THIRUVALLUVAR UNIVERSITY
MASTER OF SCIENCE
M.SC. APPLIED MICROBIOLOGY

(With effect from 2022 – 2023)

The Course of Study and the Scheme of Examination

Sl. No.	Study Components		ins. hrs / week	Credit	Title of the Paper	Maximum Marks		
	Course Title					CIA	Uni. Exam	Total
SEMESTER I								
1	**Core**	**Paper-1**	5	4	General Microbiology and Microbial Physiology	25	75	100
2		**Paper-2**	5	4	Immunology and Immunotechnology	25	75	100
3		**Paper-3**	4	4	Food and Dairy Microbiology	25	75	100
4		**Practical-1**	10	5	Lab Course - 1	50	150	200
Internal Elective for same major students								
5	**Core Elective**	**Paper-1**	3	3	**(to choose one out of 3)** A. Computational Biology B. Algal Technology C. Biosafety	25	75	100
External Elective from other major departments (Inter/multi disciplinary papers)								
6	**Open Elective**	**Paper-1**	3	3	**(to choose one out of 3)** A. Microscopic Techniques B. Basics of Microbiology C. Molecular Biology	25	75	100
			30	**23**		**175**	**525**	**700**
SEMESTER II						***CIA***	***Uni. Exam***	***Total***
7	**Core**	**Paper-4**	5	4	Medical Bacteriology and Mycology	25	75	100
8		**Paper-5**	5	4	Industrial Microbiology	25	75	100
9		**Paper-6**	4	4	Molecular Biology and Microbial Genetics	25	75	100
10		**Practical-2**	8	5	Lab Course - 2	50	150	200
Internal Elective for same major students								
11	**Core Elective**	**Paper-2**	3	3	**(to choose one out of 3)** A. Mushroom cultivation B. Biofertilizer Technology C. Intellectual Property Rights	25	75	100
External Elective for other major departments (Inter/multi disciplinary papers)								
12	**Open Elective**	**Paper-2**	3	3	**(to choose one out of 3)** A. Food Processing Technology B. Infectious Diseases and its Control C. Microbial Ecology	25	75	100
13	**Field Study**	**-**	-	2	-	100	-	100
14	**Compulsory Paper**		2	2	**Human Rights & Duties**	25	75	100
			30	**27**		**300**	**600**	**900**

SEMESTER III						CIA	Uni. Exam	Total
15	Core	**Paper-7**	5	5	Medical Virology and Parasitology	25	75	100
16		**Paper-8**	5	4	Agricultural and Environmental Microbiology	25	75	100
17		**Paper-9**	4	4	Biotechnology	25	75	100
18		**Practical-3**	10	5	Lab Course – 3	50	150	200
Internal Elective for same major students								
19	**Core Elective**	**Paper-3**	3	3	**(to choose one out of 3)** A. Bioremediation B. Research Methodology C. Marine Microbiology	25	75	100
External Elective for other major departments (Inter/multi disciplinary papers)								
20	**Open Elective**	**Paper-3**	3	3	(Choose any one from other major departments)	25	75	100
21	**MOOC Courses**	**-**	-	2	(Choose any one from the enclosed list)	-	-	100
			30	**26**		**225**	**525**	**800**
SEMESTER IV						**CIA**	**Uni. Exam**	**Total**
22	**Core**	**Paper-10**	5	5	Recombinant DNA technology	25	75	100
23	**Core**	**Project Compulsory**	19	5	Project with *viva voce*	100 (75 Project +25 viva)		100
Internal Elective for same major students								
24	**Core Elective**	**Paper-4**	3	3	**(to choose one out of 3)** A. Diagnostic Microbiology B. Microbial Nanotechnology C. Bioethics	25	75	100
External Elective for other major departments (Inter/multi disciplinary papers)								
25	**Open Elective**	**Paper-4**	3	3	(Choose any one from other major departments)	25	75	100
			30	**16**		**75**	**325**	**400**
				92				**2800**

External Elective for other major departments (Inter/multi disciplinary papers)

SEMESTER I

A. Microscopic Techniques
B. Basics of Microbiology
C. Molecular Biology

SEMESTER II

A. Food Processing Technology
B. Infectious Diseases and its Control
C. Microbial Ecology

SEMESTER III
A. Mushroom cultivation
B. Public Health Microbiology
C. Intellectual Property Rights

SEMESTER IV
A. Computational Biology
B. Biosafety
C. Algal Technology

Programme Specific Outcomes:

1. To provide an insight on the fundamentals of Microbiology
2. To create and design modern application of the concept learned
3. To practice continuous learning to maintain and achieve personal excellence
4. To use current microbial technologies and methods for economic development
5. To use current microbial technologies and methods for the betterment of human welfare
6. To use current microbial technologies and methods for the betterment of environment
7. To prepare students for promising career options in research, industries and academics
8. To apply the knowledge in nation building
9. To have an understanding of professional and ethical responsibility
10. To have an ability to function in multidisciplinary environment

THIRUVALLUVAR UNIVERSITY, VELLORE – 632 115
M.Sc. Applied Microbiology – 2022-2023 onwards

Semester: I Paper type: Core

Paper code:

Name of the Paper: GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

Credit: 4

Total Hours per Week: 5 Lecture Hours: 75 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To understand the scope and relevance of Microbiology as a scientific discipline
2. To get acquainted with various Sterilization and Disinfection methods
3. To gain knowledge on the various classification of bacteria.
4. To study the morphology and structure of viruses.
5. To get acquainted with basic concepts of microbial metabolism

Course Out Comes

1. After studying unit-1, the student will be able to understand the principles and uses of microscopes
2. After studying unit-2, the student will be able to understand the growth of microorganisms
3. After studying unit-3, the student will be able to classify microorganisms
4. After studying unit-4, the student will be able to relate the morphological features of different microorganisms
5. After studying unit-5, the student will be able to appreciate the metabolic diversity of microorganisms

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	No

UNIT-I: Teaching Hours: 15

Discovery of Microbial world – Contribution of various scientists; General characteristics used in classification, five kingdom, six kingdom, and eight kingdom concept. Evolutions of Microbiology with its recent developments in Medicine. Microscopy - Principles and applications, Simple, Compound, Dark field, Phase contrast, Fluorescent and Electron Microscopes (SEM & TEM); Stains and Dyes - Staining methods - Gram, Acid Fast, Staining of flagella, Metachromatic granules, capsule, other special staining methods - silver impregnation. Bacterial morphology, structure and characterization - cellular components of bacteria

UNIT-II: Teaching Hours: 15

Sterilization (Heat, Filtration) and Disinfection methods and their quality control. - sporulation and its mechanics - growth and nutrition - Nutritional requirements - Autotrophs, heterotrophs -

enrichment culture - growth curve - Kinetics of Growth - Mathematical expression of exponential growth phase; Measurement of growth and growth yields - Batch Culture - Synchronous growth - Techniques of pure culture.

UNIT-III: **Teaching Hours: 15**

Classification of bacteria and salient features according to Bergey's manual of determinative Bacteriology. Microbial diversity in different ecosystems. . Modern trends in microbial taxonomy. Specialized somatic Structure and Classification of fungi. Reproduction in fungi - Life cycles of fungi.

UNIT-IV: **Teaching Hours: 15**

Structure and function of viruses - classification of viruses - replication of viruses – bacteriophages. Structure and Classification of Algae - ultrastructure and life histories of microalgae belonging to various algal classes. Cyanobacteria. Protozoa - Structure and Classification.

UNIT-V: **Teaching Hours: 15**

Basic concepts of metabolism. Carbohydrate metabolism - Glycolysis - HMD, TCA & ED and other pathways. Aerobic and anaerobic respirations - Generation of energy - substrate level and oxidation phosphorylation - Electron transport chain - Lipid metabolism - Beta oxidation - proteins - primary, secondary, tertiary and quaternary structures - photosynthesis - cyclic and non -cyclic photophosphorylation.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Pelczar & Kreig (2006). Microbiology5th edition. Tata McGraw Hill, New Delhi.
2. Dubey RC and Maheswari DK (2005). A text book of Microbiology, Revised Multicolouredition, S.Chand Publishers, New Delhi.
3. Prescott, L. M., J. P. Harely and D. A. Klain, Microbiology, 2003 (5th Edition) McGraw Hill,New York.

Reference Books

1. Salle, AJ (2001). Fundamentals & Principles of Bacteriology. 7th edition. Tata McGraw-Hill, Davis.
2. Atlas R. A. Principles of Microbiology (2nd Edition), 1997. Wm. C. Brown Publishers,Iowa.
3. Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi. (4th edition). Prentice Hall International, Inc, London.
4. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.
5. Delbecco, Eisen & Ginsburg (1990) Microbiology 5th Edition Harper & raw, New York

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	S
CO2	M	S	M	S	M	S	M	S	S	M
CO3	S	M	S	M	S	S	S	S	S	S
CO4	S	S	S	S	M	S	M	M	S	M
CO5	S	S	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

SEMESTER I CORE PAPER – 2
M.Sc. Applied Microbiology – 2022-2023 onwards

Semester: I Paper type: Core

Paper code: Name of the Paper: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Credit: 4

Total Hours per Week: 5 Lecture Hours: 75 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To provide knowledge on the basic principles and definitions of immunology
2. To impart knowledge about the underlying concepts of molecular and cellular mechanisms involved in the development and regulation of the immune response
3. To learn the important concepts in Major histocompatibility and Hypersensitivity Reactions
4. To understand about autoimmune diseases and the principles behind immunomodulation.
5. To acquire skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders

Course Out Comes

1. After studying unit-1, the student will be able to describe various cells and Organs of the Immune System

2. After studying unit-2, the student will be able to characterize Antigen and Antibodies

3. After studying unit-3, the student will be able to explain Major Histocompatibility Complex

4. After studying unit-4, the student will be able to narrate the concept of Immunomodulation

5. After studying unit-5, the student will be able to make use of Immunological Techniques

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit 1: Cells and Organs of the Immune System Teaching Hours: 15

Immune system and Immune Response: Innate and acquired immunity; structure and functions of immune cells - T cells, B cells, Macrophages, NK cells and dendritic cells, Eosinophils, Neutrophils, Mast cells; Organs of immune system - Primary and secondary lymphoid organs; Primary and secondary immune response; Clonal selection theory.

Unit 2: Antigen and Antibodies **Teaching Hours: 15**

Structure and properties of antigens – Iso- and allo-antigens - antigen specificity, Haptens and adjuvants- structure and properties; Immunoglobulins – Structure, properties, types and subtypes; Generation of immunological diversity; Complement system- component, properties and functions. Complement pathways and biological significance.

Unit 3: Major Histocompatibility Complex and Hypersensitivity Reactions Teaching Hours: 15

Major Histocompatibility Complex - Structure and functions of MHC and HLA systems; Genetic control of immune response; Tissue transplantation - Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy; Hypersensitivity Reactions - Allergy, Hypersensitivity reactions-types (I, II, III, and IV), symptoms, immunodiagnosis. Lymphokines and cytokines - Interleukins and Interferons - Production, biological functions and assay methods; Immunological tolerance.

Unit 4: Autoimmunity and Immunomodulation **Teaching Hours: 15**

Autoimmunity- Autoimmune diseases – Hashimoto's disease, Systemic Lupus Erythematosus, Multiple sclerosis, Myasthenia gravis and their treatment; Immunomodulation (immunosuppression & immunostimulation), Immunotherapy, lymphocyte migration - homing and trafficking, antigen-induced lymphocyte proliferation, Granulysin mediated anti-microbial activity of T cells.

Unit 5: Immunological Techniques and Tumor immunology **Teaching Hours: 15**

Immunological Techniques: Agglutination, precipitation, immunofluorescence, immunoelectrophoresis, immunoblotting, ELISA, RIA, Flow cytometry. Production and purification of antibodies, determination of antibody titre by RID and EID. Tumor Immunology: Tumors of the Immune System, Tumor Antigens, Immune Response to Tumors, Tumor Evasion of the Immune System, Cancer Immunotherapy.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

Roitt I., Essential Immunology, 13 th edition, Blackwell Scientific Publications, 2017.
William E. Paul. Fundamental Immunology, Lippincott Williams and Wilkins; 7th edition,2012.
Anathanarayanan and Paniker, Text Book of Microbiology, 8th edition, Orient and Longman, New Delhi, 2009.

Reference Books

1. Kuby, Judy Owen, Jenni Punt, Sharon Stanford., Immunology, WH Freeman Publishers,7thEdition 2012.

2. Weir DM and Stewart, J.,Immunology, 10th Edn., Churchill Livingston, New York, 2000.
3. Tizard, Ian R., Immunology- An Introduction, 4th edition, Saunders College Publishing, NewDelhi.
4. Sunil Kumar Mohanty, K Sai Leela., Textbook of Immunology, 2nd Edition, Jaypee BrothersMedical Publishers, 2014.
5. Mark Peakman and DiegoVergani. 1st magazine, 1997, Basic and Clinical Immunology. Churchill Livingstone, New York.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	S
CO3	S	M	S	M	S	S	M	S	M	M
CO4	S	M	S	S	S	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low

Semester: I Paper type: Core

Paper code:

Name of the Paper: FOOD AND DAIRY MICROBIOLOGY

Credit: 4

Total Hours per Week: 4 Lecture Hours: 60 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about the Microorganisms important in food microbiology

2. To study the Principles of food preservation

3. To know about Contamination, preservation and spoilage and fermented foods

4. To study Dairy Microbiology & fermented milk products

5. To know about Foodborne diseases and their control

Course Out Comes

1. After studying unit-1, the student will be able to list out Microorganisms important in food microbiology

2. After studying unit-2, the student will be able to describe the Principles of food preservation

3. After studying unit-3, the student will be able to devise mechanisms to control Contamination, and spoilage of foods

4. After studying unit-4, the student will be able to describe Dairy Microbiology

5. After studying unit-5, the student will be able to predict Foodborne diseases and control them

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I - Microorganisms important in food microbiology **Teaching Hours: 12**

Food as a substrate for microbes. Microorganisms important in food microbiology.Factors influencing microbial growth in food. Extrinsic and Intrinsic factors. Sources of food contamination.

UNIT II - Principles of food preservation **Teaching Hours: 12**

Principles of food preservation, General principles and application methods –Asepsis - Techniques of removal –use of temperature (low & high). Drying, High pressure radiation and chemical preservatives.

UNIT III - Contamination, preservation and spoilage and fermented foods **Teaching Hours: 12**

Contamination, preservation and spoilage of fruits, vegetables, meat, poultry, eggs, fish and other sea foods. Canning - Methods - Types - Spoilage of canned foods. Fermented foods – Bread and Malt beverages – Beer, Wine , Vinegar. Fermented vegetables. Nutritional value of fermented foods.

UNIT IV - Dairy Microbiology **Teaching Hours: 12**

Dairy Microbiology: Micro flora of milk. Sources of milk contamination. Preservation and spoilage of milk and milk products. Microbiology of fermented milk products -Acid fermented milks (acidophilus milk, yoghurt). Slightly acid fermented milks (Cultured butter milk), Acid-alcoholic fermented milk (Kefir). Fermented Fermented foods - Fermented vegetables and dairy products. Milk production with extended self life (labneh).

UNIT V - Foodborne diseases and their control **Teaching Hours: 12**

Food borne diseases, food intoxication and their control measures - Food sanitation in foodmmanufacture and in the retail trade. Food control agencies and their regulations. HACCP, GMP, GHP.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Frazier W. C. and D.C. Westhoff, Food Microbiology, 1988 (4lh Edition), Tata McGraw HillPublishing Company Ltd.., New Delhi.
2. Moss. M. R., and M. O. Moss, Food Microbiology, 1996. New Age International (P) LimitedPublishers, New Delhi.
3. J.B. Prajapati. 1995. Fundamentals of Dairy Microbiology. Akta Prakashan Publisher.

Reference Books

1. Banwart, G. J. Basic Food Microbiology, 1989, CBS Publishers and Distributors, New Delhi.

2. Jay, J. M., Modern Food Microbiology. (4lh Edition), 1996, CBS Publishers and Distributors.
3. Milk and Milk Products. Eckles C.H., Combs W.B. and Macy H. 1998. Published by TataMcgraw Hill Publishing Co Ltd.
4. Narayanan, R. and B. Dhanalakshmi. 2013. Food Microbiology: Basic and Applied WithLaboratory Exercises. NIPA Publishers.
5. A. Bohra and Pradeep Parihar. 2006. Food Microbiology. Agrobios, Jodhpur.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	S	S	M	S	S	M
CO3	S	M	S	M	M	S	S	S	S	M
CO4	S	M	S	S	S	S	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: I Paper type: Elective

Paper code:

Name of the Paper: A. COMPUTATIONAL BIOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To introduce computers and their applications
2. To acquire knowledge about Sequence databases and its applications.
3. To get insight about sequence analysis
4. To impart knowledge about protein structures analysis through tools
5. To offer comprehensive information DNA microarray and protein microarray

Course Out Comes

1. After studying unit-1, the student will be able to know the uses of computers in the field of biology
2. After studying unit-2, the student will be able to make use of Sequence databases
3. After studying unit-3, the student will be able to perform sequence analysis
4. After studying unit-4, the student will be able to analyse and interpret protein structures using tools
5. After studying unit-5, the student will be able to appreciate the use of microarrays

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: **Teaching Hours: 9**

Introduction to computers – Types of computers – Generation – Applications of computers – Input and Output devices – ROM, RAM- Internet.

Unit II: **Teaching Hours: 9**

Data-alignment and applications; Collecting and Storing Sequence Data; Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Conversion between formats; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments tools- BLAST.

Unit III: **Teaching Hours: 9**

Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis.

Unit IV: **Teaching Hours: 9**

Basic structure and building blocks of proteins; motifs of protein structures; alpha/beta structures; Folding and flexibility, Prediction, engineering and design of protein structures; Methods to identify secondary structural elements.

Unit V: **Teaching Hours: 9**

DNA microarray: database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases; understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools. **Protein arrays**: basic principles, bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools; Protein-protein interactions.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press. 2004.
2. Bioinformatics: Sequence and Genome Analysis by Mount D., 2004 Cold Spring Harbor Laboratory Press, New York.

Reference Books

1. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., 1998, John Wiley & Sons, UK.
2. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press. 2001.
3. Cynthia Gibas and Per Jambek. Developing Bioinformatics computer skills, Shroff publishers and Distributors Pvt. Ltd., O' reilly, Madurai. 2001.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	S	S	S	S
CO3	S	M	S	M	S	S	M	S	M	M
CO4	S	M	S	S	M	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: I Paper type: Elective

Paper code:

Name of the Paper: B. ALGAL TECHNOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about algal technology, Characteristics and classification of Algae.
2. To know Algal production systems
3. To learn the uses of algae
4. To identify Algal control Methods
5. To understand the role of algae in nanobiotechnology

Course Out Comes

1. After studying unit-1, the student will be able to characterize and classify Algae
2. After studying unit-2, the student will be able to list out the significance and uses of algae
3. After studying unit-3, the student will be able to describe algal cultivation methods
4. After studying unit-4, the student will be able to appreciate the role of algae in food and feed
5. After studying unit-5, the student will be able to suggest algal control measures

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: **Teaching Hours: 9**

Introduction to algal technology; Characteristics and classification of Algae (Outline only) - Chemical composition - protein, amino acids, lipids, waxes, glycerol, vitamins, pigments, chlorophyll, carotenoids and phycobiliproteins. Distribution of economically important algae in India.

Unit II: **Teaching Hours: 9**

Characteristics, significance and Uses of the following algae - *Dunaliella*, *Haematococcus*, *Chlorella*, *Scenedesmus*, *Botryococcus*, *Porphyridium*, *Gracilaria*, *Gelidium*, Gelidiella, *Laminaria*, *Porphyra*, and *Ulva*.

Unit III: **Teaching Hours: 9**

Algal production systems; Strain selection; Algal growth curve; Culture media; indoor cultivation methods and scaling up; Measurement of algal growth; Large-scale cultivation of algae; Harvesting algae. Drying; Algal immobilization and its applications

Unit IV: **Teaching Hours: 9**

Algae as a source of food and feed; Algae as SCP - *Spirulina* mass cultivation and its applications, Algae as a source of pigments, fine chemicals and bio-fertilizers; Blue-green algal bio-fertilizer - Method of preparation, application and its advantages over inorganic fertilizers; Liquid seaweed fertilizer - Method of preparation and application. Biodiesel from algae; Phycoremediation; Role of algae in nanobiotechnology.

Unit V: **Teaching Hours: 9**

Algal control - Methods of control of algae; Algicides-preparation and Application; ultrasonic sound producing devices to control algae; Algal culture collection centers in India and abroad and their importance; Centers pursuing algal research in India and their field of interest.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Trivedi, P.C. 2001 Algal Biotechnology. Pointer publishers, Jaipur, India.
2. Barsanti, Laura and Paolo Gualtieri. 2005 Algae-Anatomy, Biochemistry and Biotechnology. Taylor & Francis, London, New York.

Reference Books

1. Borowitzka MA and Borowitzka LJ. Microalgal Biotechnology, Cambridge University Press. 1989.
2. Becker, E.W. 1994 Microalgae-Biotechnology and microbiology. Cambridge University Press.
3. Das Mihir Kumar. Algal Biotechology. Daya Publishing House.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	S	S	M	M
CO2	M	S	M	S	S	S	M	S	S	S
CO3	S	M	S	M	M	S	S	S	S	M
CO4	S	M	S	S	S	S	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: I Paper type: Elective

Paper code:
Name of the Paper: C. BIOSAFETY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn the importance of Biosafety
2. To acquire knowledge about biohazards
3. To get insight about Biocontainment levels
4. To deliver extensive knowledge on Biosafety Management
5. To offer comprehensive information on Biosafety Guidelines

Course Out Comes

1. After studying unit-1, the student will be able to describe the concept of Biosafety
2. After studying unit-2, the student will be able to list out various biohazards
3. After studying unit-3, the student will be able to narrate Biocontainment methods
4. After studying unit-4, the student will be able to employ the concept of Biosafety Management
5. After studying unit-5, the student will be able to interpret and apply Biosafety Guidelines

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Biosafety **Teaching Hours: 9**

Introduction – Historical background - Biosafety issues in Microbiology - Disease transmission and epidemiology - Levels of Specific Microorganisms, Infectious Agents and Infected Animals - Aseptic technique - Standard Microbiological Practices.

Unit II: Biohazards **Teaching Hours: 9**

Definition of GMOs & LMOs; rDNA technology - GMO applications in food and agriculture - Environmental release of GMOs - Risk - Analysis, Assessment, management and communication - Hazardous Wastes in Biological Labs – Types and Management - Bioterrorism

Unit III: Biocontainment **Teaching Hours: 9**

Concepts and Strategies – Risk Groups (from NIH Guidelines) and Biosafety Levels (from CDC Biosafety) - Biological Safety Cabinets - Primary Containment for Biohazards - Animal Biosafety and Facilities - Operations and Maintenance of Biosafety Facilities.

Unit IV: Biosafety Management **Teaching Hours: 9**

Risk Assessment - Risk Communication - Warning Signs and Labels - Working Safely with Biohazardous Agents - Disinfection and Decontamination procedures - Emergency Planning and Response - Personal Protective Equipment.

Unit V: Biosafety Guidelines **Teaching Hours: 9**

Guidelines and regulations (National and International) - Cartegana Protocol; Institutional Biosafety Committee (IBSC) - Composition and role; Role of review committee on genetic manipulation (RCGM) and GEAC; Transportation of Infectious Substances.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)

Reference Books

1. Biosafety and bioethics (2006) Rajmohan Joshi. Gyan Publishing House.
2. Microbial Biotechnology & Biosafety Aspects P. Palanivelu. Twentyfirst Century Publications. 2016
3. Biological Safety: Principles and Practices. American Society for Microbiology. 2017. Editors: Dawn P. Wooley and Karen B. Byers.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	M
CO3	S	M	S	M	S	M	S	S	S	S
CO4	S	M	S	S	M	S	M	M	S	M
CO5	S	M	M	S	S	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low

Semester: I Paper type: Open Elective

Paper code:

Name of the Paper: A. MICROSCOPIC TECHNIQUES

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To study the principle of microscopes

2. To study the principle and use of Bright field Microscope

3. To learn the principle and use of Phase contrast and Fluorescence Microscopes

4. To learn about Electron Microscopy

5. To study the principle and use of Atomic Microscopy

Course Out Comes

1. After studying unit-1, the student will be able to explain the principle of microscopes

2. After studying unit-2, the student will be able to describe the principle and use of Bright field Microscope

3. After studying unit-3, the student will be able to describe the principle and use of Phase contrast and Fluorescence Microscopes

4. After studying unit-4, the student will be able to distinguish TEM and SEM

5. After studying unit-5, the student will be able to appreciate the use of Atomic Microscopy

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT-I: Teaching Hours: 9

Introduction of Microscope – Microscopic properties of light- Resolution, Image formation by convex lens, lens aberrations - Spherical chromatic, Ocular-Manipulating the light within the Microscope.

UNIT –II: **Teaching Hours: 9**

Light Microscope, Bright field Microscope, Dark field Microscopy; Slide preparation Fixation - Staining of sample Technique - Mounting of sample - Labelling and storage of slides Application in biological science.

UNIT-III: **Teaching Hours: 9**

Phase contrast Microscopy, Fluorescence Microscope - slide preparation - fixation- staining of sample technique - mounting of the sample - labelling and storage of slides- Application in biological sciences.

UNIT-IV: **Teaching Hours: 9**

Electron Microscopy - Electron beam Principle - Construction and working of TEM (Transmission of Electron Microscope), SEM (Scanning Electron Microscope) with their merits limitations and their Application.

UNIT- V: **Teaching Hours: 9**

Atomic Microscopy working of AFM (Atomic Force Microscope) and STM (Scanning Tunnelling Microscope) with their merits limitations and their Applications. Confocal Microscope techniques.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Murphy, Douglas and Davidson, Michael - Fundamental of light Microscopy and electronicimaging, second edition.Wiley-Blackwell. 2013.
2. Cruycox, optical imaging Techinques in Cell Biology. CRC press. 2007.

3. Reference Books

4. Paurley,J.B.(ed).Handbook of Biological Confocal Microscopy, Second edition.1995 Newyork Plemum Press.
5. Jmwalls, Editor, method of surface analysis: Techniques and application. Cambridge University Press 1990
6. Fundamentals of Light Microscopy and Electronic Imaging. Ed. by Douglas B. Murphy andMichael W. Davidson. 2001. Wiley and Blackwell.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	M
CO3	S	M	S	M	S	S	M	S	S	S
CO4	S	M	S	S	M	S	M	M	S	M
CO5	S	M	M	S	S	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: I Paper type: Open Elective

Paper code:

Name of the Paper: B. BASICS OF MICROBIOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn the history of microbiology

2. To learn microscopy and staining

3. To study the characteristics of algae and fungi

4. To study about different protozoans

5. To study about viruses

Course Out Comes

1. After studying unit-1, the student will be able to narrate the contribution of scientists in the field of microbiology

2. After studying unit-2, the student will be able to appreciate the use of microscopy and staining in microbiology

3. After studying unit-3, the student will be able to compare the characteristics of algae and fungi

4. After studying unit-4, the student will be able to explain the role of protozoans as microbes

5. After studying unit-5, the student will be able to appreciate the uniqueness of viruses

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT – I: Teaching Hours: 9

Introduction to Microbiology; Five major groups of Microorganisms; Scope of Microbiology; Spontaneous generation; Brief note on the contributions of Jenner, Louis Pasteur, Robert Koch and Alexander Flemming.

UNIT – II: **Teaching Hours: 9**

Microscopy – Microscopes - principles and applications – Bright field, Dark field, Fluorescent, Phase contrast & Electron Microscope (TEM and SEM); Morphology of Bacteria – size, shape and arrangement; Structure and function of bacterial cell organelles; Stains and staining techniques – simple, Grams, acid fast and special staining – flagella, capsule, metachromatic granules.

UNIT – III: **Teaching Hours: 9**

Algae - Structure and classification (outline only); Specific examples – Microalgae, Cyanobacteria; Cultivation of algae; Algal toxins; Uses and significance of algae. **Fungi** – General characteristics, morphology and reproduction; Classification (outline only); Culturing fungi; Fungal diseases; Industrial uses of Fungi.

UNIT – IV: **Teaching Hours: 9**

Protozoa - General characteristics, morphology, reproduction and classification (outline only); Life cycle of Plasmodium as an example; Protozoan diseases.

UNIT – V: **Teaching Hours: 9**

Viruses - General characteristics, morphology, multiplication and classification (outline only); Plant, Animal and Human viruses; Virus cultivation methods; Viral Diseases; Bacteriophages.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Pelczar J.R., Chan E.C.S., and Krieg R., Microbiology, 5th Edition, Tata McGraw – Hillpublish company limited, Delhi, 2004.
2. Rajan. S and Selvi Christy (2015). Essentials of Microbiology, Anjanna Book HousePublishers, Chennai.

Reference Books

1. Prescott, L. M., J. P. Harely and D. A. Klain, Microbiology, 2003 (5th Edition) McGraw Hill,New York.
2. Atlas R. A. Principles of Microbiology (2nd Edition), 1997. Wm. C. Brown Publishers, Iowa.
3. Heritage,J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. CambridgeUniversity Press.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	M
CO3	S	M	S	M	M	S	S	S	S	S
CO4	S	M	S	S	M	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: I Paper type: Open Elective

Paper code:

Name of the Paper: C. MOLECULAR BIOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To introduce the Central Dogma of molecular biology

2. To characterize DNA, RNA and proteins

3. To study the process of DNA replication

4. To study the Molecular aspects of gene expression

5. To learn about various gene transfer mechanisms

Course Out Comes

1. After studying unit-1, the student will be able to relate DNA, RNA and proteins

2. After studying unit-2, the student will be able to appreciate the structure of proteins

3. After studying unit-3, the student will be able to narrate the events in DNA replication

4. After studying unit-4, the student will be able to describe the Molecular aspects of gene expression

5. After studying unit-5, the student will be able to distinguish various gene transfer mechanisms

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Teaching Hours: 9

Central Dogma – Concept of genes - Nucleic Acids – Components of Nucleic acids – The double helix – Circular and superhelical DNA – Determination of the base sequence of DNA

Unit II: **Teaching Hours: 9**

Structure of RNA – Methods used to study macromolecules – Isolation of nucleic acids Proteins - Chemical and Physical structure of a polypeptide chain

Unit III: **Teaching Hours: 9**

DNA replication – the basic rule for replication of all nucleic acids – Discontinuous replication – Bidirectional replication – Rolling circle replication – DNA damage and repair – Mutations and Mutants — Mutagenesis – Reversion – Suppression

Unit IV: **Teaching Hours: 9**

Plasmids - Types – properties of particular bacterial plasmids - Transposable elements – Transposons and evolution - Molecular aspects of gene expression – Transcription – messenger RNA – Translation – the genetic code – the operon model

Unit V: **Teaching Hours: 9**

Bacterial Transformation – the discovery of transformation - Bacterial Conjugation Bacteriophages – Phage genetics - Lysogeny – Transduction – DNA transfer by means of transduction – Genetic related diseases

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Friefelder D. (1995). Molecular Biology, 2nd Edn. Narosa Publishing House.
2. Weaver. R. F. Molecular Biology. 3rd ed. Mc Graw Hill publilcation , 2005.

Reference Books

1. Russel Peter. Essential Genetics. 2nd Edn, Blackwell Science Pub.
2. Alberts Bruce (2008) Molecular Biology of Cell, 5th Ed. Garland Pub.
3. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology ofGene. 5th The Benjamin / Cummings Pub. Co. Inc, 2003

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	S	S	M	S	S	S	M	M
CO3	S	M	S	M	M	S	M	M	S	S
CO4	S	M	S	S	M	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: I Paper type: Practical

Paper code:

Name of the Paper: LAB COURSE - 1

Credit: 5

Total Hours per Week: 10 Lecture Hours: Nil Tutorial Hours: Nil Practical Hours: 150

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Course Objectives

1. To study sterilization procedures

2. To observe microorganism by staining them

3. To study the morphology of blood cells

4. To study Immuno diffusion

5. To Isolate and identify bacteria from spoiled foods

Course Out Comes

1. After studying unit-1, the student will be able to make use of sterilization in experiments

2. After studying unit-2, the student will be able to observe the morphology of different microorganisms

3. After studying unit-3, the student will be able to identify and enumerate different blood cells

4. After studying unit-4, the student will be able to demonstrate Immuno diffusion

5. After studying unit-5, the student will be able to isolate and identify bacteria from spoiled foods

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

List of Experiments

General Microbiology

Principles and methods of sterilization – Autoclave, Hot air ovenDirect microscopic observations of yeast budding

Staining methods - Simple, Gram staining, Negative, spore, Capsule stainingPreparation of Culture Media - Broth, Agar, plates, slants, soft agar

Pure culture techniques - Streak plate Measurement of size of microbes – micrometryMotility determination – Hanging drop methodTotal count - Haemocytometer

Microscopic observation of fungi - Lactophenol cotton blue stainingBiochemical tests for bacterial identification

Immunology

Quantification of Blood cells using Haemocytometer

Precipitation on gels – Single radial Immuno diffusion, Ouchterlony double diffusion

Widal test – slide, tube methods

Immunoelectrophoresis

VDRL test

Isolation of buffycoat

Food Microbiology

Detection of number of bacteria in milk by standard plate count (SPC)

Determination of quality of milk sample by methylene blue reductase test

Isolation and identification of bacteria from spoiled foods

Internal Assessment Methods:

- Regularity in lab course
- Performance assessment in each eaxperiment
- Submission of Observation report

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	S	M	S	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	M
CO3	S	M	S	M	S	M	M	S	S	M
CO4	S	M	S	S	M	M	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Core

Paper code:

Name of the Paper: MEDICAL BACTERIOLOGY AND MYCOLOGY

Credit: 4

Total Hours per Week: 5 Lecture Hours: 75 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn the mechanisms involved in disease transmission by bacteria
2. To study the virulence, pathogenicity of pathogenic bacteria
3. To study the methods for treatment and prevention of medically important bacteria
4. To study the virulence, pathogenicity of pathogenic fungi
5. To study the methods for treatment and prevention of medically important fungi.

Course Out Comes

1. After studying unit-1, the student will be able to elaborate the mechanisms involved in disease transmission by bacteria

2. After studying unit-2, the student will be able to describe the mechanisms of transmission, virulence, pathogenicity of bacteria

3. After studying unit-3, the student will be able to describe the mechanisms of transmission, virulence, pathogenicity of bacteria

4. After studying unit-4, the student will be able to elaborate the mechanisms involved in disease transmission by fungi

5. After studying unit-5, the student will be able to describe the mechanisms of transmission, virulence, pathogenicity of fungi

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Teaching Hours: 15

Histroy of Medical Bacteriology. Role of Microbiology in Medicine, Classification of medically important microbes, Normal Microbial flora, Infections - Source, Mode of transmission,

etiology & epidemiology of nosocomial infections, Prevention of medically important microbes. Host-microbe interactions. Non specific defence mechanism- Mechanical barriers. Antibacterial substance.

UNIT-II: **Teaching Hours: 15**

Morphological, cultural and biochemical characteristics , epidemiology, mechanism of bacterial pathogenesis, lab diagnosis, prophylaxis and control of medically important diseases caused by: *Staphylococcus*, Group A Streptococci, *Corynebacterium*, *Clostridium*, *Bacillus*, *Mycobacterium*, Atypical *Mycobacterium*, *Escherichia*, Klebsiella, *Salmonella*, *Shigella*, *Pseudomonas*, *Vibrio*, *Niesserriae*, *Haemophilus*, *Helicobacter*.

Unit III: **Teaching Hours: 15**

Morphological, cultural and biochemical characteristics, epidemiology, mechanism of bacterial pathogenesis, lab diagnosis, prophylaxis and control of medically important diseases caused by: *Chlamydia*, *Rickettsia*, *Mycoplasma*, anaerobic bacteria, *Francisella*, *Brucella*, *Bordetella*, *Legionella*, *Listeria*, *Leptospira*, *Treponema*, Spirochaetes, Actinomycetes.

Unit IV: **Teaching Hours: 15**

Introduction – characteristics of fungi- morphology-dimorphic fungi- classification of medically important fungi- laboratory diagnosis of fungal infections- antifungal agents- superficial cutaneous mycosis- Malessezia infections, Tinea nigra, Piedra, Dermatophytoses.

Unit V: **Teaching Hours: 15**

Subcutaneous mycoses- Myotic mycetoma- systemic mycoses- histoplasmasis- Blastomycosis, coccidiomycosis, paracoccidiodomycosis- oppourtunistic systemic mycosis- aspergillosis, penicillosis - yeast of medial importance - Candida, Cryptococcus, mycotoxicoses.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Ananthanarayanan R and Jeyaram Panicker CK. Medical Microbiology, Orient Publications, New Delhi.1990.
2. Jagadish Chander (1996) A Text Book of Medical Mycology. Interprint, New Delhi.
3. Brooks, G.F., Janet S. Butel, Stephen A, Jawwetz, Melnick & Adlerberg's Medical Microbiology, 21st Edition, Prentice Hall International Inc. 1998.

Reference Books

1. Murray. P.R., G.S, Kobyashi, M. A. Pfaller and K. S. Rosenthal, Medical Microbiology, 1993, (2nd Edition), Mosby St. Louis.
2. Greenwood, D., R.C.B. Slack, and J.F. Peutherer, Medical Microbiology 1997 (15th Edition), Churchill Livingstone. New York.

3. Mims, C.A., Mims' Pathogenesis of Infectious Diseases. 1995 (4th Edition), Academic Press, London.
4. Gerard J. Tortora, Berdell, R. Funke, Christine L. Case, , Microbiology: An Introduction.8th edition Hardcover: 944 pages, Publisher: Benjamin Cummings. 2004.
5. Kenneth J. Ryan,C. George Ray, John C. Sherris, Sherris Medical Microbiology : An Introduction to Infectious Diseases , Hardcover: 992 pages, Publisher: McGraw-Hill Professional, 2003.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	M
CO3	S	M	S	M	M	S	M	S	S	M
CO4	S	M	S	S	M	S	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Core

Paper code:

Name of the Paper: INDUSTRIAL MICROBIOLOGY

Credit: 4

Total Hours per Week: 5 Lecture Hours: 75 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To get equipped with theoretical and practical understanding of industrial microbiology.
2. To know how to source for microorganisms of industrial importance from the environment.
3. To know about design of fermentors, factors affecting growth and production.
1. To understand the rationale in medium formulation and design for microbial fermentation
2. To comprehend the techniques and the underlying principles in downstream processing.

Course Out Comes

1. After studying unit-1, the student will be able to narrate theoretical and practical aspects of industrial microbiology.

2. After studying unit-2, the student will be able to explain the design of fermentors, factors affecting growth and production

3. After studying unit-3, the student will be able to appreciate the rationale in medium formulation and design for microbial fermentation

4. After studying unit-4, the student will be able to comprehend the techniques and the underlying principles in downstream processing.

5. After studying unit-5, the student will be able to appreciate how microbiology is applied in the manufacture of industrially significant products.

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: Introduction to Fermentation Technology **Teaching Hours: 15**

Principles of fermentation process and its Historical back ground; Screening of microorganisms for primary and secondary metabolites, enrichment, random and strategic screening methods for the desired products; Isolation, selection and improvement of microbial cultures; Strain improvement of the selected organism. Types of fermentation processes - Aerobic and anaerobic fermentation, Batch fermentation, Continuous fermentation, Submerged fermentation, Surface or Solid State Fermentation (SSF).

Unit-2: Fermentor design and its types **Teaching Hours: 15**

Fermentors: basic features, design and components of a typical fermentor; Sterilization of - fermentor, medium, air supply; Aseptic inoculation and sampling methods; Scale up of fermentation process; Types of Fermentors - Stirred tank reactors, Packed bed reactors, Fluidized bed reactors and Trickle flow reactors, Airlift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors, Cyclone reactors and Photo bioreactors.

Unit-3: Fermentation media and Fermentation process **Teaching Hours: 15**

Fermentation media: Natural and synthetic media; Strategies for media formulation; sources of carbon, nitrogen, vitamins, minerals; oxygen requirements; Role of buffers, precursors, inhibitors, inducers and antifoam agents. Fermentation process: kinetics of fermentation process; bioprocess control; monitoring of variables -temperature, agitation, pH and pressure.

Unit-4: Down Stream Processing **Teaching Hours: 15**

Downstream processing: Cell disintegration- Physical, chemical and enzymatic methods; Biomass separation by centrifugation, filtration and flocculation; Extraction - solvent, two phase, liquid extraction, whole broth and aqueous multiphase extraction; Purification – Chromatograghy, concentration, ultra-filtration, reverse osmosis, drying and crystallization, Solvent recovery; Quality control of fermented products.

Unit-5: Industrially important microbial products **Teaching Hours: 15**

Microbiological Production of: Alcohols – Ethanol, glycerol; Alcoholic beverages – Wine, Beer; Antibiotics - Penicillin, Streptomycin, Tetracycline; Vitamins - Vitamin C, Vitamin B12; Organic acids - citric acid, lactic acid; Amino acids – Lysine, glutamic acid; Microbial enzymes – amylases and proteases; Biodegradable plastic - polyhydroxyalkanoates (butyarate, propionate); Microbial transformation of steroids; Immobilization of microbial cells and enzymes - methods and applications.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Patel A.H. 2001. Industrial Microbiology. 3rd edition, Mac Millan India ltd, Chennai.
2. Casida J.E. 1986. Industrial Microbiology. 1st edition. Wiley Eastern publishers, UK.
3. D.K. Maheshwari, R.C. Dubey and S.C. Kang. 2006. Biotechnological Applications of Microorganisms - A Techno-Commercial Approach. I.K. International Publishing House Pvt. Ltd., New Delhi.

Reference Books

1. Doran P.M. 2013. Bioprocess Engineering Principles. Academic Press.
2. Waits, M.J., N.L. Morgan and G, Higton. Industrial Microbiology; An Introduction, 2001, Blackwell Science, Oxford.
3. Stanbury P.F., Whitaker A and Hall S.J. 2016. Principles of Fermentation technology. 3rd edition, Butterworth-Heinemann.
4. Fermentation Microbiology and Biotechnology. 2006. Second Edition. Edited by E. M. T. El-Mansi , C. F. A. Bryce , A. L. Demain and A. R. Allman. Taylor & Francis Inc.
5. Glazer A. N. and Nikaido H. Microbial Biotechnology: Fundamentals of AppliedMicrobiology, Second Edition. 2007. Cambridge University Press. Cambridge, UK.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	M	S	M	S	S	S	S	S
CO3	S	M	S	M	S	M	M	S	M	M
CO4	S	S	S	S	S	M	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Core

Paper code:

Name of the Paper: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Credit: 4

Total Hours per Week: 4 Lecture Hours: 60 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To study the Structures of DNA and RNA / Genetic Material

2. To understand the replication of DNA (Prokaryotes and Eukaryotes)

3. To comprehend the techniques of Transcription in Prokaryotes and Eukaryotes

4. To understand the cloning system

5. To outline Application of genetic engineering

Course Out Comes

1. After studying unit-1, the student will be able to narrate the structure of DNA

2. After studying unit-2, the student will be able to explain the process of replication

3. After studying unit-3, the student will be able to elaborate the process of transcription

4. After studying unit-4, the student will be able to decipher the process of cloning

5. After studying unit-5, the student will be able to appreciate the applications of molecular techniques

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-I: Structures of DNA and RNA / Genetic Material Teaching Hours: 12

DNA Structure: Miescher to Watson and Crick- historic perspective, DNAstructure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology -linking number, topoisomerases; Organization of DNA

Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit –II: Replication of DNA (Prokaryotes and Eukaryotes) Teaching Hours: 12

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involvedin DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear endsVarious models of DNA replication including rolling circle, D- loop(mitochondrial), Θ (theta) mode of replication and other accessory protein,Mismatch and excision repair.

Unit –III: Transcription in Prokaryotes and Eukaryotes Teaching Hours: 12

Transcription- promoter - concept and strength of promoter RNA Polymerase and the transcription unit .Transcription in Eukaryotes: RNA polymerases, general Transcription factors Post-Transcriptional Processing. Split genes, concept of introns and exons, RNA splicing, spliceosome machinery concept of alternative splicing, Polyadenylation and capping, Translation-Translational machinery, Charging of tRNA, aminoacyltRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides. Regulation of gene Expression.

UNIT-IV: Cloning system Teaching Hours: 12

Historical perspectives - Synthetic DNA, DNA amplification technique - PCR. Preparation of genomic library, DNA library, gene cloning system, vectors, enzymes, expressionsystem.

UNIT-V: Application of genetic engineering Teaching Hours: 12

Application of genetic engineering in medical field - genetherapy, vaccines preparation, Hybridoma and monoclonal antibody techniques. 'Nif' gene - transfer - development of resistant plant variety, Application in Pharmaceuticals - antigens, interferons, vaccines, insulin, Social impact of recombinant DNA technology.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Book

1. Antony JF, Griffiths, Gilbert WM, Lewontin RC and Miller JH (2002). Modern Genetic Analysis, Integrating Genes and Genomes, 2nd edition, WH Freeman and Company, New York.
2. Blackburn GM, Gait MJ. (1996). Nucleic acids in chemistry and biology. Oxford University press.
3. Friefelder D. (1995). Molecular Biology, 2nd Edn. Narosa Publishing House.

Reference Books

1. Click. B.R. and-Pasternat J.J. (1994) Molecular Biotechnology. ASM press. Washington DC.
2. Benjamin Lewin (1997) Genes VI, Oxford University Press.
3. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1998). Molecular biology of the gene, 4th edition, Benjamin/Cummings publishing company.
4. Old, R.S. and Primrose, S.B. (1995) Principles of Gene manipulation. An introduction to genetic Engineering. 5th Edition. Blackwell Scientific Publication, London.
5. Weaver. R. F. Molecular Biology. 3rd ed. Mc Graw Hill publilcation , 2005.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	M	S	M	S	S	S	M	S
CO3	S	M	S	M	S	S	M	S	S	M
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	M	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Elective

Paper code:

Name of the Paper: A. MUSHROOM CULTIVATION

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn about the edible and non edible mushroom.
2. To know the basics of Mushroom cultivation
3. To learn about the cultivation of important Mushroom
4. To learn about the nutritional value of Mushroom
5. To study the Economics of mushroom cultivation

Course Out Comes

1. After studying unit-1, the student will be able to differentiate edible and non edible mushroom
2. After studying unit-2, the student will be able to describe spawn preparation
3. After studying unit-3, the student will be able to explain the process of cultivation of important Mushroom
4. After studying unit-4, the student will be able to appreciate the nutritional value of Mushroom
5. After studying unit-5, the student will be able to apply the Economic concept of mushroom cultivation

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Introduction **Teaching Hours: 9**

History of Mushroom Cultivation- Morphology and life Cycle of Mushroom - Edible and Non-Edible Mushroom (Most commonly cultivated Mushrooms in the World, Distribution and Production in various Countries).

Unit II: Spawn **Teaching Hours: 9**

Types Spawn, Preparation of Spawn, Mushroom Bed Preparation and factors affecting Mushroom bed preparation, Compost: Materials used for Compost preparation , Compost Technology in Mushroom production- Casing; Raw material used for casing, preparation of Casing Material. Important Sanitation during various stages of Mushroom cultivation.

Unit III: Cultivation of important Mushroom **Teaching Hours: 9**

General process for the cultivation of *Agaricus bisporus* (White button Mushroom), *Pleurotus flabelltus* (Oyster Mushroom), *Volvariella volvaceae* (Paddy Straw Mushroom).

Unit IV: Mushroom nutritional value **Teaching Hours: 9**

Mushroom nutritional value; (Proteins, Amino acids, Vitamins, Minerals , Carbohydrates) - Pests and diseases of Edible Mushrooms (Environmental, Fungal, Bacterial, Viral, Insect Pests and Nematode diseases and competitor Moulds.

Unit V: Economics of mushroom cultivation **Teaching Hours: 9**

Economics of mushroom cultivation (fixed assets, recurring expenditure, labour, economics of cultivation throughout the year and seasonal growing formulation of project report for getting finance from funding agencies). Precautions in mushroom cultivation (precaution to be taken while selecting the area, spawn preparation, spawn run, during cropping harvesting etc.). Mushroom recipes (Western and Indian recipes, pickles, powders, jams etc)

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Mushroom production and processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
2. Mushroom- the art of cultivation, Harander Sing (1991). Sterling Publishers.

Reference Books

1. Biology and conservation of mushroom, Kaul T N (2001). Oxford and IBH Publishing Company, New Delhi.
2. Changs. T.W.A. Hanyanes 1978. "Biology and cultivation of Mushrooms" Acad press. N.Y.
3. Zadrazil. F & K. Grabbe 1983 "Edible Mushroom, Biotechnology" Vol. 3, Weinheim: verlag Chemie, Berlin.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	S	M	S	M	S
CO2	M	S	M	S	M	S	S	S	S	M
CO3	S	M	S	M	S	S	M	S	S	S
CO4	S	S	S	S	M	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low

Semester: II Paper type: Elective

Paper code:

Name of the Paper: B. BIOFERTILIZER TECHNOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To study the microorganisms used as biofertilizers

2. To learn about Biofertilization processes

3. To know about Nitrogenous Biofertilizers

4. To study the role of Cyanobacteria in biofertilizer

5. To learn the Mycorrhizae as biofertilizer

Course Out Comes

1. After studying unit-1, the student will be able to characterize the microorganisms used as biofertilizers

2. After studying unit-2, the student will be able to describe Biofertilization processes

3. After studying unit-3, the student will be able to elaborate on Nitrogenous Biofertilizers

4. After studying unit-4, the student will be able to appreciate role of Cyanobacteria in biofertilizer

5. After studying unit-5, the student will be able to describe the role of Mycorrhizae as biofertilizer

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Teaching Hours: 9

Introduction to biofertilizers - Characteristic features of the following biofertilizer organisms: Bacteria: *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia.*

Cyanobacteria: *Anabaena, Nostoc, Hapalosiphon*. Fungi: *Glomus, Gigaspora, Sclerocystis, Amanita, Laccaria*. Biofertilizers - Storage, shelf life, quality control and marketing; Advantages over chemical fertilizers.

Unit II: **Teaching Hours: 9**

Biofertilization processes - Decomposition of organic matter; soil fertility, vermicomposting. Mechanism of phosphate solubilization and phosphate mobilization. Nitrogen fixation - Free living and symbiotic nitrogen fixation. Biotechnological application in nitrogen fixation.

Unit III: **Teaching Hours: 9**

Nitrogenous Biofertilizers - Bacteria – Isolation, purification, mass multiplication, formulation of inoculums and application of inoculants of *Azospirillum* and *Azotobacter*; *Rhizobium* - Isolation, purification, mass multiplication, inoculum production, methods of application of *Rhizobium* inoculants.

Unit IV: **Teaching Hours: 9**

Isolation and purification of Cyanobacteria. Mass multiplication of cyanobacterial bioinoculants - Trough or Tank method, Pit method, Field method; methods of application of cyanobacterial inoculum. *Azolla* - mass cultivation and application in rice fields.

Unit V: **Teaching Hours: 9**

Mycorrhizae - Ecto and endomycorrhizae and their importance in agriculture. Isolation of AM fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications. Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer (*Pseudomonas striata*).

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N. Saxena. 1990. Biofertilizers, ScientificPublishers - Jodhpur.
2. Tilak, K.V.B. 1991. Bacterial Biofertilizers, ICAR Pub., New Delhi.

Reference Books

1. Purohit, S.S., P.R. Kothari and S.K. Mathur, 1993. Basic and Agricultural Biotechnology,Agro Botanical Pub. India.
2. Bagyaraj, D.J. and A. Manjunath. 1990. Mycorrhizal symbiosis and plant growth, Univ. ofAgricultural Sciences, Bangalore, India.
3. Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan Primlani forOxford and IBH Pub. Co. (P) Ltd., India.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	M	S	M	M	S	S	S	S
CO3	S	M	S	M	S	S	M	S	S	M
CO4	S	M	S	S	S	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Elective

Paper code:

Name of the Paper: C. INTELLECTUAL PROPERTY RIGHTS

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about IPR and its need
2. To get insight about Copyright
3. To deliver extensive knowledge on Patents and Elements of Patentability
4. To offer comprehensive information on Traditional Knowledge
5. To impart knowledge about Patenting of Biotechnological and Pharmaceutical products

Course Out Comes

1. After studying unit-1, the student will be able to emphasize the importance of IPR
2. After studying unit-2, the student will be able to understand the Nature of Copyright
3. After studying unit-3, the student will be able to explain the concept of Patents and Elements of Patentability
4. After studying unit-4, the student will be able to understand importance of Traditional Knowledge
5. After studying unit-5, the student will be able to apply the knowledge for Patenting Biotechnological and Pharmaceutical products

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Introduction and the need for IPR **Teaching Hours: 9**

Introduction Concept and Origin of Industrial Designs – Introduction- evolution – Legal protection - Layout Designs – Integrated circuits – Utility Models – Protection of Industrial Designs. Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.

Unit II: Nature of Copyright **Teaching Hours: 9**

Nature of Copyright - Subject matter of copyright- Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

Unit III: Patents - Elements of Patentability **Teaching Hours: 9**

Patents - Elements of Patentability: Novelty, Non Obviousness, Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademark.

Unit IV: Traditional Knowledge **Teaching Hours: 9**

Introduction Meaning and Scope of traditional Knowledge – Interface between IP and traditional Knowledge – Need and Significance of protection - Documentation of Traditional Knowledge – Databases – Traditional Knowledge Digital Library "TKDL" – AYUSH Systems of Medicines – Biodiversity Register. Statutory Protection of Traditional knowledge in India Traditional Knowledge as Property – Nature of Property in genetic Resources and associated traditional Knowledge - Ownership in Traditional Knowledge.

Unit V: Patenting of Biotechnological and Pharmaceutical products **Teaching Hours: 9**

Introduction - Protection of Biological Inventions – Plant Patent Protection in India. Plant Varieties Protection of Plant Varieties and Farmer's rights – GM Corps – Objectives of Plant Varieties Act – registration of Plant Varieties – Duration and effect of Registration – Infringement – Offences – Remedies – Biotech Patents in India - Research and Development in Biotechnology – NCE – Vaccine – Antibodies – GM.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited

Reference Books

1. IPR, Biosafety and Bioethics. By Deepa Goel, Shomini Parashar.2013. Pearson.
2. Ahuja, V. K. , Law of Copyright and Neighbouring Rights, (2007), New Delhi, Lexis Nexis
3. Pradeep S. Mehta (ed.), Towards Functional Competition Policy for India, Academic Foundation, (2005)

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	M	S	S	S	M	M
CO2	M	S	M	S	S	S	S	S	S	M
CO3	S	M	S	M	S	S	M	S	S	M
CO4	S	S	S	S	M	S	M	M	S	S
CO5	S	M	M	S	S	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Open Elective

Paper code:

Name of the Paper: A. FOOD PROCESSING TECHNOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To understand the principles of food preservation and processing
2. To obtain knowledge about preservation of food at various temperatures
3. To acquire knowledge about food preservation by radiation
4. To comprehend government regulations and policies on food control
5. To gain knowledge about processed foods

Course Out Comes

1. After studying unit-1, the student will be able to explain the methods of Preservation and processing of food

2. After studying unit-2, the student will be able to narrate the Effect of Freezing and drying on Foods

3. After studying unit-3, the student will be able to appreciate Irradiation of food

4. After studying unit-4, the student will be able to describe the process of Packaging of foods

5. After studying unit-5, the student will be able to employ Material handling in food industry

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Preservation and processing of food Teaching Hours: 9

Aim and objective, classification of foods by case of food spoilage- methods of food preservation – principles of food preservation- Asepsis – removal of microorganisms – maintenance of anaerobic conditions.

Unit II: Effect of Freezing and drying on Foods Teaching Hours: 9

Cold preservation – Freezing: requirements of refrigerated storage - controlled low temperature, air circulation and humidity, changes in food during refrigerated storage, progressive freezing, changes during freezing - Dehydration- Normal drying curve, effect of food properties on dehydration, change in food during drying, drying methods and equipments.

Unit III: Irradiation of food **Teaching Hours: 9**

Food Irradiation and Microwave Heating. Ionizing radiation and sources, unit of radiations, direct and indirect radiation effects, safety and wholesomeness of irradiated food. Microwave heating and application.

Unit IV: Packaging of foods **Teaching Hours: 9**

Properties of packaging material, factors determining the packaging requirements of various foods and brief description of packaging of frozen products, dried products, fats and oils and thermally processed foods.

Unit V: Material handling in food industry **Teaching Hours: 9**

Material handling. Elementary concept of material handling in food industry, equipment and functioning of belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor. Thermal processing: Introduction, classification of Thermal Processes, Principles of thermal processing, Thermal resistance of microorganisms, Thermal Death Time, Lethality concept.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Frazier, W. C. and D.C, Westhoff, Food Microbiology, 1988 (4th Edition), Tata McGraw HillPublishing Company Ltd., New Delhi.
2. James, M.J., Modern Food Microbiology, 2007 (2nd Edition), CBS Publishers and Distributors,New Delhi.

Reference Books

1. Adams, M.R., and Moss, M.G., Food Microbiology, 2005 (1st Edition), New Age International
(P) Ltd., New Delhi.
2. Banwant, G. J, Basic Food Microbiology, 2002 (2nd Edition) Chapman and Hall Inc., NewYork
3. Fellows, P., Food Processing Technology: Principles and Practice, (2nd Edition), WoodheadPublishing Limited and CRC Press LLC, England.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	S
CO3	S	M	S	M	S	M	M	S	M	M
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Open Elective

Paper code:

Name of the Paper: B. INFECTIOUS DISEASES AND ITS CONTROL

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To study the basic concepts of health

2. To learn about the diseases transmitted by air and vectors

3. To learn about the diseases transmitted by food and water

4. To learn about the diseases transmitted by animals

5. To know the ways of disease prevention by antibiotics and vaccines

Course Out Comes

1. After studying unit-1, the student will be able to comprehend basic concepts of health

2. After studying unit-2, the student will be able to emphasize the prevention of diseases transmitted by air and vectors

3. After studying unit-3, the student will be able to emphasize the prevention of diseases transmitted by food and water

4. After studying unit-4, the student will be able to plan the prevention of diseases transmitted by animals

5. After studying unit-5, the student will be able to appreciate the ways of disease prevention by antibiotics and vaccines

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Health **Teaching Hours: 9**

Disease – Definition, Infectious Vs Noninfectious; Pathogens – concept of pathogens, Microorganisms as pathogens; Transmission – Types, Factors; Primary infection Vs Secondary infection; Epidemic, Endemic and Pandemic.

Unit II: Diseases **Teaching Hours: 9**

Occupational Diseases - examples, pathogens – source; **Airborne diseases -** examples, pathogens – source; **Vectorborne diseases -** examples, Vectors, pathogens.

Unit III: Diseases **Teaching Hours: 9**

Foodborne diseases – examples, pathogens – source and contamination; Food hygiene; Foodborne infection, Food poisoning. **Waterborne diseases** – examples, pathogens – source and contamination; Water quality.

Unit IV: Diseases **Teaching Hours: 9**

Zoonotic Diseases – examples (Rabies, Anthrax), pathogens – source. **Sexually Transmitted infections -** examples, pathogens involved.

Unit V: Treatment **Teaching Hours: 9**

Antibiotics, Antibacterial, Antifungal, Antiviral agents - **Prevention and Control of Diseases**; Immunization – Immunity, Immune system, Vaccines – types, examples, vaccination schedule; Personal hygiene, Healthy foods.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Ananthanarayan R & Paniker C.K.J. (2013). Text Book of Microbiology, 9th edition,Universities Press, Hyderabad.
2. Monica Cheesbrough (2003). District Laboratory Practice in Tropical Countries. Part 1 & 2,Cambridge University Press.

Reference Books

1. Jawetz, Melnick, &Adelberg's. (2013). Medical Microbiology. 26th edition. McGraw-Hill,New York.
2. Murray. P.R., G.S, Kobyashi, M.A. Pfaller and K. S. Rosenthal, Medical Microbiology, 1993,(2nd Edition), Mosby St. Louis.
3. Brooks, G.F., Janet S. Butel, Stephen A, Jawetz, Melnick & Adlerberg's MedicalMicrobiology, 21st Edition, Prentice Hall International Inc. 1998.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	M	S	S	S	S	S	S	S
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	M	S	S	S	S	S	S	S	S
CO5	S	M	S	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Open Elective

Paper code:

Name of the Paper: C. MICROBIAL ECOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To study the basic concepts of Microbial ecology

2. To study the Microbial diversity in Normal environments

3. To study the Microbial diversity in extreme environments

4. To understand the Microbial Degradation of pollutants

5. To study the Marine Microbial Interactions

Course Out Comes

1. After studying unit-1, the student will be able to comprehend the basic concepts of Microbial ecology

2. After studying unit-2, the student will be able to explain the Microbial diversity in Normal environments

3. After studying unit-3, the student will be able to explain the Microbial diversity in extreme environments

4. After studying unit-4, the student will be able to decipher the Microbial Degradation of pollutants

5. After studying unit-5, the student will be able to appreciate the Interactions among Marine Microbes

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Microbial ecology **Teaching Hours: 9**

Basic concepts, Types, microbial habitats and factors affecting microbial populations; Microbial interactions - competition, commensalism, mutualism, synergism and Parasitism. Population Ecology: Characteristics of population, Population growth curves ((r and k selection) and population regulations.

Unit II: Microbial diversity in Normal environments **Teaching Hours: 9**

Terrestrial (agricultural and desert soils), aquatic (fresh water and marine), atmospheric (stratosphere) and animal (cattle, termites).

Unit III: Microbial diversity in extreme environments **Teaching Hours: 9**

Oligotrophs, thermophiles, psychrophiles, barophiles, organic solvent and radiation tolerant, metallophiles.

Unit IV: Microbial Degradation **Teaching Hours: 9**

Bioaccumulation, Bio-magnification, Biodegradation of biopolymers (polyhydroxy alkanoates), Hydrocarbons (alkanes), Halogenated and sulfonated compounds. Pesticides degradation and recent advancement in treating pesticide residues.

Unit V: Marine Microbial Interactions **Teaching Hours: 9**

Microorganisms responsible for bioluminescence in marine environment; Microbial indicators of marine pollution and control; Biofouling, biocorrosion, biofilms, biodegradation and bioremediation in marine environment; use of genetically engineered microorganisms in biodegradation.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, RedwoodCity, CA, 1993. 8. Norris et al., 1994, Handbook of Bioremediation, Lewis Publishers, London.
2. Jogdand, S.N.2010. Environmental Biotechnology (Industrial Pollution Management),Himalaya Publishing House, New Delhi.

Reference Books

1. Chatterji, A.K. 2005.Introductionto Environmental Biotechnology.
2. Environmental Microbiology by R. Mitchel (2nd edition), Wiley-Blackwell, 2009.
3. Environmental Microbiology by Raina Maier, Ian Pepper, & Charles Gerba, Academic Press,2008.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	M	S	M	S	S	S	S	S
CO3	S	M	S	M	S	S	M	S	S	M
CO4	S	M	S	S	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: II Paper type: Practical

Paper code:

Name of the Paper: LAB COURSE - 2

Credit: 5

Total Hours per Week: 8 Lecture Hours: Nil Tutorial Hours: Nil Practical Hours: 120

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Course Objectives

1. To isolate pathogens from clinical specimens and perform Antibiotic sensitivity tests
2. To carry out fermentations
3. To screen and isolate enzyme producing bacteria
4. To isolate DNA and RNA from bacteria
5. To quantify DNA, RNA and proteins using various techniques

Course Out Comes

After completing the experiments, the student will be able to

1. isolate pathogens from clinical specimens and perform Antibiotic sensitivity tests
2. carry out industrial fermentations
3. isolate enzyme producing bacteria
4. isolate DNA and RNA
5. quantify DNA, RNA and proteins

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Medical Bacteriology

Antibiotic sensitivity tests - disc method, MICStudy of normal microflora of skin
Collection and processing of – sputum, urine, faeces, pus, blood - and isolation of pathogens Acid

fast staining
Metachromatic granular staining

Medical Mycology Fungal slide cultureGerm tube testing

Industrial Microbiology
Production of Ethanol by Yeast.
Isolation of amylase producing microorganisms
Isolation of protease producing microorganisms
Isolation of lipase producing microorganisms
Production of wine from grape juice

Molecular Biology
Isolation of Genomic DNA and quantification
Isolation of Plasmid and quantification Preparation of competent cells using $CaCl_2$.
Isolation of RNA and quantification.
Preparation of standard buffers and determination of pH of a solution
Quantitative estimation of protein by Biuret method
Quantitative estimation of protein by Lowry's method
Estimation of amino acids by ninhydrin method.
Absorption spectra- UV-Visible
Paper Chromatography of amino acidsSDS Gel electrophoresis
Agarose Gel electrophoresisPCR technique

Internal Assessment Methods:

- Regularity in lab course
- Performance assessment in each eaxperiment
- Submission of Observation report

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	M	M
CO2	M	S	M	S	S	S	S	S	S	S
CO3	S	M	S	M	S	S	M	S	M	M
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: III Paper type: Core

Paper code:

Name of the Paper: MEDICAL VIROLOGY AND PARASITOLOGY

Credit: 5

Total Hours per Week: 5 Lecture Hours: 75 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To introduce the basic concepts of virology

2. To study viral diseases of human beings

3. To study the pathogenic parasites

4. To learn the treatment and control of viral diseases

5. To learn the treatment and control of parasitic diseases

Course Out Comes

1. After studying unit-1, the student will be able to describe the characteristics of viruses

2. After studying unit-2, the student will be able to explain viral diseases and their clinical manifestaion

3. After studying unit-3, the student will be able to explain the diseases caused by parasites

4. After studying unit-4, the student will be able to plan strategies for the control of viral diseases

5. After studying unit-5, the student will be able to plan strategies for the control of parasitic diseases

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit – 1 - INTRODUCTION TO VIROLOGY **Teaching Hours: 15**

Brief outline on discovery of Viruses - Nomenclature, Classification of Viruses - Distinctive properties of Viruses, Morphology & Structure. Detection of viruses and antigens in clinical

specimens - Serological diagnosis of virus infections - Cultivation of viruses- Maintenance and handling of laboratory animals and requirements of virological laboratory.

Unit – 2 - VIRAL DISEASE AND ITS CLINICAL FEATURES Teaching Hours: 15

Viruses of importance to bacteria - Bacteriophages - Their structure, types - Uses in Microbiology. Epidemiology, Life cycle, Pathogenicity, diagnosis, prevention and treatment of DNA Viruses. Pox virus – Variola, Vaccinia, Herpes Simplex Virus – Varicella Zoaster virus, Adeno virus, Hepatitis virus – A, B & C, Cytomegalo virus, Epstein Barr virus– Papilloma virus. Epidemiology, life cycle, Pathogenicity, diagnosis, prevention and treatment of RNA Viruses. Picorna viruses – Polio virus, Orthomyxo virus – Influenza virus (H1NI1), Paramyxo viruses – Mumps virus, Measles virus, Rhabdo viruses - Rabies virus, Retro virus – HIV – Yellow fever virus, newly emerging viral disease –Ebola & Zika virus.

Unit – 3 - CLASSIFICATION AND PATHOGENESIS OF PARASITES Teaching Hours: 15

Introduction and classification of parasites - Laboratory diagnostic techniques in Parasitology - Epidemiology, Life cycle, Pathogenicity, diagnosis and treatment of Amoebiasis, Giardiasis, Balantidiosis, Trypanosomiasis, Malaria, Toxoplasmosis - Leishmaniasis. - Helminthic Infections - Taenia solium, T. Saginata, Echinococcus granulosus, Fasciola hepatica, Paragonimus westermani and Schistosomes - Ascaris lumbricoids, Ancylostoma duodenale, Trichuris triuchura - Enterobius vermicularis and Wuchereria bancrofti.

Unit – 4 - TREATMENT OF VIRAL DISEASES AND INFECTIONS Teaching Hours: 15

Viruses of importance to plants and soil - Viral vaccines, their preparation and their immunization schedules - Antiviral and Viral Vaccines - Conventional vaccines, killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines. Modern approaches of virus control.

Unit – 5 - TREATMENT AND DIAGNOSTIC METHODS OF PARASITES Teaching Hours: 15

Control of Parasites - Biotechnological approaches to disease control and vaccine production. Prevention of parasitic infections - drugs and antibiotics - drug resistance. Detection and recovery of parasites from clinical specimens- Laboratory diagnostic techniques in Parasitology - Examination of Faeces, cultivation, Direct and concentration methods.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books:

1. Parija, S.C. (1996). Textbook of Medical Parasitology. Orient Longman.

2. Dimmock N.J., Primrose S.B. (1994). Introduction to Modern Virology 4th Edition. Blackwell Scientific Publications. Oxford.
3. Ananthanarayanan R. and Jayaram Panicker C.K. (1994). Text book of Microbiology. Orient Longman.

Reference Books:

1. Chatterjee, K.D. Parasitology, M.D. 12th Edition. Chatter (1980) Joe media Publishers Culcutta.
2. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.
3. Rajesh Karykarte and Ajit Damle (2003). Medical Parasitology, 3rd Edition. Books and Allied (P) Ltd, Kolkatha.
4. Morag C. and Timbury M.C. (1994). Medical Virology, 10th Edition. Churchil Livingston London.
5. Brooks, G.F., Janet S. Butel, Stephen A, Jawetz, Melnick & Adlerberg's Medical Microbiology, 21st Edition, Prentice Hall International Inc. 1998.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	S	S	M	S	S	M	S	S
CO3	S	M	S	M	S	M	M	S	M	M
CO4	S	M	S	S	S	S	S	M	M	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: III Paper type: Core

Paper code:

Name of the Paper: AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY

Credit: 4

Total Hours per Week: 5 Lecture Hours: 75 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To study the characteristics of soil microorganisms and the interactions between them

2. To study the importance of bio-geo chemical cycles

3. To study diseases of plants caused by microorganisms

4. To learn about microbial life in aquatic environments

5. To learn about microbial treatment of waste water

Course Out Comes

1. After studying unit-1, the student will be able to know the diverse group of soil microorganisms

2. After studying unit-2, the student will be able to understand the nutrient sources and cycles

3. After studying unit-3, the student will be able to know the concept of disease, causal agent, identification methods and management

4. After studying unit-4, the student will be able to understand microbial life in aquatic environments

5. After studying unit-5, the student will be able to apply microbial treatment of waste water

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I: SOIL MICROBIOLOGY **Teaching Hours: 15**

Physical and chemical characteristics and classification of soils; soils microorganisms: Interactions between microorganism – symbiosis, mutalism, commensalism, competition, amensalism, synergism, parasitism, predation. Interaction of micros with plants Rhizospere ,Phyllosphere.

UNIT-II: BIOGEOCHEMICAL CYCLE AND BIO FERTILIZERS Teaching Hours: 15

MajorBiogeochemical cycle - carbon cycle - role of microbes in carbon cycle - trophic relationships - mobilization and immobilizations of carbon with rhizosphere. Nitrogen cycle - mechanism of biological nitrogen fixation - ammonification - nitrification - denitrificatioin and microorganisms involved in such processes. Phosphorous cycle and sulphur cycle. Bio fertilizer – symbiotic nitrogen fixation (Azolla, BGA, Rhizobium, Frankia) Non –symbiotic (Azotobacter, Azospirillum) Phosphate solubilizers,VA Mycorrhizae- Isolation, mass production methods - applications methods of bio fertilizers - significance of bio fertilizers.

UNIT III: PLANT PATHOGENS Teaching Hours: 15

Plant pathogens and classification and plant diseases. Symptoms, Etiology, Epidemiology and management of the following plant diseases: Mosaic disease of tobacco; Bunchy top of banana; Leaf roll of potato; Bacterial blight of paddy; Angular leaf spot of cotton, Late blight of potato; Damping off of tobacco, Downy mildew of bajra; Powdery mildew of cucurbits; Head smut of sorghum; Leaf rust of coffee; Blight of maize/sorghum; Leaf spot of paddy, Grassy shoot of sugar cane; Root knot of mulberry.

UNIT-IV: MICROBIOLGY OF AIR AND AQUATIC MICROBIOLOGY Teaching Hours: 15

Microbiology of air : distribution and source of air borne organisms aerosol – Droplet nuclei - Assessment of air quality , air sanitation – some important - Airborne diseases caused by Bactria, fungi , viruses their symptoms and preventive measures , aquatic microbiology : ecosystems – fresh water (ponds, lakes, streams, marine, estuaries, mangroves, deep sea) water zonation – eutrophication, water borne diseases.

UNIT-V: MICROBIAL TREATMENT OF WASTE WATER Teaching Hours: 15

Potable water; Assessment of microbiological quality of water. Waste treatment;Types of wastes, characterization of solid and liquid waste – waste treatment and useful by products , Solid waste treatment - saccarification– gasification – composting. Liquid waste treatment – aerobic and anaerobic methods.Organic matter decomposition

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books:

1. Atlas, R.M. and Bartha R. 1992. Microbial ecology; Fundamental and applications. Second Edition Redwood city. CA. Benjamin/Cummings.
2. Joseph C. Daniel (1999) Environmental Aspects of Microbiology, Bright Sun publications , Chennai.
3. Ramanathan, and Muthukaruppan SM (2005) Environmental Microbiology. Om SakthiPathipagam, Annamalai Nagar.

Reference Books:

1. Dirk J, Elas V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York.
2. Grant WD, Long PL. (1981) Environmental Microbiology. Blackie Glasgow and London.
3. Fletcher, M. and Gray, T.R.G. (1987). Ecology of Microbial communities. Cambridge University Press, Cambridge, UK.
4. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York.
5. Marshall, K.C. (1985) Advances in Microbial Ecology, Vol.8, Plenum Press, U.K.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	M	S	M	S	S	M	S	M
CO3	S	M	S	M	S	S	M	S	M	M
CO4	S	M	S	M	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: III Paper type: Core

Paper code:

Name of the Paper: BIOTECHNOLOGY

Credit: 4

Total Hours per Week: 4 Lecture Hours: 60 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about the range of approaches in plant genetic engineering and production of transgenic plants and its applications.
2. To get insight about gene transfer technology in animals and applications of Animal biotechnology.
3. To deliver extensive knowledge on Medical Biotechnology.
4. To impart knowledge about bioremediation and its significance in the Environmental biotechnology.
5. To offer comprehensive information and insights in pharmaceutical biotechnology and drug designing.

Course Out Comes

1. After studying unit-1, the student will be able to appreciate plant genetic engineering and production of transgenic plants
2. After studying unit-2, the student will be able to describe various gene transfer technologies in animals
3. After studying unit-3, the student will be able to elaborate on Medical Biotechnology
4. After studying unit-4, the student will be able to appreciate the role of microorganisms in bioremediation
5. After studying unit-5, the student will be able to describe the role of microorganisms in pharmaceutical biotechnology

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit-1: Plant Biotechnology **Teaching Hours: 12**

Plant Genetic Engineering and Production of Transgenic Plants - Transformation of plant cells; Modes of gene delivery in plants - Particle bombardment, electroporation, microinjection, Agrobacterium mediated gene transfer; Plant Tissue Culture; Screening and selection of transformants - PCR and hybridization methods; Potential applications of plant genetic

engineering for crop improvement - insect-pest resistance, abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality; Bt cotton, Golden rice.

Unit-2: Animal Biotechnology **Teaching Hours: 12**

Gene transfer technology in animals: Viral and non-viral methods - Retroviral, Microinjection, Embryonic stem cells methods; IVF technology for livestock improvement; Animal tissue culture; Transgenic animals -Transgenic cattle, Transgenic sheep and goats, Transgenic fish; Applications of animal Biotechnology - Improvement of biomass, disease resistance, recombinant vaccines for poultry.

Unit-3: Medical Biotechnology **Teaching Hours: 12**

Gene Therapy - Approaches for gene therapy, Ex-Vivo vectors - Human Artificial chromosome and Bone marrow cells – Therapy for Adenosine deaminase (ADA); In vivo – viral and non-viral systems; Gene therapy for AIDS and Cancer; DNA in Disease diagnosis – Infectious and Genetic diseases; Recombinant vaccines and their types - subunit vaccine, attenuated recombinant vaccines, vector recombinant vaccines; Stem cell therapy.

Unit-4: Environmental Biotechnology **Teaching Hours: 12**

Bioaccumulation; Biomagnification; Biodegradation of hydrocarbons, pesticides, herbicides and Xenobiotic compounds; Bioaugmentation; Bioremediation and its types - in situ & ex-situ bioremediation;; Bioremediation of contaminated soil and ground water; Genetically Engineered Microorganisms (GEMs) in bioremediation; Microbial Enhanced Oil Recovery (MEOR); Bioleaching – Copper and Uranium leaching; Biosurfactants, Biofuels and Bioplastics.

Unit-5: Pharmaceutical Biotechnology **Teaching Hours: 12**

Drug Designing and Development - Current Trends in Drug Development, Drug designing-Rational, combinatorial and High Throughput screening. Clinical trials; Drug Delivery Systems – Types, Nanoparticles used in drug delivery system; Pharmaceutical products produced by mammalian cells – tissue plasminogen activator, interferons, erythropoietin, blood clotting factors. Clinical Research - Past, Present and Future.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Dubey R.C (2005). A Text of Biotechnology. Multicolour Illustrative edition, S.Chand and Company Ltd., New Delhi.
2. Bernad R Glick and Pasternak, J.J (2003). Molecular Biotechnology - Principles and Applications of Recombinant DNA.3rd edition, ASM Press, Washington, D.C.
3. Satyanarayana U (2005). Biotechnology. 1st edition, Books and Allied (P) Ltd., Kolkata.

Reference Books

1. Singh. B.D., Plant Biotechnology. Kalyani Publishers, 3rd Edition, 2015.
2. M.M. Ranga., Animal Biotechnology, Agrobios, India, 2000.
3. K Sambamurthy and Ashutosh Kar., Pharmaceutical Biotechnology, New age International Publishers, New Delhi, 2006.
4. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008.
5. Geetha Bali et al eds., Environmental Biotechnology, ApS Pub., 2001.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	M	S	S	M
CO2	M	S	M	S	S	S	S	S	M	S
CO3	S	M	S	M	S	S	M	S	M	M
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: III Paper type: Elective

Paper code:

Name of the Paper: A. BIOREMEDIATION

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about the approaches in bioremediation
2. To get insight about bioaccumulation and biomagnification processes
3. To learn about use of genetically engineered microorganism and bioremediation
4. To impart knowledge about phyto-remediation
5. To offer comprehensive information on phyto-extraction

Course Out Comes

1. After studying unit-1, the student will be able to list out the diverse group of microorganisms involved in bioremediation
2. After studying unit-2, the student will be able to explain the consequences of Bioaccumulation and biomagnification processes
3. After studying unit-3, the student will be able to appreciate the use of use of genetically engineered microorganism in bioremediation
4. After studying unit-4, the student will be able to describe phyto-remediation
5. After studying unit-5, the student will be able to apply phyto-extraction

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Overview of Bioremediation **Teaching Hours: 9**

Definition of Bioremediation - Types of pollutants - organic, inorganic in soil, water and air - Remediation by bacteria, fungi, microalgae and green plants.

Unit II: Natural attenuation **Teaching Hours: 9**

Bioaccumulation and biomagnification processes - microbial remediation by natural attenuation - biostimulation - bioaugmentation.

Unit III: Application of genetically engineered microbes **Teaching Hours: 9**

Application of immobilized microbes in soil decontamination - use of genetically engineered microorganism and bioremediation.

Unit IV: Phytoremediation **Teaching Hours: 9**

Biodegradation of organic compounds - humification and polymerization reaction - bio-transformation of metal and metal compounds - phytoremediation use of microalgae, green plants to remove pollutants.

Unit V: Phytoextraction **Teaching Hours: 9**

Continuous phyto-extraction - phyto-degradation - rhizofiltration - phyto-stabilisation - phyto-volatisation of metals - phyto-remediation of organic; Bioavailability and uptake; Biotransformation and compartmentalisation.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books:

1. Bioremediation: Principles and Applications. Editors: Don L. Crawford, Ronald L. Crawford. 1996. Cambridge.
2. Approaches in Bioremediation: The New Era of Environmental Microbiology and Nanobiotechnology. Edited by Ram Prasad, Elisabet Aranda. 2018. Springer.

Reference Books:

1. Wainwright, M. 1999. An introduction to environmental biotechnology. Boston, Mass. Klumer Academic Publishers.
2. Environmental Pollutants and Their Bioremediation Approaches. 2017. Ed. by R.N. Bharagava. CRC Press.
3. Bioremediation: Applied Microbial Solutions for Real–World Environmental Cleanup. Ed. by Ronald M. Atlas, Terry Hazen, James Philp. 2005. American Society for Microbiology.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	M	S	S	M
CO2	M	S	M	M	M	S	S	S	S	S
CO3	S	M	S	S	S	M	M	S	S	S
CO4	S	M	S	S	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low

Semester: III Paper type: Elective

Paper code:

Name of the Paper: B. RESEARCH METHODOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn the basic methods of research methodology
2. To get familiar with Components of a Research Report
3. To study about Measures of central tendency
4. To impart knowledge about Correlation analysis
5. To offer comprehensive information on Sampling theory

Course Out Comes

1. After studying unit-1, the student will be able to collect literature and design experiments
2. After studying unit-2, the student will be able to write research report
3. After studying unit-3, the student will be able to measure central tendency
4. After studying unit-4, the student will be able to perform Correlation analysis
5. After studying unit-5, the student will be able to apply Sampling theory

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Research **Teaching Hours: 9**

Definition – Literature Collection – Literature Citation – Experimental designs - Major search engines - Major Websites, book and scientific information - Identification, Selection and formulation of research problem – Research questions – Research Ethics

Unit II: Research Report **Teaching Hours: 9**

Components of a Research Report – Authors and Addresses – Abstract – Synopsis – Key words – Introduction – Materials and Methods – Results – Discussion – Acknowledgements – Summary and Conclusions – Appendices – References - Title – Tables – Figures – Formatting and Typing- Plagiarism.

Unit III: Collection of data **Teaching Hours: 9**

Primary data and Secondary data – meaning – Data collection methods – Relevances – Limitations and cautions. Measures of central tendency: Arithmetic Mean, Median, Mode,

Geometric Mean and Harmonic Mean. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation and Coefficient of Variation.

Unit IV: Correlation analysis **Teaching Hours: 9**

Karl Pearson's, Spearman's rank and Concurrent deviation methods. Regression Analysis: Simple regression equations.

Unit V: Sampling theory **Teaching Hours: 9**

Types of sampling – Sampling and non sampling error and Advantages and disadvantages in sampling – probability and non-probability sampling methods- Concept of Sampling distributions – Standard Error.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books:

1. Statistical Methods. (32nd edition - 2004), Gupta. S. P., Sultan Chand & Sons, New Delhi.
2. Dr. N. Gurumani, Research Methodology: For Biological Sciences, 2006, MJP Publishers.
3. Dr. N. Gurumani, An Introduction to Biostatistics, 2006, 2nd Edition, MJP Publishers.

Reference Books:

1. Singh, Y. K. (2006). Fundamental of Research Methodology and Statistics. New Delhi. New International (P) Limited, Publishers
2. Y. K. Singh and R. B. Bajpai, Research Methodology Data Presentation, 2008, APH Publishing Corporation, New Delhi.
3. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	M	S	S	M
CO2	M	S	M	S	M	S	S	S	S	S
CO3	S	M	S	M	S	S	M	S	S	M
CO4	S	M	S	S	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: III Paper type: Elective

Paper code:

Name of the Paper: C. MARINE MICROBIOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To have an understanding of marine Microbial Habitats
2. To study about Marine extremophiles
3. To learn various methods of Cultivation of Marine Microbes
4. To study the Marine Pollution and Bioremediation
5. To understand Microbial Products from Sea

Course Out Comes

1. After studying unit-1, the student will be able to characterize and differentiate marine Microbial Habitats
2. After studying unit-2, the student will be able to appreciate the importance of Marine extremophiles
3. After studying unit-3, the student will be able to describe various methods of Cultivation of Marine Microbes
4. After studying unit-4, the student will be able to understand Marine Pollution and suggest Bioremediation
5. After studying unit-5, the student will be able to emphasize the use of Microbial Products from Sea

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Marine Microbial Habitats **Teaching Hours: 9**

Marine environment– shallow and deep sea, coastal, mangroves and coral environments - properties of seawater , chemical and physical factors of marine environment; Diversity of microorganisms in marine environment - Archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa.

Unit II: Marine Extremophiles **Teaching Hours: 9**

Marine extremophiles - Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles, halophiles and their importance; Significance of marine microflora - Microbial endosymbionts – epiphytes, coral-microbial association, sponge-microbial association.

Unit III: Cultivation of Marine Microbes and Nutrient cycling **Teaching Hours: 9**

Methods of studying marine microorganisms - sample collection, isolation and identification; Preservation methods of marine microbes; Nutrient cycling in Marine Environment - Role of microorganisms in carbon, nitrogen, phosphorous and sulphur cycles in the marine environment.

Unit IV: Marine Pollution and Bioremediation **Teaching Hours: 9**

Pollution in marine environment; Pathogenic microorganisms, distribution, indicator organisms, prevention and control of water pollution, quality standards; Xenobiotics, heavy metals and crude oil; Native microbial consortia and Genetically Engineered Microbes in bioremediation of polluted marine sites - Biofouling – Causes and their control.

Unit V: Microbial Products from Sea **Teaching Hours: 9**

Production and applications of marine microbial products – Carrageenan, agar-agar, sea weed fertilizers, β carotene, enzyme, antibiotics, antitumour agents, biosurfactants and pigments; Preservation methods of sea foods; Quality control and regulations for microbial quality of fishes, shellfish and Marine living resources used for food.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Colin B. Munn. Marine microbiology: Ecology and Applications. 3rd Edition. 2020. Taylor & Francis Inc.
2. B. Austin. Marine Microbiology. Cambridge University Press. 1988.

Reference Books

1. Microbial Ecology of the Oceans, Third Edition. Josep M. Gasol and David L. Kirchman (editors). John Wiley & Sons, USA. 2018.
2. The Living Ocean: Marine Microbiology. E. J. Ferguson Wood. Springer Science & Business Media. 2012.
3. Se-Kwon Kim (Editor). Marine Microbiology: Bioactive Compounds and Biotechnological Applications. Wiley-VCH Verlag GmbH. 2013.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	S	S	M	S	M	M
CO2	M	S	S	S	M	S	M	S	S	S
CO3	S	M	S	M	M	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	M	M	S	S	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: III Paper type: Open Elective

Paper code:

Name of the Paper: A. MUSHROOM CULTIVATION

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

6. To learn about the edible and non edible mushroom.
7. To know the basics of Mushroom cultivation
8. To learn about the cultivation of important Mushroom
9. To learn about the nutritional value of Mushroom
10. To study the Economics of mushroom cultivation

Course Out Comes

1. After studying unit-1, the student will be able to differentiate edible and non edible mushroom
2. After studying unit-2, the student will be able to describe spawn preparation
3. After studying unit-3, the student will be able to explain the process of cultivation of important Mushroom
4. After studying unit-4, the student will be able to appreciate the nutritional value of Mushroom
5. After studying unit-5, the student will be able to apply the Economic concept of mushroom cultivation

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Introduction **Teaching Hours: 9**

History of Mushroom Cultivation- Morphology and life Cycle of Mushroom - Edible and Non-Edible Mushroom (Most commonly cultivated Mushrooms in the World, Distribution and Production in various Countries).

Unit II: Spawn **Teaching Hours: 9**

Types Spawn, Preparation of Spawn, Mushroom Bed Preparation and factors affecting Mushroom bed preparation, Compost: Materials used for Compost preparation , Compost Technology in Mushroom production- Casing; Raw material used for casing, preparation of Casing Material. Important Sanitation during various stages of Mushroom cultivation.

Unit III: Cultivation of important Mushroom **Teaching Hours: 9**

General process for the cultivation of *Agaricus bisporus* (White button Mushroom), *Pleurotus flabelltus* (Oyster Mushroom), *Volvariella volvaceae* (Paddy Straw Mushroom).

Unit IV: Mushroom nutritional value **Teaching Hours: 9**

Mushroom nutritional value; (Proteins, Amino acids, Vitamins, Minerals , Carbohydrates) - Pests and diseases of Edible Mushrooms (Environmental, Fungal, Bacterial, Viral, Insect Pests and Nematode diseases and competitor Moulds.

Unit V: Economics of mushroom cultivation **Teaching Hours: 9**

Economics of mushroom cultivation (fixed assets, recurring expenditure, labour, economics of cultivation throughout the year and seasonal growing formulation of project report for getting finance from funding agencies). Precautions in mushroom cultivation (precaution to be taken while selecting the area, spawn preparation, spawn run, during cropping harvesting etc.). Mushroom recipes (Western and Indian recipes, pickles, powders, jams etc)

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Mushroom production and processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
2. Mushroom- the art of cultivation, Harander Sing (1991). Sterling Publishers.

Reference Books

1. Biology and conservation of mushroom, Kaul T N (2001). Oxford and IBH Publishing Company, New Delhi.
2. Changs. T.W.A. Hanyanes 1978. "Biology and cultivation of Mushrooms" Acad press. N.Y.
3. Zadrazil. F & K. Grabbe 1983 "Edible Mushroom, Biotechnology" Vol. 3, Weinheim: verlag Chemie, Berlin.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	S	M	S	M	S
CO2	M	S	M	S	M	S	S	S	S	M
CO3	S	M	S	M	S	S	M	S	S	S
CO4	S	S	S	S	M	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low

Semester: III Paper type: Open Elective

Paper code:

Name of the Paper: B. PUBLIC HEALTH MICROBIOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about common waterborne diseases
2. To get insight about common air-borne diseases
3. To learn about food borne infections
4. To impart knowledge about common vector-borne diseases
5. To offer comprehensive information common nosocomial infections

Course Out Comes

1. After studying unit-1, the student will be able to describe common waterborne diseases
2. After studying unit-2, the student will be able to understand common air-borne diseases
3. After studying unit-3, the student will be able to know the concept of food borne infections
4. After studying unit-4, the student will be able to describe common vector-borne diseases
5. After studying unit-5, the student will be able to prevent the common nosocomial infections

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: **Teaching Hours: 9**

Overview on common waterborne diseases, Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of hepatitis, cholera, typhoid, amoebiasis, giardiasis, poliomyelitis, diarrhoea (bacterial and viral).

Unit II: **Teaching Hours: 9**

Overview on common air-borne diseases, Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of pneumonia, diphtheria, tuberculosis, anthrax, influenza, measles, Coronoviruses – SARS & MERS.

Unit III: **Teaching Hours: 9**

Concept on food borne infections and food intoxication, Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of Staphylococcal, Clostridial food poisoning, salmonellosis, shigellosis and travellers' diarrhoea.

Unit IV: **Teaching Hours: 9**

Overview on common vector-borne diseases and their vectors, Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of malaria, filariasis, Dengueand swine flu .

Unit V: **Teaching Hours: 9**

Concept on common nosocomial infections, Disinfection procedures of hospital environment, equipments and materials, methods of disposal of infective hospital waste and laboratory materials, monitoring of sanitation in hospital environment.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books:

1. Ananthanarayan R &Paniker C.K.J. (2013). Text Book of Microbiology, 9th edition, Universities Press, Hyderabad.
2. Monica Cheesbrough (2003). District Laboratory Practice in Tropical Countries. Part 1 & 2, Cambridge University Press.

Reference Books:

1. Jawetz, Melnick, &Adelberg's. (2013). Medical Microbiology. 26th edition. McGraw-Hill, New York.
2. Subhash Chandra Parija (2013). Text book of Medical Parasitology. 4th edition, All India Publishers and Distributors (Medical Books Publishers), New Delhi.
3. ChatterjeeK.D (2016). Parasitology, Protozoology& Helminthology. 13th edition. Joe media Publishers. Calcutta.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	S	M	S	M	M
CO2	M	S	S	S	M	S	S	S	S	S
CO3	S	M	S	M	S	S	S	S	S	M
CO4	S	S	S	S	S	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome
S – Strong , M – Medium, L – Low

Semester: III Paper type: Open Elective

Paper code:

Name of the Paper: C. INTELLECTUAL PROPERTY RIGHTS

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about IPR and its need
2. To get insight about Copyright
3. To deliver extensive knowledge on Patents and Elements of Patentability
4. To offer comprehensive information on Traditional Knowledge
5. To impart knowledge about Patenting of Biotechnological and Pharmaceutical products

Course Out Comes

1. After studying unit-1, the student will be able to emphasize the importance of IPR
2. After studying unit-2, the student will be able to understand the Nature of Copyright
3. After studying unit-3, the student will be able to explain the concept of Patents and Elements of Patentability
4. After studying unit-4, the student will be able to understand importance of Traditional Knowledge
5. After studying unit-5, the student will be able to apply the knowledge for Patenting Biotechnological and Pharmaceutical products

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Introduction and the need for IPR **Teaching Hours: 9**

Introduction Concept and Origin of Industrial Designs – Introduction- evolution – Legal protection - Layout Designs – Integrated circuits – Utility Models – Protection of Industrial Designs. Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.

Unit II: Nature of Copyright **Teaching Hours: 9**

Nature of Copyright - Subject matter of copyright- Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

Unit III: Patents - Elements of Patentability **Teaching Hours: 9**

Patents - Elements of Patentability: Novelty, Non Obviousness, Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademark.

Unit IV: Traditional Knowledge **Teaching Hours: 9**

Introduction Meaning and Scope of traditional Knowledge – Interface between IP and traditional Knowledge – Need and Significance of protection - Documentation of Traditional Knowledge – Databases – Traditional Knowledge Digital Library "TKDL" – AYUSH Systems of Medicines – Biodiversity Register. Statutory Protection of Traditional knowledge in India Traditional Knowledge as Property – Nature of Property in genetic Resources and associated traditional Knowledge - Ownership in Traditional Knowledge.

Unit V: Patenting of Biotechnological and Pharmaceutical products **Teaching Hours: 9**

Introduction - Protection of Biological Inventions – Plant Patent Protection in India. Plant Varieties Protection of Plant Varieties and Farmer's rights – GM Corps – Objectives of Plant Varieties Act – registration of Plant Varieties – Duration and effect of Registration – Infringement – Offences – Remedies – Biotech Patents in India - Research and Development in Biotechnology – NCE – Vaccine – Antibodies – GM.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited

Reference Books

1. IPR, Biosafety and Bioethics. By Deepa Goel, Shomini Parashar.2013. Pearson.
2. Ahuja, V. K. , Law of Copyright and Neighbouring Rights, (2007), New Delhi, Lexis Nexis
3. Pradeep S. Mehta (ed.), Towards Functional Competition Policy for India, Academic Foundation, (2005)

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	M	S	S	S	M	M
CO2	M	S	M	S	S	S	S	S	S	M
CO3	S	M	S	M	S	S	M	S	S	M
CO4	S	S	S	S	M	S	M	M	S	S
CO5	S	M	M	S	S	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: III Paper type: Practical

Paper code:

Name of the Paper: Lab course - 3

Credit: 5

Total Hours per Week: 10 Lecture Hours: Nil Tutorial Hours: Nil Practical Hours: 150

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Course Objectives

1. To observe parasites in clinical specimens
2. To study viruses through indirect procedures like antigen detecting ELISA, haemagglutination
3. To isolate bacteria beneficial to plant growth
4. To demonstrate Rhizosphere effect
5. To test the quality of water

Course Out Comes

1. After studying unit-1, the student will be able to identify parasites in clinical specimens
2. After studying unit-2, the student will be able to demonstrate viruses through indirect procedures like antigen detecting ELISA, haemagglutination
3. After studying unit-3, the student will be able to isolate bacteria beneficial to plant growth
4. After studying unit-4, the student will be able to demonstrate Rhizosphere effect and microbes present in Rhizosphere
5. After studying unit-5, the student will be able to ensure the quality of water by tests

Matching Table

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

List of Experiments

Medical Parasitology

Iodine preparation of stool sample for parasites

Medical Virology

Isolation of bacteriophages from sewage
Estimation of virus yields - plaque assay
Inoculation in embryonated eggs
Haemagglutination test
Hemagglutination inhibition assay

One step growth curve of bacteriophage by Burst size determination
ELISA technique

Agricultural Microbiology
Isolation and Identification of Symbiotic Nitrogen-fixing bacteria from root nodules
Laboratory scale production of biofertilizers
Isolation of phosphate solubilizing bacteria
Demonstration of Rhizosphere effect
Staining and observation of plant pathogenic fungi

Environmental Microbiology
Assessment of water quality by MPN Test
Enumeration of bacteria in water
Enumeration of bacteria and fungi in soil

Internal Assessment Methods:

- Regularity in lab course
- Performance assessment in each experiment
- Submission of Observation report

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	S	M	S	M	S
CO2	M	S	M	S	M	S	S	S	S	M
CO3	S	M	S	M	S	M	M	S	S	S
CO4	S	M	S	S	S	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: IV Paper type: Core

Paper code:

Name of the Paper: RECOMBINANT DNA TECHNOLOGY

Credit: 5

Total Hours per Week: 5 Lecture Hours: 75 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn the basics of r-DNA technology
2. To get insight about Techniques and enzymes in genetic recombination
3. To deliver extensive knowledge on Gene Cloning
4. To impart knowledge about PCR methods and Applications
5. To offer comprehensive information on Protein engineering and Pharmaceutical products

Course Out Comes

1. After studying unit-1, the student will be able to know the diverse components in r-DNA technology
2. After studying unit-2, the student will be able to list out the Techniques and enzymes in genetic recombination
3. After studying unit-3, the student will be able to describe Gene Cloning
4. After studying unit-4, the student will be able to elaborate on PCR methods and Applications
5. After studying unit-5, the student will be able to apply Protein engineering to develop Pharmaceutical products

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I: Basics of r-DNA technology **Teaching Hours: 15**

Restriction enzymes and their role in r-DNA technology-Restriction-modification system methylase,ligase, adaptors, linkers, homopolymer tailing, E.coli-Types of restriction enzymes -Plasmid vectors as cloning vehicles-Vectors for protein over expression, protein secretion and controlled expression-Bacteriophages as cloning vehicles-λ mediated vectors-M13 phage and its use, Cosmids, Phagemids, plasmids, BACS.

Unit – II: Techniques and enzymes in genetic recombination **Teaching Hours: 15**

Core techniques and essential enzymes used in recombination: restriction endonucleases,type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNAligase: Properties and specificity, S1 nuclease, BAL 31

nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation.

UNIT-III: Gene Cloning **Teaching Hours: 15**

Purpose –Genomic Library construction-Polymerase chain Reaction (PCR)-Cloning into gram negative, gram positive bacteria and Yeast-Screening of recombinants-α complementation and blue-white selection - Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries.DNA sequencing-DNA and RNA hybridization-Southern and Northern blotting-DNA sequencing-Sangers method-Basics of pyrosequencing, next generation sequencing strategies-western blotting for proteins-Semi-quantitative and Real time PCR to quantify gene expression-Yeast two hybrid system.

Unit – IV: PCR methods and Applications **Teaching Hours: 15**

Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Differential Display PCR, RAPD fingerprinting of micro-organisms, Overlap PCR, Rolling Circle Amplification Technology.

UNIT-V: Protein engineering and Pharmaceutical products **Teaching Hours: 15**

Protein engineering and proteome analysis: Proteome analysis by 2D gel electrophoresis coupled to mass spectrometric analysis. Protein arrays and their applications. Pharmaceutical products of DNA technology: Human protein replacements – insulin, hGH and Factor VIII. Human therapies – TPA, interferon, antisense molecules. Vaccines – Hepatitis B, AIDS, and DNA vaccines. Good hygienic procedure (GHP), Good manufacturing procedure (GMP), Good laboratory procedure (GLP) and ISO-9ooo- HACCP. Transgenics and animal cloning: Creating transgenic animals and plants. Animal cloning.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Principles of Gene Manipulation and Genomics-S.B.Primrose and R.M.Twyman, 2006.John Wiley & Sons Ltd.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.
3. Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.

Reference Books

1. From Genes to Genomes: Concepts and Applications of DNA Technology, Second Edition-Jeremy.W.Dale and Malcolm Von Schantz, 2007. John Wiley & Sons Ltd.
2. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007
3. PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.
4. DNA Cloning: A Practical Approach by D.M. Glower nd B.D. Hames, IRL Press,Oxford. 1995.
5. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3rd edition; CSHL Press; 2001.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	S	S	S	M	M
CO2	M	S	M	S	M	S	S	S	S	S
CO3	S	M	S	M	S	S	S	S	S	S
CO4	S	M	S	S	S	S	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: IV Paper type: Elective

Paper code:

Name of the Paper: A. DIAGNOSTIC MICROBIOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about the Organization of clinical microbiology laboratory
2. To get insight about the collection of clinical specimens
3. To deliver extensive knowledge on Examination and processing of clinical specimens
4. To impart knowledge about Serological Methods
5. To offer comprehensive information on antimicrobial resistance

Course Out Comes

1. After studying unit-1, the student will be able to organize a clinical microbiology laboratory
2. After studying unit-2, the student will be able to collect clinical specimens
3. After studying unit-3, the student will be able to examine and process clinical specimens
4. After studying unit-4, the student will be able to understand the concept and principles of Serological Methods
5. After studying unit-5, the student will be able to apply the knowledge of antimicrobial resistance in reducing the effect

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Teaching Hours: 9

Purpose and philosophy of diagnostic microbiology – Organization of clinical microbiology laboratory - Laboratory safety: General safety considerations – biohazards and practices specific to microbiology – classification of biological agents on the basis of hazards.

Unit II: Teaching Hours: 9

Collection of clinical specimens (oral cavity, throat, skin, blood, CSF, urine and faeces) associated with bacterial, viral, fungal and protozoan diseases for diagnosis - methods of transport and storage; rejection of specimen; safe disposal of specimens.

Unit III: **Teaching Hours: 9**

Examination and processing of clinical specimens - staining - Gram stain, Ziehl – Neelson staining for tuberculosis, - LPCB for fungal identification – Giemsa stained thin blood film for malaria, Wet mount and Iodine method for parasites – Culture based techniques - isolation and identification of bacterial and fungal pathogens, Automated system for identification.

Unit IV: **Teaching Hours: 9**

Serological Methods – Agglutination based methods: WIDAL, immunofluorescence – Automated methods: ELISA (commercial kits for diagnosis); Immunodetection of microbial toxins; Nucleic acid based methods - PCR.

Unit V: **Teaching Hours: 9**

Importance and determination of antimicrobial resistance/sensitivity of bacterial and fungal pathogens - Determination using disc diffusion method, Minimal inhibitory concentration (MIC), E test; Antimycotic susceptibility testing; Reporting of results (CLSI, EUCAST); Computerization - Quality assurance.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Tille P. (2013). Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby Publishers, United States.
2. Collee J.G, Fraser, A.G, Marmion B.P and Simmons A (2007). Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier Publishers. London.

Reference Books

1. Connie Mahon and Donald Lehman (2018). Text book of Diagnostic Microbiology. 6th edition, Elsevier, United States.
2. James G Cappuccino and Natalie Sherman (2004). Microbiology: A laboratory manual. 6th edition, Published by Pearson Education, United States.

3. Brooks G.F, Carroll K.C, Butel J .S, Morse S.A and Mietzner T. A (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	M	M	M
CO2	M	S	M	S	S	S	M	S	S	M
CO3	S	M	S	M	M	S	M	S	M	S
CO4	S	M	S	S	S	S	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: IV Paper type: Elective

Paper code:

Name of the Paper: B. MICROBIAL NANOTECHNOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about bionanotechnology
2. To get insight about nanoparticle synthesis
3. To deliver extensive knowledge on Nanoparticles characterization
4. To impart knowledge about nanoparticle applications in biology and medicine
5. To offer comprehensive information on the Environmental effects of nanoparticles

Course Out Comes

1. After studying unit-1, the student will be able to understand the role of nanotechnology in biology
2. After studying unit-2, the student will be able to employ different ways of nanoparticle synthesis
3. After studying unit-3, the student will be able to characterize Nanoparticles
4. After studying unit-4, the student will be able to appreciate applications of nanoparticles in biology and medicine
5. After studying unit-5, the student will be able to assess Environmental effects of nanoparticles

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit- I - Introduction to nanobiotechnology Teaching Hours: 9

History – bionanotechnology – concept and future prospects – application in Biological Sciences. Terminologies – nanotechnology, bionanotechnology, nanobiomaterials, biocompatibility, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles, nanosensors. Biotechnology to bionanotechnology, natural bionanomachines. Present status of nanobiotechnology.

Unit- II - Types of nanoparticle synthesis Teaching Hours: 9

Molecular nanobiotechnology – nanomachines – collagen. Applications of nanoparticles – cancer nanotherapy – manipulation of cell and biomolecules. Cytoskeleton and cell organelles.

Physical, chemical and biological synthesis of nanoparticles. Microbial synthesis of nanoparticles – mechanism of synthesis.

Unit III - Nanoparticles Types and their characterization techniques Teaching Hours: 9

Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization of nanoparticles – UVVis spectroscopy, particle size analyzer, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD. Other tools and techniques required for bionanotechnology: rDNA technology, site directed mutagenesis, fusion proteins, X- Ray crystallography, NMR. Bioinformatics: molecular modeling, docking, computer assisted molecular design.

Unit IV - Nanoscale applications in biology and medicine Teaching Hours: 9

Nanotechnology in biology and medicine - Micro- and nano- fluidics - Scanning probe microscopy in biology and medicine – Self assembly of biological molecules. Drug delivery – protein mediated and nanoparticle mediated. Hybridconjugates of gold nanoparticles – DNA oligomers – use of DNA molecules in nanomechanics and Computing. Nanoparticles as carrier for genetic material. Nanomedicines, Antibacterial activities of nanoparticles. Toxicology in nanoparticles

Unit V - Environmental effects of nanoparticles Teaching Hours: 9

Health and safety implications from nanoparticles: Health issues – Environmental issues – Need for regulation – Societal implications: Possible military applications – Potential benefits and risks for developing countries – Intellectual property issues – Criticism of Nanotechnology – Studies on the implications of Nanotechnology.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Elisabeth Papazoglou and Aravind Parthasarathy. Bionanotechnology. Morgan and Claypool Publishers. 2007.
2. David Goodsell S. Bionanotechnology, Lessons from Nature, Wiley-Liss, Inc. 2004.

Reference Books

1. Claudio Nicolini. Nanobiotechnology and Nanobiosciences Pan Stanford Publishing Pte. Ltd. 2009.
2. David E Reisner and Joseph D Bronzino. Bionanotechnology: Global Prospects. CRC Press. 2008.
3. Ehud Gazit. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press. 2006.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	S
CO3	S	M	S	M	S	S	M	S	S	S
CO4	S	M	S	S	M	S	M	S	S	M
CO5	S	M	M	S	S	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: IV Paper type: Elective

Paper code:

Name of the Paper: C. BIOETHICS

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn the concept of 'bioethics'
2. To acquire knowledge about Universal Declaration on Bioethics and Human Rights
3. To get insight about the composition and functioning of Ethics committees
4. To understand discrimination and stigmatization
4. To impart knowledge about bioremediation and its significance in the Environmental biotechnology.
5. To offer comprehensive information related to Social responsibility and health issues

Course Out Comes

1. After studying unit-1, the student will be able to describe the concept of 'bioethics'
2. After studying unit-2, the student will be able to explain Universal Declaration on Bioethics and Human Rights
3. After studying unit-3, the student will be able to danalyse the composition and functioning of Ethics committees
4. After studying unit-4, the student will be able to interpret consequences of discrimination and stigmatization
5. After studying unit-5, the student will be able to apply the knowledge in Social responsibility and health

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: **Teaching Hours: 9**

Ethics – definition – Bioethics – definition - The birth of the concept of 'bioethics' - History of Bioethics as a Discipline - Bioethics as bridge between facts and values - Bioethics versus medical ethics - Health and disease as values.

Unit II: **Teaching Hours: 9**

Principles of bioethics - Health care decisions include facts and values, Universal Declaration on Bioethics and Human Rights - Conflicts between bioethical principles - Limits to the autonomy of patients - Limits of justice and resource allocation

Unit III: **Teaching Hours: 9**

Ethics committees – Need, Types,Composition, Function - Human dignity and human rights - Benefit and harm – Definitions, comparing harms and benefits; Autonomy and individual responsibility, health care provider-patient relationship; 'informed consent'.

Unit IV: **Teaching Hours: 9**

Respect for human vulnerability and personal integrity; respecting privacy and confidentiality; Equality, justice and equity; discrimination and stigmatization - Non-discrimination and non-stigmatization; Respect for cultural diversity and pluralism; Solidarity and cooperation in healthcare and society.

Unit V: **Teaching Hours: 9**

Social responsibility and health; Responsibilities for governments and various sectors of society; Access to essential drugs and health services; health as a fundamental human right; HIV / AIDS as an example in ethical context; Sharing of benefits; Protecting future generations; Protection of the environment, the biosphere and biodiversity.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Bioethics for Scientists. John A. Bryant, Linda Baggott la Velle, John F. Searle. Wiley. 2002.
2. Advisory Expert Committee for the Teaching of Ethics. Bioethics Core Curriculum. UNESCO 2016.

Reference Books

1. Deni Elliot. Ethical Challenges: Building an Ethics Toolkit Authorhouse: 2008.
2. Thomas A. Shannon and Nicholas J. Kockler, An Introduction to Bioethics. 4th Edition. Paulist Press, 2009.
3. Robert J. Spitzer, S.J., Ph.D. Ten Universal Principles: A Brief Philosophy of the Life Issues. Ignatius Press, 2011.
Tom L Beauchamp. Jerffry Khan,LeRoy Walters, Anna C Mastroanni.(2013) Contemporary issues in Bioethics.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	M	S
CO3	S	M	S	M	S	S	S	S	S	M
CO4	S	M	S	S	S	S	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: IV Paper type: Open Elective

Paper code:

Name of the Paper: A. COMPUTATIONAL BIOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To introduce computers and their applications
2. To acquire knowledge about Sequence databases and its applications.
3. To get insight about sequence analysis
4. To impart knowledge about protein structures analysis through tools
5. To offer comprehensive information DNA microarray and protein microarray

Course Out Comes

1. After studying unit-1, the student will be able to know the uses of computers in the field of biology
2. After studying unit-2, the student will be able to make use of Sequence databases
3. After studying unit-3, the student will be able to perform sequence analysis
4. After studying unit-4, the student will be able to analyse and interpret protein structures using tools
5. After studying unit-5, the student will be able to appreciate the use of microarrays

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: **Teaching Hours: 9**

Introduction to computers – Types of computers – Generation – Applications of computers – Input and Output devices – ROM, RAM- Internet.

Unit II: **Teaching Hours: 9**

Data-alignment and applications; Collecting and Storing Sequence Data; Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Conversion between formats; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments tools- BLAST.

Unit III: **Teaching Hours: 9**

Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis.

Unit IV: **Teaching Hours: 9**

Basic structure and building blocks of proteins; motifs of protein structures; alpha/beta structures; Folding and flexibility, Prediction, engineering and design of protein structures; Methods to identify secondary structural elements.

Unit V: **Teaching Hours: 9**

DNA microarray: database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases; understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools. **Protein arrays**: basic principles, bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools; Protein-protein interactions.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press. 2004.
2. Bioinformatics: Sequence and Genome Analysis by Mount D., 2004 Cold Spring Harbor Laboratory Press, New York.

Reference Books

1. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., 1998, John Wiley & Sons, UK.
2. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press. 2001.
3. Cynthia Gibas and Per Jambek. Developing Bioinformatics computer skills, Shroff publishers and Distributors Pvt. Ltd., O' reilly, Madurai. 2001.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	S	S	S	S
CO3	S	M	S	M	S	S	M	S	M	M
CO4	S	M	S	S	M	S	M	M	S	S
CO5	S	M	M	S	M	S	S	M	S	M

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: IV Paper type: Open Elective

Paper code:

Name of the Paper: B. BIOSAFETY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To learn the importance of Biosafety
2. To acquire knowledge about biohazards
3. To get insight about Biocontainment levels
4. To deliver extensive knowledge on Biosafety Management
5. To offer comprehensive information on Biosafety Guidelines

Course Out Comes

1. After studying unit-1, the student will be able to describe the concept of Biosafety
2. After studying unit-2, the student will be able to list out various biohazards
3. After studying unit-3, the student will be able to narrate Biocontainment methods
4. After studying unit-4, the student will be able to employ the concept of Biosafety Management
5. After studying unit-5, the student will be able to interpret and apply Biosafety Guidelines

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: Biosafety **Teaching Hours: 9**

Introduction – Historical background - Biosafety issues in Microbiology - Disease transmission and epidemiology - Levels of Specific Microorganisms, Infectious Agents and Infected Animals - Aseptic technique - Standard Microbiological Practices.

Unit II: Biohazards **Teaching Hours: 9**

Definition of GMOs & LMOs; rDNA technology - GMO applications in food and agriculture - Environmental release of GMOs - Risk - Analysis, Assessment, management and communication - Hazardous Wastes in Biological Labs – Types and Management - Bioterrorism

Unit III: Biocontainment **Teaching Hours: 9**

Concepts and Strategies – Risk Groups (from NIH Guidelines) and Biosafety Levels (from CDC Biosafety) - Biological Safety Cabinets - Primary Containment for Biohazards - Animal Biosafety and Facilities - Operations and Maintenance of Biosafety Facilities.

Unit IV: Biosafety Management **Teaching Hours: 9**

Risk Assessment - Risk Communication - Warning Signs and Labels - Working Safely with Biohazardous Agents - Disinfection and Decontamination procedures - Emergency Planning and Response - Personal Protective Equipment.

Unit V: Biosafety Guidelines **Teaching Hours: 9**

Guidelines and regulations (National and International) - Cartegana Protocol; Institutional Biosafety Committee (IBSC) - Composition and role; Role of review committee on genetic manipulation (RCGM) and GEAC; Transportation of Infectious Substances.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)

Reference Books

1. Biosafety and bioethics (2006) Rajmohan Joshi. Gyan Publishing House.
2. Microbial Biotechnology & Biosafety Aspects P. Palanivelu. Twentyfirst Century Publications. 2016
3. Biological Safety: Principles and Practices. American Society for Microbiology. 2017. Editors: Dawn P. Wooley and Karen B. Byers.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	S	M	M
CO2	M	S	M	S	M	S	M	S	S	M
CO3	S	M	S	M	S	M	S	S	S	S
CO4	S	M	S	S	M	S	M	M	S	M
CO5	S	M	M	S	S	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

Semester: IV Paper type: Open Elective

Paper code:

Name of the Paper: C. ALGAL TECHNOLOGY

Credit: 3

Total Hours per Week: 3 Lecture Hours: 45 Tutorial Hours: Nil Practical Hours: Nil

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Course Objectives

1. To acquire knowledge about algal technology, Characteristics and classification of Algae.
2. To know Algal production systems
3. To learn the uses of algae
4. To identify Algal control Methods
5. To understand the role of algae in nanobiotechnology

Course Out Comes

1. After studying unit-1, the student will be able to characterize and classify Algae
2. After studying unit-2, the student will be able to list out the significance and uses of algae
3. After studying unit-3, the student will be able to describe algal cultivation methods
4. After studying unit-4, the student will be able to appreciate the role of algae in food and feed
5. After studying unit-5, the student will be able to suggest algal control measures

Matching Table (put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Unit I: **Teaching Hours: 9**

Introduction to algal technology; Characteristics and classification of Algae (Outline only) - Chemical composition - protein, amino acids, lipids, waxes, glycerol, vitamins, pigments, chlorophyll, carotenoids and phycobiliproteins. Distribution of economically important algae in India.

Unit II: **Teaching Hours: 9**

Characteristics, significance and Uses of the following algae - *Dunaliella*, *Haematococcus*, *Chlorella*, *Scenedesmus*, *Botryococcus*, *Porphyridium*, *Gracilaria*, *Gelidium*, Gelidiella, *Laminaria*, *Porphyra*, and *Ulva*.

Unit III: **Teaching Hours: 9**

Algal production systems; Strain selection; Algal growth curve; Culture media; indoor cultivation methods and scaling up; Measurement of algal growth; Large-scale cultivation of algae; Harvesting algae. Drying; Algal immobilization and its applications

Unit IV: **Teaching Hours: 9**

Algae as a source of food and feed; Algae as SCP - *Spirulina* mass cultivation and its applications, Algae as a source of pigments, fine chemicals and bio-fertilizers; Blue-green algal bio-fertilizer - Method of preparation, application and its advantages over inorganic fertilizers; Liquid seaweed fertilizer - Method of preparation and application. Biodiesel from algae; Phycoremediation; Role of algae in nanobiotechnology.

Unit V: **Teaching Hours: 9**

Algal control - Methods of control of algae; Algicides-preparation and Application; ultrasonic sound producing devices to control algae; Algal culture collection centers in India and abroad and their importance; Centers pursuing algal research in India and their field of interest.

Internal Assessment Methods:

Course teachers can choose one or more of the following innovative methods: Book review, Research paper review, Data collection, Paper writing practices using the course content for society and nature development, Workshops, Preparing question paper by the candidates, Assignments, Preparing course material, Open book examination, Field study, Group discussion, Slip tests.

Text Books

1. Trivedi, P.C. 2001 Algal Biotechnology. Pointer publishers, Jaipur, India.
2. Barsanti, Laura and Paolo Gualtieri. 2005 Algae-Anatomy, Biochemistry and Biotechnology. Taylor & Francis, London, New York.

Reference Books

1. Borowitzka MA and Borowitzka LJ. Microalgal Biotechnology, Cambridge University Press. 1989.
2. Becker, E.W. 1994 Microalgae-Biotechnology and microbiology. Cambridge University Press.
3. Das Mihir Kumar. Algal Biotechology. Daya Publishing House.

Course Material: website links, e-Books and e-journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	S	S	M	M
CO2	M	S	M	S	S	S	M	S	S	S
CO3	S	M	S	M	M	S	S	S	S	M
CO4	S	M	S	S	S	S	M	M	S	M
CO5	S	M	M	S	M	S	S	M	S	S

PO – Programme Outcome, CO – Course outcome

S – Strong , M – Medium, L – Low

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