SACRED HEART COLLEGE (AUTONOMOUS)

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

B.Sc MICROBIOLOGY CURRICULUM 2021 – 2022

B.Sc Microbiology - Programme Structure (Revised with effect from 2021 - 2022 Onwards)

Sem	Part	Subject Code	Subject Title	Hrs	Credit (s)	E -	CA	SE	Total
I	I	LT114	Tamil – I	5	3	3	50	50	100
	II	LE115AT	English – I	5	2	3	50	50	100
	III	ABC102	Allied Biochemistry – I	4	3	3	50	50	100
	III	PABC102	Allied Practical – I	2	1	3	40	60	100
	III	MB103	Fundamentals of Microbiology	4	4	3	50	50	100
	III	MB104	Microbial Diversity and Classification	3	3	3	50	50	100
	III	PMB102	Main Practical – I	3	3	3	50	50	100
	IV	SK104	Communication Skills	2	1	-	-	-	-
	IV	VE105A/ VE105B	Christian Religion – I/Value Education - I	2	1	3	50	50	100
	IV	CE103	Communicative English – I	-	1	-	-	-	-
Total				**30**	**22**	**-**	**-**	**-**	**-**
II	I	LT214	Tamil – II	5	3	3	50	50	100
	II	LE215AT	English – II	5	2	3	50	50	100
	III	ABC202	Allied Biochemistry – II	4	3	3	50	50	100
	III	PABC202	Allied Practical – II	2	1	3	50	50	100
	III	MB203	Microbial Physiology and Metabolism	4	4	3	50	50	100
	III	MB204	Bioinstrumentation	3	3	3	50	50	100
	III	PMB202	Main Practical – II	3	3	3	50	50	100
	IV	SK204	Leadership Skills	2	1	-	-	-	-
	IV	VE205A/ VE205B	Christian Religion – II/Value Education - II	2	1	3	50	50	100
	IV	CE203	Communicative English – II	-	1		-	-	-

Total				**30**	**22**	**-**		**-**	**-**
III	I	LT312	Tamil – III	5	3	3	50	50	100
	II	LE309T	English – III	5	2	3	50	50	100
	III	AM310C	Allied Biostatistics – I	6	5	3	50	50	100
	III	MB303	Immunology	4	4	3	50	50	100
	III	MB304	Mushroom Technology	3	3	3	50	50	100
	III	PMB302	Main Practical – III	3	3	3	50	50	100
	IV	SK304	Technical Skills	2	1		-	-	-
	IV	VE306	Human Rights	2	1	3	50	50	100
	IV	LE309P	English Lab - III	-	1	-	50	50	100
Total				**30**	**23**	**-**	**-**	**-**	**-**
IV	I	LT411	Tamil – IV	5	3	3	50	50	100
	II	LE409T	English – IV	5	2	3	50	50	100
	III	AM409C	Allied Biostatistics – II	6	5	3	50	50	100
	III	MB404	Bioinoculant Technology	4	4	3	50	50	100
	III	MB405	Microbial Genetics	3	3	3	50	50	100
	III	PMB402	Main Practical – IV	3	3	3	50	50	100
	IV	SK404	Employment Skills	2	1	-	-	-	-
	IV	VE406	Environmental Science	2	1	3	50	50	100
	IV	LE409P	English Lab IV	-	1	-	50	50	100
	V		Outreach Programme	-	2	-	-	-	-
	V		SHELTERS	-	2	-	-	-	-
	III		Internship	-	2*	-	-	-	-
Total				**30**	**27 + 2***	**-**	**-**	**-**	**-**
Sem	**Part**	**Subject Code**	**Subject Title**	**Hrs.**	**Credit (s)**	**E – Hrs**	**CA**	**SE**	**Total**
V	III	MB508	Molecular Biology and Genetic Engineering	4	4	3	50	50	100
	III	MB509	Medical Bacteriology	5	5	3	50	50	100
	III	MB510	Medical Virology	5	4	3	50	50	100
	III	MB511	Medical Mycology and Parasitology	5	4	3	50	50	100
	III	PMB502	Main Practical – V	5	4	6	50	50	100
	III	MB512A MB512B MB512C	Major Elective – I a) Public Health Microbiology b) Bioinformatics and Chemoinformatics c) Pharmaceutical Microbiology (One out of three)	4	3	3	50	50	100
	III	NMB502	Non – Major Elective – I	2	1	3	50	50	100
	III	-	SSP – 1: Entrepreneurship Microbiology	-	1*	-	-	-	-
Total				**30**	**25 + 1***	**-**	**-**	**-**	**-**
VI	III	MB608	Microbial Biotechnology	4	4	3	50	50	100
	III	MB609	Environmental Microbiology	5	5	3	50	50	100
	III	MB610	Vermitechnology	4	3	3	50	50	100
	III	MB611	Food Microbiology	5	5	3	50	50	100
	III	MB612	Industrial Microbiology	5	5	3	50	50	100
	III	PMB602	Main Practical – VI	5	4	6	50	50	100
	III	NMB602	Non – Major Elective – II	2	1	3	50	50	100

	III	-	SSP – 2: Probiotic Microbiology	-	1*	-	-	-	-
	III	-	Group Project	-	1*	-	-	-	-
	III	-	NPTEL/MOOCS/Other Certificate courses	-	1*	-	-	-	-
Total				**30**	**27 + 3***	**-**	**-**	**-**	**-**

TOTAL HOURS = 180 Hours

TOTAL CREDITS = 146 + 2 *(SSP 1 & SSP 2) + 2 *Internship + 1 *Group project + 1* from NPTEL/ MOOCS/Other Certificate courses.

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
Attendance	-	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 × 2 = 12 marks)

Section - B

Section - B shall contain 3 either or questions drawn from Two units.
Each question shall carry 6 marks. (3 × 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 × 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 Main Practical

Total: 100 Marks

Internal Assessment (50 marks)

Class Work - 20 marks

Model exam - 30 marks

Semester Examination (50 marks)

Evaluation Pattern for SSP (Entrepreneurship Microbiology & Probiotic Microbiology)

- Submission of Assignment
- One MCQ test covering the Syllabus

Evaluation Pattern for Internship

Submission of report with Certificate of attending 15 days Internship before the starting of Semester – V from the Concerned Lab.

Evaluation Pattern for Group Project

Student group will be allotted with a Project mentor who will support the students throughout the term of the Project work. At the end of the project, the groups will be tested by the Project mentor. Valuation of UG projects will be Internal.

Semester – I
4 Hours
4 Credits

MB 103: FUNDAMENTALS OF MICROBIOLOGY

Objectives

- To make students to understand the Fundamentals in Microbiology.
- To know the basic principles and types of Light microscope and Electron microscope.
- To familiarize with detailed structure of Prokaryotes.
- To acquire knowledge on various Sterilization techniques.
- To learn the Microbial cultivation techniques and methods for isolation of microorganisms.

Course Outcomes

Microbiology has played a central role in all aspects of Biological sciences. An understanding of Microbiology is thus basics to Biological research. This course will familiarize the students with fundamental knowledge on Microbiology.

S.No.	Description	Cognitive Level (K-level)
CO-1	Develop an understanding of the Fundamentals of Microbiology.	**K6, K2**
CO-2	Define and understand the concept of Cell, Cell theory, Prokaryotes and Eukaryotes.	**K1, K2**
CO-3	Categorize the various types, principles and applications of Light microscope and Electron microscope.	**K4**
CO-4	Broad knowledge on the structure and functions of organelles of Bacteria.	**K3, K6**
CO-5	Demonstrate a clear understanding of microbial control mechanisms through Sterilization techniques and Antibiotics.	**K2**
CO-6	Evaluate the methods used for the cultivation and identification of bacteria.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	3	2	2	3	3	3	3	3	3	2	3	3	3	2	3	2.7
2	2	2	3	3	2	3	1	2	3	2	3	3	2	2	3	2	2.3
3	3	1	2	3	1	3	3	3	2	3	2	2	3	3	2	3	2.4
4	2	2	3	2	3	2	2	2	3	3	3	3	3	3	3	2	2.5
5	2	3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2.1
6	3	2	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.6
																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; History and recent developments of Microbiology – Spontaneous generation and Biogenesis; Contributions of Anton van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Ignaz Semmelweis, Dmitri Ivanoski, Martinus Beijerinck, Sergei Winogradsky, Alexander Fleming and Selman Waksman; Cell - Prokaryotes and Eukaryotes; Golden age of Microbiology; Branches and Scope of Microbiology.

Unit – II

History of Microscopy; Principles of Microscopy; Difference between Simple microscope and Compound microscope; Principle, Instrumentation and Applications - Bright field microscope, Dark field microscope, Phase contrast microscope, Fluorescence microscope and Electron Microscopy – SEM & TEM; Difference between SEM and TEM.

Unit – III

Bacteria – Ultrastructure; Morphological Classification (Gram positive and Gram negative), Shape and arrangement; Cell wall; Cell membrane; Cell inclusions; Ribosomes; Capsules and Slime layer; Gas vesicles; Endospore; Surface appendages – Flagella (Arrangement and Types of Motility), Fimbriae and Pili.

Unit – IV

Microbial control terminologies; Sterilization; Physical method – Drying, Dry heat, Moist heat, Filtration, Radiation; Quality control and sterility checking; Chemical method – Disinfection and Disinfectants; Chemotherapy terminologies; Antibiotics – Classification, Antimicrobial resistance and Antibiotic sensitivity test.

Unit – V

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 techniques - Culture medium and its types; Biochemical Tests for bacterial identification.

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) Saranraj, P. 2020. Basic Techniques in Microbiology. JPS Scientific Publications, 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 Mc Graw Hill Inc. New York.
4) Powar, C. B and H. F. Daginawala. 2008. General Microbiology. Volume – II, Himalaya Publishing House, Mumbai.

Semester – I
3 Hours
3 Credits

MICROBIAL DIVERSITY AND CLASSIFICATION

Objectives

- To learn the Taxonomy of microorganisms.
- To analyze the Ultrastructure of Fungi, Algae and Protozoa.
- To understand the Classification of microorganisms.
- To recognize the fundamentals on Economic importance of microorganisms.
- To impart knowledge on Molecular identification of microorganisms.

Course Outcomes

The basic task of Microbial Diversity and Classification is to differentiate the various characteristics of microorganisms based on Ultrastructure and Classification. It enables the students to identify any microorganisms through Molecular identification. The students will be able to understand and predict the Economic importance of microorganisms.

S.No.	Description	Cognitive Level (K-level)
CO-1	Understand the knowledge of Classifications and Taxonomy of Microorganisms in detail	**K2, K3**
CO-2	Acquire the basic knowledge on the Ultrastructure, Classification, Mode of nutrition and Reproduction of Fungi, Algae and Protozoa.	**K3**
CO-3	Discuss the Economic importance of Fungi, Algae and Protozoa.	**K2**
CO-4	Examine and define the structure, properties and classification of Human, Plant and Animal viruses.	**K1**
CO-5	Explore and recommend the Molecular techniques applied in identification of microorganisms.	**K4, K5**
CO-6	Compile the basic information on the diversity and classification of Fungi, Algae, Protozoa and Algae.	**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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	2	2	3	3	2	3	2	3	3	2	3	3	3	2	2	2.5
2	3	2	3	3	2	3	2	2	2	2	3	3	2	2	3	2	2.4
3	1	2	2	3	2	2	3	3	1	3	2	2	2	2	3	3	2.2
4	3	3	2	2	2	2	1	2	3	2	3	3	2	3	3	2	2.3
5	2	2	3	1	3	2	2	2	2	1	2	2	3	2	2	2	2.0
6	3	3	1	2	3	2	3	3	2	3	2	3	2	3	2	3	2.5
																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

Phylogenetic Hierarchy; Nomenclature of Microorganisms; Taxonomy and Taxonomic Hierarchy; 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; Wose – Fox's Three Domains of Life; Genetic and Intraspecies Classification; Classification of Bacteria - Bergey's manual and its importance; Economical importance of Bacteria.

Unit – II

Fungi – Ultrastructure, Nutrition and Reproduction; Characteristics of Molds & Yeasts; Classification of Fungi; Budding in Yeast; Fungal identification (Microscopic examination) and Cultivation in Culture medium; Water molds; Economical importance of Fungi.

Unit – III

Algae – Ultrastructure and Nutrition; Role of Algae in Nature; Classification of Algae; Diatoms and Dinoflagellates; Lichens; Algal diseases of humans; Algal identification (Microscopic examination) and Cultivation in Culture medium; Economical importance of Algae.

Unit – IV

Protozoa - Ultrastructure, Classification and Nutrition; Microscopic examination of Protozoa; Slime Molds – Cellular Slime Molds & Plasmodial Slime Molds; Economic importance of Protozoa; Virus – Structure and Classification; Animal and Plant Viruses; Viroids and Prions.

Unit – V

Molecular Identification of Microorganisms – Fatty acid profiles, DNA Base composition (G + C Content), DNA Fingerprinting, Polymerase Chain Reaction (PCR), CRISPR and Nucleic acid Hybridization (Southern Blotting, DNA Chips, FISH and rRNA Sequencing).

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.

References

1) Chakraborty. 2003. A Text book of Microbiology. 2nd Edition, Published by New Central Book Agency (P) Ltd., Kolkata.
2) Dubey, R.C. and D. K. Maheswari. 2010. A Text book of Microbiology. 3rd Edition, S. Chand and Company, New Delhi.
3) Pelczar Jr. M. J., Chan, E. C. S and Kreig, N. R. 2006. Microbiology. 5th Edition Mc Graw Hill Inc. New York.
4) Powar, C. B and H. F. Daginawala. 2008. General Microbiology. Volume – II, Himalaya Publishing House, Mumbai.

Semester – I

3 Hours
3 Credits

MAIN PRACTICAL - I

1) Orientation to the Microbiology Laboratory
2) Cleaning and Sterilization of Glasswares
3) Preparation of Hand Sanitizer
4) Handling of Microscope
5) Preparation of Broth and Agar medium for Bacteria and Fungi
6) Simple Staining
7) Gram Staining
8) Capsule Staining – Negative Staining
9) Endospore Staining
10) Metachromatic Granule Staining (Demo only)
11) Acid Fast Staining (Demo only)
12) Motility Test – Hanging Drop Method
13) Lactophenol Cotton Blue (LPCB) Staining
14) KOH Wet mount

Semester – II
4 Hours
4 Credits

MICROBIAL PHYSIOLOGY AND METABOLISM

Objectives

- To analyze the Nutrient requirements and Nutrition types of microorganisms.
- To observe the Transport of Nutrients in Microorganisms.
- To study the Microbial growth and its measurement.
- To learn the Microbial metabolism and respiration.
- To understand the Photosynthesis reaction in microorganisms.

Course Outcomes

The paper Microbial Physiology and Metabolism enables the students about to know about Microbial nutrition and growth. The students will also be able to understand and predict the Intermediate metabolism and Photosynthesis of microbes.

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, Growth measurement and Preservation of microorganisms.	**K6**
CO-5	Equip students with appropriate knowledge on Microbial metabolism which includes Catabolism and Anabolism.	**K4**
CO-6	Recommend students to find the Photosynthetic reaction in microorganisms.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	3	3	3	2	3	2	3	3	2	3	3	3	3	2	2.6
2	3	2	3	3	2	3	2	2	3	2	3	3	3	2	3	2	2.5
3	2	2	2	3	2	2	3	3	2	3	2	2	3	2	3	3	2.4
4	3	3	2	2	3	2	2	2	3	2	3	3	3	3	3	2	2.5
5	3	2	3	2	3	2	2	3	2	2	2	3	3	2	2	3	2.4
6	3	3	2	2	3	2	3	3	2	3	3	3	3	3	2	3	2.6
																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

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

Unit – II

Cell division in Bacteria (Binary fission); Microbial Growth – Generation time and Growth Curve; Influence of environmental factors on growth; Measurement of microbial growth – Direct and Indirect methods; Continuous culture of microorganisms - Chemostat; Diauxic growth and Synchronus growth; Preservation of microbial cultures.

Unit – III

Microbial Metabolism – Difference between Catabolism and Anabolism; Fermentation and its types; Generation of ATP - Substrate level Phosphorylation, Oxidative Phosphorylation and Electron transport chain; Carbohydrate catabolism – Glycolysis, Phosphoketolase pathway and Entner Doudoroff pathway.

Unit – IV

Microbial Respiration - Aerobic and Anaerobic respiration by microorganisms; Aerobic Respiration – Kreb's cycle; Biosynthesis of Bacterial cell wall polysaccharides, Purines,

Pyrimidines, Amino acids and Fatty acids; Anaerobic Respiration – Acetogenesis and Methanogenesis.

Unit – V

Photosynthesis; Diversity of photosynthetic organisms; Difference between plant, algal and bacterial photosynthesis; Photosynthetic pigments; Light reaction (Photophosphorylation) and Dark reaction (Calvin cycle).

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.

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) Dubey, R.C. and D. K. Maheswari. 2010. A Text book of Microbiology. 3rd Edition, S. Chand and Company, New Delhi.
4) Pelczar Jr. M. J., Chan, E. C. S and Kreig, N. R. 2006. Microbiology. 5th Edition Mc Graw Hill Inc. New York.

Semester – II
3 Hours
3 Credits

BIOINSTRUMENTATION

Objectives

- To provide knowledge about Safety measures in Microbiology laboratory and First aid methods.
- To understand the principles and applications of various instruments used in Life science.
- To learn the techniques for operating the Microbiological instruments.
- To explain the principles and applications of types of Chromatography techniques.
- To learn principles, types and applications of Calorimeter and Spectrophotometer.

Course Outcomes

The Bioinstrumentation course offers the students with an opportunity to gain knowledge on the principles and applications of various instruments which are used in Biological laboratories.

S.No.	Description	Cognitive Level (K-Level)
CO-1	Determine the Safety measures in Microbiology laboratory and First aid methods.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3	3	2.8
2	2	2	3	3	3	2	2	3	3	3	3	3	2	3	2	3	2.6
3	2	3	2	3	2	3	3	3	2	3	2	3	3	2	3	3	2.6
4	3	3	3	2	3	2	3	2	3	2	3	3	3	3	3	2	2.6
5	3	2	3	2	3	2	3	3	2	3	3	3	3	1	2	3	2.8
6	3	3	1	3	3	3	3	3	3	2	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

Safety in Microbiology Laboratory – Electrical equipment, Heating devices, Cryogenic liquids and Radiation exposure; Personal Protection in Laboratory – Safety Spectacles, Gloves and Face masks; Hazards in the Laboratory; Radiation hazard – Sources, effects and safety measures; Biological Hazards and its disposal; Laboratory acquired infections and safety measures; First aid methods for Laboratory accidents.

Unit – II

Bioinstruments: Principle, Instrumentation, Applications and Safety aspects of pH Meter, Bacterial Incubator, Hot air oven, Autoclave, Colony counter and Laminar flow cabinet.

Unit – III

Chromatographic techniques: Principle and Applications of Paper Chromatography, Thin layer chromatography (TLC), Gel Filtration Chromatography, Adsorption Column chromatography, 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

Electrophoretic techniques: Principle, Instrumentation and Applications of Paper Electrophoresis, Gel Electrophoresis, Capillary Electrophoresis and SDS-PAGE; Gel Documentation System; Principle, Instrumentation and Applications of Colorimeter and Spectrophotometer.

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. and J. Walker. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition, Cambridge University Press, UK.

Semester – II
3 Hours
3 Credits

MAIN PRACTICAL – II

1) Serial Dilution Technique – Pour plate method and Spread plate method.
2) Pure Culture Technique – Streak plate method.
3) Bacterial Growth Curve.
4) Effect of pH on Bacterial growth.
5) Effect of NaCl on Bacterial growth.
6) Biochemical Tests – Carbohydrate fermentation, Indole, Citrate utilization, MR, VP, Urease, Catalase, Oxidase, TSI, Casein hydrolysis, Starch hydrolysis and Gelatin Liquefaction Test.

Semester – III
4 Hours
4 Credits

IMMUNOLOGY

Objectives

- To make the students to understand the Immune system.
- To provide insights to the Human Defense Mechanisms and Vaccines.
- To strengthen the knowledge of students through a detailed study on Antigens, Antibodies and Antigen – Antibody interactions
- To gain knowledge on ABO Blood grouping, Blood transfusion and Rh incompatibilities.
- To learn about various Hypersensitivity reactions and Autoimmune disorders.

Course Outcomes

Introducing the Immunology to study various types of Cells and Organs in Immune systems and Mechanism of immune activation.

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Describe the principles of immunity and types of vaccines.	**K1**
CO-2	Discuss cells and organs of immune system and its role in types of Immunity.	**K2**
CO-3	Analyse the concepts of Antigens, Haptens, Adjuvants and factors influencing Antigenicity.	**K4**
CO-4	Apply knowledge on Structure and Types of Immunoglobulins.	**K3**
CO-5	Evaluate the reactions between various antigens and antibodies and apply the knowledge in diagnosing diseases and disorders.	**K3, K5**

CO-6	Develop theoretical knowledge of Hypersensitivity reactions and Autoimmune disorders.	**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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	3	2.3
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	3	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 and Karl Landsteiner; Normal microbial flora of human body; Microbial Infection – Types, Source, Transmission and Factors predisposing to Microbial Pathogenicity; Immunity – Innate and Acquired immunity; Vaccines and Vaccination; Toxoids and Antitoxins.

Unit – II

Lymphoid System – Primary and Secondary lymphoid organs; Hematopoiesis; 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; 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); Monoclonal antibodies and its production; 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, Immunofluoresecence test, Flow Cytometry, 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); Major Histocompatibility Complex (MHC) – Structure and functions of Class – I and II MHC molecules; 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.

References

1) Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2017. Prescott's Microbiology, 10th Edition, McGraw Hill Publication, United States.
2) Chakraborty, P. 2013. A Text book of Microbiology, Published by New Central Book Agency (P) Ltd., Kolkata, India.
3) Reba Kanungo. 2017. Ananthanarayan and Paniker's Text book of Microbiology, 7th Edition, Orient Longman Limited, Chennai, India.
4) Roitt, I. M. 2011. Roitt's Essential Immunology, 12th Edition, Wiley - Blackwell Scientific publishers, London, United Kingdom.

Semester – III
3 Hours
3 Credits

MUSHROOM TECHNOLOGY

Objectives

- To encode the nutritional and medicinal importance of the Mushrooms.
- To differentiate edible and poisonous mushrooms and their effects.
- To gain a good understanding on Substrates and Spawn production for Mushroom cultivation.
- To obtain knowledge on Post-harvest Technology of Mushrooms.
- To understand various Mushroom diseases and its control measures.

Course Outcomes

The paper Mushroom Technology provides the information about the Cultivation, Disease control, Nutritional value and Medicinal value of Mushrooms.

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Provides the information about the Cultivation, Nutritional value and Pharmacological value of Mushrooms.	**K1**
CO-2	Gaining knowledge about different types of Edible and Poisonous mushrooms.	**K3**
CO-3	Analyze the pathological damages caused by microorganisms on mushrooms.	**K4**
CO-4	Demonstrate the methods for Disease control in Mushrooms.	**K2**
CO-5	Assess the Post-harvest Technology of Mushrooms.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	3	2	2	3	3	3	3	3	3	2	3	3	3	2	3	2.7
2	2	2	3	3	2	3	1	2	3	2	3	3	2	2	3	2	2.3
3	3	1	2	3	1	3	3	3	2	3	2	2	3	3	2	3	2.4
4	2	2	3	2	3	2	2	2	3	3	3	3	3	3	3	2	2.5
5	2	3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2.1
6	3	2	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.6
																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

Mushroom – Historical development, Origin, Characteristics, Importance, Morphology and Life cycle; Classification of Mushroom; 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

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*); 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; 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.

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.

Semester – III

3 Hours
3 Credits

MAIN PRACTICAL – III

1) Blood Grouping and Rh Typing.
2) Blood collection and Plasma/Serum separation.
3) Staining and Microscopic examination of Blood cells.
4) Agglutination reaction – WIDAL Test, RPR Card Test, TPHA Test, ASO Test, RA Test, CRP Test and Pregnancy Test.
5) Precipitation reaction – Mancini Radial Immunodiffusion, Ouchterlony Double Immunodiffusion, Immunoelectrophoresis and Rocket electrophoresis.
6) ELISA Test (Demonstration) only.

Semester – IV
4 Hours
4 Credits

BIOINOCULANT TECHNOLOGY

Objectives

- To study about the Formulation, Application and Quality control of Bioinoculants.
- To understand the role of Nitrogen fixers and Phosphate solubilizers in Agriculture.
- AM fungi and Algal biofertilizers.
- To learn the ability of Biocontrol agents to control the Plant pathogens.
- To gain the knowledge of Entomopathogens for the control of Insect pests.

Course Outcomes

The course Bioinoculant Technology has been designed to provide the knowledge to the students about Natural organic farming. This paper also provides the details of Production, Formulation, Method of application and Quality control of Bioinoculants.

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Acquire knowledge on Microbial inoculants.	**K3**
CO-2	Gives the knowledge to the students about Production and Formulation of Bioinoculants.	**K1, K3**
CO-3	Explains the details on Method of application and Quality control of Bioinoculants.	**K2**
CO-4	Analyzing the Symbiotic relationship between Plant and Mycorrhizal fungi.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	3	2.3
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	3	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.

Unit – II

PGPR and its role in agriculture – Direct mechanism and Indirect mechanism; Nitrogen fixation by bacteria; Isolation, Characterization (Microscopic, Cultural and Biochemical), Mass multiplication and Field application of Nitrogen fixing bacteria (*Rhizobium* sp., *Frankia* sp., *Azotobacter* sp., *Azospirillum* sp. and *Gluconacetobacter* sp.).

Unit – III

Phosphate solubilization – Phosphate solubilizing microorganisms, Mechanism of Phosphate solubilization and Screening of Phosphate solubilizing efficiency; Algal Biofertilizers – Isolation and Mass multiplication of Blue Green Algae, Mass multiplication of *Azolla*, *Azolla – Anabaena* symbiosis, Heterocyst and its importance in N_2 fixation.

Unit – IV

Mycorrhizal Bioinoculants – Significance, Types and Benefits; Arbuscular Mycorrhiza (AM) fungi – Taxonomy of AM fungi, Isolation of AM fungi, Assessment of AM colonization in roots, Culturing of AM fungi, Mass inoculum production, Field applications; Role of AM fungi in agriculture.

Unit – V

Host-parasite relationship in plants; Plant disease control agents (*Bacillus subtilis, Pseudomonas fluorescens* & *Trichoderma* sp.); Biopesticides – Entomopathogenic bacteria (*Bacillus thuringiensis*); Entomopathogenic fungi (*Beauveria bassiana*, *Isaria fumosorosea*, *Lecanicillium* sp. & *Metarhizium anisopliae*); Entomopathogenic virus (Cydia pomonella granulosis virus - CpGv); Current Research Thoughts in Bioinoculant Technology.

Text Books

1) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
2) Subba Rao N.S. 1999. Soil Microbiology, 4th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
3) Saranraj, P and P. Sivasakthivelan. 2020. Textbook of Microbial Inoculants Technology. JPS Scientific Publications, 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) 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 – IV
3 Hours
3 Credits

MICROBIAL GENETICS

Objectives

- To make the students to understand the Genetics of microorganisms.
- To focus on the basic principles of Cloning vectors.
- To gain knowledge on Gene transfer mechanism.
- To explain the Mutation and its types.
- To study the recent advances in Microbial genetic principles for strong foundation.

Course Outcomes

The application of Microbial Genetics has completely transformed the Microbiology field with new possibilities ranging from the treatment of human diseases to the development of new forms of crops. It also looks set to be the most promising and exciting science of the next few decades.

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Analyze and understand the basic principles of DNA and RNA.	**K2, K4**
CO-2	Evaluate the role of Chromosomes and its functions.	**K5**
CO-3	Apply the principles of Vectors in Gene Cloning.	**K3**
CO-4	Development of concepts on Transposable elements and Bacteriophages.	**K6**
CO-5	Better understanding of Gene transfer mechanism and its types.	**K2**
CO-6	Describe the Mutation types, Mutant detection, Mutant selection and Carcinogenecity testing	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	2	3	3	2	3	2	3	3	2	3	3	3	2	2	2.5
2	3	2	3	3	2	3	2	2	2	2	3	3	2	2	3	2	2.4
3	1	2	2	3	2	2	3	3	1	3	2	2	2	2	3	3	2.2
4	3	3	2	2	2	2	1	2	3	2	3	3	2	3	3	2	2.3
5	2	2	3	1	3	2	2	2	2	1	2	2	3	2	2	2	2.0
6	3	3	1	2	3	2	3	3	2	3	2	3	2	3	2	3	2.5
																Mean Overall Score	**2.3**
																Result	**High**

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)	Term End Exam (100)

	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

Genetics – History and Scope; Genotype and Phenotype; DNA – Structure and forms; DNA & RNA as a genetic material; Organization of Gene; Chromosomes – Structure, Types and Functions; Chromosome theory of inheritance; Chromosomal aberrations.

Unit – II

Transposons - IS elements, Composite transposons, Simple transposition, Replicative transposition, Conjugative transposons; Mechanism of Transposition; Bacteriophages – Structure, Lytic and Lysogenic cycle; Application of Bacteriophages in Genetics.

Unit – III

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; Application of Plasmids in Genetics.

Unit – IV

Genetic recombination in Bacteria – Conjugation, Transformation and Transduction; Conjugation in Archaea; Mapping the Genome – *Escherichia coli* and Bacteriophages.

Unit – V

Genetic code; 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 Carcinogenecity testing; Current Research Thoughts in Microbial Genetics.

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) Maloy, S. R., J. E. Cronan and D. Freifelder. 2001. Microbial Genetics, 2nd Edition, Narose Book Distributors Pvt. Ltd., New Delhi, India.

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 – IV
3 Hours
3 Credits

MAIN PRACTICAL – IV

1) Isolation and purification of Nitrogen fixing bacteria – *Rhizobium* sp., *Azotobacter* sp. and *Azospirillum* sp.
2) Mass production of Biocontrol agents – *Bacillus subtilis* and *Pseudomonas fluorescens, Trichoderma viride* and *Beauveria bassiana*.
3) Mass cultivation of *Azolla*.
4) Assessment of AM colonization in roots.
5) Different formulations of Bioinoculants.
6) Method of application and Quality control.

Semester – V
4 Hours
4 Credits

MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Objectives

- To make the students to understand the Molecular Biology and Genetic Engineering.
- To focus on the basic principles of DNA Replication.
- To study the Transcription and Translation process.
- To understand the concepts of Mutation and DNA Repair mechanisms.
- To under the basic concepts and applications of Genetic Engineering.

Course Outcomes

Molecular Biology and Genetic Engineering dispense recent study and innovation of significant methods and techniques. This paper embraces information on DNA Replication, Transcription, Translation, Mutation, DNA Repair mechanisms and various applications of Genetic Engineering.

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Analyze and understand the Structure and Types of DNA and DNA Replication.	**K2, K4**
CO-2	Describe the basic principles of RNA, Transcription and Translation.	**K1**
CO-3	Evaluate the Mutation, DNA damage and DNA Repair mechanisms.	**K5**
CO-4	Apply the principles of selection, construction, screening of recombinants and application of artificial transformation techniques.	**K3**
CO-5	Better understanding of Genetic engineering.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	3	3	3	2	3	2	3	3	2	3	3	3	3	2	2.6
2	3	2	3	3	2	3	2	2	3	2	3	3	3	2	3	2	2.5
3	2	2	2	3	2	2	3	3	2	3	2	2	3	2	3	3	2.4
4	3	3	2	2	3	2	2	2	3	2	3	3	3	3	3	2	2.5

5	3	2	3	2	3	2	2	3	2	2	2	3	3	2	2	3	2.4
6	3	3	2	2	3	2	3	3	2	3	3	3	3	3	2	3	2.6
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

DNA – History, Structure and Forms; DNA Replication – Types and evidence for Semi-conservative replication; Enzymes involved in DNA Replication – DNA Polymerase, Topoisomerase, DNA Helicase, SSB Proteins, DNA Primase and DNA Ligase; DNA Replication in Prokaryotes; Inhibitors of DNA replication.

Unit – II

RNA - Structure and Types; Prokaryotic Transcription; Inhibitors of Transcription; Genetic code; Prokaryotic Translation; Inhibitors of Translation.

Unit – III

Mutation and its types; DNA Damage by Physical and Chemical agents; DNA Repair Mechanism – Excision repair, Direct repair, Recombination repair, Mismatch repair and SOS Response; Regulation of Gene expression – Lactose Operon concept.

Unit – IV

Restriction enzymes for cutting DNA; Enzyme for Joining DNA; Cloning Vectors – Plasmids (pBR 322), Phages (M13 & λ) and Cosmids; BACs; YACs; PACs; Introduction to Genomics and Metagenomics; Genome Sequencing – First Generation, Second Generation, Third Generation and Fourth Generation; Construction of cDNA and Genomic Library; Applications of Genetic Engineering.

Unit – V

Nucleic acid and Protein hybridization technique – Southern, Northern and Western Blotting; Gel Electrophoresis (Agarose Gel Electrophoresis & SDS-PAGE); Polymerase Chain Reaction (PCR), Types of PCR and Applications of PCR; Current Research Thoughts in Molecular Biology and Genetic Engineering.

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.

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 – V
5 Hours
5 Credits

MEDICAL BACTERIOLOGY

Objectives

- To make the students to understand the Medical Bacteriology.
- To learn the methods of Clinical sample collection and its transport.
- To gain knowledge on Diagnostics methods for Bacterial identification.
- To study the pathogenicity, clinical symptoms and treatment for disease causing bacteria.
- To provide the ability to characterize, isolate and identify different Medically important bacteria.

Course Outcomes

To introduce the knowledge of the medically important bacteria, bacterial morphology with the main focuses being the pathogenicity, clinical symptoms, identification and treatment for different bacteria.

S.No.	Description	Cognitive Level (K-Level)
CO-1	Introducing the knowledge of the Medically important bacteria.	**K3**
CO-2	Acquire the skill of sample collection, transport and processing for bacterial identification.	**K4**
CO-3	Describe the bacterial morphology with the main focuses being the pathogenicity, clinical symptoms, identification and treatment for different bacteria.	**K1**
CO-4	Create an awareness on bacterial diseases and classification for diagnosing Gram positive bacteria and spore formers.	**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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	3	2	2	3	3	3	3	3	3	2	3	3	3	2	3	2.7
2	2	2	3	3	2	3	1	2	3	2	3	3	2	2	3	2	2.3
3	3	1	2	3	1	3	3	3	2	3	2	2	3	3	2	3	2.4
4	2	2	3	2	3	2	2	2	3	3	3	3	3	3	3	2	2.5
5	2	3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2.1
6	3	2	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.6
																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

Clinical Specimens - Collection, Transport and Storage; Epidemiology of Microbial infections; 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, 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, Streptococcus pyogenes*, *Streptococcus agalactiae,* Viridans *Streptococci* (*Streptococcus pneumoniae*) 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* sp., *Listeria monocytogenes, Corynebacterium diphtheriae, Mycobacterium leprae* and *Mycobacterium tuberculosis)*.

Unit – IV

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

Unit – V

Morphology, Cultural characteristics, Pathogenicity, Laboratory diagnosis, Treatment and Preventive measures for *Haemophilus influenzae*, *Brucella* sp., *Bordetella* sp. Spirochaetes (*Treponema pallidum*, *Borrelia* sp. and *Leptospira* sp.), *Mycoplasma* sp. and *Rickettsia* sp. 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. JPS Scientific Publications, 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) 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 – V
5 Hours
5 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 gain knowledge on Antiviral drugs, Vaccines and Vaccination.
- To study general aspects of Structure, Classification, Replication, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for Viruses.

Course Outcomes

Virologist are highly demanded in the Medical research companies, Pharmaceutical companies, Governmental agencies, Laboratory testing companies or Cancer treatment or Research companies depending upon the specialization. This paper will provide the wide knowledge on Structure, Classification, Replication, Pathogenicity, Clinical Syndrome, Laboratory diagnosis, Treatment and Preventive measures for Viruses.

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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3	3	2.8
2	2	2	3	3	3	2	2	3	3	3	3	3	2	3	2	3	2.6
3	2	3	2	3	2	3	3	3	2	3	2	3	3	2	3	3	2.6
4	3	3	3	2	3	2	3	2	3	2	3	3	3	3	3	2	2.6
5	3	2	3	2	3	2	3	3	2	3	3	3	3	1	2	3	2.8
6	3	3	1	3	3	3	3	3	3	2	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

General properties and Structure of Viruses; Classification of Virus – Based on Structure and Nucleic acid; Replication of Viruses; Laboratory diagnosis of Viruses – Microscopic examination, Cultivation of Viruses, Serological and Molecular diagnosis of Viruses; Antiviral agents; 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 & Epstein-Barr Virus); Adenoviridae (Adenovirus); Hepadnaviridae (Hepatitis – B Virus) and Papilomaviridae (Human Papilloma 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 & 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); Retroviridae (HIV); Bunyaviridae (Bunyaviruses & Arenaviruses); Togaviridae (Togaviruses - Rubella virus & Chikungunya); Flaviviridae (Flaviviruses - Yellow fever virus, Dengue virus and Hepatitis C virus).

Unit – V

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

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.

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 – V
5 Hours
5 Credits

MEDICAL MYCOLOGY AND PARASITOLOGY

Objectives

- To make the students to understand the role of Fungi, Protozoa and Helminths in Human diseases.
- 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 establish basic theoretical knowledge in the fields of Mycology and Parasitology.

Course Outcomes

Students will be familiar with current developments and advances in the field of Mycology and Parasitology. They also will gain more knowledge on Pathogenicity, Clinical

Syndrome, Laboratory diagnosis, Treatment and Preventive measures for Fungal and Parasitic diseases.

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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	2	2	3	3	2	3	2	3	3	2	3	3	3	2	2	2.5
2	3	2	3	3	2	3	2	2	2	2	3	3	2	2	3	2	2.4
3	1	2	2	3	2	2	3	3	1	3	2	2	2	2	3	3	2.2
4	3	3	2	2	2	2	1	2	3	2	3	3	2	3	3	2	2.3
5	2	2	3	1	3	2	2	2	2	1	2	2	3	2	2	2	2.0
6	3	3	1	2	3	2	3	3	2	3	2	3	2	3	2	3	2.5
																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 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; 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), Endemic Mycoses (Blastomycosis, Histoplasmosis & Coccidioidomycosis).

Unit – III

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

Unit – IV

General characteristics of Protozoa; Morphology, Life cycle, Clinical Manifestations, Lab diagnosis and Treatment for Intestinal Protozoa (*Entamoeba histolytica*, *Giardia lamblia* & *Balantidium coli*), Urogenital Protozoa (*Trichomonas vaginalis*) and Blood & Tissue Protozoa (*Plasmodium* sp., *Leishmania donovani*, *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* & *Wuchereria bancrofti*), Trematodes (*Fasciola hepatica* & *Schistosoma* sp.) and Cestodes (*Taenia saginata*, *Taenia solium*, & *Echinococcus granulosus*); Antihelminthic drugs; Current Research Thoughts in Medical 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.

References

1) Jawetz, E., J. L. Melnic 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.

Semester – V
4 Hours
3 Credits

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 for all age group.
- To Acquaint the student with basic concept of public health and prophylactic measures.
- To Public awareness, individual behavior, and disease prevention.
- To understand air, food, water, insect borne infectious diseases and its preventive measures.

Course Outcomes

Introducing the basics about the Health care and Hygienic practices to study various types of Vaccines to control the life time infectious disease.

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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	3	2.3
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	3	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; Importance of Hand washing; Role of Microbiologists in Public 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; 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.

Unit – IV

Common diseases caused by Microorganisms – Air borne, Water borne, Soil borne, Vector borne and Zoonotic diseases; Sexually transmitted diseases; 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; Current Research Thoughts in Vaccination and Pollution control.

Text Books

1) Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th Edition, CBS Publishers and Distributors, New Delhi, India.

2) 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.

Semester – V
4 Hours
3 Credits

ELECTIVE – BIOINFORMATICS AND CHEMOINFORMATICS

Objectives

- To detail the importance of Computer in the field of Life sciences.
- To explain basics and uses of internet and biological databases.
- To obtain good understanding about the interpretation of Biological database.
- To uptake knowledge in latest tools and technology.
- To provide an overview of various bioinformatics tools, databases available and sequence analysis.

Course Outcomes

The paper Computational Biology adds information about the search engines and various software tools involved in Bioinformatics and Chemoinformatics.

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 *In silico* 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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	3	2	2	3	3	3	3	3	3	2	3	3	3	2	3	2.7
2	2	2	3	3	2	3	1	2	3	2	3	3	2	2	3	2	2.3
3	3	1	2	3	1	3	3	3	2	3	2	2	3	3	2	3	2.4
4	2	2	3	2	3	2	2	2	3	3	3	3	3	3	3	2	2.5
5	2	3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2.1
6	3	2	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.6

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

Introduction to Computers – History of Computers; Generation of Computers; Operating Systems – Windows, Unix – Hardware, Software and Disc operating systems; Office applications–MS-Office, MS-Word, MS-Excel and MS PowerPoint.

Unit – II

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; Applications of Bioinformatics - Pharmaceutical industry, Immunology, Agriculture and Forestry**.**

Unit – III

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.

Unit – IV

Applied Genomics – Prokaryotic and Eukaryotic Genomes, DNA Microarray, Protein Microarray; Microarray Database, Tools for analysis of Human Genome and Human Genome Project; Functional Proteomics – Protein – protein interaction and Yeast two hybrid system.

Unit – V

Chemoinformatics - Definition, History and Development, Applications of Chemoinformatics; Drugs – Physical and Chemical properties, Mode of action and Drug designing; Docking studies; Chemoinformatics in Biology and Geoinformatics; Future perspectives in Chemoinformatics; Current Research Thoughts in Bioinformatics and Chemoinformatics.

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.

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.

Semester – V
4 Hours

3 Credits

ELECTIVE - PHARMACEUTICAL MICROBIOLOGY

Objectives

- To illustrate the Principles of Pharmaceutical Microbiology.
- To explains the concept, principles on control and management of manufacturing and quality control testing of Biopharmaceutical products.
- To understand a view on regulatory issues involving the trends in biopharmaceutical industry and changing regulatory needs related to products.
- To understand different products of microbial origin playing key role in Pharmaceutical applications.
- To understand role of Secondary metabolites in Pharmaceutical industry.

Course Outcomes

The paper Pharmaceutical Microbiology provides an overview of the concepts of manufacture Biopharmaceutical products in today's regulatory environment.

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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	2	3	3	2	3	2	3	3	2	3	3	3	2	2	2.5
2	3	2	3	3	2	3	2	2	2	2	3	3	2	2	3	2	2.4
3	1	2	2	3	2	2	3	3	1	3	2	2	2	2	3	3	2.2
4	3	3	2	2	2	2	1	2	3	2	3	3	2	3	3	2	2.3
5	2	2	3	1	3	2	2	2	2	1	2	2	3	2	2	2	2.0
6	3	3	1	2	3	2	3	3	2	3	2	3	2	3	2	3	2.5
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

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.

Unit - II

History of 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; Negative interaction between Drugs and Host.

Unit – III

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

Text Books

1) Patrick Murray, Ken Rosenthal and Michael Pfaller. 2016. Medical Microbiology, 8th Edition, Elsevier Publications, United States.
2) Luis Jimenez. 2004. Microbial Contamination Control in the Pharmaceutical Industry, Marcel Dekker Inc., New York.

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) Hugo and Russell, 2011. Pharmaceutical Microbiology. 8th Edition. Wiley Blackwell Publications.

Semester – V
0 Hours
1 Credit

SSP – 1: ENTREPRENEURSHIP MICROBIOLOGY

Objectives

- To concentrate on development role of resource government and non-government schemes for entrepreneurship programmes.

- To acquire a basic understanding on Mushroom cultivation.
- To gain knowledge on Single cell protein SCP Production of Yeast and *Spirulina*.
- To learn about the mass multiplication, production cost analysis and marketing of different types of biofertilizer.
- To study the concept of Composting and Vermicomposting.

Course Outcomes

Able to do the Mass multiplication, Production cost analysis and Marketing the Biofertilizers, Compost products, Mushrooms, Dairy products SCP and *Spirulina*.

Course Outcome (CO)	Description	Cognitive level (K level)
CO-1	Understanding the concept of Entrepreneurship.	**K2**
CO-2	Apply Skills for Entrepreneurs and provides knowledge on Financial plans.	**K3**
CO-3	Analyzing the Production, Cost benefit analysis and Marketing of Mushroom and *Spirulina platensis*.	**K4**
CO-4	Describing the Mass production and Formulation of various Microbial inoculants.	**K1**
CO-5	Advice good laboratory practices for better understanding of Microbial products production.	**K2, K5**
CO-6	Formulate the methods and quality parameters for Composting and Vermicomposting process.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	3	3	3	2	3	2	3	3	2	3	3	3	3	2	2.6
2	3	2	3	3	2	3	2	2	3	2	3	3	3	2	3	2	2.5
3	2	2	2	3	2	2	3	3	2	3	2	2	3	2	3	3	2.4
4	3	3	2	2	3	2	2	2	3	2	3	3	3	3	3	2	2.5
5	3	2	3	2	3	2	2	3	2	2	2	3	3	2	2	3	2.4
6	3	3	2	2	3	2	3	3	2	3	3	3	3	3	2	3	2.6
																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

Concept of Entrepreneur and Entrepreneurship: Definitions - Concept of Entrepreneurship, Development - Role of resource. Government and Non - Government Schemes for Entrepreneurship programmes

Unit – II

Skills for Entrepreneurs - Communication skills, Problem solving skills; Business plan development; Market need - Distribution, Price, Promotion and Market goal setting; Financial plan - Financial support for Business and Business insurance.

Unit – III

Small scale production, Large scale production, Cost benefit analysis and Marketing of Button mushroom & Oyster mushroom cultivation, Dairy products & Other microbial food products, Single cell protein - SCP Production of Yeast and *Spirulina*; Medicinal properties of Mushroom and SCP.

Unit – IV

Small scale production, Large scale production, Cost benefit analysis and Marketing of *Rhizobium* sp., *Azospirillum* sp., *Azotobacter* sp., *Gluconacetobacter* sp., *Bacillus* sp., *Pseudomonas* sp., *Trichoderma* sp., AM fungi and Blue Green Algae (BGA).

Unit – V

Mass production and Marketing of Microbial Compost and Vermicompost; Types of Compost pits; Analysis of Compost materials – Physical, Chemical and Biological methods; Laboratory and Field application; Cost-benefit analysis.

Text Books

1) Saranraj, P and P. Sivasakthivelan. 2020. Textbook of Microbial Inoculants Technology. JPS Scientific Publications, India.
2) Nagendra, S. 2008. Entrepreneurship and Management. Sanguine Technical Publishers, India.
3) Bhatia, B. S and G. S Batra. 2003. Entrepreneurship and Small Business Management. Deep and Deep Publications, India.

References

1) Naidu, N.V.R. 2008. Management and Entrepreneurship. I.K. International Pvt. Ltd., India.
2) Greene, F. 2000. Entrepreneurship ideas in action. Thomson Learning, United Kingdom.

Semester – V
2 Hours
1 Credits

Non – Major Elective I – APPLIED MICROBIOLOGY

Objectives

- To make students to understand the fundamentals of microbiology and its applications.
- To encode the importance of the role of microorganisms in food industries.
- To learn the concept of Bioinoculants and its applications in agricultural sciences.
- To study about the water borne disease and microbial standards of water quality.
- To analyze the role of microorganisms in various industries for Fermentation process.

Course Outcomes

S.No.	Description	Cognitive Level (K-level)
CO-1	Develop an understanding of the Fundamentals of Microbiology.	**K6, K2**
CO-2	Define and understand the concept of Algae and Fungi.	**K1, K2**
CO-3	Analyze the methods of Food preservation and Food spoilage by microorganisms.	**K4**
CO-4	Broad knowledge on the Economical importance of Algae and Fungi.	**K3, K6**
CO-5	Demonstrate a clear understanding of Drinking water contamination and purification methods.	**K2**

CO-6	Evaluate the methods used for the Mass multiplication of Biofertilizers for plants.	**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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3	3	2.8
2	2	2	3	3	3	2	2	3	3	3	3	3	2	3	2	3	2.6
3	2	3	2	3	2	3	3	3	2	3	2	3	3	2	3	3	2.6
4	3	3	3	2	3	2	3	2	3	2	3	3	3	3	3	2	2.6
5	3	2	3	2	3	2	3	3	2	3	3	3	3	1	2	3	2.8
6	3	3	1	3	3	3	3	3	3	2	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

Microbiology – Various branches and Scope; Cell - Prokaryotes and Eukaryotes; Bacteria – Characteristics (Gram positive and Gram negative); Culture medium; Economic importance of Bacteria.

Unit - II

Fungi and Algae – Characteristics and Economic importance. Water pollution; Bacteriological analysis of water; Water borne diseases; Purification of water.

Unit – III

Food Preservation; Lactic acid bacteria; Fermented dairy products – Cheese, Yogurt and Fermented milk; Spoilage and defects of fermented dairy products; Testing of Milk.

Unit - IV

Microbial fermentation and its types; Fermentation products - Baker's yeast, Bread and Alcoholic beverages (Beer & Wine); Cultivation and Health benefits of *Spirulina* and Mushroom.

Unit – V

Bioinoculants – Definition, Types, Importance and Advantages; Nitrogen Fixing Biofertilizers; Phosphate solubilizing microorganisms; Biopesticides; Organic farming - Composting and Vermicomposting.

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.

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 Mc Graw Hill Inc. New York.
4) Powar, C. B and H. F. Daginawala. 2008. General Microbiology. Volume – II, Himalaya Publishing House, Mumbai.

Semester – V
5 Hours
5 Credits

MAIN PRACTICAL – V

1) Collection and transport of clinical samples.
2) Identification of bacteria from clinical samples – *Staphylococcus aureus, Escherichia coli, Salmonella typhi, Shigella* sp., *Proteus vulgaris, Klebsiella pneumoniae, Vibrio cholerae* and *Pseudomonas aeruginosa*.
3) Slide Culture Technique for fungal identification.
4) Examination of *Candida albicans* by Germ tube test and Sugar assimilation test.
5) Antibiotic sensitivity test.

Semester – VI
4 Hours
4 Credits

MICROBIAL BIOTECHNOLOGY

Objectives

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

Course Outcomes

The paper Microbial Biotechnology helps the student to study theoretical concepts of Biotechnology and their applications in Genetic engineering and Microbiology. It also creates an awareness on the Intellectual property rights and patenting of Biotechnological processes.

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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	3	3	3	2	3	2	3	3	2	3	3	3	3	2	2.6
2	3	2	3	3	2	3	2	2	3	2	3	3	3	2	3	2	2.5
3	2	2	2	3	2	2	3	3	2	3	2	2	3	2	3	3	2.4
4	3	3	2	2	3	2	2	2	3	2	3	3	3	3	3	2	2.5
5	3	2	3	2	3	2	2	3	2	2	2	3	3	2	2	3	2.4
6	3	3	2	2	3	2	3	3	2	3	3	3	3	3	2	3	2.6
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

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; Microbial synthesis of Pharmaceutical products – Recombinant Vaccines, Insulin, Interferon, Hormones, Monoclonal antibodies and Polyclonal antibodies.

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).

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 Plants; Gene therapy; Stem cell therapy.

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.

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.

Semester – VI
5 Hours
5 Credits

ENVIRONMENTAL MICROBIOLOGY

Objectives

- To create the awareness about environmental problems among people.
- To provides a comprehensive overview of Biogeochemical processes relevant to environmental scientists and engineers mediated by microorganisms.
- To study about the water borne pathogens, water borne disease, microbial standards of water quality, biogenic pollution, air borne microbes and waste water management.
- To learn the Microbe Interactions and Plant – Microbe Interactions in connection with Biogeochemical cycles.
- To understand the concept of Solid waste and Liquid waste treatment.

Course Outcomes

The paper Environmental Microbiology will create awareness about Microbes and environment, distribution, diversity and ecological importance, characteristics of microorganisms in different environment and its Biogeochemical cycle. This paper will also provides a detailed knowledge on Waste water treatment technologies.

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 Microbe Interactions and Plant – Microbe Interactions in connection with Biogeochemical cycles.	**K6**
CO-5	Point out the general principles in the field of Environmental Microbiology.	**K4**
CO-6	Gain knowledge about Bioremediation and Biodegradation.	**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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	3	2	2	3	3	3	3	3	3	2	3	3	3	2	3	2.7
2	2	2	3	3	2	3	1	2	3	2	3	3	2	2	3	2	2.3
3	3	1	2	3	1	3	3	3	2	3	2	2	3	3	2	3	2.4
4	2	2	3	2	3	2	2	2	3	3	3	3	3	3	3	2	2.5
5	2	3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2.1
6	3	2	2	3	3	2	3	3	2	3	3	3	3	3	2	3	2.6
																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

Organization of the Biosphere; Ecosystem and its types; Major role of Microorganisms in Ecosystem; Atmosphere – Relationship between Microorganisms and Atmosphere; Sampling of Air; Aeroallergens; Air borne disease caused by Bacteria, Fungi and Viruses; Air pollution; Green house effect; Air Sanitation; CO_2 sequestration.

Unit – II

Terrestrial Ecosystem – Importance of Soil; Formation of Soil; 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 – Types of Aquatic ecosystem - Fresh water ecosystem, Marine ecosystem, Estuarine ecosystem and Mangrove ecosystem; Water zonations; Eutrophication; Winogradsky column; Water pollution; Bacteriological analysis of water; Water borne diseases; Purification of water; Recycling of water.

Unit – IV

Organic matter decomposition; Formation and composition of Soil organic matter - Fulvic acid & Humic acid; Biogeochemical cycles – Carbon cycle, Nitrogen cycle, Phosphorous cycle, Sulphur cycle and Iron cycle; Microbe – Microbe Interactions; Plant – Microbe Interactions.

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; Bioremediation, Biodegradation; Bioaccumulation; Bioleaching; Biodeterioration; Current Research Thoughts in Environmental Microbiology.

Text Books

1) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
2) Subba Rao N.S. 1999. Soil Microbiology, 4th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
3) Saranraj, P and P. Sivasakthivelan. 2020. Textbook of Environmental Microbiology. JPS Scientific Publications, 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) Madigan, M. T., J. M. Martinko and J. Parker. 2009. Brock's Biology of Microorganisms, 12th Edition, Pearson/Benjamin Cummings, New York.
4) Maier, R. M., I. L. Pepper and C. P. Gerba. 2009. Environmental Microbiology, 2nd Edition, Academic Press, United States.

Semester – VI
4 Hours
4 Credits

VERMITECHNOLOGY

Objectives

- To study about the properties of Soil and Microbial composting.
- To classify and compare the characteristics of earthworm species.
- 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

The course Vermitechnology has been designed to provide the knowledge to the students about Organic farming through Composting and Vermicomposting. This paper also provides the details of Earthworms and its role in Solid waste reclamation.

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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	2	3	3	2	3	2	3	3	2	3	3	3	2	2	2.5
2	3	2	3	3	2	3	2	2	2	2	3	3	2	2	3	2	2.4
3	1	2	2	3	2	2	3	3	1	3	2	2	2	2	3	3	2.2
4	3	3	2	2	2	2	1	2	3	2	3	3	2	3	3	2	2.3
5	2	2	3	1	3	2	2	2	2	1	2	2	3	2	2	2	2.0
6	3	3	1	2	3	2	3	3	2	3	2	3	2	3	2	3	2.5
																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

Composing – 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* and *Perionyx excavates*); Materials used for Vermicomposting; Vermicomposting methods – Small scale and Large scale; Packaging, Marketing and 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) Vijaya Ramesh, K. 2008. Environmental Microbiology, MJP Publishers, Chennai, India.
2) 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. Vermicology: The Biology Earth worm, Orient Longman, United Kingdom.
4) Kale Radha, D. 1998. Earthworm: Cinderella of organic farming. Prism Books Pvt. Ltd., Bangalore, India.
5) Satchell, J. E. 1983. Earthworm Ecology: From Darwin to Agriculture. Chapman and Hall, London Stephenson J., 1923. The fauna of British India - Oligo.

Semester – VI
5 Hours
5 Credits

FOOD MICROBIOLOGY

Objectives

- To encode the importance of the role of microorganisms in food industries both in beneficial and harmful ways.
- To obtain a good understanding of food microbiology.
- To become qualified as microbiologist in food industries.
- To know the role of microbes in the spoilage of food products.
- To detect and interpret the food borne infections, intoxications and prevent food borne outbreaks.

Course Outcomes

The Food Microbiology paper adds information about the role of microorganisms in many food, beverage and various industries both in production and spoilage processes.

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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	2	2	3	2	2	2	2	3	3	3	3	2	3	3	2	2.5
2	3	2	2	3	3	2	3	2	3	2	3	3	2	2	3	2	2.5
3	2	2	2	3	2	2	3	3	1	2	3	2	3	2	2	3	2.3
4	2	2	3	3	2	2	3	2	3	2	3	3	2	2	3	2	2.4
5	2	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2	2.1
6	3	3	2	2	3	3	2	3	2	2	3	3	3	2	2	3	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 and Aseptic package; Food preservatives – Natural preservatives & Chemical preservatives.

Unit – II

Microbial Contamination of Foods; Sources of Microbial Contamination; Handling & Processing practices; Contamination, Spoilage and Preservation of Cereals and its products, Sugars and its products, Canned foods, Vegetables, Fruits, Milk 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.

Unit – IV

Milk – Composition and Microflora; Lactic acid bacteria; Bacteriocin production and its health benefits; Concept of Probiotics & Prebiotics; Lactic starter cultures; Fermented dairy products – Cheese, Yogurt and Fermented milk; Spoilage and defects of Fermented dairy products; Testing of Milk and its products.

Unit – V

Food borne infection and intoxification; Seafood Toxicants; Microbiology of Food products preparation; Codes of Good Manufacturing Practices; Government Regulatory Practices and Policies – HACCP, ISI and BIS; Enforcement and Control Agencies; Microbiological criteria for food; 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.

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 – VI
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

From the Industrial Microbiology paper, students acquire the knowledge in the large scale production of Industrial product and providing the trends to cater the needs of industry.

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	PO 6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	
1	3	2	3	3	3	2	3	2	3	3	2	3	3	3	3	2	2.6
2	3	2	3	3	2	3	2	2	3	2	3	3	3	2	3	2	2.5
3	2	2	2	3	2	2	3	3	2	3	2	2	3	2	3	3	2.4
4	3	3	2	2	3	2	2	2	3	2	3	3	3	3	3	2	2.5
5	3	2	3	2	3	2	2	3	2	2	2	3	3	2	2	3	2.4
6	3	3	2	2	3	2	3	3	2	3	3	3	3	3	2	3	2.6
																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

History of Industrial Microbiology; Industrially important microorganisms; Comparison of Bacterial and Fungal fermentation; Primary and Secondary metabolites from microorganisms; Bioproducts – Classification, Types and Advantages; Design of Fermentor; Factors affecting Fermentor design; Types of Fermentor; Industrial Sterilization of Fermentor and Air.

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

Methods of Fermentation – Submerged Fermentation and Solid State Fermentation; Microbial production of Antibiotics (Penicillin & Streptomycin), Vaccines (Hepatitis – B Vaccine & Rabies Vaccine) and Organic acids (Citric acid & Lactic acid); Industrial production of Vinegar.

Unit – IV

Microbial production of Amino acids (Glutamic acid & Lysine), Vitamins (Vitamin – B2, B12, & Vitamin – C) and Enzymes (Amylases, Proteases & Pectinases).

Unit – V

Yeasts and its industrial uses; Production of Baker's Yeast *Saccharomyces cerevisiae*; Production of Food Yeast & Fodder Yeast; Microbial production of Solvents (Bioethanol and Acetone – butanol) and Alcoholic beverages (Beer & Wine); Factors affecting Alcohol fermentation; Current Research Thoughts in Industrial Microbiology.

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.

References

1) Reed, G. 2004. Prescott and Dunn's Industrial Microbiology, 4th Edition, CBS Publishers and Distributors, New Delhi, India.
2) Stanbury, P. T and A. Whitaker. 2005. Principles of Fermentation Technology, Pergamon Press, New York.
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.

Semester – VI
0 Hours
1 Credits

SSP - 2: PROBIOTIC MICROBIOLOGY

Objectives

- To list out the Commercial probiotic strains.
- To explain the definition and types of Probiotics.
- To understand the basic knowledge of Gastrointestinal Ecosystem.
- To acquire the knowledge and utilization of probiotics and prebiotics in our life.
- To develop the Entrepreneurial Skill production and assessment of probiotic microbes

Course Outcomes

Course Outcome (CO)	Description	Cognitive level (K level)
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 *In vitro* 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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3	3	2.8
2	2	2	3	3	3	2	2	3	3	3	3	3	2	3	2	3	2.6
3	2	3	2	3	2	3	3	3	2	3	2	3	3	2	3	3	2.6
4	3	3	3	2	3	2	3	2	3	2	3	3	3	3	3	2	2.6
5	3	2	3	2	3	2	3	3	2	3	3	3	3	1	2	3	2.8
6	3	3	1	3	3	3	3	3	3	2	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

Intestinal microbiota; Functions of Endogenous microflora – Gastrointestinal microbiota and Regulation of the Immune system; Role of Enteric pathogens in Gastrointestinal diseases; Treatment and Prevention of Gastrointestinal disease - Probiotics, Prebiotics and Synbiotics.

Unit – II

History of Probiotics; Types of Probiotics - Human probiotics and Animal probiotics; Physiological effects and mechanism of action of Probiotics; Side effects of Probiotics; Limitations of Probiotics; Prebiotics.

Unit – III

Lactic acid bacteria (LAB): *Lactobacillus, Leuconostoc, Pediococcus* and *Lactococcus*. Commercial probiotic strains; Genetically Modified Probiotics (GMP).

Unit – IV

In vitro assessment of Probiotic microbes: Survivability - Acid resistance, Bile salt resistance, Pepsin resistance, Pancreatin resistance and Colonization properties; Bacteriocin production and its health benefits.

Unit – V

Adaptation factors: Stress resistance - Cell envelope integrity, DNA & Protein repair; Health promoting factors – Microbe - Microbe interaction; Production of Antimicrobial peptides; Competitive exclusion; Genetic tools used for the identification of Adaptation and Probiotic factors.

Text Books

1) Kenji Sonomoto and Atsushi Yokota (2011), Lactic acid bacteria and *Bifidobacteria*, Caister Academic Press Publisher.
2) Charalampopoulos, Dimitris, Rastall and Robert (2009), Prebiotics and Probiotics Science and Technology, Springer Publication.
3) Nicholas Joseph Talley and Christopher J. Martin (2006), Clinical gastroenterology: a practical problem-based approach, Elsevier Publication.
4) Gary B. Huffnagle and Mairi Catherine Noverr (2008), GI microbiota and regulation of the immune system, Springer Publication.

References

1) Malago (2011), Probiotic Bacteria and Enteric Infections: Cytoprotection by Probiotic Bacteria, Springer Publication.
2) Wolfgang Kneifel and Seppo Salminen (2011), Probiotics and Health Claims, John Wiley and Sons Publication.
3) Dash, Allan N. Spreen and Beth M. Ley (2000), Health Benefits of Probiotics, BL Publications.
4) Yuan Kun Lee and Seppo Salminen (2008), Handbook of probiotics and prebiotics, Wiley-Interscience Publication.

Semester – VI
2 Hour
1 Credit

Non – Major Elective 2 – MICROBIAL DISEASES AND HEALTH CARE

Objectives

- To introduce the knowledge of the medically important microorganisms.
- To make the students to understand the various diseases caused by microorganisms.
- To study the clinical conditions and preventive measures for microbial diseases.
- To provide the knowledge about Antibiotics and Drugs.
- To learn about Vaccines and Vaccination.

Course Outcomes

Course Outcome (CO)	Description	Cognitive Level (K-Level)
CO-1	Introducing the knowledge of the Medically important disease causing microorganisms.	**K3**
CO-2	Differentiate normal flora from pathogens and acquire the skill for the diagnosis of microbial infections.	**K2, K3, K4**
CO-3	Describe the Types, Source and Mode of Transmission of Microbial infections.	**K1**
CO-4	Create an awareness on bacterial diseases, its symptoms and preventive measures.	**K6**
CO-5	Evaluate the role of Viruses in causing deadly diseases in human beings.	**K5**
CO-6	Detect the etiology and diseases of Fungi, Protozoa and Helminths.	**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	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PS O8	PSO9	
1	3	2	2	3	3	2	3	2	3	3	2	3	3	3	2	2	2.5
2	3	2	3	3	2	3	2	2	2	2	3	3	2	2	3	2	2.4
3	1	2	2	3	2	2	3	3	1	3	2	2	2	2	3	3	2.2
4	3	3	2	2	2	2	1	2	3	2	3	3	2	3	3	2	2.3
5	2	2	3	1	3	2	2	2	2	1	2	2	3	2	2	2	2.0
6	3	3	1	2	3	2	3	3	2	3	2	3	2	3	2	3	2.5
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

Microbial Infection – Types, Source and Mode of Transmission; Epidemiology of Diseases; Reservoirs of Microbial diseases.

Unit – II

Clinical conditions and prevention of Bacterial diseases – Typhoid, Cholera, Botulism, Anthrax, Tuberculosis and Leprosy; Antibiotics.

Unit – III

Clinical conditions and prevention of Viral diseases – AIDS, Covid-19, Rabies, Polio, Hepatitis, Small Pox and Dengue; Antiviral drugs; Vaccines and Vaccination schedule.

Unit – IV

Clinical conditions and prevention of Fungal diseases – Candidiasis, Cryptococcosis, Aspergillosis and Dermatophytes; Mycotoxins; Antifungal drugs.

Unit – V

Protozoa diseases – Amoebiasis, Malaria and Leishmaniasis; Antiprotozoan drugs; Helminth diseases - Ascariasis, Filariasis, and Taenia infection; Antihelminthic drugs.

Text Books

1) Patrick Murray, Ken Rosenthal and Michael Pfaller. 2016. Medical Microbiology, 8th Edition, Elsevier Publications, United States.
2) Subhash Chandra Parija. 2013. Textbook of Medical Parasitology, 4th Edition, All India Publishers and Distributors, India.
3) Jagdish Chander. 2017. Textbook of Medical Mycology, 4th Edition, Jaypee Brothers Medical Publishers, India.

References

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

Semester – VI
5 Hours
4 Credits

MAIN PRACTICAL – VI

1) Assessment of Milk quality by MBRT.
2) Enumeration of microorganisms in Milk and Water by SPC Method.
3) Isolation and enumeration of microorganisms from Air.
4) Isolation and enumeration of microorganisms from Fruits and Vegetables.
5) Isolation and enumeration of Antibiotic producing fungi from soil.
6) Bacteriological examination of water by MPN test.
7) Isolation of Yeast from Grapes.
8) Microscopic examination of *Spirulina platensis*
9) Cultivation and Growth analysis of *Spirulina platensis*.