



SACRED HEART COLLEGE (AUTONOMOUS)

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Accredited by NAAC (4th Cycle – under RAF) with CGPA of 3.31 / 4 at 'A+' Grade

SACRED HEART COLLEGE (AUTONOMOUS), TIRUPATTUR M.Sc Applied Microbiology - Programme Structure (Effect from 2021 – 2022)

Se m	Part	Subject Code	Subject Title	Hrs	Credit (s)	Exam Hrs	CA	SE	Total
I	Core Paper I	MB701	General Microbiology and Microbial Diversity	4	4	3	5 0	5 0	100
	Core Paper II	MB702	Microbial Physiology and Metabolism	4	4	3	5 0	5 0	100
	Core Paper III	MB703	Immunology	4	3	3	5 0	5 0	100
	Core Paper IV	MB704	Molecular Microbiology	4	4	3	5 0	5 0	100
	Core Practical I	PMB801	General and Medical Microbiology	5	-	-	-	-	-
	Core Practical II	PMB802	Immunology, Hematology and Molecular Biology	5	-	-	-	-	-
	Elective Paper I	MB705A MB705B MB705C	(to choose 1 out of 3) 1. Microbial Instrumentation 2. Biostatistics 3. Phycology and Mycology	4	3	3	5 0	5 0	100
				30	18	-	-	-	500
II	Core Paper V	MB801	Medical Bacteriology	6	4	3	5 0	5 0	100
	Core Paper VI	MB802	Medical Virology	5	4	3	5 0	5 0	100
	Core Paper VII	MB803	Medical Mycology and Parasitology	5	4	3	5 0	5 0	100
	Core Practical I	PMB801	General and Medical Microbiology	5	4	6	5 0	5 0	100
	Core Practical II	PMB802	Immunology, Hematology and Molecular Microbiology	5	4	6	5 0	5 0	100
	Elective Paper II	MB804A MB804B MB804C	(to choose 1 out of 3) 1. Pharmaceutical Microbiology 2. Bioinformatics 3. Public Health Microbiology	4	3	3	5 0	5 0	100
		PMB803 J	Internship*	-	2*	-	-	-	-

				30	23+2*	-	-	-	600
III	Core Paper VIII	MB901	Research Methodology	4	4	3	5 0	5 0	100
	Core Paper IX	MB902	Bioinoculant Technology and Plant Pathology	4	4	3	5 0	5 0	100
	Core Paper X	MB903	Mushroom Technology	4	4	3	5 0	5 0	100
	Core Paper XI	MB904	Environmental Microbiology	4	4	3	5 0	5 0	100
	Core Practical III	PMB100 1	Bioinoculant, Composting and Mushroom Technology	5	-	-	-	-	-
	Core Practical IV	PMB100 2	Environmental and Food Microbiology	5	-	-	-	-	-
	Elective Paper III	MB905A MB905B MB905C	(to choose 1 out of 3) 1. Microbial Remediation 2. Vermitechnology 3. Microbial Nanotechnology	4	4	3	5 0	5 0	100
				30	20	-	-	-	500
IV	Core Paper XII	MB1001	Food Microbiology	4	4	3	5 0	5 0	100
	Core Paper XIII	MB1002	Industrial Microbiology	5	5	3	5 0	5 0	100
	Core Paper IX	MB1004 J	Project/Dissertation with Viva voce	5	5	-	5 0	5 0	100
	Core Practical III	PMB100 1	Bioinoculant, Composting and Mushroom Technology	5	5	6	5 0	5 0	100
	Core Practical IV	PMB100 2	Environmental and Food Microbiology	5	5	6	5 0	5 0	100
	Elective Paper IV	MB1003 A MB1003 B MB1003 C	(to choose 1 out of 3) 1. Microbial Biotechnology 2. Microalgal Technology 3. Probiotic Microbiology	4	4	3	5 0	5 0	100
	-	-	Human Rights	2	1	3	5 0	5 0	100
	-	-	Self Study Paper (SSP): Comprehensive Microbiology	-	2*	-	-	-	-
	-	-	NPTEL/MOOCs/Other Certificate courses*	-	2*	-	-	-	-
Total				30	29+4*	-	-	-	700
TOTAL				120	90+6*	-	-	-	2200

TOTAL HOURS = 120 Hours

TOTAL CREDITS = 90 + 2* (Internship) + 2* (NPTEL/MOOCs/Other Certificate courses) + 2* (Self Study Paper)

REGULATION FOR THEORY

1) Evaluation Scheme for Continuous Assessment (50 Marks)

CA exam (15×2)	-	30 marks
MCQs (Unit test)	-	10 marks
Assignment	-	05 marks
Seminar	-	05 marks

2) Question Paper Pattern for CA

The question paper shall have three sections with the maximum of 50 marks with the following break-up:

Section - A

Section - A shall contain 6 Short answer questions without choice drawn from Two units
Each question shall carry 2 marks. ($6 \times 2 = 12$ marks)

Section - B

Section - B shall contain 3 either or questions drawn from Two units.
Each question shall carry 6 marks. ($3 \times 6 = 18$ marks)

Section – C

Section C shall contain 3 questions from Two units.
Two questions out of the Three are to be answered each carrying 10 marks. ($2 \times 10 = 20$ marks)

3) Question Paper Pattern for Semester Examinations

The question paper shall have Three sections with the maximum of 100 marks with the following break-up:

Section - A

Section - A shall contain 10 short answer questions without choice drawn from all the units on the basis of minimum two from unit.

Each question shall carry 2 Marks.

(10 × 2 = 20 marks)

Section - B

Section - B shall contain 5 either or questions drawn from all the Five units.

Each question shall carry 7 marks.

(5 × 7 = 35 marks)

Section – C

Section - C shall contain 5 questions drawn one each from the five units.

Three questions out of the five are to be answered each carrying 15 marks. (3×15 = 45 marks)

REGULATION FOR PRACTICALS

1) Pattern for Core Practical

Total: 100 Marks

Internal Assessment (50 marks)

Class Work - 25 marks

Model exam - 25 marks

Semester Examination (50 marks)**Evaluation Pattern for Internship**

Submission of report with Certificate of attending 20 days Internship before the starting of Semester – III from the Concerned Lab.

Evaluation Pattern for SSP (Comprehensive Microbiology)

- Submission of Assignment
- One MCQ test covering the Syllabus

Semester – I

4 Hours/4Credits

MB 701: GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY

Objectives

- To impart basic knowledge about the History and classification of Microbiology.
- To make students to understand the fundamentals and diversity of Microbiology.
- To learn the Taxonomy, Ultrastructure, Classification of microorganisms.
- To provide insights on cultivation techniques and antibiotics.
- To recognize the fundamentals on Economic importance of microorganisms.

Course Outcomes

S.No.	Description	Cognitive Level (K-level)
CO-1	Knowledge on Landmark discoveries in Microbiology and different domains classification of living organisms.	K3
CO-2	Define and examine the structure, properties and classification of Bacteria, Fungi, Algae, Protozoa and Viruses.	K1
CO-3	Broad knowledge on the structure and functions of organelles of Prokaryotes and Eukaryotes.	K3, K6
CO-4	Discuss the Economic importance of Fungi, Algae and Protozoa.	K2
CO-5	Explore and recommend the Staining techniques, Culture medium and Biochemical tests applied in identification of microorganisms.	K4, K5
CO-6	Demonstrate a clear understanding of microbial control mechanisms through Sterilization techniques and Antibiotics.	K2

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	3	3	3	2	3	3	3	2	3	3	2.7
2	2	2	3	3	2	2	3	2	3	3	2	2	3	2	1	2.3
3	3	1	2	3	1	3	2	3	2	2	3	3	2	3	3	2.4
4	2	2	3	2	3	2	3	3	3	3	3	3	3	2	2	2.6
5	2	3	3	2	2	2	2	2	2	2	2	2	3	2	2	2.2
6	3	2	2	3	3	3	2	3	3	3	3	3	2	3	3	2.7
Mean Overall Score																2.5
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Members of Microbial world; Conflict over Spontaneous generation; The Discovery of Microorganisms; Contributions of Anton van Leeuwenhoek, Louis Pasteur, Edward Buchner, Robert Koch, Ignaz Semmelweis, Joseph Lister, Paul Ehrlich, Martinus Beijerinck, Sergi Winogradsky, Alexander Fleming and Selman Waksman; Golden age of Microbiology; Branches of Microbiology; Phylogenetic Hierarchy; Nomenclature of Microorganisms; Taxonomy and Taxonomic Hierarchy; Numerical Taxonomy; Kingdom concept of Organisms classification – Lennaeus Two Kingdom concept, Haeckel Three Kingdom concept, Copeland's Four Kingdom concept, Whittaker's Five Kingdom concept, Grey & Doolittle's Six Kingdom concept and Cavalier-Smith's Eight Kingdom concept; Cell and Cell theory; Wose – Fox's Three Domains of Life; Genetic and Intraspecies Classification.

Unit – II

Bacteria – Ultrastructure; Morphological Classification (Gram positive & Gram negative), Shape and Arrangement; Cell wall; Difference between Bacterial and Archaeal Cell wall; *Mycoplasma* and L - forms; Cell membrane; Bacterial Nucleoids; Cell inclusions; Ribosomes; Capsules and Slime layer; Gas vesicles; Bacterial Cytoskeleton; Endospore and Sporulation cycle; Surface appendages – Flagella, Fimbriae and Pili; Chemotaxis and Phototaxis; Bergey's manual of Systemic Bacteriology; Economical importance of Bacteria.

Unit – III

Stains and its types; Staining techniques – Simple staining, Differential staining (Gram staining & Acid fast staining), Special staining (Capsule staining, Metachromatic granule staining, Endospore staining & Flagella staining); Motility test; Culture medium and its classification; Biochemical Tests for bacterial identification; Sterilization - Physical method and Chemical method; Quality control and Sterility checking; Required Concentrations and Times for Chemical Destruction of Microorganisms; Evaluation of Disinfectants – Phenol coefficient test, Filter paper method, Use - Dilution test, In-Use Test and Kelsey-Sykes Capacity Test; Antibiotics – Classification, Antimicrobial resistance and Antibiotic sensitivity test.

Unit – IV

Organelles of Eukaryotic cells – Plasma membrane, Nucleus, Endoplasmic reticulum, Golgi complex, Ribosomes, Lysosomes, Gas vacuoles, Mitochondria, Hydrogenosomes, Peroxisomes, Centrosome, Cytoskeleton, Chloroplast; Organs for Locomotion – Flagella, Cilia and Pseudopodia; Fungi – Ultrastructure; Classification; Characteristics of Molds & Yeast; Budding in Yeast; Nutrition and Reproduction; Fungal cell wall and its composition; Identification and Cultivation of Fungi; Water molds; Economical importance of Fungi.

Unit – V

Algae – Ultrastructure and Nutrition; Classification of Algae; Algal Chloroplast; Diatoms and Dinoflagellates; Identification and Cultivation of Algae; Economical importance of Algae; Lichens; Protozoa - Ultrastructure, Classification, Nutrition and Locomotion; Identification and Protozoa; Slime Molds – Cellular Slime Molds & Plasmodial Slime Molds; Economic importance of Protozoa; Virus – Structure and Classification; Animal Viruses and Plant Viruses; Viruses of Archaea; Viroids and Prions; Current Research Thoughts in Microbiology.

Text Books

- 1) Gerard J. Tortora, Berdell R. Funke and Christine L. Case. 2015. Microbiology – An Introduction, 12th Edition, Pearson Publishers, San Francisco.
- 2) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.

- 3) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
- 4) Madigan, M. T., Martinko, J. M., Dunlap, P. V and Clark, D. P. 2017. Brock Biology of Microorganisms, 14th edition, Prentice Hall, USA.
- 5) Robert W. Bauman. 2015. Microbiology with Body Diseases by Body System, 4th Edition, Pearson Education, UK.
- 6) Saranraj, P. 2020. Basic Techniques in Microbiology. 1st Edition, JPS Scientific Publications, India.

References

- 1) Jeffrey C. Pommerville. 2006. Alcamo's Fundamentals of Microbiology. 4th Edition, Jones and Bartlett Publishers, Canada.
- 2) Dubey, R.C. and D. K. Maheswari. 2010. A Text book of Microbiology. 3rd Edition, S. Chand and Company, New Delhi.
- 3) Kathleen Park Talaro and Bary Chess. 2015. Foundations in Microbiology. 9th Edition, McGraw Hill Publication, New York.
- 4) Pelczar Jr. M. J., Chan, E. C. S and Kreig, N. R. 2006. Microbiology. 5th Edition, McGraw Hill Inc. New York.
- 5) Marjorie Kelly Cowan. 2012. Microbiology – A System Approach. 3rd Edition, McGraw Hill Publication, United States.
- 6) Jacquelyn G. Black. 2012. Microbiology – Principles and Explorations. 8th Edition, John Wiley and Sons, United States.

Semester – I

4 Hours/4Credits

MICROBIAL PHYSIOLOGY AND METABOLISM

Objectives

- To illustrate Bacterial nutrition and their utilization.
- To discuss cultivation methods and factors related to microbial growth.
- To study the Microbial growth, nutrition and its uptake.
- To demonstrate the concepts of Microbial metabolism and Respiration.
- To understand the Photosynthesis reaction in microorganisms.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Help learners to define and understand the objectives of Microbial physiology, Microbial nutrition and Microbial metabolism.	K1, K2
CO-2	Analyze and understand the basic concepts of Nutrient requirements and Nutrition types of microorganisms.	K4
CO-3	Provide students with learning experiences that help in still deep interests in learning Transport of nutrients in Microorganisms.	K3
CO-4	Develop broad and balanced knowledge and understanding of Microbial growth, Factors influencing growth, Growth measurement and Preservation of microorganisms.	K6
CO-5	Equip students with appropriate knowledge on major fermentation and metabolic pathways for energy generation in microbial cells.	K4
CO-6	Recommend students to find the reactions of Intermediate metabolism and Photosynthesis in microorganisms.	K5

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)	Programme Specific Outcomes (PSO)	
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	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	Mean Scores of Cos
1	3	2	3	3	3	3	3	3	2	3	3	3	3	2	3	2.8
2	3	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.7
3	3	2	3	3	2	3	2	3	2	2	3	3	3	3	2	2.6
4	3	3	2	3	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	3	3	3	2	3	2	3	3	3	2	3	2	2.6
6	3	3	2	2	3	3	3	3	3	3	3	3	2	3	2	2.7
Mean Overall Score																2.7
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Microbial Nutrition – Chemical nutrient requirements and Growth factors, Nutritional groups of microorganisms; Adaptation of microorganisms towards Limited nutrients; Uptake of nutrients by cells: Passive transport - Simple diffusion, Facilitated diffusion and Osmosis; Active transport – ABC Transporters, Group translocation, Endocytosis (Phagocytosis & Pinocytosis) and Exocytosis; Difference between Passive transport and Active transport; Iron uptake by microorganisms.

Unit – II

Cell division in Prokaryotes and Eukaryotes; Microbial Growth – Generation time and Growth Curve; Influence of environmental factors on growth; Microbial life in Cold environment and High temperature; Measurement of microbial growth – Direct methods (Plate counts, Filtration, Most Probable Number [MPN] Method & Direct Microscopic Count) and Indirect methods (Turbidity, Metabolic activity and Dry weight); Continuous culture of microorganisms – Chemostat & Turbidostat; Diauxic growth and Synchronus growth; Preservation of Bacterial cultures.

Unit – III

Microbial Metabolism; Fermentation and its types; Generation of ATP - Substrate level Phosphorylation, Oxidative Phosphorylation and Electron transport chain; Carbohydrate catabolism – Glycolysis, Pentose phosphate pathway, Phosphoketolase pathway; Entner - Doudoroff pathway; Mixed acid fermentation pathway; Propionic acid fermentation pathway; Degradation of Amino acids, Proteins, Lipids, Purines and Pyrimidines.

Unit – IV

Microbial Respiration - Aerobic and Anaerobic respiration by microorganisms; Aerobic Respiration – Kreb's cycle; Biosynthesis of Polysaccharides, Peptidoglycan, Amino acids, Purines and Pyrimidines; Lipogenesis - Biosynthesis of Fatty acid, Triglycerides, Phospholipids, Sterols and Cholesterol; Anaerobic Respiration – Acetogenesis and Methanogenesis; Biosurfactant production by microorganisms.

Unit – V

Photosynthesis; Diversity of photosynthetic organisms; Phototrophic bacteria – Cyanobacteria, Purple Sulfur Bacteria, Purple Non-sulfur Bacteria, Aerobic Anoxygenic Phototrophs, Green Sulfur Bacteria, Green Non-sulfur Bacteria and Heliobacteria; Difference between plant, algal and bacterial photosynthesis; Photosynthetic pigments; Light reaction (Photophosphorylation) and Dark reaction (Calvin cycle); Biosynthesis of Chlorophyll; Quorum sensing – Mechanism of Quorum sensing, Virulence factors and Biofilm formation; Current Research Thoughts in Microbial metabolism.

Text Books

- 1) Gerard J. Tortora, Berdell R. Funke and Christine L. Case. 2015. Microbiology – An Introduction, 12th Edition, Peareson Publishers, San Francisco.
- 2) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 3) Stanier, R. Y., Ingraham, J. L., Wheelis, M. L and Painter, P. R. 2010. General Microbiology. 5th Ednition, Macmilan Education Ltd. London.
- 4) Madigan, M. T., Martinko, J. M., Dunlap, P. V and Clark, D. P. 2017. Brock Biology of Microorganisms, 14th edition, Prentice Hall, USA.
- 5) Kathleen Park Talaro and Bary Chess. 2015. Foundations in Microbiology. 9th Edition, McGraw Hill Publication, New York.
- 6) Jacquelyn G. Black. 2012. Microbiology – Principles and Explorations. 8th Edition, John Wiley and Sons, United States.

References

- 1) Caldwell, D.R., 2008. Microbial Physiology and Metabolism. Wm C Brown Publishers, England.
- 2) Chatterjee, N and Rana Shinde. 2012. Textbook of Medical Biochemistry, 8th edition, Jaypee publication, New Delhi.
- 3) Marjorie Kelly Cowan. 2012. Microbiology – A System Approach. 3rd Edition, MacGraw Hill Publication, United States.
- 4) Albert G. Moat, John W. Foster and Michael P. Spector. 2003. Microbial Physiology. 4th Edition, John Wiley and Sons, New York.
- 5) Jeffrey C. Pommerville. 2006. Alcamo's Fundamentals of Microbiology. 4th Edition, Jones and Bartelett Publishers, Canada.

Semester – I

4 Hours/3 Credits

IMMUNOLOGY

Objectives

- To provide overview of immune system, antigen antibody structure and interactions.
- To inculcate the principles of vaccine development.
- To provide insights to the Human Defense Mechanisms against Infections.
- To strengthen the knowledge of students through a detailed study on Antigens, Antibodies and Immunoassays.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Discuss cells and organs of immune system and its role in types of Immunity.	K2
CO-2	Evaluate the reactions between various antigens and antibodies and apply the knowledge in diagnosing diseases and disorders.	K3, K5
CO-3	Analyse the concepts and factors influencing immunity, HLA typing and its applications.	K3, K4
CO-4	Compare the role of MHC in graft rejection in transplantation and plan appropriate strategies.	K2
CO-5	Describe the principles of immunity for vaccine development and analyse types of hypersensitivity reactions.	K1

CO-6	Develop theoretical knowledge of various diseased conditions generated due to interplay of immune system components.	K6
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Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	2.2
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	2.5
Mean Overall Score																2.4
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

History of Immunology – Contributions of Louis Pasteur, Edward Jenner, Elie Metchnikoff, Paul Ehrlich and Karl Landsteiner; Immunity – Innate and Acquired immunity; Humoral immunity and Cell mediated immunity; Vaccines - Attenuated Live vaccine, Inactivated or Killed vaccine, Sub-unit vaccine, DNA vaccine, Synthetic peptide vaccine and Anti-idiotype vaccine; Toxoids - Antitoxins.

Unit – II

Lymphoid System – Primary and Secondary lymphoid organs; Hematopoiesis; Maturation of B – cells and T – cells; T - cell and B - cell receptors; Cells of the immune system: Lymphoid cells – B - Lymphocytes, T - Lymphocytes and NK cells; Mononuclear Phagocytes – Monocytes and Macrophages; Granulocytic cells – Neutrophils, Eosinophils, Basophils and Mast cells; Antigen presenting cells - Dendritic cells; Platelets; Erythrocytes; Cluster of Differentiation (CD); Cytokines - Properties and functions of Interleukins and Interferons; Cytokine storm.

Unit – III

Antigens – Types of Antigens, Antigenicity, Determinants of Antigenicity, Epitopes, Haptens and Adjuvants; Immunoglobulins – Structure and types (IgG, IgA, IgM, IgD & IgE); Theories of Antibody production; Isotypes, Allotypes and Idiotypes; Monoclonal antibodies and Polyclonal antibodies – Production and its applications; Complement system – Properties, Components and Functions.

Unit – IV

Laboratory Techniques in Immunology – Precipitation test (Mancini Radial Immunodiffusion, Ouchterlony Double Immunodiffusion, Immunoelectrophoresis and Rocket electrophoresis), Agglutination test (Hemagglutination, Bacterial Agglutination, Passive Agglutination & Agglutination Inhibition), Complement fixation test, Immunofluorescence test, Flow Cytometry, Immunohistochemistry, Immunoprecipitation, Avidin – Biotin Mediated Assay, Nephelometry, Hemocytometer, ELISPOT assay, RIA, ELISA and Western Blot; Immunohematology - Blood groups, Blood transfusion and Rh incompatibilities.

Unit – V

Immunodeficiency diseases; Autoimmune diseases; Hypersensitivity reactions – IgE Mediated Hypersensitivity (Type – I), Antibody Mediated Cytotoxic Hypersensitivity (Type – II), Immune Complex Mediated Hypersensitivity (Type – III) and Delayed Type Hypersensitivity (Type – IV); Transplantation immunology - Graft versus Host reaction; Immunosuppression; Oncoimmunology and Cancer Immunotherapy; Major Histocompatibility Complex (MHC); Mechanism of Resistance to Microbial infections; Current Research Thoughts in Immunology.

Text Books

- 1) Judith A. Owen, Jenni Punt, Sharon A. Stanford and Patricia P. Jones. 2009. Kuby's Immunology, 4th Edition, W. H. Freeman and Company, New York.
- 2) Jeffrey K. Actor. 2012. Elsevier's Integrated Review – Immunology and Microbiology, 2nd Edition, Sabre Foundation, China.
- 3) Roitt, I. M. 2011. Roitt's Essential Immunology, 12th Edition, Wiley - Blackwell Scientific publishers, London, United Kingdom.
- 4) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
- 5) Robert W. Bauman. 2015. Microbiology with Body Diseases by Body System, 4th Edition, Pearson Education, UK.

References

- 1) Robert W. Bauman. 2015. Microbiology with Body Diseases by Body System, 4th Edition, Pearson Education, UK.
- 2) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 3) Chakraborty, P. 2013. A Text book of Microbiology, Published by New Central Book Agency (P) Ltd., Kolkata, India.
- 4) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
- 5) Abul K. Abbas, Andrew H. H. Lichtman and Shiv Pillai. 2015. Basic Immunology, Functions and Disorders of the Immune System. 5th Edition. Elsevier.

Semester – I

4 Hours/4 Credits

MOLECULAR MICROBIOLOGY

Objectives

- To make the students to understand the Molecular Biology and Genetic Engineering.
- To focus on Genome organization, Transcription and Translation process in Prokaryotes.
- To introduce the basic principles of DNA Replication, Transcription, Translation, Mutation and DNA Repair mechanisms.
- To explain the application of various Gene cloning vectors.
- To be highly experienced in Prokaryotic and Eukaryotic Genetic Transformation.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Analyze and understand the basic principles of DNA Replication, Transcription, Translation, Mutation and DNA Repair mechanisms.	K2, K4
CO-2	Describe the central cell biological processes and how they are regulated.	K1
CO-3	Evaluate the role of Vectors in Gene Cloning.	K5
CO-4	Apply the principles of selection, construction, screening of recombinants and application of artificial transformation techniques.	K3

CO-5	Better understanding of Gene expressions.	K2
CO-6	Development of Molecular Techniques for DNA and Protein analysis.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	2	2	2	2	2	3	3	2	3	3	2.4
2	3	2	2	3	2	2	3	2	3	2	2	2	2	3	3	2.4
3	2	2	2	3	2	2	3	2	2	2	3	2	3	3	2	2.3
4	2	2	3	3	1	2	3	2	3	2	3	3	2	2	2	2.3
5	2	2	3	2	2	2	2	3	2	2	2	2	2	2	2	2.1
6	2	2	1	2	2	3	2	3	2	3	3	1	3	2	2	2.2
Mean Overall Score																2.3
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Genetics – History and Scope; DNA & RNA as a genetic material; DNA – History, Structure and forms; Organization of Gene in Prokaryotes and Eukaryotes; Chromosomes – Structure, Types and Functions; Chromosome theory of inheritance; Chromosomal aberrations. DNA Replication – Types and evidence for Semi-conservative replication; Enzymes involved in DNA Replication; DNA Replication in Prokaryotes and Eukaryotes; Inhibitors of DNA replication.

Unit – II

RNA - Structure and Types; Transcription and Inhibitors of Transcription; Genetic code; Translation and Inhibitors of Translation; Regulation of Gene expression – Lactose Operon concept and Tryptophan Operon concept; DNA Damage by Physical and Chemical agents; Mutation - Mutagens and Mutagenesis; Spontaneous Mutation; Induced Mutation and Point Mutation – Silent Mutation, Missense Mutation, Non-sense Mutation and Frameshift Mutation; Mutant detection, Mutant selection and Carcinogenicity testing; DNA Repair Mechanism – Excision repair, Direct repair, Recombination repair, Mismatch repair and SOS Response.

Unit – III

Restriction enzymes for cutting DNA; Enzyme for Joining DNA; Cloning Vectors – Plasmids (pBR 322), Phages (M13 & λ) and Cosmids; Plasmids – Structure, Characteristics, Types, Replication, Plasmid copy number, Partitioning and Segregative stability of Plasmids, Incompatibility of Plasmids, Isolation of Plasmids, Purification of Plasmid DNA and Desirable properties of Plasmid vector.

Unit – IV

Transposons - IS elements, Composite transposons, Simple transposition, Replicative transposition and Conjugative transposons; Mechanism of Transposition; Bacteriocinogens; Bacteriophages - General characteristics, Structure, Replication of Double stranded DNA Bacteriophages - Lytic cycle and Lysogenic cycle; Replication of Single stranded DNA

Bacteriophage (M13 phage); Typing of Bacteriophage; Genetic recombination in Bacteria – Conjugation, Transformation and Transduction; Conjugation in Archaea.

Unit – V

Molecular Identification of Microorganisms – Fatty acid profiles, Flow Cytometry, DNA Base composition (G + C Content), DNA Fingerprinting, Nucleic acid Hybridization (Southern Blotting, Northern Blotting, DNA Chips, Ribotyping & rRNA Sequencing and FISH); Protein hybridization technique – Western Blotting technique; Gel Electrophoresis (Agarose Gel Electrophoresis & SDS-PAGE); Introduction to Genomics and Metagenomics; Genome Sequencing – First Generation, Second Generation, Third Generation and Fourth Generation; Metagenomics; CRISPR; Polymerase Chain Reaction (PCR), Types of PCR and Applications of PCR; Current Research Thoughts in Molecular Microbiology.

Text Books

- 1) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 2) Freifelder, D. 2008. Molecular Biology, 2nd Edition, Narose Book Distributors Pvt. Ltd., New Delhi, India.
- 3) Old, R. S and S. B. Primrose. 2006. Principles of Gene Manipulation, 7th Edition, Blackwell Scientific Publications, London.
- 4) Nelson, D. L and Cox, M. M. 2008. Leininger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.
- 5) Brown T. A. 1995. Gene Cloning. 4th Edition, Chapman and Hall.

References

- 1) Gardner, E. J., M. J. Simmons and D. P. Snustad. 2005. Principles of Genetics, 8th Edition, John Wiley and Sons, New York.
- 2) Klug, W. S and M. R. Cummings. 2001. Essentials of Genetics, 4th Edition, Prentice Hall, New Jersey.
- 3) Chatterjee, N and Rana Shinde. 2012. Textbook of Medical Biochemistry, 8th Edition, Jaypee publication, New Delhi, India.
- 4) Weaver, R. F. 2008. Molecular Biology, 5th Edition, McGraw Hill, New York.

Semester – I

4 Hours/3 Credits

ELECTIVE: MICROBIAL INSTRUMENTATION

Objectives

- To understand the principles and applications of various instruments used in Life science.
- To learn the techniques for operating the instruments.
- To study the concepts of Biological and Radiation hazard materials.
- To explain the principles and applications of types of centrifuge and chromatography techniques.
- To learn principles, types and applications of Spectroscopy.

Course Outcomes

Course Outcome (CO)	Description	Cognitive Level (K-Level)
CO-1	Determine the Safety measures in Microbiology laboratory.	K3
CO-2	Define and explain the principles and applications of various instruments used in Life science.	K1, K2
CO-3	Explain the Working principles and Applications of Various Microbiology laboratory instruments.	K4

CO-4	Analyzing the principles and applications of types of Chromatography techniques.	K4
CO-5	Evaluate the Working principle and Applications of Electrophoresis techniques.	K5
CO-6	Perform the detailed analysis on Calorimeter and Spectrophotometer.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	3	3	3	2	2	3	3	3	3	3	3	2	3	2.8
2	2	2	3	3	3	3	3	3	3	3	2	3	2	2	2	2.6
3	2	3	2	3	2	3	2	3	2	3	3	2	3	3	3	2.6
4	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	2	3	3	2	3	3	3	3	1	2	2	3	2.8
6	3	3	1	3	3	3	3	2	3	3	3	3	3	3	3	2.5
Mean Overall Score																2.6
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

History of Microscopy; Principles of Microscopy; Principle, Instrumentation and Applications - Bright Field Microscopy, Dark Field Microscopy, Phase Contrast Microscopy, Fluorescence Microscopy, Differential Interference Contrast (DIC) Microscopy, Confocal Scanning Laser Microscopy, Two – Photon Microscopy (TPM), Scanning Acoustic Microscopy (SAM), Electron Microscopy – Scanning Electron Microscopy (SEM) & Transmission Electron Microscopy (TEM), Scanned – Probe Microscopy – Scanning Tunneling Microscopy and Atomic Force Microscopy.

Unit – II

Bioinstruments - Principle, Instrumentation and Applications of pH Meter, Bacterial Incubator, Hot air oven, Autoclave, Colony counter, Lyophilizer and Laminar flow cabinet. Electrophoretic techniques - Principle, Instrumentation and Applications of Paper electrophoresis, Gel electrophoresis, Immunoelectrophoresis, Capillary electrophoresis and SDS-PAGE; Gel Documentation System.

Unit – III

Chromatographic techniques - Principle and Applications of Paper Chromatography (Ascending Paper Chromatography & Descending Paper Chromatography), Thin Layer Chromatography (TLC), Gel Filtration Chromatography, Adsorption Column Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Countercurrent Chromatography (CCC), Gas Chromatography, High Performance Liquid Chromatography (HPLC) and HPTLC.

Unit – IV

Centrifugation techniques - Basic principles of Centrifuge; Types of Centrifuges – Small Bench Centrifuges, Large Capacity Refrigerated Centrifuges, High Speed Refrigerated Centrifuges and Ultracentrifuges; Different types of Rotors; Types of Centrifugation - Differential

centrifugation, Density gradient centrifugation and Centrifugal elutriation; Safety aspects of Centrifuges.

Unit – V

Spectroscopy - Principle, Instrumentation and Applications of Colorimeter, Spectrophotometer, UV-Vis Spectrophotometer, Flame Photometry, Atomic Absorption Spectroscopy, IR Spectrophotometry, Fourier Transform Infrared Spectroscopy (FT-IR), Nuclear Magnetic Resonance (NMR) and X – ray Crystallography; Biosensors – Basic characteristic, Components, Requirements, Types and Applications; Current Research Thoughts in Microbial Instrumentation.

Text Books

- 1) Arumugam, S. 2002. Biomedical Instrumentation, Anuratha Agencies Publishers, 2nd edition, India.
- 2) Asokan, P. 2001. Analytical Biochemistry, Chinnaa Publications, India.
- 3) Gurumani, N. 2014. Research Methodology for Biological Sciences, MJP Publisher, India.
- 4) Veerakumari, L. 2019. Bioinstrumentation, MJP Publisher, India.

References

- 1) Chatwal, G. R and S. K. Anand. 2003. Instrumental Methods of Chemical Analysis. 5th Edition, Himalaya Publishing House, Mumbai
- 2) Mandeep Singh. 2014. Introduction to Biomedical Instrumentation, Paperback publishers, India.
- 3) Sharma, B. K. 2007. Instrumental Methods of Chemical Analysis, Krishna Prakashan Media (P) Ltd, India.
- 4) Wilson, K., Walker, J., Clokie, S and Hofmann, A. 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edition, Cambridge University Press.

Semester – I

4 Hours/3 Credits

ELECTIVE: BIOSTATISTICS

Objectives

- To demonstrate the importance of data collection and presentation of data
- To perform methods used for measuring central tendency, deviation and error
- To discuss Probability theory and applications
- To explain Correlation, regression and hypothesis testing methods
- To identify appropriate method for analysis of variance and learn few statistical packages

Course Outcomes

Course Outcome (CO)	Description	Cognitive Level (K-Level)
CO-1	Classify the data and understanding the role of Biostatistics in research.	K2
CO-2	Provide basic knowledge of statistics and tools used for several quantitative analysis in Microbiology.	K1
CO-3	Apply and provide knowledge of data collection and presentation of data in various fields of Microbiology.	K1, K3
CO-4	Assess and implement central tendency, deviation and error in the data collected during research.	K5
CO-5	Apply and develop the knowledge of probability theory and its applications in research data analysis.	K3, K6

CO-6	Predict the significance of the biological phenomenon on the basis of available data set.	K2
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Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	2	2	3	2	2	2	2	2	3	2	2	3	3	2.3
2	3	2	2	2	2	2	3	2	2	2	2	2	2	3	3	2.2
3	2	2	2	3	1	2	3	2	1	2	3	2	3	3	2	2.2
4	2	2	3	3	2	2	3	1	3	2	3	3	1	2	2	2.2
5	2	2	3	2	2	2	2	3	2	1	2	2	1	2	2	2.0
6	2	2	1	2	2	3	2	2	2	3	3	2	3	2	2	2.2
Mean Overall Score																2.2
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

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

Unit – II

Measures of Central tendency – Mean – Geometric and Harmonic, Median and Mode and Percentiles; Measures of Dispersion - Range, Quartile deviation, Mean deviation, Standard deviation and Coefficient of variation; Standard error, Skewness and Kurtosis.

Unit – III

Probability: Random experiment, Events, Sample space, Mutually exclusive events, Independent and dependent events, Statement of addition and Multiplication theorems of probability, Random variables (Discrete and continuous), Probability Distributions - Binomial, Poisson and Normal distributions.

Unit – IV

Correlation - Types, Methods, Coefficient of correlation; Regression – Equations and Regression lines; Testing of hypothesis - Null Hypothesis, Alternate hypothesis, Type I and Type II errors; Tests of Significance - Chi-square test, Student t test and Z score.

Unit – V

Analysis of Variance, ANOVA - One-way classification and Two-way classification; Completely Randomized Design (CRD), Randomized Block Design (RBD), Least Significant Difference (LSD) and Duncan's multiple range test (DMR); Statistical package - Features of Statistical software; SPSS for various applications in Biostatistical programme; R Programming Language.

Text Books

- 1) Rastogi, V. B. 2011. Fundamental of Biostatistics. 2nd Edition, Ane books Pvt. Ltd.
- 2) Gupta, S. P. 2017. Statistical methods. 45th Edition, Sultan Chand & Sons Publisher, New Delhi.
- 3) Snedecar, G. W and Cochran, W. G. 1967. Statistical Methods. Oxford Press.
- 4) Zar, J. H. 2008. Biostatistical analysis. 4th Edition, Pearson education Inc. New Jersey.

References

- 1) Chatwal, G. R and S. K. Anand. 2003. Instrumental Methods of Chemical Analysis. 5th Edition, Himalaya Publishing House, Mumbai
- 2) Rosner, B. 2016. Fundamentals of Biostatistics, 8th Edition, Cengage Learning, USA.
- 3) Pagano, M and Gauvreau, K. 2018. Principles of Biostatistics, 2nd Edition, CRC press.
- 4) Daniel, W. W. 1999. Biostatistics: A foundation for analysis in health sciences. 7th Edition, John Wiley & Sons, New York.

Semester – I

4 Hours/3 Credits

ELECTIVE: PHYCOLOGY AND MYCOLOGY

Objectives

- To illustrate the basics of Phycology and Mycology.
- To understand the relevance of algal- fungal interactions in maintaining aquatic periodicity.
- To implement the biomimetic products by studying the real internal symbiotic mechanisms in lichen.
- To acquire knowledge regarding harmful environmental changes occurred due to anthropogenic activity via lichen indicator.
- To study the various applications of Algae and Fungi.

Course Outcomes

Course Outcome (CO)	Description	Cognitive Level (K-Level)
CO-1	Illustrate the basic principles of Phycology and Mycology.	K2
CO-2	Understanding and evaluate the natural biodiversity for controlling pollution rate.	K2, K6
CO-3	Identify, Classify and Cultivate medically important fungi and parasites.	K1, K2
CO-4	Evaluate the toxic effect of fungi and algae for avoid the hazardous affects.	K5
CO-5	Examine the food industry in curbing the growth of toxic mold in food and animal feed.	K1
CO-6	Focusing on associative benefits of Algae and Fungi.	K4

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	3	3	3	3	3	3	2	3	3	3	3	2	3	2.8
2	3	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.7
3	3	2	3	3	2	3	2	3	2	2	3	3	3	3	2	2.6
4	3	3	2	3	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	3	3	3	2	3	2	3	3	3	2	3	2	2.6
6	3	3	2	2	3	3	3	3	3	3	3	3	2	3	2	2.7
Mean Overall Score																2.7
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

History of Indian Phycology; Ultrastructure of Algae; Classification of Algae; Habitat and Distribution of Algae – Freshwater and Marine; Reproduction of Algae – Sexual and Asexual reproduction; Life cycle of Algae; Culture medium for Algae cultivation; Bioluminescence; General characteristics of Cyanophyta, Dinophyta, Cryptophyta, Rhodophyta, Chrysophyta, Bacillariophyta, Xanthophyta, Phaeophyta, Chlorophyta, Charophyta and Euglenophyta.

Unit – II

Algal protein and Algal peptides; SCP – Cultivation and Health benefits; Pigments from Algae – Carotenoids, Phycocyanin and Phycoerythrin; Growth promoting substance from microalgae; Algal Toxins. Phycoremediation - Heavy metals remediation, Dye degradation and Hydrocarbon degradation; Products from Algae – Biofuels, Biodiesel, Biobutanol and Biohydrogen; Nanoparticles from Algae; Algae in Transgenics; Antimicrobials from microalgae; CO₂ sequestration; Algae in Space.

Unit – III

Fungi - General characteristics, Vegetative structure, Ultrastructure, Origin, Occurrence and Distribution, Nutrition, Ecological groups, Respiration and Reproduction; Economic importance of Fungi.

Unit – IV

Fungal taxonomy - Nomenclature and Classification of Fungi; Classification of Mycoses; Characteristics of Molds and Yeasts; Characteristic features of Chytridiomycetes, Zygomycota, Ascomycota, Basidiomycota, Urediniomycetes, Ustilaginomycetes, Glomeromycota and Microsporidia.

Unit – V

Fungi as food and natural recycler; Fungi in Antibiotics production; Fermented products from fungi - Organic acids and Enzymes; Pigment production from Fungi; Fungal diseases in plants, animals and humans; Fungi as Biocontrol agent and Bioinsecticide; Mycotoxins and its types; Current Research Thoughts in Phycology and Mycology.

Text Books

- 1) Hoek, C., Mann, D. G and Jahns, H. M. 1995. Algae - An introduction to Phycology, 39; Cambridge University Press.
- 2) Stephen, J. O. 1993. Bacteria, Algae, and Protozoa - Cold Spring Harbor Laboratory Press.
- 3) Sarabhai, B. P and Arora, C. K. 2005. Textbook of Algae. Anmol Publishing Pvt. Ltd. New Delhi.
- 4) Sharma, O. P. 2001. Textbook of Algae. Tata McGraw Hill Company, New Delhi.
- 5) Sharma, O. P. 2001. Text book of Fungi. Tata McGraw Hill Company, New Delhi.

References

- 1) Khan, M. 1970. Algae today, Gajendra Singh Gahlot at Siva Printers, Dehra Dun, India.
- 2) Amrik, S. A. 2003. Phycology: Principles, processes and applications. Daya Publishing House, Delhi.
- 3) Rajarao, V. N. 1990. Perspectives in Phycology, Today and Tomorrow Printers and publishers, New Delhi.
- 4) Steve, P. 2009. Protozoans, Algae & Other Protists - Capstone Press.

Semester – II

6 Hours/4 Credits

MEDICAL BACTERIOLOGY

Objectives

- To impart in-depth understanding of normal flora and its importance, learn bacterial classification and virulence factors contributing to pathogenicity.

- To provide insights into processing of samples and laboratory diagnosis of pathogenic bacteria.
- To illustrate methods involved in collection and transport of samples and its biosafety guidelines for bacterial identification.
- To teach various cultivation methods, pathogenesis and clinical features of bacteria affecting humans.
- To provide the ability to characterize, isolate and identify different Medically important bacteria.

Course Outcomes

Course Outcome (CO)	Description	Cognitive Level (K-Level)
CO-1	Introducing the knowledge of the Medically important bacteria.	K3
CO-2	Differentiate normal flora from pathogens, analyse the factors contributing to pathogenicity and acquire the skill of sample collection, transport and processing for bacterial identification.	K2, K3, K4
CO-3	Describe the morphology with the focuses being the pathogenicity, symptoms, identification and treatment for different bacteria.	K1
CO-4	Analyse and create an awareness on bacterial diseases and classification for diagnosing Gram positive bacteria and spore formers.	K3, K6
CO-5	Evaluate the implications of Mycobacterial diseases and drug resistance in the society.	K5
CO-6	Detect the etiology and virulence factors of Gram negative bacterial diseases, interpreting the laboratory results after following standard operating procedures.	K2

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	3	3	3	2	3	3	3	2	3	3	2.7
2	2	2	3	3	2	2	3	2	3	3	2	2	3	2	1	2.3
3	3	1	2	3	1	3	2	3	2	2	3	3	2	3	3	2.4
4	2	2	3	2	3	2	3	3	3	3	3	3	3	2	2	2.6
5	2	3	3	2	2	2	2	2	2	2	2	2	3	2	2	2.2
6	3	2	2	3	3	3	2	3	3	3	3	3	2	3	3	2.7
Mean Overall Score																2.5
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit - I

Normal microbial flora of human body; Microbial Infection – Types, Source, Transmission and Factors predisposing to Microbial Pathogenicity; Epidemiology of Microbial infections; Clinical Specimens - Collection, Transport and Storage; Laboratory diagnosis of Bacteria – Staining techniques, Culture medium, Biochemical tests and Serological tests; Antibiotics –

Microorganisms involved in Antibiotics production, Spectrum of activity of Antibiotics; Classification based on mode of action, Antibiotic Sensitivity Test and Antimicrobial Resistance.

Unit – II

Morphology, Cultural characteristics, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for Gram Positive Cocci - *Staphylococcus aureus*, Coagulase negative *Staphylococcus* sp., *Streptococcus pyogenes*, *Streptococcus agalactiae*, Viridans *Streptococci* (*Streptococcus pneumoniae*), *Enterococcus* sp. and Gram Negative Cocci – *Neisseria meningitidis* and *Neisseria gonorrhoeae*.

Unit – III

Morphology, Cultural characteristics, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for Gram Positive Bacilli - *Bacillus anthracis*, *Bacillus cereus*, *Clostridium tetani*, *Clostridium perfringens*, *Clostridium botulinum*, *Clostridium difficile*, *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Corynebacterium diphtheriae*, *Nocardia brasiliensis*, *Mycobacterium leprae*, *Mycobacterium tuberculosis* and *Mycobacterium avium* Complex.

Unit – IV

Morphology, Cultural characteristics, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for Enterobacteriaceae (*Escherichia coli*, *Klebsiella pneumoniae*, *Proteus* sp., *Salmonella* sp., *Shigella* sp., *Serratia marcescens* and *Yersinia pestis*), *Pseudomonas aeruginosa*, *Vibrio cholerae*, *Aeromonas hydrophila*, *Campylobacter jejuni* and *Helicobacter pylori*.

Unit – V

Morphology, Cultural characteristics, Pathogenicity, Laboratory diagnosis, Treatment and Preventive measures for *Haemophilus influenzae*, *Pasteurella multocida*, *Propionibacterium acne*, *Francisella tularensis*, *Brucella* sp., *Bordetella pertussis*, *Legionella pneumophila*, Spirochaetes (*Treponema pallidum*, *Borrelia* sp. and *Leptospira* sp.), *Mycoplasma* sp., *Rickettsia* sp. and *Chlamydia trachomatis*; Current Research Thoughts in Medical Bacteriology.

Text Books

- 1) Jawetz, E., J. L. Melnic and E. A. Adelberg. 2013. Review of Medical Microbiology, 26th Edition, Lange Medical Publishers, New York.
- 2) Patrick Murray, Ken Rosenthal and Michael Pfaller. 2016. Medical Microbiology, 8th Edition, Elsevier Publications, United States.
- 3) Saranraj, P. 2020. Medical Bacteriology, 1st Edition, JPS Scientific Publications, India.
- 4) Robert W. Bauman. 2015. Microbiology with Body Diseases by Body System, 4th Edition, Pearson Education, UK.

References

- 1) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 2) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
- 3) Chakraborty, P. 2013. A Text book of Microbiology, Published by New Central Book Agency (P) Ltd., Kolkata, India.
- 4) Baron, E. J and S. M. Finegold. 1990. Bailey and Scott's Diagnostic Microbiology, 8th Edition, The C.V. Mosby Company. St. Louis, Missouri.

Semester – II

5 Hours/4 Credits

MEDICAL VIROLOGY

Objectives

- To make the students to understand the role of viruses in major diseases.

- To provide the knowledge on general characters and classification of viruses.
- To teach the structure, cultivation and various strategies of Virus replication.
- To impart knowledge regarding the diagnostics, clinical aspects and related implications of human viral diseases and emerging viral infections.
- To describe the growth behaviour differences between normal cells and cells transformed by DNA and RNA viruses.

Course Outcomes

Course Outcome (CO)	Description	Cognitive Level (K-Level)
CO-1	Recognize characters of different types of viruses.	K1
CO-2	Compare the complex interaction between viruses and host cells.	K2
CO-3	Analyze and teach newer emerging viral infections including the viral mutant forms for emerging.	K3, K4
CO-4	Outline the basics and essential concepts of Virology.	K4
CO-5	Evaluate and discuss the structure, classification, pathogenesis, replication, purification and disease control.	K5, K6
CO-6	Discuss viral vaccines and create awareness about the new emerging threats of viral diseases and modern approaches of virus control.	K2, K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	2	2	2	2	2	3	3	2	3	3	2.4
2	3	2	2	3	2	2	3	2	3	2	2	2	2	3	3	2.4
3	2	2	2	3	2	2	3	2	2	2	3	2	3	3	2	2.3
4	2	2	3	3	1	2	3	2	3	2	3	3	2	2	2	2.3
5	2	2	3	2	2	2	2	3	2	2	2	2	2	2	2	2.1
6	2	2	1	2	2	3	2	3	2	3	3	1	3	2	2	2.2
Mean Overall Score																2.3
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

General properties and Structure of Viruses; Classification of Virus – Based on Host, Structure and Nucleic acids; Replication of Viruses; Viral pathogenesis; Viral Epidemiology; Lab diagnosis of Viruses – Microscopic examination, Cultivation of Viruses, Serological and Molecular diagnosis of Viruses; Antiviral agents; Viral vectors for therapy; Interferons; Interleukins; Viral Vaccines and its Immunization Schedule; Control of Viral spread.

Unit – II

General properties, Structure, Replication, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for DNA Viruses – Poxviridae (Pox Virus); Herpesviridae (Herpes Simplex Virus, Varicella Zoster Virus, Cytomegalovirus and Epstein-Barr Virus); Adenoviridae (Adenovirus); Hepadnaviridae (Hepatitis – B Virus);

Papillomaviridae (Human Papilloma Virus); Polymaviridae (BK Virus & JC Virus) and Parvoviridae (B19 Parvo Virus).

Unit – III

General properties, Structure, Replication, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for RNA Viruses – Paramyxoviridae (Parainfluenza virus, Measles virus, Mumps virus, Respiratory syncytial virus & Nipah virus); Orthomyxoviridae (Influenza virus); Coronaviridae (SARS, MERS & Covid-19); Caliciviridae (Noroviruses); Rhabdoviridae (Rabies Virus).

Unit – IV

General properties, Structure, Replication, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for RNA Viruses – Filoviridae (Ebola virus & Marburg virus); Retroviridae (HIV, Human T-cell lymphotropic virus & Other Oncogenic Retroviruses); Togaviridae (Togaviruses - Rubella virus & Chikungunya); Flaviviridae (Flaviviruses - Yellow fever virus, Dengue virus & Hepatitis C virus).

Unit – V

General properties, Structure, Replication, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for RNA Viruses – Reoviridae (Rotavirus & Colorado Tick fever virus); Bunyaviridae (Bunyaviruses & Arenaviruses); Arenaviridae (Lassa fever virus); Picornaviridae (Rhinoviruses, Poliovirus, Echoviruses, Coxsackievirus & Hepatitis A virus); Current Research Thoughts in Medical Virology.

Text Books

- 1) Jawetz, E., J. L. Melnick and E. A. Adelberg. 2013. Review of Medical Microbiology, 26th Edition, Lange Medical Publishers, New York.
- 2) Patrick Murray, Ken Rosenthal and Michael Pfaller. 2016. Medical Microbiology, 8th Edition, Elsevier Publications, United States.
- 3) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
- 4) Robert W. Bauman. 2015. Microbiology with Body Diseases by Body System, 4th Edition, Pearson Education, UK.

References

- 1) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 2) Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5th Edition, Blackwell publishing, USA.
- 3) Baron, E. J and S. M. Finegold. 1990. Bailey and Scott's Diagnostic Microbiology, 8th Edition, The C.V. Mosby Company. St. Louis, Missouri.
- 4) John, B. C and Venetia, A. S. 2007. Virology, Principles and Applications. John Wiley and Sons limited, England.

Semester – II

5 Hours/4 Credits

MEDICAL MYCOLOGY AND PARASITOLOGY

Objectives

- To illustrate the basics of medically important Fungi and Parasites.
- To provide in-depth knowledge on Superficial and Systemic fungi.
- Demonstrate the importance of Opportunistic infections caused by fungi.

- To study general aspects of Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for Fungal and Parasitic diseases.
- To explain the role of Protozoans and Helminths as infectious agents.

Course Outcomes

Course Outcome (CO)	Description	Cognitive Level (K-Level)
CO-1	Identify, Classify and Cultivate medically important fungi and parasites.	K1, K2
CO-2	Evaluate and analyze the role of superficial and systemic fungi.	K4, K5
CO-3	Predict the importance of fungi causing opportunistic infections in immunocompromised individuals.	K2
CO-4	Assess the role of Protozoans and Helminthes in anthroponotic and zoonotic infections.	K5
CO-5	Apply diagnostic techniques to identify, isolate and interpret fungal and parasitic infections.	K3, K4
CO-6	Creating awareness on appropriate preventive and chemotherapeutic measures.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	3	3	3	3	3	3	2	3	3	3	3	2	3	2.8
2	3	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.7
3	3	2	3	3	2	3	2	3	2	2	3	3	3	3	2	2.6
4	3	3	2	3	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	3	3	3	2	3	2	3	3	3	2	3	2	2.6
6	3	3	2	2	3	3	3	3	3	3	3	3	2	3	2	2.7
Mean Overall Score																2.7
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

General characteristics of Fungi (Mold and Yeast); Classification of Human Mycoses – Superficial Mycoses, Cutaneous Mycoses, Subcutaneous Mycoses, Endemic Mycoses and Opportunistic Mycoses; Pathogenesis of Fungal diseases - Primary fungal pathogens and Opportunistic fungal pathogens; Laboratory diagnosis of fungi from clinical specimens – Microscopic examination, Culture medium; Antigenic, Biochemical, and Molecular Markers for Direct Detection of Invasive Fungal Infections; Antifungal agents; Antifungal activity testing methods; Mechanism of resistance to Antifungal agents.

Unit – II

General Characteristics, Pathogenesis, Clinical Manifestations, Laboratory Diagnosis and Treatment for Opportunistic Mycoses (Candidiasis, Cryptococcosis, Aspergillosis,

Trichosporonosis, Hyalohyphomycosis, Mucormycosis, Phaeohyphomycosis and Pneumocytosis); Endemic Mycoses (Blastomycosis, Histoplasmosis, Coccidioidomycosis, Paracoccidioidomycosis and Penicilliosis).

Unit – III

General Characteristics, Pathogenesis, Clinical Manifestations, Laboratory Diagnosis and Treatment for Superficial Mycoses (Black piedra, White piedra, Tinea nigra & Pityriasis versicolor), Cutaneous and Subcutaneous Mycoses (Dermatophytoses, Tinea unguium, Onychomycosis, Mycotic keratitis and Chromoblastomycosis); Mycotoxins and Mycotoxins.

Unit – IV

General characteristics of Protozoa; Morphology, Life cycle, Clinical Manifestations, Lab diagnosis and Treatment for Intestinal Protozoa (*Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum* & *Balantidium coli*), Urogenital Protozoa (*Trichomonas vaginalis*) and Blood and Tissue Protozoa (*Plasmodium* sp., *Leishmania donovani*, *Leishmania tropica*, *Leishmania mexicana*, *Leishmania braziliensis*, *Toxoplasma gondii*, *Trypanosoma cruzi* & *Trypanosoma brucei*); Antiprotozoan drugs.

Unit – V

General characteristics of Helminths; Morphology, Life cycle, Clinical Manifestations, Lab diagnosis and Treatment for Nematodes (*Ascaris lumbricoides*, *Trichuris trichiura*, *Enterobius vermicularis* & *Wuchereria bancrofti*), Trematodes (*Fasciola hepatica*, *Paragonimus westermani* & *Schistosoma* sp.) and Cestodes (*Taenia saginata*, *Taenia solium*, *Dipylidium caninum* & *Echinococcus granulosus*); Anthelmintic drugs; Current Research Thoughts in Mycology and Parasitology.

Text Books

- 1) Subhash Chandra Parija. 2013. Textbook of Medical Parasitology, 4th Edition, All India Publishers and Distributors, India.
- 2) Jagdish Chander. 2017. Textbook of Medical Mycology, 4th Edition, Jaypee Brothers Medical Publishers, India.
- 3) Patrick Murray, Ken Rosenthal and Michael Pfaller. 2016. Medical Microbiology, 8th Edition, Elsevier Publications, United States.
- 4) Chatterjee, J. 2009. Medical Parasitology. 13th Edition, CBS Publishers, New Delhi.
- 5) Robert W. Bauman. 2015. Microbiology with Body Diseases by Body System, 4th Edition, Pearson Education, UK.
- 6) Alexopolus, C. J and Mims, C. W. 1995. Introductory Mycology. 4th Edition, John Wiley and Sons, New York.

References

- 1) Jawetz, E., J. L. Melnick and E. A. Adelberg. 2013. Review of Medical Microbiology, 26th Edition, Lange Medical Publishers, New York.
- 2) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 3) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
- 4) Levanthal, R and Cheadle, R. S. 2012. Medical Parasitology. 6th Edition, S. A. Davies Co., Philadelphia.
- 5) Choidini, P. L., Moody, A. H and Manser, W. M. 2001. Atlas of Medical Helminthology and Parasitology. 4th edition, Churchill Living Stone.

Semester – II

4 Hours/3 Credits

ELECTIVE - PHARMACEUTICAL MICROBIOLOGY

Objectives

- To illustrate the Principles of Pharmaceutical Microbiology.

- To understand the basics of Pharmaceutical Microbiology and important microorganism playing role pharmaceutically.
- To understand different products of microbial origin playing key role in Pharmaceutical applications.
- To understand role of Secondary metabolites in Pharmaceutical industry.
- To understand good practices and regulation involved in utilizing microbial product for pharmaceutical application

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Understanding and explaining the role of microbes in Pharma industries in both positive and negative aspects.	K2
CO-2	Administering antibiotics and determine Antibiotics resistance for advanced Drug delivery system.	K3
CO-3	Analyzing and determining drug formulation regarding to guidelines and regulations.	K3, K4
CO-4	Examining microbial contamination during pharmaceuticals formulations and production.	K1
CO-5	Advice good laboratory practices for better understanding.	K2, K5
CO-6	Formulate regulations for utilizing microbial product in pharmaceutical applications.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	3	3	3	2	2	3	3	3	3	3	3	2	3	2.8
2	2	2	3	3	3	3	3	3	3	3	2	3	2	2	2	2.6
3	2	3	2	3	2	3	2	3	2	3	3	2	3	3	3	2.6
4	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	2	3	3	2	3	3	3	3	1	2	2	3	2.8
6	3	3	1	3	3	3	3	2	3	3	3	3	3	3	3	2.5
Mean Overall Score																2.6
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Pharmaceutically Useful and Problematic Microorganisms; Identification and Characterization of Pharmaceutically Important Microbes; Microbial contamination of Pharmaceutical products; Pharmaceutical products and its Sterilization; Sterility testing of Pharmaceutical products and Quality assurance; Good Manufacturing Practices (GMP) and Good Laboratory

Practices (GLP) in Pharmaceutical industry; Laboratory animals for Pharmaceutical testing; Biosensors in Pharmaceutical industry.

Unit - II

History of Chemotherapy; Common terminologies related to Chemotherapy; Drugs - Definition, Sources, Classification, Routes of Drug administration, Dosage forms, Drug receptors, Mechanism of action of Drugs, Combined effect of Drugs, Factors modifying Drug action and Selective toxicity; Molecular principles of Drug delivery; Drug delivery system in Gene therapy; Negative interaction between Drugs and Host.

Unit – III

Chemical Disinfectants, Common terminologies related to Disinfectants; Antiseptics and Preservatives – Acids and Esters, Alcohols, Aldehydes, Biguanides, Halogens, Heavy metals, Hydrogen peroxide & peroxygen compounds, Phenols, Surface active agents and Dyes; Required Concentrations and Times for Chemical Destruction of Microorganisms; Evaluation of Disinfectants – Phenol coefficient test, Filter paper method, Use - Dilution test, In-Use Test and Kelsey-Sykes Capacity Test. Antimicrobial combination and systems; Disinfection policy.

Unit – IV

Antibiotics – Cell wall inhibitors, Cell membrane inhibitors, Protein synthesis inhibitors, Nucleic acid inhibitors and Antimetabolites; Antimicrobial drug resistance; Antibiotic sensitivity tests; Therapeutic index; Common side effects of Antibiotics.

Unit – V

Antiviral drugs; Antifungal drugs; Antiprotozoan drugs; Vaccines and its types; Covid-19 Vaccine and its impacts; Anthelmintic drugs; Common side effects of Antiviral, Antifungal, Antiprotozoan and Anthelmintic drugs; Natural products as Antimicrobial agents – Medicinal plants, Mushrooms, Kitchen spices, Algae, Actinobacteria and Lactic acid bacteria; Government regulatory practices and policies in Pharmaceuticals; Current Research Thoughts in Pharmaceutical Microbiology.

Text Books

- 1) Luis Jimenez. 2004. Microbial Contamination Control in the Pharmaceutical Industry, Marcel Dekker Inc., New York, USA.
- 2) Hugo and Russell. 2011. Pharmaceutical Microbiology. 8th Edition. Wiley Blackwell Publications, USA.
- 3) Ashutosh Kar. 2008. Pharmaceutical Microbiology, New Age International Publishers, New Delhi, India.
- 4) Vyas, S. P and Dixit, V. K. 2010. Pharmaceutical Biotechnology, CBS Publishers & Distributors, New Delhi, India.
- 5) Geoff Hanlon and Norman A. Hodges. 2013. Essential Microbiology for Pharmacy and Pharmaceutical Science, Wiley-Blackwell, USA.

References

- 1) Stephen P Denyer, Norman A Hodges and Sean P Gorman. 2011. Hugo and Russell's Pharmaceutical Microbiology, 8th Edition, Blackwell Publishing Company, New York, United States.
- 2) Thomas N. Tozer, Malcolm Rowland. Introduction to Pharmacokinetics and Pharmacodynamics: The Quantitative Basis of Drug Therapy. 2006. Lippincott Williams & Wilkins publishers.
- 3) Nita K. Pandit. 2007. Introduction to the Pharmaceutical Sciences. Lippincott Williams & Wilkins publishers.
- 4) Joseph D Nally. 2016. Good Manufacturing Practices for Pharmaceuticals. 6th Edition, CRC Press, USA.
- 5) Madhu Raju Saghee, Tim Sandle and Edward C. Tidswell. 2011. Microbiology and Sterility Assurance in Pharmaceuticals and Medical Devices, Business Horizons.

ELECTIVE - BIOINFORMATICS**Objectives**

- To explain basics and uses of internet and biological databases.
- To provide an overview of various bioinformatics tools, databases available and sequence analysis.
- To provide knowledge on database concept, management, retrieval along with utilization in gene and protein analysis.
- To demonstrate the use of tools for parsing and retrieving sequences and structures from appropriate databases and predicting genes.
- To impart in-depth knowledge on deducing protein structures, analyse the expression of proteins, genes and to study variations.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Effectively use internet in biological database searching, communicating biological data by depositing, storing and retrieving sequences and structures.	K3
CO-2	Analyse and identify genes and proteins from a set of sequences using appropriate Bioinformatic tools.	K1, K4
CO-3	Apply the evolutionary relatedness in predicting structure, function of biomolecules, metabolism and to Perform <i>In silico</i> Drug designing.	K3, K6
CO-4	Demonstrate and evaluate the protein and nucleotide interaction through Bioinformatics tools.	K2, K5
CO-5	Deduce the structure of proteins, gene expressions.	K4, K6
CO-6	Justify the variations thus applying Bioinformatics in several fields for benefit of the society.	K5

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	3	3	3	2	3	3	3	2	3	3	2.7
2	2	2	3	3	2	2	3	2	3	3	2	2	3	2	1	2.3
3	3	1	2	3	1	3	2	3	2	2	3	3	2	3	3	2.4
4	2	2	3	2	3	2	3	3	3	3	3	3	3	2	2	2.6
5	2	3	3	2	2	2	2	2	2	2	2	2	3	2	2	2.2
6	3	2	2	3	3	3	2	3	3	3	3	3	2	3	3	2.7
Mean Overall Score																2.5
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Bioinformatics – Definition, History and Development, Role of Bioinformatics in Biology; Introduction to Internet - Local area and wide area network, Types of files – HTML, TXT and PDF; Search Engines - Types and applications; Application of Bioinformatics.

Unit – II

Biological sequence database – Primary databases (NCBI, EMBL and DDBJ), Secondary databases – Nucleic acid secondary databases and Protein secondary databases; Phylogenetic analysis and Sequence submission tools; Sequence Annotation; DNA analysis for repeats (Direct and Inverted palindromes) related tools BLAST, FASTA, SSEARCH, Phylogenetic analysis and Multiple sequence alignment.

Unit – III

Applied Genomics – Prokaryotic and Eukaryotic Genomes, DNA Microarray, Microarray Database, Tools for analysis of Human Genome and Human Genome Project; Pharmacogenomics; Proteomics – Protein – protein interaction and Yeast two hybrid system; Protein Microarray; MALDI-TOF method of analysis of Proteins; 2D Two Gel Electrophoresis; Proteomics in Drug discovery.

Unit – IV

Structural Biology; Principles of Structural organization, Conformational analysis and Structure determination; Visualization and Computational methods used in Protein structure prediction, Homology modelling, Threading, Abinitio, Neural networks and Structure based drug design; Molecular docking - Mechanisms in Molecular docking, Virtual screening, Active site analysis tools, Docking tools de novo Ligand design; Application of Molecular docking.

Unit – V

Commercial application of Bioinformatics, Genome technology, High throughput sequencing and assembly; Genomics in Medicine - Disease monitoring and Profiles for Therapeutic Molecular Targeting; Drug discovery and genomics; Comparative Proteomics and its applications; IPR and Bioinformatics patents; Current Research Thoughts in Bioinformatics.

Text Books

- 1) Jin Xiong. 2006. Essential Bioinformatics, 1st Edition, Cambridge University Press, New York, United States.
- 2) Hooman Rashidi and Lukas K. Buehler. 2005. Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, Taylor & Francis Group, United Kingdom.
- 3) Mount, D. W. 2013. Bioinformatics Sequence and Genome analysis. 2nd Edition, CBS Publishers, New Delhi.
- 4) Rastogi, S. C., Mendiratla, N and Rastogi, P. 2013. Bioinformatics methods and applications - Genomics, Proteomics and Drug Discovery. Prentice Hall India.

References

- 1) Stephen A. Krawetz, David D. Womble. Stephen A. Krawetz and David D. Womble. 2003. Introduction to Bioinformatics: A theoretical and Practical approach, Humana Press, USA.
- 2) Bryan Bergeron. 2002. Bioinformatics Computing, Prentice Hall.
- 3) Claverie, J. M and C. Notredame. 2003. Bioinformatics for Dummies, Wiley Publishing, Inc., United Kingdom.
- 4) Xiong, J. 2011. Essential Bioinformatics, First south Indian Edition, Cambridge University Press.

ELECTIVE – PUBLIC HEALTH MICROBIOLOGY

Objectives

- To strengthen the knowledge of personal health care and hygienic to students.
- To provide a detailed study on vaccine and its schedule throughout the life time.
- To acquaint the student with basic concept of public health and prophylactic measures.
- To understand air, Food, water, insect borne infectious diseases.
- To create public awareness, individual behavior, and disease prevention.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Create awareness to prevent disease, promote health, and prolong life among the population as a whole.	K6
CO-2	Provide conditions in which people can be healthy and focus on entire populations, not on individual patients or diseases.	K1, K4
CO-3	Operate and employ the National disease control plans for major infectious diseases.	K3
CO-4	Understanding the Comprehensive health education campaigns to increase public awareness of these diseases in rural areas of India.	K2
CO-5	Support for the investigation, management and control of infection and outbreaks of Communicable disease.	K5
CO-6	Provide assistance during field investigations by processing Clinical samples.	K1

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	2.2
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	2.5
Mean Overall Score																2.4
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Hygiene – Personal hygiene and Grooming routines; Importance of Public Health Microbiology; Factors for Good health; Importance of Hand washing; Role of Microbiologists in Public health; Indicators of health; National Health Programmes; Health status in India; Present and Future challenges in Public health.

Unit – II

Vaccines and Vaccination – History, Types of Vaccines, Route of Administrations, Mechanisms of Inducing immunity; Diseases prevented by Vaccination; Microbial synthesis of Vaccines; Vaccines for Tuberculosis and Covid-19; Vaccination schedule; Vaccine risks and safety.

Unit – III

Child Health Management – General child health and Types of infection in Child; Vaccination schedule in Children – New born, Child below 5 years and Child below 10 years; Vaccination schedule for Adults - Hepatitis B vaccines, MMR vaccines, Tetanus vaccines and Varicella vaccines; Vaccines for Travelers; Universal Immunization Programme; Public awareness about Vaccines and Vaccination.

Unit – IV

Common diseases caused by Microorganisms – Air borne, Water borne, Soil borne, Vector borne and Zoonotic diseases; Vaccination for Pets; Methods for controlling Insect vectors; Sexually transmitted diseases and its awareness to public; Air pollution and Indicators of Air pollution; Water pollution; Water quality and analysis of Drinking water quality; Sanitary surveys; World Health Organization (WHO) and Centre for Disease Control and Prevention (CDC).

Unit – V

Industrial Pollution and Toxic pollutants from industries; Hygienic practices in Industries; Hygienic practices in Hospitals; Nosocomial Infections and its preventive measures; Vaccines for Healthcare workers; Biomedical wastes and its management in Hospitals; Public awareness about Water, Air and Insect borne diseases; Current Research Thoughts in Vaccines and Pollution control.

Text Books

- 1) Robert S. Burlage. 2012. Principles of Public Health Microbiology. Jones & Bartlett learning LLC, Canada.
- 2) Robert W. Bauman. 2015. Microbiology with Body Diseases by Body System, 4th Edition, Pearson Education, UK.
- 3) Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th Edition, CBS Publishers and Distributors, New Delhi, India.
- 4) Prasada Rao, J. V. R. 1999. Manual for Control of Hospital Associated Infections National AIDS Control Organization. Ministry of Health and Family Welfare, Government of India. New Delhi.

References

- 1) Judith A. Owen, Jenni Punt, Sharon A. Stanford and Patricia P. Jones. 2009. Kuby's Immunology, 4th Edition, W. H. Freeman and Company, New York.
- 2) Chaudhri, A. K. 1998. Tripathy, G. C. and D. Sharma - Common sense rules for wellbeing, Naval Printing Press, New Delhi.
- 3) Dunne, J. 1997. Webb, M., R. Scott and P. Beale - First Aid Manual, 7th Edition, Dorling Kindersley Ltd., London.
- 4) Spencer, John F. T., Alicia L. Ragout de Spencer. 2004. Public Health Microbiology- Methods and Protocols. Springer.

Semester – I & II

5 Hours/4 Credits

PRACTICAL – I: GENERAL AND MEDICAL MICROBIOLOGY

- 1) Orientation to the Microbiology Laboratory

- 2) Sterilization Techniques
- 3) Handling of Microscopes
- 4) Preparation of Broth and Agar medium for Bacteria and Fungi
- 5) Bacterial Staining Techniques
- 6) Motility Test – Hanging Drop Method
- 7) Biochemical tests for Bacterial identification
- 8) Pure culture technique – Spread plate technique and Pour plate technique
- 9) Bacterial Growth curve
- 10) Effect of pH, NaCl concentration and UV light on Bacterial growth.
- 11) Lyophilization of Bacterial culture.
- 12) Collection and transport of clinical samples.
- 13) Identification of bacteria from clinical samples – *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhi*, *Shigella* sp., *Proteus vulgaris*, *Klebsiella pneumoniae*, *Vibrio cholerae* and *Pseudomonas aeruginosa*.
- 14) Antibiotic sensitivity test – Disc diffusion assay.
- 15) Antibiotic sensitivity test – Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC).
- 16) Determination of β -Lactamase activity- Acidometric method and Iodometric method.
- 17) Slide Culture Technique for fungal identification.
- 18) Examination of *Candida albicans* by Germ tube test and Sugar assimilation test.
- 19) Microscopic examination of Protozoa.
- 20) Microscopic examination of Algae.
- 21) Inoculation of Viruses in Egg membrane.
- 22) Isolation of Bacteriophages and Plaque assay.

Semester – I & II

**5 Hours/4
Credits**

PRACTICAL – II: IMMUNOLOGY, HEMATOLOGY AND MOLECULAR MICROBIOLOGY

- 1) Blood collection and Plasma/Serum separation.
- 2) Blood Grouping and Rh Typing.
- 3) Staining and Microscopic examination of Blood cells - RBC, WBC and Differential Cell Counts.
- 4) Separation of Lymphocytes from Peripheral Blood by Density Gradient Centrifugation.
- 5) Purification of Antibodies by Ammonium Sulfate Precipitation.
- 6) Agglutination reaction – WIDAL Test, RPR Card Test, TPHA Test, ASO Test, RA Test, CRP Test and Pregnancy Test.
- 7) Precipitation reaction – Mancini Radial Immunodiffusion, Ouchterlony Double Immunodiffusion, Immunoelectrophoresis, Serum electrophoresis and Rocket electrophoresis.
- 8) ELISA Test.
- 9) Isolation of Plasmid DNA
- 10) Isolation of Chromosomal DNA
- 11) Transformation in *Escherichia coli*
- 12) Estimation of DNA by Diphenylamine method.
- 13) Estimation of RNA.

14) Chromatographic techniques – Paper chromatography, Thin Layer chromatography and Column chromatography

15) Polymerase Chain Reaction (PCR)

Semester – III

4 Hours/4 Credits

RESEARCH METHODOLOGY

Objectives

- To learn about research designs, ethics in scientific research, data collection and analysis of scientific data using software.
- To analyze the Art of Report and Scientific writing.
- To study the basic Statistics methods used for Life science research.
- To gain the knowledge on Laboratory animals and its maintenance.
- To provide insights on importance of scientific communication, ethical issues in research, plagiarism and IPR.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Provides knowledge to collect Research paper from different Web sources.	K1, K2, K3
CO-2	Demonstrate the importance of Scientific communication, Ethical issues in research.	K2
CO-3	Identify appropriate methods for Analysis of variance and learn few Statistical packages	K4
CO-4	Provides knowledge about the maintenance and ethics related to Laboratory animals.	K1, K3
CO-5	Evaluate the students about reading the different ongoing research in area of Microbiology.	K5
CO-6	Creating an awareness on Plagiarism and IPR.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	2	2	3	2	2	2	2	2	3	2	2	3	3	2.3
2	3	2	2	2	2	2	3	2	2	2	2	2	2	3	3	2.2
3	2	2	2	3	1	2	3	2	1	2	3	2	3	3	2	2.2
4	2	2	3	3	2	2	3	1	3	2	3	3	1	2	2	2.2
5	2	2	3	2	2	2	2	3	2	1	2	2	1	2	2	2.0
6	2	2	1	2	2	3	2	2	2	3	3	2	3	2	2	2.2
Mean Overall Score																2.2
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Importance and need for research; Basic and Applied Research; Essential steps in Research; Ethics and Scientific research; Designing of research work; Hypothesis and Null – hypothesis;

Scientific writing – Research article, Review article, Case reports and Short communication; Components of a Research report – Title, Author name & Institution details, Abstract, Introduction, Review of Literature, Materials and Methods, Results, Discussion, Summary, Conclusion, Acknowledgement and References – Harvard and Vancouver systems; Components of Thesis writing.

Unit – II

Importance of Scientific communication - Types and Modes of Scientific communications; Journals in Microbiology and Life Sciences; Impact factor of Journals; Indexing agencies for Journals; Book publication – Text books, Monographs and Edited books; Ethical issues related to Publishing; Plagiarism and Self plagiarism; Software to detect Plagiarism; Role of Computers in Biology; Useful search engines for Research; Social media related to Research

Unit - III

Collection and Classification of Data; Representation of Data - Tabulation, Frequency distribution, Diagrams and Graphs; Measurement of Central tendency; Tests of Significance - Chi-square test, Student t-test and Z score; Analysis of Variance – ANOVA (One-way classification and Two-way classification); Completely Randomized Design (CRD), Randomized Block Design (RBD), Least Significant Difference (LSD) and Duncan's multiple range test (DMR); SPSS for various applications in Biostatistical programme; R Programming Language.

Unit – IV

Laboratory animals used for Life Science Research; CPCSEA Guidelines for Laboratory Animal Facility: Veterinary care - Animal procurement, Quarantine, Stabilization & Separation and Surveillance, Diagnosis & Treatment; Animal Husbandry for Animal maintenance – Caging or Housing system, Sheltered or Outdoor housing, Social environment, Monitoring Animal activity, Food, Bedding and Water; Sanitation, Cleanliness and Waste disposal in Animal house; Record keeping in Animal house; Standard Operating Procedures for Animal Husbandry; Transport of Laboratory Animals; Anesthesia and Euthanasia.

Unit – V

Composition of Institutional Ethical Committee (IEC) - General Ethical Issues, Laboratory Animal Ethics, Food and Drug safety Ethics; Ethical issues in Human Gene Therapy and Human Cloning; Environmental release of Genetically Engineered Microorganisms; Intellectual Property Rights (IPR) – Protection of IPR in India, Terminology Associated with IPR and Issues Relating to IPR; Patentable and Non – patentables; World Intellectual Property Rights Organization (WIPO); Research funding agencies in India.

Text Books

- 1) Gurumani, N. 2004. Research Methodology for Biological Sciences. MJP Publishers, India.
- 2) Anderson, J. B and M. Poole. 2011. Assignment and Thesis Writing. 4th Edition, Wiley India Private Limited, UK.
- 3) Kothari, C. R and G. Garg. 2004. Research Methodology: Methods and Techniques. 2nd edition, New Age International Publishers, India.
- 4) Sateesh, M. K. 2008. Bioethics and Biosafety. I. K. International Pvt. Ltd, New Delhi, India.

References

- 1) Gupta, S. P. 2013. Fundamentals of Statistics, Sultan Chand, India.
- 2) Goel, D and S. Parashar. 2013. IPR, Biosafety and Bioethics. Pearson Education in South Asia.
- 3) Ethical guidelines for biomedical research on human subjects. ICMR, New Delhi, 2000.

4) Ahuja, V. K. 2017. Laws Relating to Intellectual Property Rights. Lexis Nexis.

Semester – III

4 Hours/4 Credits

BIOINOCULANT TECHNOLOGY AND PLANT PATHOLOGY

Objectives

- To study about the Production, Formulation, Method of application and Quality control of Bioinoculants.
- To create an awareness on Soil microorganisms in Agriculture.
- To understand the role of Nitrogen fixers, Phosphate solubilizers, AM fungi and Algal biofertilizers.
- To give knowledge on Plant pathogen interaction and its control.
- To learn the ability of Biopesticides and Biocontrol agents in Plant growth.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Acquire knowledge on Bioinoculant technology.	K3
CO-2	Gives the knowledge to the students about Natural organic farming.	K1, K3
CO-3	Explains the details of Production, Formulation, Method of application and Quality control of Bioinoculants.	K2
CO-4	Analyzing the diseases causing ability of microorganisms in plants and its control measures.	K4
CO-5	Developing different methods for the Pest control using microbes.	K6
CO-6	Recommending the factors for good Soil quality and Agricultural output through sustainable Microbiological applications.	K5

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	2.2
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	2.5
Mean Overall Score																2.4
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Bioinoculants – Definition, Types and Importance; Advantages of Biofertilizers over Chemical fertilizers; Formulations of Bioinoculants; Methods and application of Bioinoculants in different crops; Quality control of different Bioinoculants; Plant – Microbe Interaction; PGPR and its role in agriculture – Direct mechanism and Indirect mechanism; Role of PGPR in Soil Bioremediation.

Unit – II

Nitrogen fixation by bacteria; Isolation, Characterization, Mass multiplication, Field application and Plant growth promoting activities of Nitrogen fixing bacteria (*Rhizobium* sp., *Frankia* sp., *Azotobacter* sp., *Azospirillum* sp. and *Gluconacetobacter* sp.). Phosphate solubilization – Phosphate solubilizing microorganisms, Screening of Phosphate solubilizing efficiency, Mechanism of Phosphate solubilization and Benefits of Phosphate solubilizing microorganisms; Algal Biofertilizers – Isolation and Mass multiplication of Blue Green Algae (BGA), Mass multiplication of *Azolla*, *Azolla* – *Anabaena* symbiosis, Heterocyst and its importance in N₂ fixation.

Unit – III

Mycorrhizal Bioinoculants – Significance, Types and Benefits; Arbuscular Mycorrhiza (AM) fungi – Taxonomy, Isolation, Assessment of AM colonization in roots, Mass inoculum production, Field applications; AM fungi and Abiotic stress; Role of AM fungi in agriculture; Biopesticides – Entomopathogenic bacteria (*Bacillus thuringiensis*); Entomopathogenic fungi (*Beauveria bassiana*, *Verticillium lecanii*, *Isaria fumosorosea*, *Lecanicillium* sp. & *Metarhizium anisopliae*); Entomopathogenic virus (Cydia pomonella granulosis virus - CpGv); Plant disease control agents (*Bacillus subtilis*, *Bacillus megaterium*, *Pseudomonas fluorescens* & *Trichoderma viride*).

Unit – IV

History of Plant Pathology; Host-parasite relationship in plants; Principles of Plant diseases; Plant Disease Triangle; Plant diseases - Symptoms and Types; Pathogenic and Non-pathogenic Plant diseases; Plant Pathology in Practice - Plant Clinic and Plant Doctor Concept; Biochemical aspects of disease development; Principle of Biotrophic, Hemibiotrophic and Perthotrophic colonization; Molecular detection of Phytopathogens.

Unit – V

Antibiosis and Biological control of Soil borne plant pathogens; Microbial pest management; Mycotoxins in plants; List of important Plant diseases; Bacterial diseases – Blight of rice, Citrus canker & Wilt of potato; Fungal diseases – Blast of rice, Late blight of potato, Rust of wheat, Smut of sugar cane, Wilt of cotton, Tikka leaf spot of ground nut, Mildews of fruits, Leaf curl disease & Little leaf disease; Viral diseases - Mosaic disease; Disease Resistance - Biochemical and Genetic aspects; Defense mechanism in Plants; Current Research Thoughts in Bioinoculant Technology and Plant Pathology.

Text Books

- 1) Saranraj, P and Sivasakthivelan, P. 2020. Text Book of Bioinoculants Technology. 1st Edition, JPS Scientific Publications, India.
- 2) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
- 3) Subba Rao N.S. 1999. Soil Microbiology, 4th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
- 4) Mehrotra, R. S. 1983. Plant Pathology, Tata McGraw Hill Publishing Company Ltd., New Delhi.

References

- 1) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.

- 2) Atlas, R.M and R. Bartha. 1998. Microbial Ecology. Fundamentals and Applications, 4th Edition, Red Wood City. C.A. Benjamin.
- 3) Bagyaraj, D. J and G. Rangasamy. 2002. Agricultural Microbiology, 2nd Edition, Prentice Hall, India.
- 4) Mahendra K. Rai. 2005. Hand book of Microbial Biofertilizers, The Haworth Press, Inc. New York.

Semester – III

4 Hours/4 Credits

MUSHROOM TECHNOLOGY

Objectives

- To modify of the Mushroom cultivation in a scientific way for livelihood.
- To differentiate edible and poisonous mushrooms and their effects.
- To encode the importance of the Mushrooms.
- To outline the process of Mushroom cultivation.
- To obtain a good understanding of Mushroom cultivation and its disease control.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Provides the information about the Cultivation, Nutritional value and Medicinal value of Mushrooms.	K1
CO-2	Gaining knowledge about different types of Mushrooms.	K3
CO-3	Analyze the pathological damage on mushrooms and outline the post-harvest practices.	K4
CO-4	Demonstrate the methods for Disease control in Mushrooms.	K2
CO-5	Assess the nutrient and medicinal value of edible mushrooms and analyse effects of mushroom poisoning.	K5
CO-6	Develops Entrepreneurial skill on Production and Marketing of Mushroom.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of Cos
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	3	3	3	2	3	3	3	2	3	3	2.7
2	2	2	3	3	2	2	3	2	3	3	2	2	3	2	1	2.3
3	3	1	2	3	1	3	2	3	2	2	3	3	2	3	3	2.4
4	2	2	3	2	3	2	3	3	3	3	3	3	3	2	2	2.6
5	2	3	3	2	2	2	2	2	2	2	2	3	2	2	2	2.2
6	3	2	2	3	3	3	2	3	3	3	3	3	2	3	3	2.7
Mean Overall Score																2.5
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10

Create	5	5	20
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Unit - I

Mushroom – Historical development, Origin, Characteristics, Importance, Morphology and Life cycle; Classification of Mushroom; Commonly cultivated mushrooms in the world; Nutritional value of Mushroom; Medicinal value of Mushroom; Edible mushrooms and Non-edible mushroom; Medicinal and Environmental uses of Mushrooms.

Unit - II

Mushroom farms – Farm layout and Farm hygiene; Substrates used for Mushroom cultivation; Spawn production for Mushroom cultivation – Starter culture, Sterilization process, Clean Environmental Condition, Cultures, Preparation of Media & Slants, Spawn containers, Mother Spawn, Preparation of Final Spawn, Precautions and Storage of Spawn.

Unit - III

Genetic Improvements of Mushroom; Growth factors for Mushroom cultivation; Cultivation of Button mushroom (*Agaricus bisporus*), Oyster mushroom (*Pleurotus sajor – caju*), Milky mushroom (*Calocybe indica*), Reizhi mushroom (*Ganoderma lucidum*) and Paddy straw mushroom (*Volvariella volvacea*); Management of wastes generated during Mushroom cultivation; Insect pests and its management during Mushroom cultivation.

Unit - IV

Diseases of Mushrooms – Bacterial disease (Bacterial blotch, Mummy disease & Drippy gill), Viral disease (Die back disease); Fungal diseases (Dry bubble disease, Wet bubble disease, Cobweb disease, *Trichoderma* Blotch and Mildew caused by *Cladobotrym* sp. and *Aphanocladium* disease); Fungal competitors during Mushroom cultivation - Green mould, Olive Green mould, Brown plaster mould, White plaster mould, Inkcaps, Yellow mould, Sepedonium Yellow mould, Lipstick mould, Oedocephalum mold, False truffle and Cinnamon mould.

Unit - V

Post Harvest Technology of Mushroom – Harvesting, Grading, Packaging & Storage, Transportation, Preservation and Marketing (Fresh market and Drying); Environmental impact of Mushroom cultivation; Mushroom food recipes; Antimicrobial compounds from Mushroom; Economical value of Mushroom; Cost analysis for Mushroom cultivation; Challenges in Mushroom cultivation; Mushroom Research Centers in India; Current Research Thoughts in Mushroom Technology.

Text Books

- 1) Kannaiyan. 2001. Handbook of Edible Mushrooms, TNAU Publication, Coimbatore, India.
- 2) Alice, D., K. Muthusamy and M. Yesuraja. 1999. Mushroom Culture, Agricultural College, Research Institute Publications, Madurai, Tamil Nadu, India.
- 3) Russell, S. 2003. Essential Guide to Cultivating Mushrooms. 1st Edition. Storey Publishing, LLC.
- 4) Tiwari, S. C and Kapoor, P. 2018. Mushroom - The art of Cultivation. 1st Edition. Mittal Publications, India.

References

- 1) Marimuthu, T. 1991. Oster Mushroom, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
- 2) Nita Bhal. 2000. Handbook on Mushrooms, 2nd Edition, Volume - I and II, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
- 3) Tripathi, D. P. 2005. Mushroom Cultivation, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
- 4) Naidu, N. V. R. 2008. Management and Entrepreneurship. I.K. International Pvt. Ltd., India.

ENVIRONMENTAL MICROBIOLOGY**Objectives**

- To describe the distribution and enumeration of air microflora and categorize the air borne diseases.
- To discuss the Terrestrial ecosystem and Aquatic ecosystem.
- To give an overview about role of microorganisms for the cycle of Carbon, Nitrogen, Phosphorus and Sulphur in the nature.
- To illustrate the process of Solid waste treatment and Sewage water treatment, and determine the role of microorganisms in water pollution and water quality.
- To gain knowledge about Bioremediation mechanisms provided by microbes.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Assess the role and importance of microorganisms in Atmosphere, Hydrosphere and Pedosphere.	K5
CO-2	Understanding the role of microorganism in recycling Soil nutrients through Biogeochemical cycles.	K2
CO-3	Provides a detailed knowledge on Solid waste and Waste water treatment technologies.	K1, K3
CO-4	Create an awareness to students with current research in environmental microbiology.	K6
CO-5	Point out the general principles and subject knowledge in the field of Environmental Microbiology.	K4
CO-6	Gain knowledge about Bioremediation and Biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability.	K3

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	3	3	3	3	3	3	2	3	3	3	3	2	3	2.8
2	3	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.7
3	3	2	3	3	2	3	2	3	2	2	3	3	3	3	2	2.6
4	3	3	2	3	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	3	3	3	2	3	2	3	3	3	2	3	2	2.6
6	3	3	2	2	3	3	3	3	3	3	3	3	2	3	2	2.7
Mean Overall Score																2.7
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10

Create	5	5	20
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Unit – I

Organization of the Biosphere; Common Terminologies in Microbial Ecology; Microbiome; Ecosystem and its types; Major role of Microorganisms in Ecosystem; Atmosphere – Aeromicrobiology and Relationship between Microorganisms and Atmosphere; Sampling of Air; Aeroallergens; Air borne disease; Air pollution; Indicators of Air pollution; Green house effect; Air Sanitation; CO₂ sequestration.

Unit – II

Terrestrial Ecosystem – Importance of Soil; Formation of Soil; Composition of Soil; Soil Horizons; Soil characteristics (Physical & Chemical); Soil Microbiology – Major group of Soil microorganisms; Qualitative microflora of soil (Bacteria, Actinobacteria, Fungi, Viruses, Algae & Protozoa); Soil types and their microflora; Quantification of Soil microflora; Role of microorganisms in Soil fertility.

Unit – III

Aquatic ecosystem – Major communities of Aquatic ecosystem (Phytoplankton and Zooplankton); The Microbial Loop; Types of Aquatic ecosystem - Fresh water ecosystem, Marine ecosystem, Estuarine ecosystem and Mangrove ecosystem; Water zonations; Eutrophication; Winogradsky column; Bioluminescence; Water pollution; Bacteriological analysis of water; Water based disease transmission mechanism – Water borne, Water-washed, Water-based and Water related; Water borne diseases; Purification of water; Recycling of water.

Unit – IV

Organic matter decomposition; C:N Ratio; Formation and composition of Soil organic matter - Fluvic acid & Humic acid; Biogeochemical cycles – Carbon cycle, Nitrogen cycle, Phosphorous cycle, Sulphur cycle and Iron cycle; Microbe – Microbe Interactions; Plant – Microbe Interactions; Root exudates and Rhizosphere effects.

Unit – V

Solid waste management - Incineration, Composting & Sanitary Landfill; Sewage treatment – Small scale sewage treatment (Cesspools, Septic tank & Imhoff's tank) and Large scale sewage treatments (Primary treatment, Secondary treatment, Tertiary treatment & Anaerobic Sludge Digestion); Xenobiotics; Acid Mine Drainage; Bioremediation; – Uranium, Hydrocarbons, Pesticides, Chlorinated compounds and Plastics; Biodegradation; Bioaccumulation; Bioleaching; Biodeterioration of Paper, Leather, Wood, Textiles, Stone and Concrete; Microbially Induced Corrosion; Biofilms in Environment; Pollution control bodies and Environmental laws in India; Current Research Thoughts in Environmental Microbiology.

Text Books

- 1) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
- 2) Saranraj, P and Sivasakthivelan, P. 2020. Text Book of Environmental Microbiology. 1st Edition, JPS Scientific Publications, India.
- 3) Subba Rao N.S. 1999. Soil Microbiology, 4th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
- 4) Jeffrey C. Pommerville. 2006. Alcamo's Fundamentals of Microbiology. 4th Edition, Jones and Bartlett Publishers, Canada.
- 5) Kathleen Park Talaro and Barry Chess. 2015. Foundations in Microbiology. 9th Edition, McGraw Hill Publication, New York.

- 6) Jacquelyn G. Black. 2012. Microbiology – Principles and Explorations. 8th Edition, John Wiley and Sons, United States.

References

- 1) Marjorie Kelly Cowan. 2012. Microbiology – A System Approach. 3rd Edition, MacGraw Hill Publication, United States.
- 2) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 3) Patel, A. H. 2016. Industrial Microbiology, 2nd Edition, Laxmi Publications, New Delhi, India.
- 4) Madigan, M. T., J. M. Martinko and J. Parker. 2009. Brock's Biology of Microorganisms, 12th Edition, Pearson/Benjamin Cummings, New York.
- 5) Maier, R. M., I. L. Pepper and C. P. Gerba. 2009. Environmental Microbiology, 2nd Edition, Academic Press, United States.

Semester – III

4 Hours/3 Credits

ELECTIVE: MICROBIAL REMEDIATION

Objectives

- To motivate against environmental pollution.
- To find solution for pollution using microbes.
- To study the remediation process by plants, fungi, plants and algae.
- To develop knowledge about the environmental risk assessment and remediation.
- To gain knowledge on role of microorganisms in their environment.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Developing basic skills Environmental microbiology and Microbial remediation of wastes.	K6
CO-2	Finding solution for various pollution related problems.	K5
CO-3	Understand and explain the microbial metabolism of environmental contaminants.	K2
CO-4	Describing the principle of remediation process by various aspects.	K1
CO-5	Determining the Scientific problem related to pollution and remediation process will be explained.	K3
CO-6	Analyzing the scientific problem related to pollution and remediation process.	K4

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	3	3	3	2	3	3	3	2	3	3	2.7
2	2	2	3	3	2	2	3	2	3	3	2	2	3	2	1	2.3
3	3	1	2	3	1	3	2	3	2	2	3	3	2	3	3	2.4
4	2	2	3	2	3	2	3	3	3	3	3	3	3	2	2	2.6
5	2	3	3	2	2	2	2	2	2	2	2	2	3	2	2	2.2
6	3	2	2	3	3	3	2	3	3	3	3	3	2	3	3	2.7
Mean Overall Score																2.5
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)	Term End Exam (100)
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	I CA (50)	II CA (50)	Marks Allotment
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Bioremediation - Process and Organisms involved; Constraints and priorities of Bioremediation; Major pollutants and Polluted sites; Bioaugmentation; Intrinsic and Engineered Bioremediation; Pollutants and associated risks; Polyaromatic hydrocarbon pollution; Organic pollutant degradation; Advantages and Disadvantages of Bioremediation.

Unit – II

Microbes involved in Aerobic and Anaerobic processes in nature - Removal of Heavy metals; Biotransformation of Heavy metals and Xenobiotics; Petroleum biodegradation; Microbial leaching of Ores - Process, Microorganisms involved and Metal recovery with special reference to Copper and Iron; Dechlorination; Biodegradable plastics and Super bug.

Unit – III

Aerobic and Anaerobic digesters - Design and Various types of Digester for Bioremediation of Industrial effluents; Pros and Cons of Anaerobic process; Dendroremediation; Composting of Solid wastes; Methane production and important factors involved; Sulphur, Iron and Nitrate reduction; Hydrocarbon degradation; Nitroaromatic compounds degradation; Bioremediation of dyes; Bioremediation in Paper and Pulp industries.

Unit – IV

Fungi, Mushrooms and their enzymes in Bioremediation; Transformation of Industrial and Agro-industrial wastes into useful products; Characteristic of Solid and Liquid waste; Solid waste management - Incineration, Composting & Sanitary landfill; Sewage treatment – Small scale sewage treatment (Cesspools, Septic tank & Imhoff's tank) and Large scale sewage treatments (Primary treatment, Secondary treatment & Tertiary treatment).

Unit – V

Phytoremediation of polluted soil and wastewater; Advantages of Phytoremediation; Phycoremediation of Domestic and Industrial wastewater; Advantages of Phycoremediation; Potentials of Microalgae for Industrial effluents treatment; Conventional methods vs Algal technology; Novel technologies for Bioremediation of Industrial effluents; Genetic engineering in Bioremediation; Pollution control bodies and Environmental laws in India; Current Research Thoughts in Microbial Remediation.

Text Books

- 1) Singh, S. N. 2014. Biological Remediation of Explosive Residues, Springer International Publishing, Switzerland.
- 2) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
- 3) Saranraj, P and Sivasakthivelan, P. 2020. Text Book of Environmental Microbiology. 1st Edition, JPS Scientific Publications, India.
- 4) Cheremisinoff, N. P. 2013. Biotechnology for Waste and Wastewater Treatment, Elsevier, UK.
- 5) Sathyanarayana, T., Johri, B. N and Prakash, A. 2012. Microorganisms in Environmental Management – Microbes and Environment, Springer, Heidelberg.

References

- 1) Chandrappa, R and Das, D. B. 2012. Solid Waste Management Principles and Practice, Springer-Verlag, Heidelberg.

- 2) Anjum, N. A., Pereira, M. E., Ahmad, I., Duarte, A. C., Umar, S and Khan, N. A. 2013. Phytotechnologies Remediation of Environmental Contaminants, CRC Press, Boca Raton, FL, USA.
- 3) Gupta, D. K. 2013. Plant-Based Remediation Processes, Springer-Verlag, Berlin Heidelberg.
- 4) Gupta, D. K and Sandalio, L. M. 2013. Metal Toxicity in Plants: Perception, Signaling and Remediation Springer, Berlin Heidelberg.
- 5) Khan, M. S., Zaidi, A., Goel, R and Mussarat, J. 2012. Biomanagement of Metal-Contaminated Soils, Springer, Dordrecht.

Semester – III

4 Hours/3 Credits

ELECTIVE: VERMITECHNOLOGY

Objectives

- To study about the properties of soil and microbial composting.
- To classify and compare the characteristics of earthworm species and waste materials needed for Vermicomposting.
- To describe the process and benefits of Vermicomposting.
- To understand the biology of Earthworms and its role in Vermicomposting.
- To learn the ability of Earthworms in Organic farming and Solid waste reclamation.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Provide the knowledge to the students about Organic farming through Composting and Vermicomposting.	K1, K3
CO-2	Compare the difference between Microbial composting and Vermicomposting.	K2
CO-3	Observe the Biology of Earthworms and its role in Vermicomposting process.	K1
CO-4	Finding the details of Earthworms and its role in Solid waste reclamation.	K5
CO-5	Categorize the types of Earthworms and feed needed for Vermicomposting.	K4
CO-6	Develop various methods of Vermicomposting and its benefits to soil and plants.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	2	2	2	2	2	3	3	2	3	3	2.4
2	3	2	2	3	2	2	3	2	3	2	2	2	2	3	3	2.4
3	2	2	2	3	2	2	3	2	2	2	3	2	3	3	2	2.3
4	2	2	3	3	1	2	3	2	3	2	3	3	2	2	2	2.3
5	2	2	3	2	2	2	2	3	2	2	2	2	2	2	2	2.1
6	2	2	1	2	2	3	2	3	2	3	3	1	3	2	2	2.2
Mean Overall Score																2.3
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Vermitechnology – History and Scope; Influence of Soil microorganisms in Vermitechnology; Development and Future of Vermitechnology in India and other countries; Earthworms – Diversity, Geographical distribution, Morphology, Life cycle and Behaviour patterns.

Unit – II

Burrowing activity of Earthworms; Physical, Chemical and Biological changes caused by Earthworms in Soil; Drilospheres and Vermicasts; Effect of Earthworm is Soil structure – Carbon, Nitrogen and Phosphorous Transformation; Microclimate of Rhizosphere and Drillosphere.

Unit – III

Composting – Wastes used for Composting process; Methods of Composting; Difference between Microbial Composting and Vermicomposting; Millicomposting; Factors affecting Composting process; Analysis of Physico-chemical characteristics and Microbial quality of Compost materials; Microbial Composting - Aerobic and Anaerobic Composting.

Unit – IV

Vermicompost – Morphological identification of Earthworm species used in Vermicompost production (*Eisenia fetida*, *Eisenia andrei*, *Dendrobaena veneta*, *Eudrilus eugeniae*, *Lampito mauririi* and *Perionyx excavates*); Methods for Collection and Preservation of Earthworms; Materials used for Vermicomposting; Vermicomposting methods – Small scale and Large scale; Packaging, and Marketing; Factors influencing Vermicomposting process; Cost benefit analysis of Vermicompost; Applications of Vermicomposting in Agriculture and Horticulture practices; Advantages of Vermicompost over Chemical inputs.

Unit - V

Vermiculture; Vermiculture unit – Materials required and Maintenance; Vermiwash and its applications; Feeding habits and food for Composting worms; Importance of Microorganisms as Food for Earthworms; Problems in Vermiculture units and Remedial suggestions; Problems during Vermicomposting - Pests, Parasites and Pathogens; Earthworms in recycling of various Solid wastes; Benefits of Earthworms other than Vermicomposting; Current Research Thoughts in Vermitechnology.

Text Books

- 1) Edwards, C. A., Arancon, N. Q and Sherman, R. L. 2011. Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management. 1st Edition, CRC Press, USA.
- 2) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
- 3) Subba Rao N.S. 1999. Soil Microbiology, 4th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.

References

- 1) Satyanarayana, U. 2005. Biotechnology, 1st Edition, Books and Allied (P) Ltd., Kolkata, India.

- 2) Edwards, C. A and Bohlen, P. J. 1996. Biology and Ecology of Earthworms, Chapman and Hall, London.
- 3) Ismail, S. A. 1997. Vermitechnology: The Biology Earth worm, Orient Longman, United Kingdom.
- 4) Kale Radha, D. 1998. Earthworm: Cinderella of organic farming. Prism Books Pvt. Ltd., Bangalore, India.

Semester – III

4 Hours/3 Credits

ELECTIVE – MICROBIAL NANOTECHNOLOGY

Objectives

- To assess types of nanoparticles for various medical research to find out the solution of human diseases.
- To overcome the disadvantages of nanoparticle application.
- To Physical and chemical properties of nanoparticles give idea about the biological process.
- To apply the nanoparticle research in human health sector for their healthy society.
- To motivate the researchers to carry the better advanced research on this field.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Arrange the historical events in the field of Nanotechnology and its development.	K6
CO-2	Provide knowledge on synthesis of Nanoparticles and its vast applications.	K1, K3
CO-3	Evaluate and characterize the methods for nanoparticles to know about its physical and chemical properties.	K5
CO-4	Analyze the Physical and chemical properties of nanoparticles for its Bioactivity.	K4
CO-5	Motivate the researchers to carry the better advanced research on this field.	K2
CO-6	Collect a better knowledge about targeting drug delivery by nanoparticles	K3

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	2	2	3	2	2	2	2	2	3	2	2	3	3	2.3
2	3	2	2	2	2	2	3	2	2	2	2	2	2	3	3	2.2
3	2	2	2	3	1	2	3	2	1	2	3	2	3	3	2	2.2
4	2	2	3	3	2	2	3	1	3	2	3	3	1	2	2	2.2
5	2	2	3	2	2	2	2	3	2	1	2	2	1	2	2	2.0
6	2	2	1	2	2	3	2	2	2	3	3	2	3	2	2	2.2
Mean Overall Score																2.2
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10

Create	5	5	20
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Unit – I

History of Nanotechnology; Common Terminologies – Nanotechnology, Microbial nanotechnology, Nanomedicine, Nanowires, Quantum Dots, Nanocomposite and Nanoparticles; Applications of Nanotechnology in Life Sciences; Present status and Future prospects of Microbial Nanotechnology.

Unit - II

Molecular Nanotechnology - Nanomachines and Collagen; Uses of Nanoparticles - Cancer therapy and Manipulation of cell and biomolecules; Types of Nanoparticles - Physical, Chemical and Biological; Microbial synthesis of Nanoparticles.

Unit – III

Nanoparticles - Types and functions; Physical and Chemical properties of Nanoparticles; Carbon nanotubes; Nanorobots; Characterization of Nanoparticles using UV-Vis, FTIR spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD and Nanoparticle size analyzer.

Unit – IV

Advantages of Nanoparticles - Drug targeting, Protein detection and MRI; Development of Green chemistry; Commercial viability of Nanoparticles. Disadvantages – health risk associated with nanoparticles; Inadequate knowledge on nanoparticles research.

Unit – V

Drug delivery - Protein and Nanoparticle mediated; Uses of Nanoparticles in MRI, DNA and protein microarrays; Nanotechnology in Health, Agriculture and Environmental sectors; Toxicology in Nanoparticles; Current Research Thoughts in Microbial Nanotechnology.

Text Books

- 1) David, S. G. 2004. Bionanotechnology, Lessons from nature, John Wiley & Sons Inc. Publication.
- 2) Parthasarathy, B. K. 2007. Introduction to Nanotechnology, Isha Publication, India.
- 3) Elisabeth, P and Aravind, P. 2007. Bionanotechnology. Morgan & Claypool Publishers, USA.
- 4) Bernd, R. 2006. Microbial Bionanotechnology: Horizon Scientific Press, Canada.

References

- 1) David, E. R and Joseph, D. B. 2009. Bionanotechnology: Global Prospects. CRC Press, USA.
- 2) Ehdud, G. 2013. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology, World Scientific Publishers, UK.
- 3) Silva, G. A and Parpura, V. 2011. Nanotechnology for Biology and Medicine: At the building block level, Springer Science, USA.

Semester – IV

4 Hours/4

Credits

FOOD MICROBIOLOGY

Objectives

- To distinguish the intrinsic and extrinsic factors of growth of microbes in food and illustrate the various food preservation techniques.
- To describe the causes of spoilage of different types of food and plan the methods for detecting the causative microbes of food spoilage.

- To obtain a good understanding of food microbiology and become qualified as microbiologist in food industries.
- To detect and interpret the food borne infections, intoxications and prevent food borne outbreaks.
- To implement quality control and represent the standards in food production.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Understand the principles of microorganisms during various food-processing and preservation steps.	K2
CO-2	Apply the role of microorganisms, various preservation techniques, and assess the growth factors of food pathogens in food industry.	K3
CO-3	Evaluate the food contamination and spoilage, detect food pathogens based on physical, chemical and immunological methods.	K5
CO-4	Adapt an appropriate preservative technique for food.	K6
CO-5	Identify the interactions between microorganisms and the food environment, and factors influencing their growth and survival.	K1
CO-6	Plan hygiene and sanitation protocol, apply Hazard analysis, Food laws and standards for good quality in food production.	K4

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	2.2
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	2.5
Mean Overall Score																2.4
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

History and Development of Food Microbiology; Importance of microorganisms in Food microbiology – Mold, Yeast and Bacteria; Microbial growth in food - Intrinsic and Extrinsic factors; Principles of Food preservation – High & Low temperature, High pressure, Drying, Radiation, Modified atmosphere, Pulsed Electric fields, Aseptic package and Manothermosonication; Food preservatives – Natural preservatives & Chemical preservatives.

Unit – II

Microbial Contamination of Foods; Sources of Microbial Contamination – Green plants, Fruits, Animals, Air and Handling & Processing practices; Classification of foods in term of potential for spoilage; Contamination, Spoilage and Preservation of Cereals and its products, Sugars and

its products, Canned foods, Vegetables, Fruits, Milk products, Alcoholic products, Egg, Meat products, Seafoods and Poultry products.

Unit – III

Fermentation and its types; Traditional Indian fermented foods; Production of Baker's Yeast; Bread production from Yeast and its spoilage; Fermented Vegetables – Olives, Pickles & Sauerkraut; Fermented Meat & Fish; Mold fermentations – Tempeh, Soy sauce & Rice wine and Mycoprotein; Genetically Modified Foods (GMF).

Unit – IV

Milk – Composition, Microflora and Prevention of Microbial contamination; Products from Milk; Lactic acid bacteria; Bacteriocin production and its health benefits; Diseases caused by Lactic acid bacteria; Concept of Probiotics & Prebiotics; Lactic starter cultures; Fermented dairy products – Cheese, Butter, Cream Yogurt and Fermented milk; Spoilage and defects of Fermented dairy products; Testing of Milk and its products; Microbiology of Ice cream and related products.

Unit – V

Food borne infection and intoxication; Seafood Toxicants; Mycotoxins in Agricultural food crops; Biosensors in Food; Food wastes and its types; Microbiology of Food products preparation; Codes of Good Manufacturing Practices; Government Regulatory Practices and Policies – FDA, EPA, HACCP, ISI, BIS and FSS; Enforcement and Control Agencies; Microbiological criteria for food; Recent trends and development in Food Technologies in India; Current Research Thoughts in Food Microbiology.

Text Books

- 1) William C. Frazier and Dennis C. Westhoff. 2013. Food Microbiology, 5th Edition, McGraw Hill, New York.
- 2) James M. Jay, Martin J. Loessner and David A. Golden. 2005. Modern Food Microbiology, 7th Edition, Springer Publications, United States.
- 3) Martin R. Adams and Maurice O. Moss. 2008. Food Microbiology, 3rd Edition, RSC Publishing, United Kingdom.
- 4) Vijaya, R. K. 2004. Food Microbiology. 1st Edition, MJP Publishers, Chennai, India.

References

- 1) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 2) Patel, A. H. 2016. Industrial Microbiology, 2nd Edition, Laxmi Publications, New Delhi, India.
- 3) Casida, L. E. 2007. Industrial Microbiology, New Age International Publishers, New Delhi, India.
- 4) Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th Edition, CBS Publishers and Distributors, New Delhi, India.

Semester – IV

5 Hours/5 Credits

INDUSTRIAL MICROBIOLOGY

Objectives

- To impart theoretical knowledge of role of microbes in Industrial production of different bioproducts.
- To describe the industrial Fermentation processes.
- To explain the Construction, Design and Operation of Fermentor.

- To encompass the use of Industrially important microorganisms in the manufacture of food or industrial products.
- To study the use of microorganisms for the production of Antibiotics, Vaccines, Organic acids, Organic solvents, Amino acids, Vitamins and Industrial enzymes.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Describe different fermentation techniques, bioreactor design, inoculum development for industrial fermentations, Microbial growth and product formation kinetics.	K1
CO-2	Media formulation and sterilization, isolation, preservation and improvement of industrially important microorganisms.	K6
CO-3	Assimilate knowledge on basics and different stages in Industrial fermentation process.	K3
CO-4	Evaluate theoretical knowledge on design, construction and working of different types of fermenters and medium formulation on an industrial scale.	K3, K5
CO-5	Plan industrial production of microbial products and stages in downstream process.	K4
CO-6	Understanding the Industrial production of Antibiotics, Vaccines, Organic acids, Organic solvents, Amino acids, Vitamins and Industrial enzymes.	K2

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	3	3	3	2	2	3	3	3	3	3	3	2	3	2.8
2	2	2	3	3	3	3	3	3	3	3	2	3	2	2	2	2.6
3	2	3	2	3	2	3	2	3	2	3	3	2	3	3	3	2.6
4	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	2	3	3	2	3	3	3	3	1	2	2	3	2.8
6	3	3	1	3	3	3	3	2	3	3	3	3	3	3	3	2.5
Mean Overall Score																2.6
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

History of Industrial Microbiology; Industrially important microorganisms; Comparison of Bacterial and Fungal fermentation; Primary and Secondary metabolites from microorganisms; Bioproducts – Classification, Types and Advantages; Types of Fermentation process – Batch fermentation, Fedbatch fermentation & Continuous fermentation; Methods of Fermentation – Submerged fermentation & Solid state fermentation; Design of Fermentor; Factors affecting Fermentor design; Types of Fermentor; Industrial Sterilization of Fermentor and Air; Fermentation economics; Computer control of Fermentation process.

Unit – II

Difference between Wild strains and Industrial strains; Industrial strains – Characteristics, Screening techniques, Industrial strain development methods, Preservation of Industrial strains and Preparation of Inoculum; Fermentation medium – Composition and Sterilization; Downstream Processing; Foam formation and Antifoam agents.

Unit – III

Microbial production of Antibiotics (Penicillin, Streptomycin & Tetracyclines), Vaccines (Hepatitis – B Vaccine & Rabies Vaccine), Organic acids (Citric acid, Acetic acid, Lactic acid & Gluconic acid) and Amino acids (Glutamic acid & Lysine); Microbial assay of Antibiotics and Amino acids.

Unit – IV

Microbial production of Vitamins (Vitamin – B₂, B₁₂, & Vitamin – C) and Enzymes (Amylases, Proteases & Pectinases); Microbial assay of Vitamins and Enzymes; Production of SCPs – Bacterial proteins, Actinomycetous proteins, Fungal proteins and Algal proteins; Biopolymers – Classification, Properties, Applications and Industrial production of Polyhydroxyalkanoates (PHAs) and Poly-lactic acid (PLA); Production of Biodiesel, Biological Hydrogen and Biogas.

Unit – V

Yeasts and its industrial uses; Production of Baker's Yeast *Saccharomyces cerevisiae*; Factors influencing the selection of Baker's Yeast for Fermentation; Contaminants during production of Baker's Yeast; Production of Food Yeast & Fodder Yeast; Microbial production of Solvents (Bioethanol, Glycerol & Acetone – butanol) and Alcoholic beverages (Beer & Wine); Factors affecting Alcohol fermentation; Current Research Thoughts in Microbial Fermentation Technology.

Text Books

- 1) Patel, A. H. 2016. Industrial Microbiology, 2nd Edition, Laxmi Publications, New Delhi, India.
- 2) Casida, L. E. 2007. Industrial Microbiology, New Age International Publishers, New Delhi, India.
- 3) Waites, M. J. 2007. Industrial Microbiology, Blackwell Publishing Company, United Kingdom.
- 4) Stanbury, P. T and A. Whitaker. 2005. Principles of Fermentation Technology, Pergamon Press, New York.

References

- 1) Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th Edition, CBS Publishers and Distributors, New Delhi, India.
- 2) Crueger, W and Crueger, A. 2000. Biotechnology: A Test Book of Industrial Microbiology, Second Edition, Panima Publishing Corporation, New Delhi, India.
- 3) William C. Frazier and Dennis C. Westhoff. 2013. Food Microbiology, 5th Edition, McGraw Hill, New York.
- 4) Martin R. Adams and Maurice O. Moss. 2008. Food Microbiology, 3rd Edition, RSC Publishing, United Kingdom.

ELECTIVE: MICROBIAL BIOTECHNOLOGY**Objectives**

- To learn the basic tools in Microbial Biotechnology.
- To study the various Immobilization techniques.
- To understand the various concepts of Recombinant DNA Technology and Microbial products.
- To understand the production of Microbial Biotechnology products.
- To emphasize on IPR issues and need for knowledge in patents in Biotechnology.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Describe about different metabolites like antibiotics, organic acids, enzymes, drugs, vitamins, therapeutic peptides and pharmaceutical products, biopesticides and biofertilizers of microbial origin.	K1
CO-2	Analyze theoretical concepts of Biotechnology and their applications in Genetic engineering and Microbiology.	K4
CO-3	Assimilate knowledge on basics and different stages in Microbial fermentation process.	K3
CO-4	Evaluate the concept of Recombinant technology with special emphasis in microbial system.	K5
CO-5	Creates an awareness on the Intellectual property rights and patenting of Biotechnological processes.	K6
CO-6	Understanding the various concepts of Recombinant DNA Technology and Microbial products.	K2

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	3	3	3	3	3	3	2	3	3	3	3	2	3	2.8
2	3	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.7
3	3	2	3	3	2	3	2	3	2	2	3	3	3	3	2	2.6
4	3	3	2	3	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	3	3	3	2	3	2	3	3	3	2	3	2	2.6
6	3	3	2	2	3	3	3	3	3	3	3	3	2	3	2	2.7
Mean Overall Score																2.7
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Biotechnology – Definition, Various branches and Scope; Metabolites from Microorganisms – Primary and Secondary metabolites; Microbial production of Industrial enzymes; Enzyme immobilization – Immobilization techniques and Advantages; Industrial application of Enzymes.

Unit – II

Recombinant DNA technology – Principles and applications; Cutting and joining enzymes in rDNA technology; List of Protein products from rDNA Technology; Genetic engineering of microbes for Plant improvement; Hairy root culture and their applications; Recombinant Vaccines; Microbial synthesis of Pharmaceutical products – Recombinant Vaccines, Insulin, Interferon, Hormones, Monoclonal antibodies and Polyclonal antibodies; Steroid transformations - Substrates, Typical structures, Microorganisms, Inoculum preparation, 11-hydroxylation, process and Recovery.

Unit – III

Production of Microbial biotechnology products – Xanthan, Dextran, Biosurfactants, Steroids transformation and Polyhydroxyalkanoates (PHA & PHB); Biofuels – Bioethanol, Biodiesel, Biological Hydrogen and Biogas; Microbiology of Methane production - Methanogenesis; Biopolymers – Classification, Properties, Applications and Industrial production of Polyhydroxyalkanoates (PHAs) and Poly-lactic acid (PLA); Production of Microbial Pesticides.

Unit – IV

SCP (Algae & Yeast) – List of organisms, Cultivation Techniques, Advantages and Disadvantages; SCP cultivation from wastes; Genetically modified foods; Recombinant Microbes; Transgenic Animals; Transgenic; Organisms in Agriculture and Aquaculture; *Agrobacterium* mediated transfer; Synthetic Biology; Gene therapy; Stem cell therapy; Stem cell research – Reproductive cloning and Therapeutic cloning.

Unit – V

Animals used for laboratory experiments; Care and Maintenance for Laboratory animals; Ethics in Animal experimentation; Ethical issues in Human Gene Therapy; Protection of Biotechnological inventions – Patent protection, Trade secrets and Plant Breeder's Rights; Biowarfare and Bioterrorism; Current Research Thoughts in Microbial Biotechnology.

Text Books

- 1) Dubey, R. C. 2014. A Text Book of Biotechnology, 5th Edition, S. Chand Publishing, India.
- 2) Satyanarayana, U. 2005. Biotechnology, 1st Edition, Books and Allied (P) Ltd., Kolkata, India.
- 3) Patel, A. H. 2016. Industrial Microbiology, 2nd Edition, Laxmi Publications, New Delhi, India.
- 4) Casida, L. E. 2007. Industrial Microbiology, New Age International Publishers, New Delhi, India.

References

- 1) Old, R. S and S. B. Primrose. 2006. Principles of Gene Manipulation, 7th Edition, Blackwell Scientific Publications, London.
- 2) Jogdand, S. N. 2005. Gene Biotechnology, Himalaya Publishing House, Mumbai, India.
- 3) Singh, B. D. 2012. Biotechnology, 5th Edition, Kalyani Publishers, Chennai, Tamil Nadu, India.
- 4) Kumarasan, V. 2001. Biotechnology, Published by Saras Publication, Nagercoil, Tamil Nadu, India.

ELECTIVE: MICROALGAL TECHNOLOGY**Objectives**

- To learn the basic tools in Microbial Biotechnology.
- To learn about classification, characteristics of microalgae.
- To formulate algal cultures and importance of culture collections.
- To learn Upstream and Downstream techniques of microalgae.
- To analyze the benefits of Microalgae for this universe.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Understanding the benefits of Algae to environment.	K2
CO-2	Formulate algal cultures and importance of culture collections.	K6
CO-3	Describe commercial production of fuels and microbial enzymes.	K1
CO-4	Apply knowledge on Basic cultivation technology of microalgal cultivation technique.	K3
CO-5	Develop techniques on removal of heavy metals from contaminated water using microalgae.	K6
CO-6	Focus the idea about Bioremediation using microalgae.	K4

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	2	2	2	2	2	3	3	2	3	3	2.4
2	3	2	2	3	2	2	3	2	3	2	2	2	2	3	3	2.4
3	2	2	2	3	2	2	3	2	2	2	3	2	3	3	2	2.3
4	2	2	3	3	1	2	3	2	3	2	3	3	2	2	2	2.3
5	2	2	3	2	2	2	2	2	3	2	2	2	2	2	2	2.1
6	2	2	1	2	2	3	2	3	2	3	3	1	3	2	2	2.2
Mean Overall Score																2.3
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Microalgae – Characteristics, Habitat, Distribution, Morphology, Reproduction (Asexual & Sexual) and Life cycle; Cyanobacteria; Diatoms; Algal identification (Microscopic examination) and Cultivation in Culture medium; Photosynthesis in Microalgae; Freshwater algae and Marine algae; Economical importance of Microalgae.

Unit – II

Photobioreactor based Microalgal production; Downstream processing; Heterotrophic production; Mass cultivation in Circular – Tubular column, Raceway pond and Pit method; Mass cultivation of *Chlorella*, *Spirulina* and *Dunaliella*; Algal bloom; Factor influence Algal growth – Nutrients, Temperature and Light.

Unit – III

Microalgal proteins and peptides; SCP – Advantages, Disadvantages and Pigments – Carotenoids, Phycocyanin & Phycoerythrin; Growth promoting substance from Microalgae; Extracellular polymeric Substance; Microalgal Toxins.

Unit – IV

Microalgae in Human welfare –Nutraceuticals, Pharmaceuticals, Biofertilizers and Pollution control; Biofuels – Biodiesel, Biobutanol, Biohydrogen and Bioethanol; Nanoparticles from microalgae; Algae in Transgenics; Antimicrobials from microalgae; Algal food colorants; Microalgae in CO₂ sequestration; Algae in Space.

Unit – V

Targeted Genetic Modifications: Genome shuffling and Evolutionary Engineering of Microalgae; Application of Microalgae in Synthetic biology; Bioluminescence; Quorum sensing in Microalgae – Introns, CRISPR-CAS discovery, Mode of action and Application; Current Research Thoughts in Microalgal Technology.

Text Books

- 1) Amrik, S. A. 2003. Phycology: Principles, processes and applications. Daya Publishing House, New Delhi, India.
- 2) Steve, P. 2009. Protozoans, Algae & Other Protists, Capstone Press, USA.
- 3) Hoek, C., Mann, D. G and Jahns, H. M. 1995. Algae - An Introduction to Phycology, 39; Cambridge University Press, UK.
- 4) Sharma, O. P. 2001. Textbook of Algae. Tata McGraw Hill Company, New Delhi, India.

References

- 1) Ismail, R., Sanjay K. Gupta, Amritanshu, S., Poonam, S., Sheena, K and Faizal, B. 2016. Microalgae Applications in Wastewater Treatment. 7th Edition, New India Publication, New Delhi, India.
- 2) Biris, E. S., Maria, T., Tania, M., Radu, M and Antonia, O. 2016. Applications of Microalgae in Wastewater Treatments. ProEnvironment, India.
- 3) Stephen, J. O. 1993. Bacteria, Algae, and Protozoa - Cold Spring Harbor Laboratory Press, USA.
- 4) Sarabhai, B. P and Arora, C. K. 2005. Textbook of Algae. Anmol Publishing Pvt. Ltd. New Delhi, India.

Semester – IV

4 Hours/3 Credits

ELECTIVE: PROBIOTIC MICROBIOLOGY

Objectives

- To acquire the knowledge and utilization of Probiotics and Prebiotics in our daily life.
- To develop the Entrepreneurial Skill production and assessment of Probiotic microbes.
- To list out the Commercial probiotic strains.
- To explain the definition and types of Probiotics.
- To characterize the limitation and dosage of Probiotics

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
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CO-1	Understand the basic knowledge of Gastrointestinal Ecosystem.	K2, K3
CO-2	Learn the Gastrointestinal microbiota and regulation of the Immune system.	K1
CO-3	Develop the Entrepreneurial Skill production and assessment of Probiotic microbes.	K6
CO-4	Knowledge about the Genetically modified probiotics.	K3
CO-5	Evaluate the <i>In vitro</i> assessment of probiotic microbes.	K5
CO-6	Analyze and explore the Genetic tools used for the identification of adaptation and probiotic factors.	K4

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	3	2	2	3	3	3	3	2	3	3	3	2	3	3	2.7
2	2	2	3	3	2	2	3	2	3	3	2	2	3	2	1	2.3
3	3	1	2	3	1	3	2	3	2	2	3	3	2	3	3	2.4
4	2	2	3	2	3	2	3	3	3	3	3	3	3	2	2	2.6
5	2	3	3	2	2	2	2	2	2	2	2	2	3	2	2	2.2
6	3	2	2	3	3	3	2	3	3	3	3	3	2	3	3	2.7
Mean Overall Score																2.5
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I

Gastrointestinal tract architecture; Intestinal microbiota; Functions of Endogenous microflora; Gastrointestinal microbiota and regulation of the immune system; Factors affecting the Gut microbial balance; Role of enteric pathogens in Gastrointestinal diseases; Treatment and prevention of Gastrointestinal disease - Antibiotics, Probiotics, Prebiotics, Synbiotics.

Unit – II

History of Probiotics; Features of Probiotics; Types of Probiotics - Human probiotics and Animal probiotics; Forms of Probiotics; Probiotic territorial colonization; Physiological effects and Mechanism of action of Probiotics; Side effects and safety profile of Probiotics; Limitations of Probiotics; Dosage of Probiotics; Prebiotics – Definition and Prebiotics vs. Probiotics; Prebiotics in Diet and Health benefits.

Unit – III

Probiotic strains - Lactic acid bacteria (LAB): *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Lactococcus*; Actinobacteria: *Bifidobacteria*, *Streptomyces* and *Oerskovia*; Fungi - *Saccharomyces*, *Candida* and *Aspergillus*. Others Probiotic strains: *Escherichia coli*, *Bacillus* and *Enterococcus*; Commercial Probiotic strains; Genetically Modified Probiotics (GMP).

Unit – IV

In vitro assessment of Probiotic microbes – Survivability, Acid resistance, Bile salt resistance, Pepsin resistance and Pancreatin resistance; Colonization properties - Aggregation, Hydrophobicity, Adhesion with intestinal epithelial cell lines, Mucin adhesion assay, Biofilm forming ability, Hemolytic activity and Antibiotic resistance; Functional properties - Antimicrobial activity, Bacteriocin production, Bile salt hydrolase activity and Production of digestive enzymes; *In vivo* assessment of probiotic microbes in chicken model.

Unit – V

Adaptation factors - Stress resistance, Cell envelope integrity, DNA repair and Protein repair; Transport and Hydrolysis of bile (*bsh* gene); Adhesion factors - S layer and Mucus binding proteins (*mub* gene), LTA, EPS and PG; Health promoting factors - Microbe - Microbe interaction, Production of Antimicrobial peptides and Competitive exclusion; Genetic tools used for the identification of Adaptation and Probiotic factors; Current Research Thoughts in Probiotic Microbiology.

Text Books

- 1) William C. Frazier and Dennis C. Westhoff. 2013. Food Microbiology, 5th Edition, McGraw Hill, New York.
- 2) Kenji Sonomoto and Atsushi Yokota. 2011. Lactic acid bacteria and *Bifidobacteria*, Caister Academic Press Publisher, China.
- 3) Charalampopoulos, Dimitris, Rastall and Robert. 2009. Prebiotics and Probiotics. Science and Technology, Springer Publication, USA.
- 4) Nicholas Joseph Talley and Christopher J. Martin. 2006. Clinical Gastroenterology: A practical problem-based approach, Elsevier Publication, USA.
- 5) Gary B. Huffnagle and Mairi Catherine Noverr. 2008. GI microbiota and regulation of the immune system, Springer Publication, USA.

References

- 1) Malago. 2011. Probiotic Bacteria and Enteric Infections: Cytoprotection by Probiotic Bacteria, Springer Publication, USA.
- 2) Wolfgang Kneifel and Seppo Salminen. 2011. Probiotics and Health Claims, John Wiley and Sons Publication, UK.
- 3) Natasha Trenev, 1998. Probiotics: Nature's Internal Healers, Penguin Publication, India.
- 4) Dash, Allan N. Spreen and Beth M. Ley. 2000. Health Benefits of Probiotics. BL Publications, India.
- 5) Yuan Kun Lee and Seppo Salminen. 2008. Handbook of Probiotics and Prebiotics, Wiley-Interscience Publication, UK.

Semester – IV

**0 Hours/2
Credits**

SSP: COMPREHENSIVE MICROBIOLOGY

Objectives

- To understand the overall concept of all fields of Microbiology.
- To provide knowledge about basic and advanced concepts in Microbiology.
- To compare the characteristics of various categories of microorganisms.
- To train the student for their Competitive exams (NET) like ARS/ASRB/CSIR.
- To motivate the students to participate in Microbiology Competitive exams.

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Gain knowledge about the overall concepts of Microbiology.	K3
CO-2	Describe the basic and advanced concepts in Microbiology.	K1
CO-3	Compare the characteristics of various categories of microorganisms.	K2
CO-4	Focus the role of microorganisms in food, agriculture, environment and industrial sectors.	K4

CO-5	Understand and evaluate the role of microorganisms in various Competitive exams.	K2, K5
CO-6	Help student to score and qualify in the NET exam which will be conducted by ARS/ASRB/CSIR.	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)										Mean Scores of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	PSO 10	
1	3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	2.8
2	3	2	3	3	2	3	3	3	3	3	3	3	3	2	3	2.8
3	3	2	3	3	3	3	2	3	2	2	3	3	3	3	2	2.6
4	3	3	2	3	3	2	3	2	3	3	3	3	3	2	3	2.7
5	3	2	3	3	3	3	2	3	2	3	3	3	2	3	2	2.6
6	3	3	2	2	3	3	3	3	3	3	3	3	3	3	2	2.8
Mean Overall Score																2.7
Result																High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	10
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	20

Unit – I (History of Microbial world)

History, Development and Scope of Microbiology; Evolution of Microbial life; Theory of Spontaneous generation; Prokaryotes; Eukaryotes; Archaeobacteria; Techniques used in Identification and Classification of bacteria; Important groups of Prokaryotes - Photosynthetic bacteria, Blue Green Algae, *Mycoplasma* and Actinobacteria; Heterotrophic bacteria; Nitrobacteria; Nitrogen fixing bacteria; Cyanobacteria; Lactic acid bacteria; Halophiles; Thermophiles; Acidophiles; Methanogens; Structure of Virus; Classification of Virus; Lytic and Lysogenic cycle; Plant viruses; Viroids.

Unit - II (Microbial Ecology and Physiology)

Principles of Microbial Ecology; Microbiology of Ecosystems – Soil, Rhizosphere and Phyllosphere; Water – Fresh water and Marine; Air Microbiology; Microbial interactions – Symbiosis, Synergism, Commensalism, Parasitism, Amensalism, Antagonism and Predation; Adaptation of microorganisms to various Ecosystem; Microbial growth curve; Mathematical expression of growth – Continuous and Batch culture; Diauxic and Synchronous growth; Microbial nutrition; Bacterial Metabolism – Aerobic and Anaerobic respiration; Electron Transport Chain; Microbial Photosynthesis; Oxidative and Substrate level Phosphorylation; Biosynthesis of Cell wall; Protein breakdown by microbes.

Unit - III (Soil Microbiology)

Soil Microorganisms – Major groups, Decomposition of organic matter and Soil health; Root exudates and Rhizosphere effects; Manipulation of rhizosphere microflora in plant productivity; Microbial Biomass; Nitrogen cycle – Ammonification, Nitrification and Denitrification; Microbial transformation of Phosphorous, Sulphur and Minor nutrients; Role of biofertilizers in agriculture and forestry; Bioremediation of soil; PGPR and their mode of action; Formation and composition of soil organic matter: Fulvic acid and Humic acid.

Unit - IV (Environmental Microbiology and Basic Microbiological Techniques)

Isolation and preservation of different types of microorganisms; Methods of Sterilization and Disinfection; Microscopy – Optical microscope, Phase contrast microscope, Fluorescent

microscope, Dark field microscope and Electron microscope; Microbial assay of Vitamins, Enzymes and Antibiotics; Pollution of water, soil and air; Role of microorganisms in Pollution, Sources of pollution and their disposal; Management of Solid and Liquid organic wastes; Composting; Biogas; Water purification; Sewage treatment; Water borne diseases; Water management.

Unit –V (Microbial Biotechnology)

Industrial production of metabolites – Organic acids, Alcohols, Antibiotics; Fermentor design and types; Control of fermentation process – Batch, Fedbatch and Continuous; Downstream processing in fermentation industry; Production of Single Cell Protein (SCP) – SCP as food and feed; Production of Probiotics (Bioactive foods), Hormones, Biofertilizers and Biopesticides; Phytoremediation; Microbiology of raw and processed foods; Fermented food – Vinegar, Wine, Sauerkraut, Pickles, Cheese and Yoghurt; Food preservation, contamination and spoilage; Food borne illness and intoxicification; Food as substrate for microorganisms; Microflora of meat, fish, egg, fruits, vegetables, juices, flour and canned foods; Biodegrading microbes.

Text Books

- 1) Gerard J. Tortora, Berdell R. Funke and Christine L. Case. 2015. Microbiology – An Introduction, 12th Edition, Peareson Publishers, San Francisco.
- 2) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
- 3) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
- 4) Satyanarayana, U. 2005. Biotechnology, 1st Edition, Books and Allied (P) Ltd., Kolkata, India.
- 5) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
- 6) Subba Rao N.S. 1999. Soil Microbiology, 4th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.

References

- 1) Dubey, R.C. and D. K. Maheswari. 2010. A Text book of Microbiology. 3rd Edition, S. Chand and Company, New Delhi.
- 2) Chakraborty. 2003. A Text book of Microbiology. 2nd Edition, Published by New Central Book Agency (P) Ltd., Kolkata.
- 3) Pelczar Jr. M. J., Chan, E. C. S and Kreig, N. R. 2006. Microbiology. 5th Edition McGraw Hill Inc. New York.
- 4) William C. Frazier and Dennis C. Westhoff. 2013. Food Microbiology, 5th Edition, McGraw Hill, New York.
- 5) Patel, A. H. 2016. Industrial Microbiology, 2nd Edition, Laxmi Publications, New Delhi, India.
- 6) Casida, L. E. 2007. Industrial Microbiology, New Age International Publishers, New Delhi, India.
- 7) Waites, M. J. 2007. Industrial Microbiology, Blackwell Publishing Company, United Kingdom.

Semester – III & IV

5 Hours/5 Credits

PRACTICAL – III: BIOINOCULANT, COMPOSTING AND MUSHROOM TECHNOLOGY

- 1) Isolation, Purification, Mass production and Formulation of Nitrogen fixing bacteria – *Rhizobium* sp., *Azotobacter* sp. and *Azospirillum* sp.

- 2) Isolation, Purification, Mass production and Formulation – *Bacillus subtilis* and *Pseudomonas fluorescens*, *Trichoderma viride* and *Beauveria bassiana*.
- 3) Isolation of Phosphate solubilizers from Soil.
- 4) Study of Phylloplane microflora by Leaf impression method.
- 5) Estimation of Plant growth promoting substance produced by PGPR.
- 6) Antagonistic activity of Biocontrol agents.
- 7) Assessment of AM colonization in roots.
- 8) Different formulations of Bioinoculants.
- 9) Method of application and Quality control.
- 10) Mass cultivation of *Azolla* and BGA.
- 11) Preparation of Microbial Compost and Vermicompost.
- 12) Analysis of Physical, Chemical and Microbial characteristics of Microbial Compost and Vermicompost.
- 13) Substrates preparation for Mushroom cultivation.
- 14) Spawn production for Mushroom cultivation.
- 15) Sterilization process and Media preparation for Mushroom cultivation
- 16) Cultivation of Milky mushroom and Oyster mushroom

Semester – III & IV

5 Hours/5 Credits

PRACTICAL – IV: ENVIRONMENTAL AND FOOD MICROBIOLOGY

- 1) Assessment of Milk quality by MBRT and Resazurin method.
- 2) Enumeration of microorganisms in Milk by Direct Microscopic Count and SPC Method.
- 3) Enumeration of microorganisms in Water by SPC Method.
- 4) Estimation of Physical parameters of Waste water.
- 5) Bacteriological examination of water by MPN test.
- 6) Isolation and enumeration of microorganisms from Air.
- 7) Isolation and enumeration of microorganisms from Fruits and Vegetables.
- 8) Isolation and enumeration of Antibiotic producing fungi from soil.
- 9) Estimation of Soil enzymes - Urease and Phosphatase.
- 10) Extracellular enzyme activities – Amylase, Cellulase, Protease and Lipase.
- 11) Preparation of Immobilized Sodium alginate beads.
- 12) Isolation of Fungi from spoiled Bread.
- 13) Isolation of Cellulose, Phenol and Pesticide degrading bacteria.
- 14) Determination of inhibitory effect of Food preservatives.
- 15) Isolation and Microscopic examination of Yeast from Grapes.
- 16) Media formulation and Cultivation of *Spirulina platensis*
- 17) Microscopic examination, Growth analysis and Extraction of *Spirulina platensis*.
- 18) Extraction of Pigments from microorganisms.