ACHARYA NAGARJUNA UNIVERSITY

A State Government University, Accredited with "A" Grade by NAAC

Nagarjuna Nagar - 522 510, Guntur, Andhra Pradesh, India.

M.Sc. MICROBILOGY

SYLLABUS

2022 - 2023 onwards

UNIVERSITY COLLEGE OF SCIENCES

PROGRAM CODE:

ANUCS13


ACHARYA NAGARJUNA UNIVERSITY
సత్యం సర్వం ప్రతిష్ఠితమ్

ABOUT UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY (ANU)

- A Brief Profile

Acharya Nagarjuna University, a State University established in 1976, has been constantly striving towards achieving progress and expansion during its existence for over four decades, in terms of introducing new courses in the University Colleges, affiliated colleges and professional colleges. Spread over 300 acres of land on the National High Way (NH-16) between Vijayawada and Guntur of Andhra Pradesh, the University is one of the front ranking and fastest expanding Universities in the state of Andhra Pradesh. The University was inaugurated on 11th September, 1976 by the then President of India, Sri Fakruddin Ali Ahmed and celebrated its Silver Jubilee in 2001. The National Assessment and Accreditation Council (NAAC) awarded "A" grade to Acharya Nagarjuna University and also has achieved 108 International ranks, 39 National ranks UI Green Metrics rankings and many more It is named after Acharya Nagarjuna – one of the most brilliant preceptors and philosophers, whose depth of thought, clarity of perception and spiritual insight were such that even after centuries, he is a source of inspiration to a vast number of people in many countries. The University is fortunate to be situated on the very soil where he was born and lived, a soil made more sacred by the aspiration for light and a state of whole sameness by generations of students. With campus student strength of over 5000, the University offers instruction for higher learning in 68 UG & PG programs and guidance for the award of M.Phil. and Ph.D. in 48 disciplines spread over six campus colleges and one PG campus at Ongole. It also offers 160 UG programs in 440 affiliated colleges in the regions of Guntur and Prakasam Districts. It has a Centre for Distance Education offering 87 UG & PG programs. Characterized by its heterogeneous students and faculty hailing from different parts of the state and the country, the University provides most hospitable environment for pursuing Higher Learning and Research. Its aim is to remain connected academically at the forefront of all higher educational institutions. The University provides an excellent infrastructure and on- Campus facilities such as University Library with over one lakh books & 350 journals; Computer Centre; University Scientific Instrumentation Centre; Central Research Laboratory with Ultra-modern Equipment; Well-equipped Departmental Laboratories; Career Guidance and Placement Cell; Health Centre; Sports Facilities with Indoor & Outdoor Stadiums and Multipurpose Gym; Sports Hostel; Separate hostels for Boys, Girls, Research Scholars and International Students; Pariksha Bhavan (Examinations Building); Computers to all faculty members; Wi-Fi connectivity to all Departments and Hostels; Canteen, Student Centre & Fast-food Centre; Faculty Club; Dr. H.H. Deichmann & Dr. S.John David Auditorium cum Seminar Hall; Post office; Telecom Centre; State Bank of India; Andhra Bank; Energy Park; Silver Jubilee Park; Fish ponds; internet center; xerox center; cooperative stores; Water harvesting structures.

VISION, MISSION & OBJECTIVES OF THE UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY

VISION

To generate sources of knowledge that dispels ignorance and establishes truth through teaching, learning and research.

MISSION

To promote a bank of human talent in diversified faculties – Commerce & Management Studies, Education, Engineering & Technology, Humanities, Law, Natural Sciences, Pharmacy, Physical Education & Sports Sciences, Physical Sciences and Social Sciences that would become an investment for a prosperous society.

OBJECTIVES

- To inspire and encourage all who would seek knowledge through higher education and research.
- To provide quality instruction and research for the advancement of science and technology.
- To promote teaching and research studies in disciplines of societal relevance.
- To bridge the gap between theory and practice of the principles of higher education.
- To develop human talent necessary for the industry.
- To open up avenues of higher education and research through non-formal means.
- To invite and implement collaborations with other institutes of higher learning on a continuous basis for mutual academic progress.
- To motivate and orient each academic department/centre to strive for and to sustain advanced levels of teaching and research so that the university emerges as an ideal institute of higher learning.
- To focus specially on the studies involving rural economy, justifying its existence in the rural setting.

VISION

&

MISSION OF THE COLLEGE

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

VISION OF THE COLLEGE:

University College of Sciences envisages to be a good team of people with scientific temperament, research bent and a flair for Teaching & Learning for the betterment of the Community, Society, State and the Country at large.

MISSION OF THE COLLEGE:

The College intends to incubate and nurture the Leaders, Mentors, Educators and researchers who can transform the country and contribute to advances in science while addressing the challenges faced by the society for the betterment of human life.

VISION & MISSION OF THE DEPARTMENT

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF BOTANY & MICROBIOLOGY

M.Sc. MICROBIOLOGY

VISION OF THE DEPARTMENT:

To be a world-class hub for interdisciplinary education and research programs in microbial biotechnology to improve human health and the environment.

MISSION OF THE DEPARTMENT:

To promote high-impact education and innovative research in a diverse and inclusive environment, exploring fundamental questions in microbiology and translating discoveries into products of agriculture, antibiotic and anticancer.

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF BOTANY & MICROBIOLOGY

M.Sc. MICROBIOLOGY

PROGRAMME OUTCOMES (PO's):

On completion of two years M.Sc. Microbiology, students will be able to

PO1	Domain Knowledge: Demonstrate the knowledge of basic concepts, principles and applications of Microbiology and its applied fields**.**
PO2	Resource utilization: cultivate the laboratory skills to acquire and use appropriate learning resources including library e-learning resources, ICT tools to enhance knowledge base and stay abreast of recent developments
PO3	Analytical and Technical Skills: Ability to handle/use appropriate tools /techniques/equipment with an understanding of the standard operating procedures ,safety aspects /limitations
PO4	Critical thinking and problem solving; Identify and critically analyse pertinent problems in microbiology discipline using appropriate techniques as well as approaches to arrive at viable conclusions /solutions
PO5	Project management: Demonsrate knowledge and scientific understanding to identify research problems ,design experiments ,use appropriate methodologies ,analyse and intrepret data and provide solutions. Exhibit organizational skills and the ability o manage time and resources
PO6	Individual and Team work: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7	Effective communication: Communicate effectively in sproken and written form as well as through electronic media with the scientic community and society at large. Demonstrate the ability to write dessertations, reports make effective presentations and documentation
PO8	Environment and Society :analyse the impact of scientific and technological advances related to the environment and society
PO9	Ethics: Commitment to professional ethics and responsibilities
PO10	Life-long learning; Ability to engage in life-long learning in the context of the rapid developments in microbiology

PROGRAMME SPECIFIC OUTCOMES (PSO's):

At the end of the M. SC Microbiology Course, students will be able to

PSO1	Acquire basic microbiology laboratory skills and expertise in the use of instruments applicable to microbial and algal research, application of clinical methods and the analysis of observations.
PSO2	Understand Prokaryotic and eukaryotic genetic systems ; physiology and metabolism of microorganisms and application in agriculture and immunological research and ethical regulations and patenting rules
PSO3	Gain familiarity with the application of microbes for the synthesis of valuable products from microorganisms, gain basic knowledge in the application of bioinformatics tools to understand actions of microbial products in vetermary, pharmacy and microbial biotechnology research.
PSO4	Explore the application of knowledge of microbial biotechnology in the environment sustainability, Food and microbial industries.
PSO5	Demonstrate knowledge and scientific understanding to identify research problems ,design experiments, use appropriate methodologies, analyze and interpret data and provide solutions of contemporary microbiology research

Overall, the programme is reasoning and application oriented, equipping the student eligible for research and jobs in various sectors and entrepreneurship abilities

STRUCTURE

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF BOTANY & MICROBIOLOGY

M.Sc. MICROBIOLOGY

COURSE STRUCTURE

Course Code		L	P	S/M/P	C	CIA	ESE	Total
SEMESTER I								
MB1.1(22)	1.1 - Virology	4			4	30	70	100
MB1.2 (22)	1.2 – Microbial Biochemistry and Analytical Techniques	4			4	30	70	100
MB1.3(22) Compulsory Foundation –I	1.3 – Bacteriology	4			4	30	70	100
MB1.4 (22) Elective Foundation -I	1.4 (a) – Biology of Eukaryotic Microbes	4			4	30	70	100
	1.4 (b) – Marine Microbiology							
	1.4 (c) – Algal Biology							
MB PI (22)			**6**		4	30	70	100
MB PII (22)			**6**		4	30	70	100
SEMINARS				6				
SEMESTER II								
MB2.1(22)	2.1– Microbial Physiology and Metabolism	4			4	30	70	100
MB2.2 (22)	2.2 – Microbial Genetics and Molecular Biology	4			4	30	70	100
MB 2.3 (22) Compulsory Foundation –II	2.3 – Immunolgy	4			4	30	70	100
MB 2.4 (22) Elective Foundation -II	2.4 (a) – Agricultural Microbiology	4			4	30	70	100
	2.4 (b) – Clinical Microbiology							
	2.4 (c) – Bioethics and Intellectual Properties							
MB PI (22)	2.1 + 2.2		**6**		4	30	70	100
MB PII (22)	2.3 + 2.4		**6**		4	30	70	100
Skill Development Course				6				

SEMESTER III								
MB3.1(22)	3.1 – Medical Microbiology	4			4	30	70	100
MB3.2 (22)	3.3 – Recombinant DNA technology	4			4	30	70	100
MB3.3 (22) Elective-I	3.3 (a) – Cellular Microbiology and Bioinformatics	4			4	30	70	100
	3.3 (b) – Veterinary Microbiology							
	3.3 (c) – Nano biotechnology							
MB3.4 (22) Elective- II	3.4 (a) – Fermentation Technology	4			4	30	70	100
	3.4 (b) – Microbial Enzymes							
	3.4 (c) – Pharmaceutical Microbiology							
MB PI (22)	2.1 + 2.2		**6**		4	30	70	100
MB PII (22)	2.3 + 2.4		**6**		4	30	70	100
Skill Development Course				6				
SEMESTER IV								
MB4.1(22)	4.1 – Environmental Microbiology	4			4	30	70	100
MB4.2 (22)	4.2 – Food Microbiology	4			4	30	70	100
MB4.3 (22) Elective-I	4.3 (a) – Industrial Microbiology	4			4	30	70	100
	4.3 (b) – Environmental toxicology							
	4.3 (c) – Ecofriendly technologies							
MB4.4 (22) Elective- II	4.4 (a) – Biofertilizer technology	4			4	30	70	100
	4.4 (b) – Mushroom and SCP							
	4.4 (c) – Organic Farming and Vermi Composting							
MB PI (22)				6	4	30	70	100
MB PI (22)				6	4	30	70	100
Project work				6	4			100
								2500

	M SC MICROBIOLOGY (TWO YEAR) PROGRAMME									
	[END SEMESTER EXAMINATIONS] **Bloom's Taxonomy-Questions Confirming to level K1 to K6 ***									
		Iyear (1st&2nd semesters)					II year(3rd and 4th semesters)			
		Level	Session	Questions &Marks	Total marks		Level	Session	Questions &Marks	Total marks
A	Semester end	K4	**A**	Five out of Eight 5X4	20		K4	**A**	Five out of Eight 5X4	20
		K5	B	5X 10 (one from each unit)	50		K5	B	5X 10	50
					70					
B	Internal Examination (Best out of Two)	K4	A	2X5 (Two out of Three)	10		K4	A	2X5 (Two out of Three)	10
		K5		2X10	20		K5		2X10	20
					70					
A+B	**70+30**				100					**100**
C										

*K1: Knowledge level (one word answers) with weightage of marks 01

K2: Understand level (one word logical answer) with weightage of marks 02

K3: Mathematical or short answer questions (one or two sentences) with weightage of marks 03

K4: Short answer questions with application or concept (150-250 words) with weightage of marks 04 to 09

K5: Creative /descriptive /analysis /essay type questions with weightage of marks 10 and above

In view of the merit of the students secured admission either through state level /university level entrance examination with single window counseling, adopted the level knowledge from K4 to K6 only

FIRST SEMESTER

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF BOTANY & MICROBIOLOGY

M.Sc. MICROBIOLOGY

SEMESTER-I

Semester	MB 1.1 (22): VIROLOGY	L	T	P	C
1		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To gain knowledge on architecture of the various types of viruses, know the various methods of Isolation and cultivation strategies, the complexity of viral genomes and utilize the information in vaccine preparation.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the diversity of viral morphology and genome and Know the diseases caused by sub viral agents.
CO2	Understand the Isolation of the viruses by egg inoculation method and gain technique of the serological tests for viral diseases
CO3	Understand the classification of plant viruses, knowledge about important plant viral diseases and viral transmition and control measures
CO4	Gain thorough knowledge about important animal viral diseases
CO5	Gain knowledge about viruses infecting bacteria, algae and fungi. And different types of vaccines

UNIT-I

Brief outline of discovery of viruses; properties of viruses. Morphology of viruses- Structure, Capsid architecture; envelopes and peplomers. Chemistry of viruses- viral proteins, genome – structure and types.Study of sub-viral agents – Brief account of diseases caused by viroids – PSTV, Cadang cadang; Prions- Scrape, Cruetzfeld jakob; Satellite viruses, Satellite RNA's.

UNIT-II

General methods of cultivation of viruses-in embryonated eggs, experimental animals and cell cultures, monolayer cultures, cell lines.General methods of purification of viruses. Serological methods for detection of viruses- haemagglutination& HAI, immunoflourescense, ELISA, PCR and RIA. Infectivity assay – plaque method.

UNIT-III

Taxonomy of plant viruses, Symptoms of diseases caused by plant viruses (morphological, Physiological and histological), Ultra structure and life cycles of TMV and CaMV, Transmission of plant viruses – mechanical and biological (vector and nonvector), Basic control measures of plant diseases- vector and chemical control.

UNIT-IV

Taxonomy of human viruses. Ultra structure and brief account on life cycles of RNA viruses- Polio, Influenza and HIV.Ultra structure and brief account on life cycles of DNA viruses- Vaccina, Adenovirus, SV40.

UNIT-V

Ultra structure and life cycles of bacteriophages- M13, Mu, T4 & lambda.General account of viruses of Cyanobacteria, algae and fungi.Viral vaccines- Types, preparation and production of vaccines.New generation vaccines- genetic recombinant vaccines.General account on interferons and antiviral drugs.

REFERENCE BOOKS:

1) Dimmock Nj, Primrose Sb (1994). Introduction to Modern Virology IV Edition, Blackwell Scientific publications. Oxford.
2) Morag, C And Timbury M (1994). Medical Virology, Churchill Livingstone, CONRAT HF, KIMBALL PC and LEVY JA (1994).Virology-III Ed. Englewoood cliff, New Jersey.
3) Mathews, Re (1992). Functional of plant Virology, Academic Press, San Diego.TOPLEY and WILLIAMS (1995). Text book on Principles of Bacterilogy, virology and immunology, Edward Arnold, London.
4) William Hayes (1985), The genetics of bacteria and Their viruses, black Well Scientific publishers, London.
5) David Ga Walkey (1985). Applied Plant Virology. William Heinemann Ltd, London.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 1.2 (22): MICROBIAL BIOCHEMISTRY AND ANALYTICAL TECHNIQUES	L	T	P	C
1		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Understand the basic concepts of biomolecules, protein biochemistry of microorganisms, protein purification technology. And basic principles and operational skill of analytical techniques. To gain adequate knowledge and understanding the concept for seeking jobs in research laboratories and corporate companies.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Acquire knowledge on carbohydrates, lipids and nucleic acids, Analysis of microbial biomolecules and biochemical variations among microorganisms.
CO2	Complete understanding of structural and functional stoichiometry of proteins in microorganisms. And help to understand chaperones of biological significance.
CO3	Understanding of enzymes significance. explore novel microorganisms and hands on skill to deal with advanced research of protein purification and lipid characterization.
CO4	Gain knowledge and application of spectroscopy advance methods and centrifugation applications.
CO5	Knowledge gain on analytical tools such as chromatography,centrifugation and electrophoresis and hands on skill on purification and separation of primary and secondary metabolites along with chemical dynamics.

UNIT-I

Properties of Biomolecules: Carbohydrates – Structure and physicochemical properties of mono and oligosaccharides. Structures and biological importance of structural and storage polysaccharides.Lipids– Physicochemical properties of fatty acids, Triacylglycerols, Glycolipids, Phospholipids, Lipid aggregations (micelles, monolayers, bilayers, liposomes).Nucleic Acids: Structure of DNA and RNA. Renaturation and denaturation of DNA, cot values of DNA.

UNIT-II

Aminoacids: classification, amino acid properties, essential amino acids, Biological significance.

Proteins: peptide bond and types of peptides, peptides of non-protein origin, three dimensional structure of proteins (Primary, Secondary, Tertiary, Quaternary). Chaperones, denaturation and renaturation of proteins.

UNIT-III

Enzymes – Nature and outline classification of enzymes, binding energy, activation energy, rates of reactions, MM equation, factors influencing the enzyme action, mechanism of enzyme action, enzyme inhibitors, allosteric enzymes, isoenzymes, ribozymes, abzymes.Protein purification and characterization methods, methods of lipid separation and analysis.

UNIT-IV

Spectroscopy – Principles and applications of UV-Vis, NMR, ESR and Mass spectroscopy.

Centrifugation: Instrumentation for centrifugation, principles and applications of differential and density gradient centrifugation.

UNIT-V

Chromatography – Principles and applications of adsorption, ion exchange, gel filtration, affinity and ion exchange chromatography.

Electrophoresis – Principles and applications of Polyacrylamide, Agar, Pulsefied, and Immuno electrophoresis.

SUGGESTED BOOKS:

1) Nelson and Cox 2000. Lehninger Principles of Biochemistry.
2) Moat, A. Gand J.N. Foster.1999. Microbial Physiology.
3) Wilson, K and J.Walker 1995. Practical Biochemistry. Principles and Techniques. 4thed.
4) Upadhyay, A., Upadhyay, K and Nirmalendru Nath. 2003. Biophysical Chemistry – Principles and Techniques.
5) David Freifeilder and W. Freeman 1982. Physical Biochemistry – Applications to Biochemistry and Molecular Biology. 2nded.
6) Caldwell, D.R. 1995. Microbial Physiology and Metabolism.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 1.3 (22): BACTERIOLOGY	L	T	P	C
1		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To gain knowledge of microorganisms and their different classification systems Understand the principles and identification characters to be involved for taxonomical classification of bacteria and. methodologies involved isolation, sterilization and preservation of bacterial cultures. Focus on the nutritional forms teria and growth patterns of bacteria. And the characteristic features of important groups as well as genera of bacteria.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the criteria employed in proposing different classification systems and basic principles followed during nomenclature and classification of bacteria. parameters used in identification of an unknown bacteria and comprehend the functions of various structures and components of a prokaryotic bacterial cell.
CO2	Understand different sterilization techniques that should microbiological laboratories. Know the important methods for isolation of bacteria from different sources and staining and preservation of bacteria in laboratories for further use.
CO3	Know the nutritional requirements of different bacteria and the growth characteristics of bacteria and influence of environmental factors on bacterial growth
CO4	Have an idea about the characteristic features of three important groups of eubacteria.
CO5	Figure out the specific and distinguishing features of the listed bacterial genera which helps the students in tentative identification of bacteria.

UNIT-I

Outline classification of microorganisms – Different types of kingdom systems (Haeckel`s three kingdom concept, Whittaker`s five kingdom concept); three domain concept of Carl Woese. Principles of bacterial taxonomy and classification of bacteria – Numerical taxonomy, Identification characters – morphological, staining, physiological, biochemical and genetical (mol% G+C, Nucleic acid hybridization, 16S rRNA sequencing) characters. Bacterial classification as per the latest edition of Bergey's Manual of Systematic Bacteriology. Ultrastructure of typical bacterial cell – Surface appendages, Cell envelope and Cytoplasmic components. Sporulation in bacteria.

UNIT-II

Sterilization methods to control bacterial growth – Physical (Heat, Filtration, Radiation)and Chemical methods. General methods of isolation of bacteria from soil (Plating methods, Serial dilution technique, MPN technique, Contact slide technique, Winogradsky column) and water (Multiple tube fermentation test, Membrane filter technique); anaerobic culture methods. Maintenance and Preservation of bacterial cultures – Sub-culturing, Oil over laying, Lyophilization, Cryo- preservation. Techniques for staining bacteria – Negative, Simple and Differential staining methods.

UNIT-III

Bacterial Nutrition – Nutritional classification of bacteria, Essential macronutrients, micronutrients and growth factors. Bacterial Growth – Growth characteristics of bacteria on solid medium, Kinetics of growth, Typical bacterial growth curve, Diauxie growth curve, Batch culturing, Continuous culturing – chemostat and turbidostat, synchronous culturing.Factors affecting the bacterial growth; Methods for measurement of bacterial growth.Bacterial Homeostasis.

UNIT-IV

Classification, General characters, Reproduction and significance of Archaeobacteria. Classification, General characters, Reproduction and significance of Cyanobacteria. Classification, General characters, Reproduction and significance of Actinomycetes.

UNIT-V

Taxonomy and characteristic features of the following bacterial genera-*Agrobacterium*, *Bacillus*, *Clostridium*, *Escherichia*, *Mycoplasma*, *Nitrosomonas*, *Pseudomonas*, *Rhizobium*, *Rickettsia*, *Spirochaete*, *Staphylococcus*, *Streptococcus*.

REFERENCE BOOKS:

1) Brock, T.D.and Madigam, M.T. – Biology of Micoroorgansims (1999)
2) Prescott, L.M., Harley, J.P. Klein, D.A. – Microbiology (2008)
3) Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R. – The Microbial World (1988)
4) Pelczar, M.J, Chan, E.C.S., Kreign, N.R. – Microbiology (2006)
5) Black, J.G.- Microbiology – Principles and Explorations (1999)
6) Atlas, R.M. – Priniciples of Microbiology (1996)
7) Salle AJ. Fundamental principles of Bacteriology (2001)
8) Birge-Modern Microbiology
9) Schlegel HG. General Microbiology (2008)
10) Sneath, P.H.A., Mair, N.S., Elizabeth, M. –Bergey`s Bergey`s Manual of Systematic Bacteriology
11) Dubey RC and Maheswari DK. - A Text Book of Microbiology (2010)
12) Alcamo E. - Fundamentals of Microbiology (2001)

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 1.4 (A) (22): BIOLOGY OF EUKARYOTIC MICROBES	L	T	P	C
1		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Imparts knowledge on Ultra structure of eukaryotic cell, Structure, organization and functions of cell organelles and Distribution, classification and importance of eukaryotic microbes.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the basic concept of eukaryotic cell and microscopic observation structure and function of different eukaryotic cell organelles.
CO2	Able to understand algal biology and its significance in industrial application and commercial production by utilizing resources.
CO3	Able tounderstand the distribution of thallus organization and reproduction of algae and explore to the positive and negative aspects of algae.
CO4	Able to analyze nutrition and reproduction of fungi .and its significance in agriculture and Industry. .
CO5	Gain knowledge in scientific understanding of different protozoan parasites and their pathogenesis towards human health and environment

UNIT-I

Ultra structure of eukaryotic cell; Organelles of eukaryotic cell – Ultrastructure of Cell wall, Cell membrane, Nucleus, Chloroplast, Mitochondria, Endoplasmic reticulum, Ribosome, Golgi apparatus, Lysosomes.

UNIT-II

Phases of cell cycle, role of check points in monitoring and regulation of cell cycle, Kinenins. Cell division – different stages of mitosis and meiosis.

Cytoskeleton – definition, types and structure of cytoskeletal filaments, role of cytoskeleton in cell division.

UNIT-III

Algae – Distribution, General account, Thallus organization, nutrition, reproduction and classification of algae. Economic importance of algae – Algae as primary producers and commercial products.Algae as SCP.Algal blooms and toxins.

UNIT-IV

Fungi – General characters, Nutrition (parasitic, saprophytic & symbiotic), Reproduction, Parasexuality. Ainsworth's system of classification.

Importance of fungi in Agriculture and Industry.Importance of yeasts.Edible and poisonous mushrooms.Mycotoxins.

UNIT-V

Protozoa – General account, morphology, nutrition and locomotion.Brief account of – *Entamoeba, Trypanosoma, Leishmania, Trichomonas, Giardia, Balantidium* and *Pneumocystis*.

REFERENCE BOOKS:

1) Introductory Phycology - HD Kumar
2) Biology of Algae – Round
3) The Fungi - Alexopolus
4) Prescott *et al*- Microbiology
5) Barner R.D – Invertebrates Zoology

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	3	3	3	2	3	2
CO2	3	3	2	2	2	2	1	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	1	3	3	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	2	3	3	3	3	3	3	3	2	3	2

Semester	MB 1.4 (B) (22): MARINE MICROBIOLOGY	L	T	P	C
I		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Able to understand Marine environment and associated marine microbes. And their dynamics and knowledge on significance of marine microorganisms.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge the nature of marine ecosystems, communities and their associations.
CO2	Comprehend the dynamic role of microorganisms in different useful activites in marine environment.
CO3	Understand the contribution of marine microbes towards the production of beneficial and detrimental metabolites
CO4	Understand and compare the nature and characteristics of different groups of microbes of extreme environments.
CO5	To know microbial flora and diseases of fish and shrimp seafood, and aquaintance with diagnostic procedures for the identification of seafood contamination.

UNIT-I

Marine Ecosystem: Mangrove and Estuarine microbes, microbial loop. Marine microbial communities – Phytoplankton and Zooplankton.Microbial associations – Endosymbionts, Epiphytes, Coral-microbial and Sponge-microbial associations.

UNIT-II

Dynamics of Marine Microbes - Phototrophic microbes, Nitrogen fixers, Iron limitation, Ocean fertilization; Decomposition of organic matter; Bioleaching and biodeterioration of natural and synthetic materials; Oil degradation.

UNIT-III

Microbial interactions; Microbes of Biotechnological importance; Microbial products: Primary and Secondary metabolites - Enzymes, Antibiotics, Organic acids, Toxins, Biosurfactants and Pigments.

UNIT-IV

Microbes of extreme environments – Extremophiles, Halophiles, Thermophiles, Psychrophiles, Osmophiles, Barophiles.

UNIT-V

Seafood microbiology – Microbial flora (pathogenic and non-pathogenic) of Fish and Shrimp.Diseases of Fish and Shrimp and control measures.Rapid diagnosis of seafood contamination.

REFERENCE BOOKS:

1) Colin Munn, Marine Microbiology: Ecology & Applications 2nd Edition. Garland Science, Taylor & Francis, 2009. ISBN: 978-0815365174.
2) David L. Kirchman, Microbial Ecology of the Oceans, 2nd Edition, John WIley & Sons, 2008. ISBN: 978-0470043448

3) M.T. Ma digan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006
4) Bhakuni, D.S. and Rawat, D.S. (2005). Bioactive marine natural products. Anamaya Publishers, New Delhi.
5) Joseph Selvin and A. S. Ninawe (2009). Shrimp Disease Management. ANE Publishers.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	3	3	3	2	3	2
CO2	3	3	2	2	2	2	1	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	1	3	3	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	2	3	3	3	3	3	3	3	2	3	2

Semester	MB 1.4 (C) (22): ALGAL BIOLOGY	L	T	P	C
I		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Impart knowledge on recent developments in algal classification, cultivation and harvesting. And cognizant of beneficial and detrimental impact of algae.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Understand the molecular phylogeny classification of algae,and algal diversity in aquatic habitats..
CO2	Gain knowledge on algal cultivation and different cultivation methods of micro and macro algae.
CO3	Attain knowledge on the activities and role of algae in impacting the aquatic life and human health.
CO4	Know the importance of algal members in safeguarding the environment.
CO5	Gain knowledge on algal products and their benefit of mankind.

UNIT-I

Contributorys works of Pioneer Phycologists.Classification of algae: Classical and Recent developments; Molecular Phylogeny – Polyphasic approach.Algae of Diverse habitats – Fresh water, Marine water and Brackish water.Algal communities of Extreme environments.

Fossil algae.

UNIT-II

Different algal culture techniques; General Principles; Physical parameters; Culture media; Strain improvement. Methods for cultivation of Micro algae and Macro algae.Algal cultivation and production in India.

UNIT-III

Eutrophication; Significance of algal blooms and control measures.Algal Toxins produced by different algal groups.Bioaccumulation and Biomagnification of algal toxins.Impact of algal toxins on aquatic life and humans.

UNIT-IV

Role of algae in pollution control, CO_2 sequestration, Bioredemiation, Soil fertility and treatment of wase water plants.Algal Biofuels – bio-diesel, bio-ethanol and biological hydrogen production.

UNIT-V

Products of Algal Source: Nutraceuticals, Biomedical compounds, Biofertilizers, Polysaccharies, Pigments, Dietary fibres and Animal feed.

REFERENCE BOOKS:

1) Fritsch, F.E. 1945. The Structure and Reproduction of Algae Vol. I & II. Cambridge Univ. Press, Cambridge, London.
2) Sharma O.P. 2011. Algae. TATA McGraw-Hill, India.
3) South G.R. and Whittick A. 1987. Introduction to Phycology. Blackwell Scientific Publications, London.

4) Lee R.E. 1989. Phycology Vol. II. Cambridge Univ. Press. Cambridge, London.
5) Anderson R.A. 2005. Algal Culturing Techniques. Physiological Society of America, Elsevier Academic Press, USA.
6) Sahoo D. and Qasim S.Z. (Eds). 2002. Sustainable Aquaculture. APH Publishing Corporation, New Delhi, India.
7) Murthy A.V.S.S. 2005. A text book of algae. I.K. International Pvt., Ltd., New Delhi.
8) Southcott G.R. and Whittick A. 1987. Introduction to Phycology. Blackwell Scientific Publication, UK.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	3	3	3	2	3	2
CO2	3	3	2	2	2	2	1	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	1	3	3	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	2	3	3	3	3	3	3	3	2	3	2

SECOND SEMESTER

M.Sc. MICROBIOLOGY

SEMESTER-II

Semester	MB 2.1 (22): MICROBIAL PHYSIOLOGY AND METABOLISM	L	T	P	C
2		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To introduce basic concepts of thermodynamics and energy kinetics, energy transduction and carbon reduction mechanisms, biological oxidation of carbohydrates and energy production, and aminoacid metabolisms.

COURSE OBJECTIVE (CO):At the end of the course, the student will be able to

CO1	Able to understand concept of thermodynamics and energy kinetics, in phosphorylation reactions and transport of solutes of microorganisms.
CO2	Understanding of Oxygenic and anoxygenic photosynthesis and energy transduction, microbial photosynthetic pigments and their role in energy transduction.
CO3	Gain knowledge on carbon reduction mechanisms of microorganisms, biological significance of chemo autotrophs and fermentation reactions and their biological significance
CO4	Understand the differences in microbial glycolysis and Electron transport system.
CO5	Help to acquire knowledge and hands on skill on biosynthesis of amino acids, fatty acids poly amines.

UNIT-I

Concept of thermodynamic principles, entropy, enthalpy, concept of free energy. Oxidation – reduction potential, ATP structure, free energy change in oxidation/reductions, different types of phosphorylations, solute uptake – passive and active transport, Phosphotransferase system, Iron uptake, group translocation; Regulation of bacterial metabolism.

UNIT-II

Photosynthesis – Oxygenic (cyanobacteria) and anoxygenic (Rhodospirillaceae, Chromatiaceae, Chlorobiaceae, Chloroflexaceae); Photosynthetic pigments, Bacteriorhodopsin, Photochemistry of photosystems; Photosynthetic Carbon Reduction (Calvin Cycle, RTCA, Hydroxy propionate pathway, reductive acetyl COA pathway).

UNIT-III

Chemolithotrophy: - Hydrogen (H_2), Carbon monoxide (Co), ammonia (NH_3), nitrite(NO^-_2), sulphur (S^0) and Iron (Fe^{2+}) Oxidizing Bacteria; bioluminescence. Respiration – EMP, ED, HMP, Methyl glyoxylate. HMP pathways, TCA cycle, ETC in bacteria and mitochondria, ETC inhibitors. Anaplerotic sequences.

UNIT-IV

Anaerobic respiration (SO_4^{2-} and NO_3^-).Fermentations – Mixed acid, propionate and Butyrate-Butanol fermentations. Syntrophy, anaerobic food chain, gluconeogenesis.Methanogenesis and its biological importance.

UNIT-V

Biosynthesis of aminoacid.Catabolism of amino acids (deamination, decarboxylation and transamination).Protein degradation – exo and endo proteases.Fatty acid synthesis (saturated and unsaturated), Fatty acid degradation (saturated and unsaturated). Bacterial cell wall synthesis (+ve and –ve). Polyamine biosynthesis, Biochemistry of 'N_2' fixation.

SUGGESTED BOOKS:

1) Reddy and Reddy (2005). Microbial physiology.
2) Freeman, W.H.(2001). Biochemistry, by Stryer, 5th edition
3) Nelson and Cox.2000; Lehninger principles of Biochemistry
4) Moat, A.G and J.W. Foster (1999). Microbial physiology
5) Caldwell, D.R.1995. Microbial Physiology and Metabolism
6) David White.1995. The Physiology and Biochemistry of Prokaryotes
7) Gottschalk, G. Bacterial Metabolism
8) Hans G. Schlegel. General Microbiology
9) Lansing M. Prescott et al. 2005. Microbiology

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	3	3	3	2	3	2
CO2	3	3	2	2	2	2	1	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	1	3	3	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	2	3	3	3	3	3	3	3	2	3	2

Semester	MB 2.2 (22): MICROBIAL GENETICS AND MOLECULAR BIOLOGY	L	T	P	C
2		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To understand the genetics, mutations and genetic recombination, protein synthesis and the regulation mechanisms of gene expression and nif genes for nodulation**.**

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Basic knowledge on genes, gene concept, Plasmids and mutations.
CO2	Hands on skill in handling genetic experiments on recombination and transformation. .
CO3	Understand the concept of DNA replication and molecular biology of RNA and proteins.
CO4	Gain knowledge on regulation of gene expression...
CO5	Gain knowledge on transposons of prokaryotes and eukaryotes and Genome rearrangements and regulation of genome activity.

UNIT-I

Experimental evidences for establishing the nucleic acids as genetic material. Gene concept– classical concept, Modern concept (cistron, muton, recon, exon & intron); Different theories of gene concept. Plasmids – Definition, characteristics of plasmids, types of plasmids, properties of F plasmids, R plasmids, col plasmids, Ti plasmids and other plasmids; Replication of plasmids; Isolation of plasmids; Significance of plasmids.Mutations – spontaneous mutations versus induced mutations; somatic & germinal mutations; Types of mutations – morphological, conditional, nutritional, forward, backward, suppressor, point and frame shift mutations; Radiation induced mutations – ionizing and non-ionizing radiation. Chemical mutagens – Base analogues, nitrous acid, acridines, alkylating and hydroxylating agents. Screening and isolation of mutants.

UNIT-II

Genetic recombination in Bacteria – Transformation, Conjugation, Transduction (Generalized and Specialized); Gene mapping in bacteria; Gene transfer techniques – Electroporation, Microinjection, Biolistics and chemical methods. Applications of bacterial genetic recombination. Phage Genetics – Lytic phage – Genome organization of phage T4, genetic recombination; gene mapping and gene expression in T4 life cycle. Lysogenic phage – λ-phage genome organization; gene mapping; genetics of lysogenic life cycle; recombination.

UNIT-III

Replication of DNA – Semi-conservative replication, enzymology of replication, continuous and discontinous DNA synthesis.Unidirectional replication, bi-directional replication, rolling circle replication.

DNA damage and repair - Types of DNA damage- deamination, alkylation, pyrimidine dimers; Repair mechanisms – Photoreactivation, base excision repair, nucleotide excision repair, post replication and recombination repair, methyl-directed mismatch repair and SOS repair.

Gene expression – Central dogma of gene action; Transcription – structural components of RNA polymerases, initiation, elongation and termination of transcription; post transcriptional processing and RNA splicing in eukaryotes; Translation – components involved (mRNA, ribosomes, amino acyl-tRNAs), initiation, elongation and termination of translation; Post translational modifications of polypeptide.

UNIT-IV

Regulation of Gene expression in bacteria – Operon concept, Inducible and repressible operons, Positive and negative regulations, Inducer molecules, Repressor molecules, Co-Repressor molecules.Induction and catabolite repression of lac operon in *E. coli*.Repression and attenuation of trp operon in *E. coli*.Positive and negative controls in ara operon in *E. coli*.Genetics of nitrogen fixation – nif genes, regulation of nif genes (local control and global control mechanisms); nod genes and their regulation.

UNIT - V

Transposable elements in bacteria - IS elements, Composite transposons, Tn3 transposons. Transposable elements in eukaryotes - Ac and Ds elements in maize, Ty elements in yeast, transposons in Drosophila, Human retrotransposons. Mechanisms of transposition – Conservative and replicative modes. Genome rearrangements – mating type switching in yeast; diversity in Ig molecules. Regulation of genome activity during sporulation by special σ subunits.

REFERENCE BOOKS:

1) Gene VII – Benjamin lewin (2000)
2) Principles of genetics – Gardener, E.J., Simmons, M.J., Snustad,D.P. (1991)
3) Genetics – Peter J Russell (1998)
4) Microbial Genetics – David Freifelder (1990)
5) Molecular Biology – David Freifelder (2001)
6) Molecular genetics of bacteria – Dale JW
7) Principles of genetics – Tamarin RH (1999)
8) An introduction to Genetic analysis - Suzuki,D.T et al.
9) Molecular Cell Biology - Darnell, J., Lodish, H. Baltimore, D. (1986)
10) Cell and Molecular Biology - Karp,G. (1986)
11) Molecular Genetics of Bacteria - Dale,J.W.
12) Principles of Genetics - Snustad, D.P., Simmons, M.J., Jenkins, J.B. (1997).

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	3	3	3	2	3	2
CO2	3	3	2	2	2	2	1	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	1	3	3	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	2	3	3	3	3	3	3	3	2	3	2

Semester	MB 2.3 (22) : IMMUNOLOGY	L	T	P	C
2		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To understand the cells, and organs in immune Response and types of Antigen-Antibody reactions, hypersensitivity and basic information about Tumour immunology and Auto immunity disorders.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Able to understand types of immunity, structure and functions of immune cells and organs.
CO2	Hands on skill on serological tests and diagnosis of diseases.
CO3	Understand the concept of DNA replication and molecular biology of RNA and proteins.
CO4	Gain knowledge in transplantation immunology, auto immune diseases and tumor immunology.
CO5	Acquire knowledge of immune response to infections and Hands on skill on vaccine development.

UNIT - I

History of immunology. Structure, composition and functions of cells and organs involved in immune system- B-cells, T-cells, phagocytes, auxilliary cells, soluble mediators. Lymphokines and Cytokines, functions of important Interleukins; Lymphoid organs- primary (Thymus and bone marrow), secondary (spleen and lymph node); Types of immunity - Innate and acquired immunity; Humoral and cell mediated immunity; primary and secondary.immune response.

UNIT - II

Antigens- nature and properties; haptens and toxoids. Immunoglobulins- structure, heterogenicity, types, sub-types; antibody production- hybridoma technique, catalytic enzymes. Complement system- structure, components, pathways and biological sequences of complement activation. Antigen- antibody reactions- agglutination, precipitation, complement fixation, Immuno fluorescence microscopy, ELISA, RIA.

UNIT – III

Hypersensitivity reactions- antibody mediated- Anaphylaxis; antibody dependent cell toxicity; immune complex mediated reactions; cell mediated hypersensitivity reactions. Brief account on the respective diseases.

UNIT – IV

Structure and functions of MHC. Transplantation immunology- concept, tissue typing methods, role of HLA, survival of allograft, graft versus host reaction. Autoimmunity- general account of autoimmune diseases; mechanism and therapy of Rheumatoid arthritis. Tumor immunology- Tumor diagnosis by onco fetal antigens, effector mechanisms in tumor immunology.

UNIT –V

Immune response to infectious diseases: viral infections, bacterial infections, protozoan diseases. Vaccines – Designing vaccines for active immunization, whole organism vaccines, purified macromolecules as vaccines, recombinant vector vaccines, DNA vaccines, Synthetic peptide vaccines and multivalent subunit accines.

REFERENCE BOOKS:

1) Roitt, i.m. (1998). Essentials of Immunology. ELBS, Blackwell Scientific Publishers, London.
2) Kuby's Immunology. IV Edition. Freeman and Company, New York.
3) Klaus d elgert (1996) immunology- Understanding of immune system. Wiley- Liss. ny.
4) Topleyand Williams (1995). Text book on Principles of Bacteriology, Virology and immunology, Edward Arnold, London.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 2.4 (A) (22) : AGRICULTURAL MICROBIOLOGY	L	T	P	C
2		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To underatand the basic concepts of Agricultural Microbiology rhizosphere and Phyllosphere and disease identification and importence of biofertilizers and biopesticides**.**

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge on Rhizosphere, PGPR, and Phyllosphere.
CO2	Categorize and emphasize the different biofertilizers and phosphate solubilizing microbes in agriculture..
CO3	Understand the Examination and identification of the symptoms caused by major plant pathogens..
CO4	Able tocategorize and control different plant diseases, and different types of biopesticides.
CO5	Gain knowledge on basic concepts of biostatistics to interpret the results.

UNIT-I

Rhizosphere – Microbial flora of rhizosphere soil, rhizosphere effect; root exudates; soil fungistasis. Techniques - soil plate, contact slide method, Fluorescence microscopy.Plant growth promoting rhizobacteria, Siderophores.Phyllosphere microflora and their significance.

UNIT-II

Biofertilizers - Mycorrhiza – Ecto mycorrhizas and Arbuscular mycorhiza, *Azatobacter* and *Azospirillum*.N - fixing cyanobacteria; Legume-Rhizobium association – Nitrogenase, Rhizobia complex, cross-inoculation groups; Development, structure and functions of legume root nodules.Phosphate solubilizing microorganisms and their use.

UNIT-III

Concept of disease in plants; Symptoms caused by plant pathogenic fungi, bacteria and viruses. Symptomology, etiology, epidemiology and control of following plant diseases: Late blight of potato, powdery mildew of cucurbits, black stem rust of wheat, grain smut of sorghum, tikka disease of groundnut, blast disease of rice, angular leaf spot of cotton and tobacco mosaic disease.

UNIT-IV

General principles of plant disease control – Plant quarantine, seed treatment, cultural practices, chemical control, development of disease resistance varieties; Biological control of plant diseases. Biopesticides – *Bacillus thuringiensis*, NPV and CPV.

UNIT – V

Biostatistics - Basic principles; Measures of Central tendency – Mean, Median, Mode; Standard deviation and Standard Error; Simple hypothesis tests – Students 't'- test , 'F'- test and Chi-square test. Analysis of variance – one-way ANOVA and two-way ANOVA, Correlation and Linear Regression. Experimental designs – Randomized Block Design (RBD) and Completely Randomized Design (CRD).

REFERENCE BOOKS:

1) Subbarao, N.S. 2000. Soil Microbiology 4th Edn.
2) Subbarao, N.S. 1995 Biofertilizers in Agriculture and Forestry
3) Tilak, K.V.B.R. 1991. Bacterial biofertilizers, ICAR publications
4) Atlas, R.M. and Bartha, R. 1998. Microbial ecology: Fundamentals and Applications, Addison Wiesley Longman Publications
5) Lynch and Poole, 1983 Microbial ecology, ELBS Publications
6) Singh, R.S. 1990 Plant diseases 6th Edn. Oxford & IBH publications
7) Rangaswami,G. and Mahadevan, A. 1999. Diseases of crop plants in India. Prentice Hall of India publications, New Delhi
8) Rangaswami, G. and Bagyaraja, D.J.2001. Agricultural Microbiology, 2nd Edn., Prentice Hall of India, New Delhi.
9) Mehrotra, R.S.1980. Plant Pathology, Tata
10) Schaum's Outline Statistics by Murray.R, Spiegel, Larry. J.Stephens, 4th edition, McGraw Hill Companies.
11) Zar, J. - Bio-statistical Analysis, Prentice Hall of India.
12) An introduction to Bio-Statistics by N.Gurumani.2009 – MJP Publications.
13) Daniel, 2006, Biostatistics, Eighth Edition. John Wisley and sons.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 2.4. (B) (22): CLINICAL MICROBIOLOGY	L	T	P	C
2		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Hands on skill in molecular diagnosis of diseases caused by bacteria, viruses, fungi, and parasites and awareness of public health, laboratory quality, safety, management and regulation

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Acquire hands on skill bacterial and microbial techniques for isolation of pure cultures of microbes
CO2	Able to distinguish parasitic infectious bacterial diseases. ..
CO3	Acquire knowledge on different diagnostic methods related parasitic infections.
CO4	Gain knowledge on the clinical significance of fungi, and identification of fungal pathogens
CO5	Have knowledge and understanding of pathogenic, diagnostic and therapeutic aspects of clinical virology

UNIT-I

General Principles in Clinical Microbiology: Safety and specimen management. Approaches to diagnosis of infectious diseases, Role of microscopy, Traditional cultivation and identification, nucleic acid-based analytic methods for microbial identification and characterization, Immunochemical methods used for organism detection, Serologic diagnosis of infectious diseases, Evaluation of antimicrobial activity: Principles of antimicrobial action and resistance, Laboratory methods and strategies for antimicrobial susceptibility testing.

UNIT-II

Principles of Identification: Overview of bacterial identification methods and strategies, *Staphylococcus,Micrococcus, Streptococcus, Enterococcus, Bacillus, Listeria, Corynebacterium, Erysipelothrix, Lactobacillus, Nocardia, Streptomyces, Rhodococcus, Enterobacteriaceae, Acinetobacter, Stenotrophomonas, Pseudomonas, Burkholderia, Vibrio, Aeromonas, Bordetella, Moraxella, HACEK, Haemophilus, Campylobacter, Helicobacter, Legionella, Brucella, Bordetella, Francicella, Neisseria, mycobacteria,* Anaerobes, Obligate intracellular and non-cultivable bacteria, cell wall-deficient bacteria, spirochetes.

UNIT-III

Parasitology: Laboratory methods for the diagnosis of parasitic infections, intestinal protozoa, blood and tissue protozoa, other protozoa, Intestinal nematodes, tissue nematodes, blood and tissue nematodes, intestinal cestodes, tissue cestodes, intestinal trematodes, liver and lung trematodes, blood trematodes.

UNIT-IV

Mycology: Laboratory methods for the diagnosis of fungal infections, Hyaline molds, Mucorales, dermatophytes, opportunistic and systemic mycoses, dematiaceious molds, Pneumocystis , yeasts, antifungal susceptibility testing, therapy, and prevention.

UNIT-V

Virology: Overview of the methods and strategies in virology, viruses in human disease, antiviral therapy, susceptibility testing and prevention.

REFERENCE BOOKS:

1) David Greenwood, Richard Slack, John Peutherer, Mike Barer, Medical Microbiology 17th Ed., Churchill Livingstone, 2007.
2) Murray P.R., Pfaller M.A., Tenover F.C., & Yolken R.H. 2007. Clinical Microbiology, ASM Press.
3) Bauman, R.W. 2009. Microbiology: with Diseases by Body System; Benjamin Cummings Sherris, John C, Medical Microbiology: An Introduction to Infectious Diseases, 2nd Edition, Elsevier.
4) David Wilks, Mark Farrington and David Rubenstein 2010. Infectious Diseases Manual: Blackwell Science.
5) George F. Brooks, Karen C. Carroll, Janet S.Butel, Stephen A. Morse. 2007. Jawetz, Melnick & Adelberg's Medical Microbiology. 24th Ed. McGraw-Hill Professional.
6) Harvey, R.A., Champe, P.C. & Fisher, B.D. 2007. Lippincott's Illustrated Reviews: Microbiology. Lippincott Williams and Wilkins, New Delhi/New York.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 2.4 (C) (22): BIOETHICS AND INTELLECTUAL PROPERTIES	L	T	P	C
2		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Focus on the basic concepts of Bioethics and Ethical issues ,concept of Biosafety and Levels of Biosafety regulations and guidelines and Intellectual property right .

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Understand the importance of Principles,and Ethical issues,Interpret the significance of biosafety licence and clearance
CO2	Able to Understand significance of biosafety regulations & recommendations
CO3	Acquire knowledge on importance of issues of biosafety and risk management and Understand policies of biosafety
CO4	Understand intectual property and their types, and e importance of issues of biosafety and risk management
CO5	Understand a PCT application, forms of patents and patentability, Patent databases, Patent infringementand law.

Unit -I:

Bioethics: Introduction ,- Definition – Principles of Bio ethics –General issues related to environmental release of genetically modified microorganisms. Ethical issues related to the use of animal as models for microbial diseases- Animal ethics norms in India - Licensing of animal house - Ethical clearance norms for conducting studies on human subjects. Ethical issues related to research in embryonic stem cell cloning.

Unit – II

Biosafety: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals

Unit - III

Biosafety of Genetically Modified Organisms – Introduction to biosafety. Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations –types of biosafety containment Ethics in use of animals for scientific research; Ethical clearance norms for conducting studies on human subjects; Definition of GMOs & LMOs; Advanced Information Agreement (AIA) procedure - procedures for GMOs intended for direct use, risk assessment, handling, transport, packaging and identification of GMOs. National Environment Policy.

Unit –IV

Introduction to intellectual property and intellectual property rights Types, patents, copy rights, trade marks, design rights, geographical indications – importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO). Need for protection of Intellectual Property Types of IP: International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India

Unit -V

Procedure for filing a PCT application, forms of patents and patentability, The patentability of microorganisms, process and product patenting, Indian and international agencies involved in IPR & patenting, Patent databases, Patent infringement. Traditional knowledge and Patent law for protection; Geographical Indicators.

REFERENCE BOOKS:

1) Ahuja, V.K., Law Relating to Intellectual Property Rights, 3 rd Ed. Lexis Nexis
2) Cornish, W. R., Intellectual Property (Latest Edition)
3) Intellectual Property Rights by Paul Goldstein.
4) Kilner, John, et.al, eds., Cutting-Edge of Bioethics. Eerdmans 2002.
5) B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
6) Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer (India) (2014)
7) Bareact, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
8) Kankanala C., Genetic Patent Law & Strategy, 1st Edition
9) Diane O. Fleming. (2006); Biological safety: Principles and Practices, 4th edition. ASM Press
10) Richard Sherlock, John D., 2002, Morrey, Ethical Issues in Biotechnology Rowman Littlefield. 6. Frederic H. Erbisch, Karim M. Maredia (2004). Intellectual Property Rights in Agricultural Biotechnology, CABI Publisher.
11) Mittal D.P. (1999). Indian Patents Law. Taxmann Allied Services (p) Ltd.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

THIRD SEMESTER

M.Sc. MICROBIOLOGY

SEMESTER-III

Semester	MB 3.1 (22): MEDICAL MICROBIOLOGY	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Understand the basic concepts and medical terms,the host pathogen interaction, etiology, pathogenesis, diagnosis, treatment and prevention of important microbial diseases

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Able to know hospital acquired infections and the control measures. Categorize epidemic, endemic and pandemic diseases. And methods of transmission and the control of epidemics
CO2	Advanced knowledge on medically important bacteria– diasease pathogenesis, diagnosis and prophylaxis
CO3	Aquire Advanced knowledge on medically important fungi – diasease pathogenesis, diagnosis and prophylaxis. Distinguish systemic and opportunistic fungal infections.
CO4	Understand Importance of different viral diseases. Detection of different viral diseases.
CO5	Know the different types of antibacterial drugs. Importance of antiviral drugs and their mechanism of action and fungal drugs along with the mode of action..

UNIT-I

Important developments in Medical Microbiology.Normal microbial flora of human body. Nosocomial infections and their control. Epidemiology – Types of epidemics, disease reservoirs, methods of transmission and control of epidemics.

UNIT-II

Detailed study of the pathogen, pathogenesis, symptoms, epidemiology, diagnosis and control of the diseases caused by the following bacteria: *Staphyloccus aureus, Streptococcus pneumoniae, Neisseria meningitidis, Corynebacterium diphtheriae, Clostridium tetani, Salmonella typhi, Vibrio cholerae, Treponema pallidum* and *Mycobacterium tuberculosis*.

UNIT - III

Detailed study of the pathogen, pathogenesis, symptoms, epidemiology, diagnosis and control of the following fungal infections.Dermatomycoses – tineas; Systemic mycoses – Histoplasmosis and Cryptococcosis; Opportunistic mycoses – Candidiasis and Aspergillosis.

UNIT-IV

Detailed study of the following viral diseases – Poliomyelitis, Influenza, Rabies,Hepatitis, AIDS. Brief note on oncogenic viruses.

UNIT-V

Chemotherapy: Properties of chemotherapeutic drugs, chemical nature, clinical use and mode of action of the following drugs. Antibacterial drugs: Sulpha drugs, Penicillins, Cephalosporins, Streptomycin, Tetracyclines, Chloramphenicol, Rifamycin, Polymyxin. Antifungal drugs: Imidazoles, Flucytosine, Nystatin, Amphotericin-B. Antiviral drugs: Amantadine, Azidothymidine, Acyclovir.

REFERENCE BOOKS:

1) Ananthanarayana, R. and Panicker, C.K.J. 2000. Text book of Microbiology, Oriental Longman publications
2) Jawetz *et al*. 1998. Medical Microbiology 21st Edn. Prentice Hall International Inc.
3) White, D.O. and Fenner, F. 1994 Medical Virology, Academic Press, London
4) Bailey and Scott 1998 Diagnostic Microbiology (10th Edn.) Published by Mosby.
5) Madigan *et al*. 1997. Brock's Biology of Microorganisms 8th Edn. Prentice Hall International Inc.
6) Presscott *et al*. 2005. Microbiology 3rd. edition.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 3.2 (22): RECOMBINANT DNA TECHNOLOGY	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To impart knowledge Students get acquainted with various tools of cloning of genes, gene transfer mechanisms and expression strategies for both prokaryotic and eukaryotic genes**.**

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge on hand skills to isolate and purify nucleic acids (DNA &RNA) for routine laboratory procedures, using different types of vectors, enzymes and oligonucleotides.
CO2	Gain knowledge and understand different strategies of DNA sequencing methods and probes of various molecular diagnostic diseases.
CO3	Gain knowledge the principal of PCR, protein synthesis using site directed mutagenesis and sequencing of DNA using blotting techniques.
CO4	Understand the cloning strategies for production of recombinants, basic practical aspects of applying cloning strategies for construction of genomic and cDNA libraries. Over expression of cloned genes in prokaryotes and Eukaryotes.
CO5	Students gain knowledge and significance of model organisms in recombinant DNA technology and describe recombinant gene expression systems.

UNIT-I

Introduction and importance of recombinant DNA technology. Tools in DNA technology: Enzymes: restriction endonucleases, DNA and RNA polymerases, DNA ligases, S1nuclease, polynucleotide kinase, alkaline phosphatases, Oligonucleotides – linkers, adaptors and homopolymer tails. Characteristics of different types of Vectors – plasmids (pBR322, phagemids, cosmids), Yeast artificial chromosomes, Ti plasmid derivatives, caulimoviruses, constructs of SV40.

UNIT-II

DNA sequencing: Chemical and enzymatic methods. Automated sequencing.Genome sequencing and physical mapping of genomes.

Molecular diagnostics: Preparation of DNA and RNA probes and their application, nucleic acid hybridization, factors influencing hybridization and Microarrays.

UNIT - III

PCR - Principles, factors affecting PCR, different types of PCR and their applications. Site-directed mutagenesis– Definition, types – PCR based site-directed mutagenesis, Random mutagenesis and its applications. Blotting techniques: Southern, Northern and Western blotting techniques.

UNIT-IV

Cloning strategies: Generation of DNA fragments, and construction of cloned gene intothe vector. Methods of transformationof rDNA into host. Screening and identification of recombinants (antibiotic, nucleic acid and protein based methods). Construction of DNA libraries - genomic and cDNA libraries.Strategies for over expression of cloned genes in prokaryotic expression systems - *E.coli* expression, Yeast expression systems. Strategies for over expression of cloned genes in Eukaryotic expression systems- Baculovirus and mammalian expression systems.

UNIT-V

Production of human growth hormone and insulin using recombinant microorganisms. Development of transgenic plants with desired traits – herbicidal, pest and stress resistance and for various economically important plant products –Transgenic plants as bioreactors. Problems associated with expression of foreign DNA in plant cells. Development of transgenic animals with desired traits – construction of expression vectors, transfer of cloned genes, production and use of transgenic animals – mice, cow, sheep, & goat. Problems associated with expression of foreign DNA in animal cells.

REFERENCE BOOKS:

1) Old and primrose. 1994. Principles of Gene Manipulation: An introduction to genetic engineering. 5th ed. Blackwell Scientific publ.
2) Glick and Pasternak 1994, Molecular Biotechnology, panama publ.
3) Watson et al 1992 Recombinant DNA. Freeman & co
4) Walker and Rapley 2002. Molecular biology and Biotechnology 4th ed. Panima publ
5) Ratledge & Kristinsen 2001 Basic Biotechnology, University press
6) Higgins and Hames (eds) Protein expression : A practical approach., Oxford University press
7) Hunt & Liveey (eds) 2000 Functional Genomics, Oxford University press
8) Krenzer & Massey – Recombinant DNA and Biotechnology: A guide for teachers 2nd ed. ASM press.
9) Brown, t.a. (2001). *Gene cloning and DNA Analysis*. 4th Edition. Blackwell Publishers
10) Gene biotechnology – S.N. Jogdand.
11) Principles of Gene Manipulation - An Introduction to Genetic Engineering - R. W. Old and S. B. Primrose.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 3.3 (A) (22): CELLULAR MICROBIOLOGY AND BIOINFORMATICS	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To provide the students a clear picture of pathogen interactions with its host. bacterial toxins and their mode of action, cell signalling in prokaryotes and eukaryotes, the basic concepts and applications of Bioinformaticss and their applications for sequence alignment.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Know the different adhesions of pathogen and host, and the important mechanisms of bacterial adhesion and Aware of the consequential effects of adhesion and invasion.
CO2	Distinguish the nature of different secretion systems of bacteria that interact with animal as well as plant hosts. Differentiate the bacterial toxins into different broad categories basing on their mode of action and target molecules.
CO3	know the different pathways of cell-signalling mechanisms and their components
CO4	Recognize the importance of cell-to-cell and intracellular communications for the survivality of cell or organism.
CO5	Able to retrieve the data from biological data baseshe gene and protein sequences information with structures. Transform the given data into FASTA format and to use it in BLAST search.

UNIT-I

Bacterial adhesion to Host Cells: Basic principles of microbial adhesion – pre adhesion events, molecular mechanisms of adhesion, bacterial adhesins. Consequences of bacterial adhesion.

Bacterial Invasion – Routes of invasion (phagocytosis, induced endocytosis, active invasion). Intracellular niches for pathogens (intralysosomes, isolated vacuoles, cytosol). Mechanisms of bacterial invasion (Zipper mechanism and trigger mechanism); Consequences of invasion. Intracellular motility and intercellular spread of pathogenic bacteria.

UNIT-II

Types of Secretion systems in Animal-and plant- interacting bacteria. Bacterial toxins – Toxins acting on cell surface (super antigens, toxins cleaving cell surface molecules, pore forming toxins).Soluble toxins with an Intracellular target (toxins acting on protein synthesis and G-Proteins; cAMP generating toxin).Toxins directly delivered by bacteria into eukaryotic cell cytoplasm (EPEC Tir; *P.aeruginosa* exoenzyme *S; C.botulinum* exoenzyme 3). Biological effects of toxin action (cell death, nerve transmission, interactions with cytokines, signal transduction).

UNIT-III

Basic characteristics of cell signalling systems. Extracellular first messengers in signalling.Intracellular second messengers (cAMP, IP3, DAG, Calcium ions) in signalling.Eukaryotic cell-to-cell signalling–GPC receptor, RTK receptor, endocrine hormone signaling, cytokine signaling.

UNIT-IV

Prokaryotic cell-to-cell signalling (quorum sensing and bacterial pheromones, signals controlling conjugation in *Enterococcus faecalis*, signals controlling sporulation in *Myxococcus xanthus*).

Intracellular signalling mechanisms in prokaryotes.

Apoptosis – triggering of apoptosis, effector molecules of apoptosis, induction of apoptosis by microbes, activation of host cell receptors that signal apoptosis.

UNIT-V

Bioinformatics – introduction, scope and applications. Data bases – CBI Genebank, PDB, OMIM, EMBL. Literature Data Bases- Pub Med, Agricola, Med line.Types of Biological data bases; Sequence databases, Structural databases, Protein secondary structure prediction.Tools for sequence alignment – BLAST, FASTA. Visualization of protein structures using Rasmol or SPDB Viewer. Proteomics: Basics of proteomics; proteome analysis – two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Applications of proteomics.

REFERENCE BOOKS:

1) Cellular Microbiology – Henderson et. al. (1999).
2) Cellular Microbiology – Cossart et. al. (2000).
3) Genomes – T.A. Brown (2002).
4) Principles of Genetics – Snustad et. al. (1997).
5) Genes VII – Lewin (2000).
6) Bioinformatics: Methods and Applications (Genomics, Proteomics and Drug Discovery) - S.C. Rastogi et al., Kindle Edition.
7) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins - Edited by Andreas D. Baxevanis and B.F. Francis Ouellette (1998, ISBN-13: 978-0471383918)
8) Biological sequence analysis - Durbin, Eddy, Krogh, Mithison.
9) Introduction of Bioinformatics - T.A. Attwood - D.J. parry – smith (2001).
10) Bioinformatics a Practical Approach - K. Mani & N. Vijayaraj, Aparna Publications, Coimbatore.
11) Proteomics – Pennington, S.R. and Dunn M.J. (2002)

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 3.3 (B) (22): VETERNARY MICROBIOLOGY	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Able to diagnose various dreadful and contagious diseases caused by viruses and bacteria. Veterinary Microbiology course is basically for those students who want to enhance their understanding of the role of microbes in animal health and diseases.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge of specific bacterial infections and mode of transfer in cattle, sheep and goat and in poultry.
CO2	knowledge of specific viral infections and mode of transfer and prevention in cattle, sheep and goat and in poultry
CO3	knowledge of specific fungal l infections and mode of transfer treatment and prevention in cattle, sheep and goat and in poultry
CO4	Gain knowledge of specific fungal infections and mode of transfer treatment and prevention in cattle, sheep and goat and in poultry
CO5	Able to gain knowledge in therapeutic control of various infections using synthetic antibiotics and they may know the effect of environment by extensive use of antibiotics.

Unit – 1

Bacterial diseases inCattle: Johne's Disease, Pink Eye, Brucellosis, Leptospirosis, Anthrax, Plague. Sheep and goat: blue tongue, Peste-des-Petits Ruminants (PPR), Sheep pox.

Poultry: Fowl Typhoid, Fowl Cholera, Avian Tuberculosis, Fowl Coryza, Omphalitis, Coliform Infection. Clostridium Infections.

Unit - 2

Viral disease in cattle: Rabies, Japanese encephalitis, Vira diseases in sheep & Goat: Rabies, Contagious Ecthyma (Soremouth), Ringworm (Dermatophytosis), Chlamydiosis, Campylobacteriosis. Listeriosis. Salmonella & Q Fever (Query Fever, Coxiellosis).Viral diseases in Poultry: Egg drop syndrome, Markers' disease Infectious bursal disease, fowl pox, Inclusion body hepatitis.

Unit – 3

Fungal disease in cattle: Histoplasma capsulatum (causes histoplasmosis), Blastomyces dermatitidis (causes blastomycosis), and Coccidioides immitis (causes coccidioidomycosis).Fungal diseases in goat and sheep: candidiasis, cryptococcosis facial eczema.fungal placentitis sporotrichosis & zygomycosis.Fungal diseases in poultry: Aspergillosis or Brooder Pnumonia, Aflatoxicosis

Unit - 4

protozoan and nematode parasites in Veterinary: Parasitic infections in cattle: Babesiosis, Theileriosis, Sarcocystosis, Neosporosis, Coccidiosis, Cryptosporidiosis, Giardiasis, Besnoitiosis, Toxoplasmosis, Tryponosomosis. Parasitic infections in sheep and Goat:Internal Parasites: Nematodes (roundworms), Cestodes (Tape worms), Trematodes (Flukes).External parasites: Ticks, Keds, Biting Lice, Sucking Lice, Mites, Nasal bots.Parasitic infections in poultry:Internal parasites: round worms, Tapeworms, gape warms, Spirochaetosis.External parasites: Lice, mites, bugs, fleas.

Unit – 5

Therapeutic control of Veterinary diseases and important antibiotics: The use of antibiotics in veterinary medicine, Characteristics and environmental contamination, Detection and quantification of antibiotics in to the environment.Aminoglycosides, ß-Lactam Antibiotics, Chloramphenicol, Fluoroquinolones.Glycopeptides, Lincosamides, Macrolides, Polymixins, Rifamycins,Streptogramins, Tetracyclines & Diaminopyrimidines (Trimethoprim)

SUGGESTED READINGS:

1) Clinical Veterinary Microbiology, 2e 2nd Edition by Markey MVB PhD DipStat MRCVS, Bryan, Leonard MVB PhD MRC (2013)
2) Veterinary Immunology 10th Edition by Ian R Tizard
3) Veterinary Microbiology and Microbial Disease October 2011 P. J. Quinn, B. K. Markey F. C. Leonard
4) Textbook of veterinary microbiology S N Sharma & S C Adlakha
5) Veterinary Microbiology D. Scott McVey, Melissa Kennedy, M. M. Chengappa, John Wiley & Sons, 30-May-2013

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 3.3 (C) (22): NANOBIOTECHNOLOGY	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Would enlighten the students to understand basic concepts of synthesis and application of nanotechnology.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Understand and apply principles of physics, chemistry and engineering for understanding the scientific phenomenon in nano science.
CO2	Biosynthesis of nanomaterials by using different microorganisms is cost-effective and eco-friendly
CO3	Gain the knowledge on nano biometerials and types of Natural biomaterial products. Understand properties of most nano particles used in biology research.
CO4	Understand the importance of nanoparticles in biology and medicine as micro and nano fluidics and significance of nano particles in drug delivery system..
CO5	Understand the influence of nanoparticles on the environment and the relevant safety issues. Intellectual property *(*IP*)* rights are essential in today's technology-driven age. Building a strategic IP portfolio is economically

UNIT-I

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanocomposite, nanotubes, nanowires and Characterization of nanoparticles – UV-VIS IR spectroscopy, TEM, SEM, AFM, EDS, XRD. Emergence of bionanotechnology.

UNIT-II

Microbial nanotechnology – Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

UNIT-III

Preparation of nano biomaterials – Polymeric scaffolds collagen, Elastins: Mucopolysaccharides, proteoglycans, cellulose and derivates, Dextrans, Alginates, Pectins and Chitin. Nanoparticles – types (Silver, Gold and Titanium). Physical and chemical properties and functions.

UNIT-IV

Applications in biology and medicine: Nanotechnologies for biology and medicine - Micro- and nano- fluidics - Scanning probe microscopy in biology and medicine – Self-assembly of biological molecules. Drug delivery – protein mediated and nanoparticle mediated. Hybrid conjugates of gold nanoparticles – DNA oligomers in nano mechanics and Computing. Nanoparticles as carrier for genetic material.Genetically Modified Organisms (GMO) and applications.

UNIT-V

Health and safety implications: Health issues – Environmental issues – regulation guidelines. Societal implications- Possible military applications – Potential benefits and risks to developing countries – Intellectual property issues – Criticism of Nanotechnology

REFERENCE BOOKS:

1) Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication.
2) Elisabeth Papazoglou and Aravind Parthasarathy (2007).Bionanotechnology. Morgan & Claypool Publishers.
3) Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
4) David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Glo
5) Chaudhery Hussain (2022) Handbook of Microbial Nanotechnology,1st Edition.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 3.4 (A) (22): FERMENTATION TECHNOLOGY	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To gain knowledge and hands on skill on fermentation technology on Screening of microorganisms with commercially valuable products, differences between submerged and solid state fermentations their advantages , downstream processing ,construction and design of different types of fermenters and effluent disposal technique, commercialization of product through its economics.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Understand the basic principle of fermentation process and its application in industry, components required for fermentation process.
CO2	Evaluation commercially valuable microbial strains and application of genetic engineering tools to improve the potential of strain. Preservation of valuable strains Analysis of physical and chemical factors to formulate culture medium and designing the medium
CO3	Acquire the skill of construction of Fermentor, different types of fermentation processes. which will helps to gain easy employment.
CO4	Acquire the knowledge in construction of solid state fermenters, different types of industrial effluents and their disposal. And cost effective production of products with low input and economics of product and productivity.
CO5	Acquire the skill of down streaming process of valuable products from valuable microorganisms. Different types of industrial effluents and their disposal.

UNIT-I

Introduction to fermentation processes: The range of fermentation processes, chronological development of fermentation industry, component parts of fermentation process. Primary and secondary metaboloites. Screening of commercially valuable microorganisms: Primary and secondary screening procedures.

UNIT-II

Strain improvement of industrially important microorganisms: Conventional and modern genetic engineering approaches. Preservation of commercially useful microbial cultures: Storage at reduced temperatures, storage in dehydrated form. Design of culture media for industrial fermentations: Sources of energy, carbon and nitrogen, minerals, growth factors, buffers, addition of precursors and metabolic growth regulators, oxygen requirements, antifoams.

UNIT-III

Fermentors: Basic functions, body construction, aeration and agitation systems, maintenance of aseptic conditions, valves and steam traps, types of fermentors .Fermentation processes: Batch, fed-batch, semi-continuous and continuous fermentation systems, dual and multiple fermentations.

UNIT-IV

Recovery and purification of fermentation products (Downstream process): Separation of microbial cells from liquid fraction (filtration, centrifugation, and flocculation), cell disruption, solvent extraction, chromatography, membrane processes, drying of the product. Solid-state fermentations: Characteristics, microbial growth, production of enzymes and other metabolites, processes: Criteria used for scale-up, physical, chemical and process factors.

UNIT -V

Microbial production of commercially important metabolites. Treatment of industrial effluents: Physical, chemical and biological (aerobic and anaerobic) treatments, disposal of effluents. Economics of the fermentation process.

REFERENCE BOOKS:

1) Biotechnology- A text book of Industrial Microbiology. W.Crueger and A.Cruegar, 2000.
2) Manual of Industrial Microbiology and Biotechnology, Biochemistry and Technology. Joshi and Pandey (Eds.), 2 vols. 1999.
3) Priniciples of fermentation technology. P.F.Stanbury, A.Whitaker and S.J.Hall, 1997.
4) Molecular Biotechnolgy. B.R.Glick and J.J.Paternak, 1996.
5) Concepts in Biotechnology. D.Balasubramanian, C.F.A.Bryce, K.Dharmalingam, J.Green, Kunthala Jayaraman, 1996.
6) Microbial Biotechnology. A.N.Glazer and H.Nikaido, 1995.
7) Comprehensive Biotechnology-The principles, applications and regulations of Biotechnology in Industry, agriculture and Medicine. Murray Moo-Young (Editor-in-Chief), 1989.
8) A Revolution in Biotechnology. J.L. Marx (Ed.), 1989.
9) Biotechnology- A comprehensive treatise in 8 vols. H.J.Rehm and G.Reed (Eds.), 1985.
10) Microbial Technology. H.J. Peppler and D.Perlman1980.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 3.4 (B) (22): MICROBIAL ENZYMES	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Give knowledge about nomenclatures, characteristics and mechanism of enzymes, their biochemical calculation for enzyme kinetics, various applications of enzymes that can benefit food industry**.**

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Get knowledge in the basic concepts of enzymes and understand the isolation and purification of enzymes from various sources**.**
CO2	Understand the enzyme kinetics theories of enzyme kinetics, and the mechanisms of enzyme regulation
CO3	Able to understand Enzyme inhibition. Types of inhibition, clinical applications of competitive inhibition.
CO4	Acquire the knowledge in understanding the importance of ***coenzymes*** in metabolic activities, gain knowledge on allosteric enzymes.
CO5	Acquire the skill of *Immobilized enzyme* and understand the detrimental *effects* of low and high temperatures and their importance in industrial usage.

UNIT -I

Enzymes - General characteristics, classification and nomenclature Enzyme units, specific activities and turnover number. Structure of Active site. Non protein enzymes – Ribozymes. Methods of enzyme isolation and Enzyme purification. Methods of enzyme assay,

UNIT -II

Enzyme Kinetics: Pre steady state and steady state kinetics. Fast kinetics -Flow and relaxation methods. Factors influencing enzyme kinetics: Effect of pH, temperature, enzyme and substrate concentration. Michaels – Menten constant , linear transformation - Lineweaver - Burk plot.

Eadie - Hofstee plot, Hanes - Wolf equation, Significance of Km and Vmax, Kinetics of allosteric enzymes, MWC and KNF models. Hill's equation and coefficient, Bisubstrate reactions.

UNIT –III

Enzyme Inhibition: Irreversible and reversible, competitive, non competitive, uncompetitive, mixed inhibition, Suicidal inhibition (Kinetic differentiate and graphical methods). Clinical applications of competitive inhibition: PABA, methotrexate, methanol poisoning and insecticides poisoning.

Mechanism of enzyme action: Acid base catalysis, covalent catalysis, strain proximity and orientation effects. Mechanism of action of lysozyme, chymotrypsin, ribonuclease and carboxypeptidase.

UNIT –IV

Coenzymes: Multienzyme complexes - PDH, FADH2, Coenzyme A. Metal dependent enzymes and metalloenzymes, Zymogen.

Allosteric regulation of Aspartate transcarboamylase.

UNIT –V

Immobilization of Enzymes

Methods of immobilization, application of immobilized enzymes. Enzyme Engineering-Modification in the structure and active site of enzymes.

Industrial Enzymology: Amylases, glucose isomerases, cellulose degrading enzymes, pectic enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production.

REFERENCE BOOKS:

1) "Enzymology and Enzyme Technology" by Bhatt S M.
2) "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry" by Palmer T and P L Bonner.
3) "Enzyme Technology" by S Shanmugam and T Sathishkumar.
4) "Microbial Enzymes in Bioconversions of Biomass (Biofuel and Biorefinery Technologies)" by Vijai Kumar Gupta
5) "Metabolism and Enzymology of Nucleic Acids: Including Gene Manipulations" by Jan Zelinka and Jozef Balan.
6) "Enzyme Technology: Pacemaker of Biotechnology" by Prasad N K.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 3.4 (C) (22): PHARMACEUTICAL MICROBIOLOGY	L	T	P	C
3		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Able to understand methods of identification, cultivation and preservation of various micro organisams, pharmaceutical processing and industry 3.To learn sterility testing of pharmaceutical products and t microbiological standardization of Pharmaceuticals and e cell culture technology and its applications in pharmaceutical industries.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge in the accept of chemothereutic agents of synthetic and semi synthetic antibiotics with their mode of action.
CO2	Gain knowledge in development of new therapeutics against antibiotic resistant agents and phages involved in phage therapy.
CO3	Understand various disinfection and sterilization techniques, evaluate the sterility testing, microbial assays, pharmacopoeial standards of sterilization process
CO4	Gain hand on skill on microbial spoilage, of pharmaceutical products and deterioration. Due to this, products must be preserved during storage and multi dose use in order **to reduce or eliminate spoilage caused by microbial contamination**.
CO5	Understand and define quality and its concept and cost involved and gain knowledge in L strategic planning and implementation of quality systems. Learn important ICH guidelines on pharmaceutical product development and testing. Learn the concept of bench marking in quality

Unit I

Introduction to chemotherapeutic agents: History and development of chemotherapeutic agent, Properties of antimicrobial agents; Types of chemotherapeutic agents – Synthetic, Semisynthetic, Natural. Antibiotics: Types of antibiotics with their mode of action; antibacterial, antifungal, antiviral, antiprotozoal.

Unit II

Antibiotic resistance and development of new therapeutics: Development of antibiotic resistance, Mechanism of antibiotic resistance, Antimicrobial Peptides: History, properties, sources, mode of action, application. Phage therapy: introduction to phages, lytic cycle, types of phages involved in phage therapy Plant based therapeutic agents.

Unit III

Sterilization and Microbial spoilage of pharma products: Microbial contamination spoilage and hazard: Sources of contamination, factors affecting survival and growth, breakdown of active ingredient and general formulations. Principles of sterilizations with respect to pharmaceutical industries. Methods of sterilizations: Steam, dry heat, Radiation, Gaseous and Filtration.

Unit IV

Preservation of Pharma Products: Principles of preservation: objectives of preservation, the ideal preservative, rational development of a product preservative system etc. Antimicrobial preservatives and their properties: antimicrobial activity, factors affecting antimicrobial activity, preservative monographs. Preservative stability and efficacy.methods of Preservative evaluation and testing.

Unit V

Quality Management in pharmaceutical: Production Management and Documentation: ICH, ISO 9000 series, total quality management, validation for tablets and parenterals, practice of WHO GMP. Industrial Safety: Industrial hazards and their prevention, fire, accidents, mechanical and electrical equipment, industrial effluent testing. Drug stability: Solution stability, solid stability, parameters for physical stability testing, protocol for physical stability testing program, accelerated studies and shelf life assignment.

SUGGESTED READINGS:

1) Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications
2) Prescott's Microbiology 8th Edition by Willey, Joanne, Sherwood, Linda, Woolverton, Chris
3) Pharmaceutical Microbiology by Ashutosh Kar.
4) A text book of Pharmaceutical Microbiology, First edition Dr. Rohit Shankar Mane

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

FOURTH SEMESTER

M.Sc. MICROBIOLOGY

SEMESTER-IV

Semester	MB 4.1 (22): ENVIRONMENTAL MICROBIOLOGY	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To understand the significant role of microorganisms in the environment and knowledge l to conserve the health of environment. aerospora, aerallegins and their and their impact on environment. Types of aquatic microorganisms, water pollution through coliforms, water purification strategies and sewage treatment techniques. diversity of soil microorganisms their role in bio geo chemical equilibrium and their benefits and harms to soil environment. Bio exploitation of microorganisms for Nitrogen fertilizer, bioremediation, bioleaching and Bioenergy aspects.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Understand the aerial microorganisms and their mode of adaptations in air. Acquire the knowledge of impact of seasons and day and night conditions on airspora. Understand the technology to detect aerospora of indoor and outdoor environment. Acquire the skill of screening of aeroallergins and allergic substances.
CO2	Acquire the knowledge of detection and enumeration of coliforms and kill to analyse water quality. Analysis of physical and chemical factors that influence potable water. Acquire the skill of sewage water treatment technique.
CO3	Acquire the knowledge on soil microflora and their diversity. Evaluation of microbial populations of soil environment and their role as beneficiary or antagonistic organisms in soil ecosystems.
CO4	Acquire the knowledge on nature, mechanism and importance of microorganisms in C, S & P transformations and mechanisms and ecological significance of transformations of nitrogenous compounds.
CO5	Gain the knowledge of different types of environmental conservation benefits of microorganisms such as Bioremediation of polluted soils Bioleaching of minerals and Bioenergy.

UNIT-I

Aerial environment; kinds of micropropagules in air; adaptations of airspora to aerial environs.

Seasonal and diurnal periodicities of airspora; importance of aerobiological studies. Methods of detecting the micropropagules in extramural and intramural environs- air sampling techniques. General account on aeroallergens and allergic reactions.

UNIT-II

Aquatic environment, microorganisms in water bodies-phytoplankton populations and importance. Sampling of water samples, detection and enumeration of microorganisms in water, coliform test for water quality. Treatment of waters for drinking purpose.BOD determination.Sewage water treatment.

UNIT-III

Soil environment: components of soil, diversity and abundance of dominant soil microorganisms, methods of isolation and estimation of soil microflora. Soil organic matter-nature, synthesis and decomposition.Beneficial and antagonistic interaction among soil microorganisms.

UNIT-IV

Transformation of carbon, sulphur, phosphorus and iron (nature of microorganisms, mechanism and importance) in soil. Organisms, mechanisms and ecological significance of transformations of nitrogenous compounds in soil – Dinitrogen fixation, ammonification, nitrification and denitrification.

UNIT-V

Bioremediation of polluted soils: Microbial degradation of xenobiotics – recalcitrance of pesticides in soil, microbial degradation of pesticides. Microbial degradation of petroleum products (hydrocarbons) in oil spills. Bioleaching of minerals- factors affecting leaching, microbial leaching processes of copper, uranium and gold. Bioenergy – role of microorganisms in production of biogas, hydrogen and bioethanol.

REFERENCE BOOKS:

1) RAPLH MITCHELL - Environmental Microbiology (1978)
2) LYNCH & POOLE - Microbial Ecology : A conceptual approach (1979)
3) PAUL & CLARK - Soil Microbiology & Biochemistry (1989)
4) GREGORY - The Microbiology of atmosphere (1973)
5) RHEINHEIMER - Aquatic Microbiology (1974)
6) TILAK - Aerobiology (1997)
7) SUBBA RAO - Soil Microorganisms and Plant Growth (1995)
8) SUBBA RAO - Soil Microbiology (1999)
9) SUBBA RAO - Biofertilizers in Agriculture and Forestry (1995)
10) ATLAS & BARTHA - Microbial Ecology (1997)
11) MAIER, PEPER & GERBA - Environmental Microbiology (2000)
12) COYNE - Soil Microbiology (2000)
13) RATLEDGE C - Biochemistry of Microbial degradation

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 4.2 (22): FOOD MICROBIOLOGY	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To facilitate the students with the knowledge of factors influencing the microbial activity in foods and also the methods of microbial examination of foods. microbial spoilage of different foods and methods for food preservation. Role of microorganisms in dairy industry. food-borne illnesses caused by contaminated foods and the food control agencies and their acts. pros and cons of Genetically modified foods.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the various sources through which the microorganisms can contaminate the foods. Realize the influence of different internal and external factors that effect the activity of microbes in foods. Know the processes for assessing the level of microbial contamination
CO2	Clearly realize the causes of microbial spoilage of different categories of foods. Understand the appropriate physical and chemical methods of food preservation to avoid the spoilage of different kinds of foods.
CO3	Know the normal microbial flora of milk, sources of contamination and spoilage of milk. Acquaint with the preparation and importance of various fermented milk products.
CO4	Acquaint with the preparation and importance of various fermented food products. Know about the concept and therapeutic uses of different probiotics. Know the different genetically modified foods and their biosafety.
CO5	Realize the deleterious nature of various food poisoning and food borne infections, about good food manufacturing practices,.

UNIT-I

Introduction to Food Microbiology. Microorganisms associated with foods and sources of microbial contamination of foods. Factors affecting microbial activity in foods – intrinsic factors (Nutrient content, pH, Redox potential, Water activity) and extrinsic factors (Relative humidity, Temperature, Gaseous atmosphere).Methods for microbial examination of foods – enumeration methods, alternative methods and rapid methods.

UNIT-II

Food spoilage – causes of food spoilage, microbial spoilage of vegetables, fruits, cereals & cereal products, fresh and processed meats, poultry & eggs, fish & shellfish, beverages (beer and wine) and canned foods.

Food preservation methods – low temperature, high temperature, drying, radiation and chemical preservation (salting, benzoic acid, sorbic acid, sulphur dioxide, sulphates, nitrites, nitrates, acetic acid, antibiotics).

UNIT-III

Dairy microbiology – Microorganisms in milk (normal flora & biochemical types of bacteria), sources of contamination of milk, causes of milk spoilage, enumeration of microorganisms in milk samples, fermented milk products (natural butter milk , cultured butter milk, acidophilus milk, bulgarian butter milk, kumiss, kefir, yoghurt), types and production of Cheddar cheese.

UNIT-IV

Fermented foods – Fermented vegetables (Sauerkraut); Alcoholic beverages (beer, wine); Non-alcoholic beverages (tea, coffee); Fermented meat products; Bread making.

Introduction to Probiotics.

GM foods and biosafety.

UNIT-V

Food poisoning and food-borne infections – botulism, gastroenteritis of *Staphylococcus* and *Clostridium perfringens*, Salmonellosis, Shigellosis, Listeriosis, Vibriosis, Yersiniosis, paralytic shellfish poisoning. Preventive measures – Good manufacturing practices, health hazard critical control point analysis. Food control Agencies and Acts.International commission on the microbiological specifications for foods.

REFERENCE BOOKS:

1) Food Microbiology - Frazier WC and Westhoff Dc (2003)
2) Food Microbiology - Adams, MR and Moss, MO (2015)
3) Modern Food Microbiology - James M.Jay (1996)
4) Basic Food Microbiology - George J. Banwart (1989)
5) Food Processing and preservation -Sivasankar, B (2002)
6) Essentials of food Microbiology -John Garbutt (1997)
7) Outlines of Dairy Technology - Sukumar De (1997)
8) Dairy Microbiology - Robinson RK (1990)

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 4.3 (A) (22): INDUSTRIAL MICROBIOLOGY	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Get equipped with theoretical and practical understanding of industrial microbiology. Identify techniques applicable for improvement of microorganisms based on known biochemical pathway and regulation mechanism. Comprehend the techniques and the underlying principals in downstream processing.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge on large-scale and profit motivated production of microorganisms for direct use. Techniques in manufacture of other commercial products, production of drugs (antibiotics), chemicals and fuels of industrial significance. Acquire hands on skill to identify microbes that produce novel bioactive compounds.
CO2	Understand the basic principle of bioprocessing of Enzymes, Vitamins, Amino acids and Organic acids of industrial significance. Technical skill in formulation of media.
CO3	Acquire the skill in bioprocessing of polysaccharides of bacteria, fungi and yeast
CO4	Understand biotransformation of secondary metabolites and bioconversion of various important biomolecules such as steroids and sterols. Bioremediation of industrial waste.
CO5	Gain knowledge and skills on enzyme immobilization methods for industrial purpose and large scale production of products. principles of various ways of immobilization techniques and Intellectual Property Rights to build an industry for production of products and marketing and its outcome.

UNIT-I

Introduction to Industrial Microbiology: Definition, scope, microorganisms, properties and industrial products. Production of antibiotics by fermentation: Microbial groups producing antibiotics. Production, biosynthesis and regulation, strain development, production medium, fermentation, recovery of Penicillin, semi-synthetic penicillins, Tetracyclines and Streptomycin: Production of organic feed stocks by fermentation: Ethanol, Acetone/butanol fermentation.

UNIT-II

Fermentative production of Enzymes: Microbial enzymes for industrial use. Amylases: Microbial groups producing ά–amylases, β–amylases, glucoamylases, pullulanases, strain development, medium formulation, Process conditions and recovery. Proteases: Microbial production of Alkaline, Neutral and Acid Proteases, Production methods. Industrial production of vitamins by microorganisms: vitamin B12 and Riboflavin-Structure, biosynthesis and production process. Production of Nucleosides and Nucleotides by fermentation: Structure, biosynthesis and production process.

UNIT-III

Production of Organic acids by fermentation: Microbial strains producing Organic acids. Microbial strains, biosynthesis and production process of Citric acid and Acetic acid. Production of Amino acids by fermentation: Microbial strains employed in Amino acid Production. Production strains, biosynthesis and production process of L-Glutamic acid and L-Lysine: Microbial polysaccharides: Nature, mechanism of synthesis, bacterial polysaccharides, fungal polysaccharides and yeast polysaccharides.

UNIT-IV

Microbial Transformations: Types of bioconversion reactions, procedures for biotransformation, application of Bioconversions, transformation of steroids and sterols, transformation of non-steroid compounds, transformation of antibiotics.

Industrial waste management: Types of waste (Solid, liquid, air, toxic, medical, radioactive) and their management. Bioremediation of various types of industrial waste. Concept of xenobiotics and their management.

UNIT-V

Immobilization of cells and enzymes: Matrices for immobilization, Methods of immobilization, Immobilized cell fermentations versus conventional fermentations, applications of immobilized cells and enzymes.

Intellectual Property Rights: Copy right patent, Trademark, Trade secrets, Utility model, procedure for patent filing, Geographical indication, Industrial design rights.

Bio safety - Concept of Biosafety regulation in development and handling of recombinant microbial products

REFERENCE BOOKS:

1) Biotechnology-A text book of Industrial Microbiology. W. Crueger and A.Cruegar, 2000.
2) Manual of Industrial Microbiology and Biotechnology. A.L.Demain and J.W.Davies (Eds), 1999.
3) Biotechnology:Food fermentation-Microbiology, Biochemistry and Technolgy. Joshi and Pandey (Eds.), 2 vols.1999.
4) Molecular Biotechnology. B.R. Glick and J.J.Paternak, 1996.
5) Concepts in Biotechnology. D.Balasubramanian, C.F.A.Bryce,
6) K.Dharmalingam, J.Green, Kunthala Jayaraman, 1996.
7) Microbial Biotechnology. A.N.Glazer and H.Nikaido, 1995.
8) Comprehensive Biotechnology-The principles, applications and regulations of Biotechnology in Industry, agriculture and Medicine. Murray Moo-Young (Editor-in-Chief), 1989.
9) A Revolution in Biotechnology. J.L.Marx (Ed.), 1989.
10) Biotechnology-A comprehensive treatise in 8 vols. H.J.Rehm and G.Reed (Eds.), 1985.
11) Microbial Technology. H.J.Peppler.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 4.3 (B) (22): ENVIRONMENTAL TOXICOLOGY	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	Get equipped with theoretical and practical understanding of industrial microbiology. Identify techniques applicable for improvement of microorganisms based on known biochemical pathway and regulation mechanism. Comprehend the techniques and the underlying principals in downstream processing.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge on scope ,goal and concepts of environmental toxicology
CO2	Acquire hands on skill Toxicity testing;.
CO3	Acquire the skill in handling Heavy metals toxicology: Immuno toxicity, histotoxicity, celltoxicity, neurotoxicity, nanotoxicity;
CO4	Acquire awareness on Public health hazards; Radiation hazards and pollution related diseases; Environmental forensics; Chemical and safety evaluation.
CO5	Gain knowledge and skills on Bio-transformation of Xenobiotics. Biomonitoring of toxic chemicals and parameters,bio indicators and Environmental monitoring

UNIT- I

Introduction to toxicology, scope, goals and branches of toxicology; Toxicants and Toxicity-influencing factors, drugtoxicity, biochemical basis of toxicity– mechanism of toxicity and recept or mediated events, acute and chronic toxicity. Selective toxicity. Concentration and dose, Toxicity of chemical mixtures – synergism and antagonism.

UNIT-II

Dose – Response relationships – Graded response, quantal response, Time action curves. Statistical concept of toxicity. Threshold Limit Value (TLV); LC50; Margin of safety; Toxicity curves; Cumulative toxicity and LD50 & CTF. Toxicity testing; Toxicity curves. Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC50, Limitation and importance of Bioassay, Acute Toxicity (single); Subacute Toxicity

UNIT- III:

Heavy metals toxicology: Bio-chemical cycles of toxic metals, Metabolism, toxicity monitoring and exposure standards for heavy metals such as Cadmium, Lead, Nickel, Mercury, Arsenicinhumans Chronic Toxicity; Teratogenicity, carcinogenicity and mutagenicity. Immunotoxicity, histotoxicity, celltoxicity, neurotoxicity, nanotoxicity; Biomonitoring of Toxic Chemicals - Objectives, programs & parameters, concepts of bioindicators –groups with examples

UNIT-IV:

Toxicantsas Public health hazards; Toxicology of major pesticides Environmental impacts of pesticides - Persistence, Bio accumulation and Bio magnifications in food chain. Food additives – types, functions and related health hazards; Radiation hazards and pollution related diseases; Environmental forensics; Chemical and safety evaluation.

UNIT -V:

Bio-transformation of Xenobiotics (Selective Toxicity); Principles, Receptorsites, absorption and storage of xenobiotics; types of Bio transformations; microsomal oxidations, mixed function oxygenases, conjugation, biotransformation of organo-chlorine and organo-phosphorous pesticides, Absorption, translocation and excretion of xenobiotics. Antidotal procedures in Toxicology. Biomonitoring of toxic chemicals and parameters, Concept of bioindicators and Environmental monitoring.

REFERENCE BOOKS:

1) Jerome O.Niragu and Lakshminarayana J.S.S.(1989).Aquatic Toxicology and Water QualityManagement,JohnWiley&Sons.23
2) Sharma P.D.(1994). Environmental Biology and Toxicology, Rastoggi and Company. M.Sc. Environmental Science,
3) Meera AsthanaandAsthanaD.K.(1990).EnvironmentalPollutionandToxicology,A lka Printers.
4) Mettelev V.V, Kanaev A.I and Dzasokhova N.G.(1971).Water Toxicology, Amerind Publishing Co.Pvt.Ltd.
5) Standard Methods for the Examination of water and Waste water,17thEd.,(1989).A PHA-AWWA-WPCF
6) Guithinier Perry.(1980).Introduction to Environmental Toxicology, Elsevier.
7) Waldron H.A.(1980). Metalsin Environment. Academic Press, Toronto.
8) Butter G.C.(1988). Principles of Ecotoxicology.John Wiley and Sons.
9) Moriarty F.(1983). Ecotoxicology. Academic Press, NewYork.
10) Oehme W.F.(1989). Toxicity of Heavy Metals in Environment Marcel Dakkar Inc., NewYork.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 4.3 (C) (22): ECOFRIENDLY TECHNOLOGIES	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To impart the knowledge and awareness for the environmental protection for real-time contribution during an execution of engineering practices in the society.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Gain knowledge about different types of environmental pollutions and their control measure and various social aspects related to the environment
CO2	Understand the Concept of an eco-system, , types, characteristic features,
CO3	Acquire awareness on Environmental Pollution: Solid waste Management:. Disaster management.
CO4	Acquire awareness on Social issues and the Environment, Environmental ethics, Climate change, global warming,
CO5	Gain knowledge and skills on Environment protection Act Wild life protection Act, Forest conservation Act, Issues involved in enforcement of environmental legislations

UNIT – 1

Environmental studies and Natural Resources: Definition, scope and importance of environmental studies. Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems; (a) Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forests and tribal people. (b)Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems. (c) Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources. (d)Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers-pesticides problems, water logging, salinity. (e) Energy Resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources

UNIT -II

Eco Systems: Concept of an eco-system, Structure and function of an eco-system, Producers, consumers, decomposers, Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems: (a) Forest ecosystem (b)Grass land ecosystem (c) Desert ecosystem. (d) Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT – III

Environmental Pollution: Definition: Causes, effects and control measures of; (a) Air pollution (b) Soil pollution (c) Marine pollution (d) Noise pollution (e) Nuclear hazards Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
Disaster management: Floods, earth quake, cyclone and landslides

UNIT – IV

Social issues and the Environment: [10 L] From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics: issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

UNIT – V

Environment protection Act, Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection Act, Forest conservation Act, Issues involved in enforcement of environmental legislations.

SUGGESTED BOOKS:

1) Textbook of Environmental studies, Erach Bharucha, UGC.
2) Fundamental concepts in Environmental Studies, D. D. Mishra, S Chand & Co Ltd.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 4.4 (A) (22): BIOFERTILIZER TECHNOLOGY	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	To understand the significant role of microbial bio fertilizers and conserve the health of environment. hands on skill for large scale production and field application of biofertilizers. Practical training towards entrepreneurship

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	To understand the biofertilizer microorganisms and their mode of adaptations. preparation of bio fertilizers technology and acquire the skill of screening.
CO2	Acquire knowledge on detection and enumeration of symbiotic and nonsymbiotic inoculants nd the skill of large scale bioprocessing.
CO3	Acquire knowledge on detection and enumeration of mycorrhiza and phosphate solubilizers. physical and chemical factors that influence inoculum production
CO4	Acquire knowledge in the production of vermicompost. Gain knowledge for production at industrial level.
CO5	Acquire knowledge in maintenance of quality. Gain knowledge on industrial quality assurance of microbial products.

UNIT-I

Introduction: importance & scope of biofertilizers in agriculture & organic farming.

History of biofertilizer production; classification of biofertilizers, Factors influencing efficacy of biofertilizers. Advantage of biofertilizers over chemical fertilizers.Types of biofertilizers, qualitative screening of phosphate solubilization, ammonia and IAA production; mechanism of action of phosphate solubilization, ammonia and IAA production.Benefits of biofertilizers. Buying and storage methods of biofertilizers. Cautions and limitations of biofertilizers. Carrier material: Different types of carrier materials, properties of carrier, sterilization methods of carrier, advantages and disadvantages of carrier material.

UNIT-II

Rhizobium – Morphology, molecular identification, collection and preservation of root nodules, isolation technology of different strains, screening of N_2 fixation. Bioprocessing (carrier based and liquid inoculants), Field application methods.

Case study: Inoculation and fertilization methods of *Rhizobium* inoculants for Soy bean in Japan.

Azospirillum - Morphology, molecular identification, collection and isolation technology of endophytic bacteria, associate bacteria from rice fields. Screening of ammonia production. Bioprocessing (mass inoculum and liquid inoculants), Field application methods.

Case study: Inoculation and fertilization methods of *Azospirillum* inoculants for corn in Indonesia.

UNIT-III

Mycorrhiza - Morphology, collection, identification and isolation technology of Vesicular-arbuscular mycorrhiza from roots and spores. Bioprocessing (Trap culture and peat culture), preservation, field application methods.

Phosphate solubilizers - Morphology, collection, identification and isolation of inorganic phosphate and organic phosphate solubilizers from soil. Bioprocessing (carrier based and liquid inoculants), preservation, field application methods.

Case study: Improvement of soil condition with phosphate solubilizers on fifty years long term experiments in rice in Korea.

UNIT-IV

Vermicompost - Importance of vermicompost, economic importance of earthworms in maintenance of soil structure. Useful species of earthworms (Local species of earthworms.Exotic species of earthworms).Limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).Physico-chemical parameters of vermicompost. Different Methods of vermicomposting (Small- and large-scale Bed method, Pit method Small Scale Earthworm farming for home gardens).Nutritional composition of vermicompost for plants, comparison with other fertilizers.

UNIT-V

General concept of Quality control: Microbial function and shelf life of recommended biofertilizers, Properties of microbial products and Quality management.

Quality control procedures- mother culture test, broth culture test, peat culture.

Quality control of laboratory; preparation room, growth room and storage room.

Inoculationon media, count of colony forming units. Quality text for certifications and prospects.

REFERENCE BOOKS:

1) The Complete Technology Book on Biofertilizer and Organic Farming (2nd Revised Edition) – 2012 by NIIR Board
2) Microbes as Bio-fertilizers and their Production 2015-By S.G.Borkar
3) Hand Book Of Microbial biofertilizer 2006 - edited by M.K. Roy

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 4.4 (B) (22): MUSHROOM CULTIVATION AND SINGLE CELL PROTEIN	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	The aim of the course is to impart knowledge of mushroom cultivation and single cellprotein skill for self employment and entrepreneur ship.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Know the importance of mushrooms and their scope in present and future prospects
CO2	Know the basic principles, culture techniques of mushroom farming, growth media and spawn running.
CO3	Acquire knowledge and hands on skill in post-harvest treatment of a mushroom crop like processing and drying preservation and gain knowledge in economics of mushroom cultivation like packing and marketing.
CO4	Acquire knowledge in understanding the scope and importance of SCP and gain knowledge on different microorganisms that can be used as SCP..
CO5	Gain hands on skill for protein extraction from pure or mixed cultures of algae, yeasts, fungi and bacteria and practice in post harvesting technology of recovery, drying, medicinal value, economics of SCP.

UNIT-I

Importance of mushrooms, Scope, past, present status and future prospects.Morphology, classification, edibility and poisonous properties, sterilization, contamination, structural changes during the development of the mushroom fungi.Life cycles of *Volvariella* sps, *Pleurotus* sps, *Agaricus* sps.Button mushroom and genetic improvement of mushroom strains.

UNIT-II

Culture techniques of mushroom farming, growth media, spawn running. Cultivation of different mushrooms: paddy straw mushroom, oyster mushroom, milky mushroom and button mushroom. Harvesting of mushrooms.Composting: importance in waste recycling.

UNIT-III

Post harvest technology: Processing of mushrooms, production of dried mushrooms from fresh mushrooms, Preservation of mushrooms – freezing, dry freezing, drying, canning, quality assurance and economics of mushroom cultivation.Value added products of mushrooms. Health benefits of mushrooms - Medicinal and nutritional values of mushrooms.

UNIT-IV

Introduction, History and importance of Single Cell Proteins, Scope and future prospects. Different genera of Algae, Yeasts, Fungi and Bacteria as single cell protein.

UNIT-V

Production of single cell protein - Media optimization, culture maintenance and product evaluation.Post harvest technology- recovery, drying, economical significance of SCP. Processing of SCP for food usage, advantages and limitations of SCP. Applications of SCP.

REFERENCE BOOKS:

1) Nita bahl, 2002, Handbook on mushrooms, 4th edition vijaya primal for Oxford & IBHpublishing Co pvt Ltd., New Delhi.
2) Hand book on mushroom cultivation 1999.tnau publication
3) Chang T.S. and Hayes W.A.., 1978.The biology and cultivation of Edible Mushrooms. Acadamic Press, Newyork.
4) M.c, Nair, C.Gokulapalan and Lulu das1997.Topics on mushroom cultivation, scientific publishers, Jodhpur, India.
5) Ignacimuthu, S. 1997. Applied plant biotechnology, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

Semester	MB 4.4 (C) (22): ORGANIC FARMING AND VERMICOMPOSTING	L	T	P	C
4		4	0	6	4

LEARNING OBJECTIVES (LO):

LO	The aim of the course is to impart knowledge to minimize the use of chemical fertilizer by organic farming and to understand the scope, concept, advantages and disadvantages of organic farming.

COURSE OBJECTIVE (CO): At the end of the course, the student will be able to

CO1	Know the importance of Distinguish different soil types and their importance in organic farming.
CO2	Acquire hands on skill Understand the significance of organic farming.
CO3	Acquire knowledge and hands on skill Gain knowledge on types, nutritive value and preparation of organic manures.
CO4	Acquire knowledge in understanding the scope and importance of Know the preparation, types and applications of biofertilizers.
CO5	Gain the knowledge about significance of vermin compost.

UNIT–I

Soil and its physical characters, Soil types- alluvial, laterite, clay, loam.Physical testing and assessment of soil types. Soil conditioners – Lime, dolomite, gypsum, organic use of soil conditioners for better management of soil.

UNIT–II

Concept of Organic farming – Practical, positive and negative aspects of chemical fertilizer applications. Need for organic farming. Organic farming – Vision, concept, principles and benefits of organic farming.

UNIT–III

Conventional farming verses organic farming; Organic manures; Types of compost- green manure, farmyard manure. Nutritive value of compost; Methods of compost preparation.

UNIT–IV

Biofertilizers: Methods of compost preparation. Types, production, processing of Biofertilizers; Methods of application of biofertilizers.

UNIT-V

Vermi composting: An overview of vermin composting, introduction to vermin composting, definition, meaning, their role in biotransformation of residues, maintenance of soil structure and economic importance. Local and useful species of earthworm, choosing the right worm.

REFERENCE BOOKS:

1) Hand book of organic farming and biofertilizers-M.K.GUPTA
2) Biofertilizers technology – R.SHANKARA REDDY
3) Biofertilizers technology- KHANNAIYAN. S
4) Practical handbook of agriculture science – HANSON

Course Outcome	Programme Outcome										Programme specific Outcome				
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	3	3	2	3	3	2	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2

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