6. Isolation and Quantification of Genomic DNA and Plasmid DNA from *E.coli*
7. Characterization of Plasmid DNA by Agarose gel electrophoresis
8. Restriction Digestion and Ligation of DNA
9. Polymerase Chain Reaction
10. Random Amplified Polymorphic DNA
11. Restriction Fragment Length Polymorphism
12. Insilico method of RFLP and Secondary Structure Prediction of RNA
13. Separation of Protein by SDS PAGE
14. Transfer of Protein - Western blot

REFERENCE BOOKS

S. No	Author	Title	Publisher	Year
1.	Swagat Kumar Dash, HrudayanathThatoi , Supriya Dash	Practical Biotechnology: Principles and Protocols	Dreamtech Press	2020
2.	SiddraIjaz& Imran UlHaq	Recombinant DNA Technology	Cambridge Scholar UK	2019
3.	Gunasekaran, P	Laboratory Manual in Microbiology	New Age International Publishers,New Delhi	2018
4.	Dr.P V G K Sarma	Molecular Biology A Practical Manual	MJP Publishers	2017

5.	K.R. Aneja	Pathology and Biotechnology	New Age International Publishers	2017
6.	Michael L. Shuler, FikretKargi & Matthew DeLisa	Bioprocess Engineering: Basic Concepts	Prentice Hall,US	2017
7.	Brown TA	Gene cloning and DNA Analysis Introduction	Blackwell Science Ltd., London.	2016
8.	Old RW & Primrose SB	Principles of Gene Manipulation - An Introduction to Genetic Engineering	Blackwell Scientific Publications, London	2014
9.	Sambrook, J &Russel DW	Molecular Cloning : A Laboratory Manual	Cold Spring Harbor, N.Y. : Cold Spring Harbor Laboratory Press	2014
10.	Judith W. Zyskind &Sanford I. Bernstein	Recombinant DNA Laboratory Manual	Academic Press	2014

Web Links

1. https://www.youtube.com/watch?v=Vrs-KUNl3WU
2. https://www.youtube.com/watch?v=e4iV-dCCKAM
3. https://www.youtube.com/watch?v=CSDnJvTufDI
4. https://www.youtube.com/watch?v=Uq6jZZKocgs
5. https://www.youtube.com/watch?v=Tdb0N_PMpEI
6. https://www.youtube.com/watch?v=Hv6Z9HDhNKg
7. https://www.youtube.com/watch?v=n6MhidjYpww
8. https://www.youtube.com/watch?v=tcPgdR9_t64
9. https://www.youtube.com/watch?v=uKeMiAZ8Zu4

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.