# ETHIRAJ COLLEGE FOR WOMEN
# (AUTONOMOUS)
# DEPARTMENT OF MICROBIOLOGY
# B.Sc., MICROBIOLOGY
# SYLLABUS TO BE EFFECTIVE FROM 2021-2022

# ETHIRAJ COLLEGE FOR WOMEN
**(AUTONOMOUS)**
**CHENNAI-600 008.**

## DEPARTMENT OF MICROBIOLOGY

## SYLLABUS

## CHOICE BASED CREDIT SYSTEM
## OUTCOME BASED EDUCATION

## (OFFERED FROM THE ACADEMIC YEAR 2021-2022)

# INDEX

## REVISED SYLLABUS OF JUNE 2021

Department of Microbiology is revising syllabi with effect from the academic year 2021 -2022 with Part IV and Part V components. Part IV and Part V components will seek to build the capacity of the students and provide inputs for her social service and social analyzing capabilities.

The course duration is three years. Every academic year is divided into two semester sessions. Each semester will have a minimum of 90 working days and each day will have 5 working hours. Teaching is organized into a modular pattern of credit courses. Credit is normally related to the number of hours a teacher teaches a particular subject. It is also related to the number of hours a student spends learning a subject or carrying out an activity.

## PREAMBLE

The Department of Microbiology submits changes and additions suggested in the UG curriculum that are

- Improvisation of course content in Core and Elective papers.
- Repetition of course content was avoided and shifting of papers were done.
- Papers were merged to include new courses.

## REGULATIONS

### 1. ELIGIBILITY FOR ADMISSION:

Candidates for admission to the first year of the Degree of Microbiology course shall require to have passed Biology / Botany and Zoology in Higher Secondary Examinations conducted by the Government of Tamil Nadu or an Examination accepted as equivalent thereto by the syndicate of the University of Madras.

### 2. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the Degree only if she has undergone the prescribed course of study for a period of not less than three academic years, passed the examination of all Six Semesters prescribed.

**3. COURSE OF STUDY:**

The main subjects of study for Bachelor Degree shall consist of the following:

**PART – I** : Foundation Courses exclusive for Languages.

**PART – II** : Foundation English

**PART – III** : Core Subjects and Allied Subjects

**PART – IV** : Non-Major Electives and Soft Skills.

**PART – V** : Extension Activities / Sports / NCC.

**4. PASSING MINIMUM:**

A candidate shall be declared to have passed in each Paper/Practical of all subject of the study wherever prescribed, if she secured NOT LESS THAN 40% of the marks prescribed for the end semester examinations and the total marks of continuous assessment and the end semester examinations.

**5. CLASSIFICATION OF SUCCESSFUL CANDIDATES:**

Successful candidates passing the examinations and securing the marks (i) 60 percent and above and (ii) 50 percent and above but below 60 percent in the aggregate shall be declared to have passed the examination in the First and Second class respectively. Candidates who pass all the examination (Part I, II, III&IV) prescribed for the course in the First appearance alone are eligible for ranking.

## PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

On obtaining an undergraduate degree the students will be able to:

**PEO1**: Apply and advance the knowledge and skills acquired, to become a creative professional in their chosen field.

**PEO2**: Engage in self-directed continuous learning, aimed at global competency, which will promote professional and personal growth.

**PEO3**: Develop management skills and entrepreneurial skills, by harnessing core competencies tempered by values and ethics.

**PEO4**: Work towards achieving economic and social equity for women through application of relevant knowledge.

**PEO5**: Contribute to promoting environmental sustainability and social inclusivity.

# PROGRAM OUTCOMES (PO)

**PO1**: To promote and apply scientific knowledge for finding sustainable solution to solve the issues pertaining to the society/industry.

**PO2**: Identify, analyze and formulate novel ideas to yield, substantial results in the fields of research utilizing the principles of physical and biological science.

**PO3**: Relate key concepts and scientific principles to various scientific phenomenon and their applications in day-to-day life.

**PO4**: Cultivate unparalleled comprehension of fundamental concepts relevant to basic sciences leading to an individual progress and career advancement at the national and global levels.

**PO5**: To communicate effectively their views and ideas orally/written in English and in other related languages.

**PO6**: Design solutions for complex problems and design system components or processes that meet the specific needs with appropriate consideration for public health and safety, cultural, societal and environmental conditions.

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

**PSO1:** Outline the History, Systematics, Biodiversity, Morphology and Physiology of Microorganisms.

**PSO2:** Apply current techniques to Microbial Systems and harness the potentials of Microorganisms in various divisions of Microbiology for betterment of mankind.

**PSO3:** Analyze the concepts in Microbial Genetics, Immunity, Biotechnology and Methods involved in Diagnosis of Infectious diseases and Immunological disorders.

**PSO4:** Evaluate the Role of Microorganisms in Clinical Pathogenesis, Food Safety, Agriculture, Dairy, Bioprocessing and Pharmaceutical Industries.

**PSO5:** Utilize Analytical, Computer and Statistical skills in various fields of Life Sciences.

**PSO6:** Apply Communication Skills, Core Values and Environmental Awareness with Social Responsibility for Entrepreneurship and Employability.

## PROGRAMME PROFILE-B.Sc., MICROBIOLOGY

| SEM | PART | COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS/ WEEK | TOTAL HOURS | CA | SE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| I | Part I | | Language I | 3 | 6 | 90 | 40 | 60 | 100 |
| | Part II | | English-I | 3 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/1C/FM1 | Fundamentals of Microbiology-I | 5 | 7 | 105 | 40 | 60 | 100 |
| | Part III | | Allied Biochemistry -I | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/2C/PR1 | Basic Techniques in Microbiology | - | 3 | 45 | - | - | - |
| | Part III | | Allied Biochemistry Practical | - | 2 | 30 | - | - | - |
| | Part IV | | Environmental Studies | 2 | 2 | 30 | - | 50 | 50 |
| | Part IV | | Soft Skill | 3 | 2 | 30 | - | 50 | 50 |
| II | Part I | | Language II | 3 | 6 | 90 | 40 | 60 | 100 |
| | Part II | | English-II | 3 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/2C/FM2 | Fundamentals of Microbiology-II | 5 | 7 | 105 | 40 | 60 | 100 |
| | Part III | | Allied Biochemistry –II | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/2C/PR1 | Basic Techniques in Microbiology | 4 | 3 | 45 | 40 | 60 | 100 |
| | Part III | | Allied Biochemistry Practical | 2 | 2 | 30 | 40 | 60 | 100 |
| | Part IV | | Soft Skill | 3 | 2 | 30 | - | 50 | 50 |
| | Part IV | | Value Education | 2 | 2 | 30 | - | 50 | 50 |
| | **Credits for I and II Semester = 46** | | | | | | | | |
| III | Part I | | Language III | 3 | 6 | 90 | 40 | 60 | 100 |
| | Part II | | English-III | 3 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/3C/BAI | Basic and Applied Immunology | 5 | 7 | 105 | 40 | 60 | 100 |
| | Part III | MB21/3A/BBI | Allied-Biostatistics and Bioinstrumentation | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/4C/PR2 | Immunology and Microbial Genetics Practical | - | 3 | 45 | - | - | - |
| | Part III | MB21/4A/PR1 | Allied- Biostatistics, Essentials of Computers and Bioinformatics Practical | - | 2 | 30 | - | - | - |
| | Part IV | MB21/3N/FHB or 1a/b/c | Fermented Foods and Health Benefits | 2 | 2 | 30 | - | 50 | 50 |
| | Part IV | | Soft Skill | 3 | 2 | 30 | - | 50 | 50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| IV | Part I | | Language IV | 3 | 6 | 90 | 40 | 60 | 100 |
| | Part II | | English-IV | 3 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/4C/MIG | Microbial Genetics | 5 | 7 | 105 | 40 | 60 | 100 |
| | Part III | MB21/4A/ECB | Allied–Essentials of Computers and Bioinformatics | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/4C/PR2 | Immunology and Microbial Genetics Practical | 4 | 3 | 45 | 40 | 60 | 100 |
| | Part III | MB21/4A/PR1 | Allied- Biostatistics, Essentials of Computers and Bioinformatics Practical | 2 | 2 | 30 | 40 | 60 | 100 |
| | Part IV | MB21/4N/HGA or 1a/b/c | Home Gardening | 2 | 2 | 30 | - | 50 | 50 |
| | Part IV | | Soft Skill | 3 | 2 | 30 | - | 50 | 50 |
| | **Credits for III and IV Semester = 46** | | | | | | | | |
| V | Part III | MB21/5C/BAV | Bacteriology and Virology | 4 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/5C/SAM | Soil and Agricultural Microbiology | 4 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/5C/FMB | Food Microbiology | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/5E/NBT or MB21/5E/ BEY | Nanobiotechnology / Bioenergy | 5 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/5E/WMT or MB21/5E/MCT | Waste Management / Mushroom Cultivation | 5 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/6C/PR3 | Medical Microbiology | - | 3 | 45 | - | - | - |
| | Part III | MB21/6C/PR4 | Applied Microbiology | - | 3 | 45 | - | - | - |
| | | Self-Study Paper | Forensic Science and Crime Investigation* | 2 | - | - | 100 | - | 100 |
| VI | Part III | MB21/6C/MPY | Mycology and Parasitology | 4 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/6C/EEM | Microbial Ecology and Environmental Microbiology | 4 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/6C/RDT | Recombinant DNA Technology | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/6C/IND | Industrial Microbiology | 4 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/6E/CMP or MB21/6E/GLT | Commercial Microbial Products / Good Laboratory Practices and Techniques | 5 | 5 | 75 | 40 | 60 | 100 |
| | Part III | MB21/6C/PR3 | Medical Microbiology | 4 | 3 | 90 | 40 | 60 | 100 |
| | Part III | MB21/6C/PR4 | Applied Microbiology | 4 | 3 | 90 | 40 | 60 | 100 |
| | | Self-Study Paper | General Aptitude for Competitive Examinations* | 2 | - | - | 100 | - | 100 |
| **Credits for V and VI Semester = 51 + 4*** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Self-Study Papers for Advanced Learners(Students with distinction in First to Fourth semesters and First to Fifth semesters) Two Self-Study Papers** | | | | | | | | | |
| **Part V- Extension Activity – 1 credit** | | | | | | | | | |
| **II B.Sc. BIOCHEMISTRY** | | | | | | | | | |
| **III** | Part III | MB21/3A/AM1 | Allied Microbiology-I | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/4A/PR2 | Allied Microbiology Practical | - | 2 | 30 | - | - | - |
| **II B.Sc. BIOCHEMISTRY** | | | | | | | | | |
| **IV** | Part III | MB21/4A/AM2 | Allied Microbiology-II | 4 | 4 | 60 | 40 | 60 | 100 |
| | Part III | MB21/4A/PR2 | Allied Microbiology Practical | 2 | 2 | 30 | 40 | 60 | 100 |

**PART IV- NON-MAJOR ELECTIVE OFFERED BY THE DEPARTMENT**

| Semester | Course Code | Course Title | Hours/ Week | Credits | Marks |
|---|---|---|---|---|---|
| Semester III | MB21/3N/FHB | Fermented Foods and Health Benefits | 2 | 3 | 50 |
| Semester-VI | MB21/4N/HGA | Home Gardening | 2 | 3 | 50 |

**Part V NCC/NSS/SPORTS/CSS/SPORTS/CSS/YRC/RRC/ROTRACT/CERTIFICATE COURSE**

# EVALUATION PATTERN FOR CONTINUOUS ASSESSMENT
## INTERNAL VALUATION BY COURSE TEACHERS

### CORE / ELECTIVE / PROJECT-THEORY PAPERS

| S.NO | COMPONENT | TIME | MAX.MARKS | CA MARK |
|---|---|---|---|---|
| 1 | Test I | 2 Hours | 50 Marks (To be Converted To 10 Marks) | 10 |
| 2 | Test II | 2 Hours | 50 Marks (To be Converted To 10 Marks) | 10 |
| 3 | Assignment/Seminar/Field Visit | | | 10 |
| 4 | Participatory Learning | | | 10 |
| | Total | | | 40 |

### PART III--PRACTICAL PAPERS

| S.NO | COMPONENT | TIME | MAX.MARKS | CA MARK |
|---|---|---|---|---|
| 1 | Test I | 2 Hours | 50 Marks (To be Converted To 10 Marks) | 10 |
| 2 | Test II | 2 Hours | 50 Marks (To be Converted To 10 Marks) | 10 |
| 3 | Maintenance of Observation/Record | | | 10 |
| 4 | Participatory Learning | | | 10 |
| | Total | | | 40 |

### CA QUESTION PAPER PATTERN

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-3X2 marks** | **50** | **06** | **50** |
| **K1. K 2** | **B-3/4x8marks** | **500** | **24** | |
| **K2, K 3** | **C-1/2x20 marks** | **1200** | **20** | |

## RUBRICS FOR CONTINUOUS ASSESSMENT

| | |
|---|---|
| **Assignment** | Content/Originality/Presentation/Schematic Representation and Diagram/Bibliography |
| **Seminar** | Organisation/Subject Knowledge/Visual Aids/Confidence level/presentation-Communication and Language |
| **Field Visit** | Participation/Preparation/Attitude/Leadership |
| **Participation** | Answering Questions/Clearing Doubts/Participating in Group Discussions/Regular Attendance |
| **Case Study** | Finding the Problem/Analysis/Solution/Justification |
| **Problem Solving** | Understanding Concepts/Formula and Variable Identification/Logical Sequence/Answer |
| **Group Discussion** | Preparation/Situation Analysis/Relationship Management/Information Exchange/Delivery Skills |
| **Flipped/Blended Learning** | Preparation/Information Exchange/ Group interaction/Clearing doubts |

## END SEMESTER EVALUATION PATTERN

**THEORY PAPERS**
**PART – III**
**SEMESTER**- I/II/III/IV/V/VI
Double valuation by course teacher and external examiner
Maximum Marks: 100 to be converted to 60
Passing Marks: 40/100

**PRACTICAL PAPERS**
**SEMESTER** II/IV/VI
Double Valuation by Internal Examiner and External Examiner
Maximum Marks: 100 to be converted to 60
Passing Mark: 40

**PART – IV**
Single Valuation by Course Teacher
Written Test
Maximum Marks 50
Passing Marks: 20/50

**SELF-STUDY PAPER**
Single Valuation by Course Teacher
Written Test
Maximum Marks 100
Passing Marks: 40/100

## SEMESTER I
## COURSE PROFILE-PROGRAMME OF STUDY

| COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS/ WK | TOTAL HOURS | L-T-P | CA | SE | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | Language I | 3 | 6 | 90 | | 40 | 60 | 100 |
| | English-I | 3 | 4 | 60 | | 40 | 60 | 100 |
| MB21/1C/FM1 | Fundamentals of Microbiology-I | 5 | 7 | 105 | 4-3-0 | 40 | 60 | 100 |
| | Allied Biochemistry –I | 4 | 4 | 60 | | 40 | 60 | 100 |
| MB21/2C/PR1 | Basic Techniques in Microbiology | - | 3 | 45 | | - | - | - |
| | Allied Biochemistry Practical | - | 2 | 30 | | 40 | 60 | 100 |
| | Environmental Studies | 2 | 2 | 30 | 2-0-0 | | 50 | 50 |
| | Soft Skill | 3 | 2 | 30 | - | | 50 | 50 |
| | **TOTAL CREDITS** | **20** | | | | | | |

## SEMESTER- I

## FUNDAMENTALS OF MICROBIOLOGY I

**TOTAL HOURS: 105** **COURSE CODE: MB21/1C/FM1**
**CREDITS : 5** **LT P : 4 3 0**

**COURSE OBJECTIVES**

1. Acquire an insight on history and developments in Microbiology.
2. Introduce eukaryotic and prokaryotic cell structure.
3. Learn the construction, working principle and application of different types of microscopes.
4. Expose them to staining techniques employed in visualizing microorganism.
5. Attain adequate knowledge on various physical and chemical sterilization methods.

**COURSE OUTLINE**

**UNIT I** **20 Hours**

History of Microbiology - Spontaneous Generation vs Biogenesis hypothesis. Microbiology as Modern Science. Contributions of Scientists - Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Alexander Fleming, Joseph Lister, Paul Ehrlich, Martinus Beijerinck, Dimitri Ivanovski, Selman Waksman. Classification of Microorganisms – Three Kingdom, Whittaker's Five Kingdom and Eight Kingdom concepts.

**UNIT II** **20 Hours**

Prokaryotic Cell Structure– Cell Size, Shape, Arrangements, Capsule, Slime, S Layer, Fimbriae, Flagella, Pili, Cell Wall, Cell Membrane, Periplasmic Space, Ribosomes, Mesosomes, Nucleoid, Chromosome and Plasmids, Inclusions bodies, Gas vacuoles, Bacterial endospore. General characteristics, structure and reproduction in Cyanobacteria (Spirulina and Anabaena). General characteristics of Acellular microorganisms - (Viruses, Viroids, Prions) and Cellular microorganisms (Algae, Fungi and Protozoa).Eukaryotic Cell structure- Cytoskeleton, Cytoplasmic membrane, Golgi apparatus, Endoplasmic reticulum, Mitochondria, Ribosomes, Nucleus and Chloroplast. Differences between Prokaryotic and Eukaryotic Microorganisms.

**UNIT III** **25 Hours**

Microscopy – Light Spectrum. Principles and Applications of Microscope - Magnification, Resolving power, Numerical Aperture. Principles and Applications - Bright Field, Dark Field, Phase Contrast, Inverted Microscope, Stereo
Microscope and Fluorescence Microscopy. Electron Microscopy - TEM, SEM and Specimen Preparation Methods.

**UNIT IV** **20 Hours**

Stains and Staining Techniques - Definition of Auxochrome, Chromophores - Acidic and Basic Dyes, Natural dyes, Mordant and its functions. Classification of Staining - Simple, Differential and Special Staining. Principles and Procedures of Gram Staining, Acid Fast Staining, Endospore Staining, Metachromatic Granule staining, Nuclear staining and Flagellar staining. Negative Staining - Capsule Staining.

**UNIT V** **20 Hours**

Methods of Sterilization- Physical Methods - Mode of Action and Applications of Heat- Dry and Moist, Pasteurization and Tyndallisation, Incineration. Radiation – UV rays, X rays, γ rays, Filtration - HEPA filters and Membrane filters. Chemical Methods - Mode of Action,

Applications and Quality control- Alcohol, Acid, Alkali, Halogen, Heavy Metals, Phenol and Phenol derivatives, Formaldehydes, Ethylene Oxide and Detergents.

**RECOMMENDED TEXT BOOKS**


1. Pelczar M.J., Chan E.C.S. and Kreig N.R. (2007). Microbiology 7$^{th}$edn. McGraw-Hill New York.
2. Prescott L.M., Harley J.P and Klein D.A. (2013). Microbiology 9$^{th}$edn. McGraw-Hill Publications.
3. Salle A.J. (1984). Fundamental Principles of Bacteriology, 7$^{th}$edn. Tata McGraw-Hill Publications Ltd.


**REFERENCES**


1. Stanier R.Y., Ingraham J.L., Wheelis M.L. and Painter R.R (2010). General Microbiology, 5$^{th}$edn. MacMillan Press Ltd.
2. Tortora G.J., Funke B.R. and Case C.L. (2013). Microbiology-An Introduction, 11$^{th}$edn. Benjamin Cummings.
3. Madigan M.T., Martinko J.M. and Parker J. (2005). Brock – Biology of Microorganisms, 11$^{th}$edn, Pearson Prentice Hall International Inc.
4. Nester E.W. and Anderson D.G. (2004). Microbiology-A Human Perspective, 4$^{th}$edn. McGraw Hill Publications.
5. Atlas R. (1997). Principles of Microbiology, 2$^{nd}$edn. Wm.C.Brown Publishers.


**JOURNALS**

1. Systematic and Applied Microbiology.
2. Advances in Applied Microbiology.

**E-LEARNING RESOURCES**

1. https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
2. https://study.com/academy/lesson/eukaryotic-and-prokaryotic-cells-similarities-and-differences.html
3. http://physics.fe.uni-lj.si/students/predavanja/Microscopy_Kulkarni.pdf
4. https://courses.lumenlearning.com/microbiology/chapter/staining-microscopic specimens/
5. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/sterilization/index.html

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO1 | Understand development in Microbiology and list the contributions of various scientists. |
| CO2 | Illustrate the structure and function of eukaryotic and prokaryotic cells. |
| CO3 | Utilize the principles and applications of different types of microscopes. |
| CO4 | Apply various staining procedures for visualising microorganisms under the microscope. |
| CO5 | Assess the implication of various sterilization procedures and biosafety measures in clinical labs and industries. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 3 | 1 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 2 |
| **Average** | **2.8** | **2.4** | **2** | **2.4** | **2.2** | **1.8** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online Platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | One or Two Sentences | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight) (**One to be taken from each unit.. Remaining 3 questions can be from any 3 units) | 500 | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | 1200 | **40** | |

## SEMESTER II

## COURSE PROFILE-PROGRAMME OF STUDY

| COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS/ WK | TOTAL HOURS | L-T-P | CA | SE | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | Language II | 3 | 6 | 90 | | 40 | 60 | 100 |
| | English-II | 3 | 4 | 60 | | 40 | 60 | 100 |
| MB21/2C/FM2 | Fundamentals of Microbiology-II | 5 | 7 | 105 | 4-3-0 | 40 | 60 | 100 |
| | Allied Biochemistry –II | 4 | 4 | 60 | | 40 | 60 | 100 |
| MB21/2C/PR1 | Basic Techniques in Microbiology | 4 | 3 | 45 | 0-0-3 | 40 | 60 | 100 |
| | Allied Biochemistry Practical | 2 | 2 | 30 | | 40 | 60 | 100 |
| | Value Education | 2 | 2 | 30 | 2-0-0 | | 50 | 50 |
| | Soft Skill | 3 | 2 | 30 | | | 50 | 50 |
| | **TOTAL CREDITS** | **26** | | | | | | |

**SEMESTER- II**
**FUNDAMENTALS OF MICROBIOLOGY- II**

**TOTAL HOURS: 105** **COURSE CODE: MB21//2C/FM2**
**CREDITS : 5** **L T P 4 3 0**

**COURSE OBJECTIVES**

1. Explain microbial nutrition, growth and culturing techniques.
2. Discuss factors affecting microbial growth.
3. Impart knowledge on various microbial metabolic pathways.
4. Describe photosynthesis process.
5. Outline the structure and mode of action of various Antibiotics.

**COURSE OUTLINE**

**UNIT I** **20 Hours**

Nutritional requirements – Macronutrients, Micronutrients and Growth Factors, Nutritional types of Bacteria - Photoautotrophs, Photoorganotrophs, Chemolithotrophs, Chemoorganotrophs with examples. Nutrition transport mechanisms – Iron Uptake, Passive diffusion and Active transport. Culture Media, Types of Culture Media – Defined, Complex, Selective, Differential, Enriched and Enrichment Media.

**UNIT II** **20 Hours**

Microbial Growth - Generation time, Growth Curve and Phases of Growth in Bacteria. Batch, Continuous and Synchronous cultures. Anaerobic culture techniques. Measurement of Microbial growth - Cell number and Cell Mass. Factors affecting microbial growth – pH, Temperature, Oxygen Concentration and Water activity. Maintenance and Preservation of cultures – Sub-cultures, Mineral oil method, Lyophilisation.

**UNIT III** **25 Hours**

An overview of Metabolism - Embden Meyerhof Pathway, Entner-Doudoroff Pathway, Pentose Phosphate Pathway, Tricarboxylic Acid Cycle. Electron Transport Chain and Oxidative Phosphorylation. Chemiosmosis. ATP synthesis. Anaerobic respiration. Fermentation-Homolactic Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation and Butanediol Fermentation.

**UNIT IV** **20 Hours**

Photosynthesis - Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle. Glyoxylate cycle. Gluconeogenesis. Overview of biosynthesis of Amino acids, Pyrimidines and Purines, Lipids and Peptidoglycan.

**UNIT V** **20 Hours**

Antibiotics – General Characteristics, Antibiotic Susceptibility Testing – Dilution Susceptibility tests, Disk Diffusion test. Mechanism of action – Sulfonamides, Quinolones, Penicillin, Cephalosporins, Tetracyclines and Chloramphenicol. Origin and transmission of Drug Resistance.

**RECOMMENDED TEXT BOOKS**

1. Willey J., Sherwood L. and Woolverton C. J. (2017). Prescott's Microbiology. 10th edn. McGraw-Hill International edition.
2. Pelczar M.J., Chan E.C.S. and Kreig. N.R. (2007). Microbiology 7th edn. McGraw-Hill New York
3. Lim D. (1998). Microbiology, 2nd edn. WCB McGraw-Hill Publications.

**REFERENCES**


1. Stanier R.Y, Ingraham J.L., Wheelis M.L., and Painter R.R. (2010). General Microbiology, 5th edn. MacMillan Press Ltd.
2. Tortora, G.J., Funke B.R. and Case, C.L. (2013). Microbiology-An Introduction, 11th edn. Benjamin Cummings.
3. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5th edn. McGraw Hill Publications.
4. Wheelis M. (2007). Principles of Modern Microbiology, 1st edn. Jones and Bartlett Publishers, Inc.
5. Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). Brock - Biology of Microorganisms, 13th edn. Benjamin-Cummings Pub Co.


**JOURNALS**

1. Journal of Applied Microbiology.
2. Journal of Pure and Applied Microbiology.

**E-LEARNING RESOURCES**

1. https://www.britannica.com/science/bacteria/Growth-of-bacterial-populations
2. https://bio.libretexts.org/@go/page/9188
3. https://microbiologynotes.org/measurements-of-microbial-growth/
4. https://bio.libretexts.org/@go/page/10681
5. http://photobiology.in2fo/Jones.html

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO1 | Analyse the nutritional requirement of microorganisms and their cultivation techniques under laboratory conditions. |
| CO2 | Utilize microbial growth, its measurement and preservation techniques in different disciplines. |
| CO3 | Assess various metabolic pathways occurring in microorganisms and their significance. |
| CO4 | Explain the stages in microbial photosynthesis and its significance. |
| CO5 | Acquire knowledge about antibiotics, their classification and mode of action. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO 2** | 2 | 3 | 2 | 2 | 3 | 2 |
| **CO 3** | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO 4** | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO 5** | 2 | 3 | 2 | 2 | 2 | 3 |
| **Average** | **2.2** | **2.2** | **2.2** | **2** | **2.2** | **2.2** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online Platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | One or Two Sentences | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight) (**One to be taken from each unit.. Remaining 3 questions can be from any 3 units) | 500 | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | 1200 | **40** | |

## MAJOR PRACTICAL
## BASIC TECHNIQUES IN MICROBIOLOGY

**TOTAL HOURS: 90** **COURSE CODE: MB21/2C/PR1**
**CREDITS : 4** **LT P 0 0 3**

**COURSE OBJECTIVES**

1. Focus on basic concepts in microscopy and sterilization.
2. Study about different staining techniques.
3. Learn various cultivation methods used to study microorganisms.

**COURSE OUTLINE**

1. Cleaning of Glassware and Laboratory rules.
2. Microscopy - Compound microscope - Principle, Operation, Uses and Maintenance.
3. Principle and Methods of sterilization - Moist heat - Autoclave, Dry heat - Hot air Oven and Filtration method - Membrane filtration technique.
4. Quality control of sterilization- chemical and biological methods.
5. Smear Preparation and Simple staining.
6. Differential Staining-Gram staining.
7. Endospore Staining.
8. Negative Staining- Capsule Staining.
9. Direct examination of Algae - *Oscillatoria, Volvox, Nostoc.*
10. Staining of fungi-LPCB - Yeast- *Candida*; Mold- *Aspergillus, Mucor, Rhizopus* & *Penicillium*.
11. Micrometry - Determination of size of Yeast.
12. Slide culture technique.
13. Demonstration of motility by Hanging drop method.
14. Demonstration of motility using soft agar.
15. Measurement of pH of medium - pH strips and pH meter.
16. Preparation of saline- Bacteriological and normal.
17. Preparation of Liquid media - Peptone Water and Nutrient Broth.
18. Solid media - Basal- Nutrient agar & NA Slant, Enriched-Blood Agar, Selective - EMB agar.
19. Pure culture method- Streak plate technique and study of colony morphology.
20. Enumeration of bacteria– serial dilution-Pour plate and Spread plate method.
21. Antibiotic sensitivity testing - Disc Diffusion- Kirby Bauer method.
22. Biochemical analysis- Catalase, Oxidase, IMViC, Urease & Carbohydrate Fermentation.

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Apply the concept of microscopy to visualize microorganisms and methods of sterilization and their applications. |
| CO 2 | Utilize the methodology and application of different staining techniques. |
| CO 3 | Evaluate different cultivation methods of microorganism and its importance. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 3 | 2 | 1 | 2 |
| **CO 2** | 3 | 2 | 3 | 2 | 1 | 2 |
| **CO 3** | 3 | 2 | 3 | 2 | 2 | 2 |
| **Average** | **3** | **2** | **3** | **2** | **1.3** | 2 |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**QUESTION PAPER PATTERN**:

**Time: 6 Hours (3 Hours, Two days)** **Max Marks: 60**

**Major Practical : 25 marks**
**Minor Practical : 15 marks**
**Spotters (5 x 2) : 10 marks**
**Record : 10 marks**

## SEMESTER III COURSE PROFILE-PROGRAMME OF STUDY

| COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS /WK | TOTAL HOURS | L-T-P | CA | SE | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | Language III | 3 | 6 | 90 | | 40 | 60 | 100 |
| | English-III | 3 | 4 | 60 | | 40 | 60 | 100 |
| MB21//3C/BAI | Basic and Applied Immunology | 5 | 7 | 105 | 4-3-0 | 40 | 60 | 100 |
| MB21//3A/BBI | Allied-Biostatistics and Bioinstrumentation | 4 | 4 | 60 | 3-1-0 | 40 | 60 | 100 |
| MB21//4C/PR2 | Immunology and Microbial Genetics Practical | - | 3 | 45 | | | | |
| MB21/4A/PR1 | Allied- Biostatistics, Essentials of Computers and Bioinformatics Practical | - | 2 | 30 | | 40 | 60 | 100 |
| MB21/3N/FHB 1a/b/c | Fermented Foods and Health Benefits | 2 | 2 | 30 | 2-0-0 | - | - | 50 |
| | Soft Skill | 3 | 2 | 30 | | | | 50 |
| | **TOTAL CREDITS** | **20** | | | | | | |

## SEMESTER III

## BASIC AND APPLIED IMMUNOLOGY

**TOTAL HOURS: 105** **COURSE CODE: MB21/3C/BAI**
**CREDITS : 5** **L T P: 4 3 0**

**COURSE OBJECTIVES**

1. Understand the basic concepts in Immunology.
2. Impart knowledge about human defense mechanisms against infections.
3. Assess the applications of immunological techniques.
4. Outline immune response and vaccines.
5. Acquire knowledge about hypersensitive reactions, autoimmune disorders, immunodeficiency disorders and oncoimmunology.

**COURSE OUTLINE**

**UNIT I** **20 Hours**

Introduction - History, Scope of Immunology and Recent developments. Cells of Immune System. Hematopoiesis. Lymphoid and Myeloid Lineage. Mononuclear - Phagocytic System. Mechanism of Inflammation. Lymphoid Organs- Primary – Thymus, Bone Marrow and Bursa of Fabricius. Secondary - Lymph Node and Spleen. Tertiary - CALT, GALT and MALT.

**UNIT II** **22 Hours**

Host Parasite relationship and Immunity. Introduction and Classification of Immunity. Innate and Acquired immunity. Factors involved in Immunity. Complement. Immunoprophylaxis- Importance and Applications. Active and Passive immunization- Advantages and Disadvantages. Latest Immunization Schedule. Vaccine and its types.

**UNIT III** **20 Hours**

Antigens and Antibodies. Antigens - Factors influencing Antigenicity and Immunogenicity. Epitopes, Haptens, Super Antigen, Mitogen, Adjuvants. Antibodies – Structure, Classification, Types and Functions. Theories of Antibody production. Antibody Superfamily. Production of Monoclonal Antibodies - Hybridoma Technology. Antigen and Antibody Interactions. Agglutination, Flocculation and Precipitation Tests. Dot Blot and Slot Blot Tests.

**UNIT IV** **20 Hours**

Major Histocompatability Complex (MHC) - Introduction, MHC Genes, MHC Types and Pathways. Applications of MHC. MHC Deficiency disorders. Graft Rejection. Transplantation Immunology. Hypersensitivity – Introduction. Types - Mediators, Mechanism and Disorders. Skin test – Immediate and Delayed.

**UNIT V** **23 Hours**

Autoimmune disorders–Organ specific- Hashimoto disease and Myasthenia Gravis, Systemic - SLE and Sjogren Syndrome. Immunodeficiency Disorders - Primary - SCID and XLA; Secondary - Leukemia and Multiple Myeloma. An Overview of Oncoimmunology.

**TEXTBOOKS**

1. Kuby J. (2007). Immunology. 2nd edn. H.W. Freeman and Company. New York.
2. Janeway C., Travers P., Walport M. and Shlomchik M. (2001). Immunobiology. 6th edn. Garland Science.
3. Stites D.P., Terr A.I and Parslow T.G. (1997).Medical Immunology. 9th edn. Prentice Hall Inc.1997

**REFERENCE BOOKS**

1. Roitt R.I. (2005). Essential Immunology.10th edn. Blackwell Scientific Publishers.
2. Tizard R. and Saunders I. (2010). Immunology-An Introduction. 4th edn. College Publishing, Philadelphia.
3. Nairn R. and Helbert M. (2005). Immunology for Medical Students. 2nd edn. Mosby International limited.
4. Pelczar M.J., Chan E.C.S. and Kreig N.R. (2007) Microbiology 7th edn, McGraw-Hill New York.
5. Benjamini E., Coico R. and Sunshine G. (2009) Immunology: A Short Course. 6th edn. Wiley–Blackwell.

**JOURNALS**

1. Journal of Clinical Immunology.
2. Indian Journal of Comparative Microbiology, Immunology and Infectious diseases.

**E LEARNING RESOURCES**

1. https://www.mechanobio.info › Development
2. https://www.journals.elsevier.com/clinical-immunology/recent-articles
3. https://microbiologybook.org/mayer/ab-ag-rx.htm
4. https://www.ebi.ac.uk/interpro/potm/2005_2/Page2.htm
5. http://www.immunopaedia.org.za/immunology/archive/type-i-iv-hypersensitivity- reactions/immune-complex-formation/hypersensitivity-reactions/?print=print

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Acquire in depth knowledge about cells and organs of immune system. |
| CO 2 | Appraise the concepts and factors influencing immunity and vaccination. |
| CO 3 | Elucidate the reactions between various antigens and antibodies that form the basic platform for host parasite interactions. |
| CO 4 | Analyze graft rejection in transplantation by learning the MHC molecules and their functions. Analyse and learn the mechanism of hypersensitivity with examples. |
| CO 5 | Illustratively assess autoimmune and immunodeficiency disorders and an overview on oncoimmunology. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 2 | 3 | 3 | 2 |
| **CO 3** | 3 | 2 | 3 | 2 | 2 | 3 |
| **CO 4** | 2 | 2 | 3 | 2 | 2 | 3 |
| **CO 5** | 1 | 1 | 3 | 2 | 2 | 3 |
| **Average** | **2** | **2.2** | **2.6** | **2.4** | **2.2** | **2.6** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | One or Two Sentences | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight) (**One to be taken from each unit.. Remaining 3 questions can be from any 3 units) | 500 | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | 1200 | **40** | |

## SEMESTER – III

## ALLIED -BIOSTATISTICS AND BIOINSTRUMENTATION

**TOTAL HOURS: 60** **COURSE CODE: MB21/3A/BBI**
**CREDITS: 4** **LT P: 3 1 0**

**COURSE OBJECTIVES**

1. Learn the methods of statistical analysis.
2. Understand Data collection and analysis.
3. Provide knowledge on basic laboratory instrument working and principle
4. To impart foundation in main components of research framework.
5. Appreciate the components of scholarly writing and presentation.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Introduction to Biostatistics. Definition of Data, Types and its Collection Methods. Diagrammatic and Graphical representation of Data. Probability- Addition and Multiplication Theorem of Probability.

**UNIT II** **15 Hours**

Measure of Central Tendency- Mean, Mode and Median. Measure of Dispersion- Standard deviation and Standard error. Test of Significance-Hypothesis testing- Chi-square test, t-test, F-test, ANOVA-One way and Two way classifications (Simple problems based on these tests).

**UNIT III** **15 Hours**

Centrifugation - Principle, working, maintenance and types of Centrifuge. Electrophoresis - Definition, Types and Isoelectric Focusing. Biosensors - Definition, Components of Biosensors, Types –Electrochemical, Enzyme, Environmental Biosensors. Applications - in Medicine, Pollution control, Industry and Military.

**UNIT IV** **10 Hours**

Principle and working of Colorimeter, UV and Visible Spectrophotometer. Turbidometry, Raman Spectroscopy, Fluorimetry and Atomic Absorption Spectroscopy. Chromatography - Types, Principle and Applications of- TLC, Column Chromatography - Adsorption, Ion exchange, Affinity, Gas-Liquid, HPLC and HPTLC.

**UNIT V** **10 Hours**

Intellectual property Rights-Types, Patent, Copyright, Trademark, Design, Geographical indications. Plagiarism and Biopiracy.

**RECOMMENDED TEXT BOOKS**

1. Banerjee P.K. (2009). Introduction to Biostatistics, 3rdedn. S. Chand and Company Ltd.
2. Webster J.G. (2004). Bioinstrumentation- 4thedn. John Wiley & Sons (Asia) Pvt. Ltd, Singapore.
3. Veerakumari L. (2009). Bioinstrumentation- 5thedn. MJP Publishers, Chennai.

**REFERENCE BOOKS**

1. Rastogi V.B. (2009). Fundamentals of Biostatistics, 2ndedn. Anne Books Pvt Ltd.
2. Boyer R.F. (2000). Modern Experimental Biochemistry, 3rdedn. Pearson Publication.
3. Gurumani N. (2009). An Introduction to Biostatistics, 2ndedn. MJP Publishers.
4. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7thedn. Cambridge University Press.
5. Skoog A. and West M. (2014). Principles of Instrumental Analysis, 14thedn. W.B.Saunders Co., Philadephia.

**JOURNALS**

1. International Journal of Biostatistics and Computational Biology.
2. International Journal of Instrumentation Technology.

**E-LEARNING RESOURCES**

1. https://statisticsbyjim.com/basics/measures-central-tendency-mean-median-mode/
2. https://machinelearningmastery.com/statistical-hypothesis-tests/
3. http://www.biologydiscussion.com/biochemistry/centrifugation/centrifuge- introduction-types-uses-and-other-details-with-diagram/12489
4. https://study.com/academy/lesson/what-is-chromatography-definition-types-uses.html
5. https://www.watelectrical.com/biosensors-types-its-working-and-applications/

**COURSE OUTCOME**

| CO NUMBER | CO STATEMENT |
|---|---|
| CO 1 | Acquire information about basics of biostatistics and its application in research. |
| CO 2 | Use hypothesis testing methods to solve research problems. |
| CO 3 | Acquire theoretical knowledge about basic laboratory equipments and its applications in various fields. |
| CO 4 | Learning the essential steps for designing a research report for scientific communication |
| CO 5 | To understand the importance of ethical issues in research, plagiarism and IPR. |

**MAPPING OF CO WITH PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 2 | 3 | 1 |
| **CO2** | 2 | 2 | 2 | 2 | 3 | 2 |
| **CO3** | 2 | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 1 | 2 | 2 | 2 | 3 | 2 |
| **CO5** | 2 | 3 | 3 | 3 | 3 | 2 |
| **AVERAGE** | 1.6 | 2.0 | 2.0 | 2.4 | 3 | 1.8 |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks (Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

# SEMESTER- III

## NON MAJOR ELECTIVE PAPER
## FERMENTED FOODS AND HEALTH BENEFITS
## (For other discipline students)

**TOTAL HOURS: 30** **COURSE CODE: MB21/3N/FHB**
**CREDITS : 2** **LT P 2 0 0**

**COURSE OBJECTIVES**

- Understand the process of fermentation and related aspects.
- Provide knowledge on various fermented food products.
- Learn about the health benefits and demerits of probiotics.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Fermentation- Definition, Types, Application and Health Benefits. History of Fermented Food. Microbes involved in Fermentation of Foods. Milk based Fermented Food – Curd, Yoghurt, Cheese and Buttermilk- Manufacture Process and Health benefits.

**UNIT II** **10 Hours**

Fermented Foods- Grain based- Soy Sauce, Bread, Idly and Dosa. Vegetable based- Pickle, Sauerkraut, Kombucha and Apple Cider Vinegar. Meat Based- Salami. Fish Based Fermented Foods-Bagoong terong, Garum, Hakari, Kusaya.

**UNIT III** **10 Hours**

Probiotic- Definition, Products and its Health Benefits. Characteristics of Probiotics- Tolerance, Stability, Maintenance of Probiotic Microorganisms. Mechanism of Action of Probiotics. Prebiotic and its Health Benefits. Synbiotics.

**RECOMMENDED TEXTBOOKS**


1. Prescott and Dunn, (1982). Industrial Microbiology.4$^{th}$edn. CBS Publishers and Distributors.
2. Jay J.M. (2005). Modern Food Microbiology.4$^{th}$edn. CBS Publishers and Distributors, *New* Delhi. .


**REFERENCES**


1. Hui Y.H. (2016). Handbook of Animal - Based Fermented Food and Beverage Technology, 2$^{nd}$edn. CRC Press, New York.
2. Prescott L.M, Harley J.P and Klein D.A. (2013). Microbiology, 9$^{th}$edn. McGraw-Hill Publications.
3. Dubey R.C. and Maheshwari D.K. (2007). A Textbook of Microbiology, 1$^{st}$edn. S. Chand and Company Ltd.


**JOURNALS**

1. International Journal of Fermented Foods.
2. Journal of Ethnic Foods.

**E-LEARNING RESOURCES:**

1. https://www.med.umich.edu/pfans/_pdf/hetm-2017/0717-fermentedfoods.pdf
2. https://www.healthline.com/nutrition/11-super-healthy-probiotic-foods#TOC_TITLE_HDR_5
3. https://www.biotechnologynotes.com/industrial-biotechnology/fermentation-process/fermentation-types-8-types-of-fermentations-industrial-biotechnology/13695

**TEACHING METHODOLOGY**

Lecture (Chalk and Talk-online platforms-LCD), Problem Solving, Group Discussion.

**COURSE OUTCOME**

| | |
|---|---|
| CO 1 | Utilize the knowledge on fermentation in industrial processes |
| CO2 | Use the techniques learnt to become an entrepreneur. |
| CO 3 | Apply the knowledge gained for healthy living |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 1 | 3 | 2 | 2 | 2 |
| **CO 2** | 2 | 2 | 1 | 1 | 2 | 3 |
| **CO 3** | 1 | 3 | 2 | 2 | 2 | 2 |
| **Average** | **1.6** | **2** | **2** | **1.6** | **2** | **2.3** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, ONLINE PLATFORMS, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**Question Paper Pattern**
**End Semester Examination**

| Bloom's Category | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| K1, K2 | A – 10x 5Marks<br>(12 Questions will be given) | 200 | 50 | 50 |

## SEMESTER IV COURSE PROFILE-PROGRAMME OF STUDY

| COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS/ WK | TOTAL HOURS | L-T-P | CA | SE | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | Language IV | 3 | 6 | 90 | | | | |
| | English-IV | 3 | 4 | 60 | | | | |
| MB21/4C/MIG | Microbial Genetics | 5 | 7 | 105 | 4-3-0 | 40 | 60 | 100 |
| MB21/4A/ECB | Allied - Essentials of Computers and Bioinformatics | 4 | 4 | 60 | 3-1-0 | 40 | 60 | 100 |
| MB21/4C/PR2 | Immunology and Microbial Genetics Practical | 4 | 3 | 45 | 0-0-3 | 40 | 60 | 100 |
| MB21/4A/PR1 | Allied- Biostatistics, Essentials of Computers and Bioinformatics Practical | 2 | 2 | 30 | 0-0-2 | 40 | 60 | 100 |
| MB21/4N/HGA 1a/b/c | Home Gardening | 2 | 2 | 30 | 2-0-0 | | | 50 |
| | Soft Skill | 3 | 2 | 30 | | | | 50 |
| | **TOTAL CREDITS** | **26** | | | | | | |

## SEMESTER – IV

## MICROBIAL GENETICS

**TOTAL HOURS: 105** **COURSE CODE: MB21/4C/MIG**
**CREDITS: 5** **L T P : 4 3 0**

**COURSE OBJECTIVES**

1. Provide knowledge on structure of DNA, plasmids and their replication.
2. Explain the cause and types of DNA mutation and DNA repair mechanisms.
3. Discuss the gene expression and regulation in prokaryotes.
4. Study the role of phages in genetics
5. Learn mechanisms of gene transfer and recombination.

**COURSE OUTLINE**

**UNIT I** **20 Hours**

DNA as Genetic material, Structure of DNA. Factors affecting structure of DNA, Forms of DNA, Supercoiling of DNA, DNA replication – Enzymes, Stages and Models. Rolling Circle Replication. Plasmids and their Significance.

**UNIT II** **20 Hours**

Mutation –Definition, Causes and Types – Spontaneous and Induced Mutations. Isolation and identification of Mutants – Methods for Mutant selection – Replica plating, Ames test. DNA Repair Mechanisms- Photo Reactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.

**UNIT III** **22 Hours**

Gene expression in Prokaryotes– Structure of mRNA, rRNA and tRNA, Genetic Code, Transcription- RNA Polymerase and Stages of Transcription, Post Transcriptional Processing – Polyadenylation, capping and Splicing of Introns, Transcriptomics – Definition and Transcriptomics Analysis, Translation- Stages and Inhibitors. Operon Concept – *lac* and *trp* Operon.

**UNIT IV** **20 Hours**

Bacteriophage - T4 Virulent Phage: Structure, Life cycle and DNA replication. Lambda phage- Structure, Genetic map, Lytic and Lysogenic cycle. Applications of Phages in Microbial Genetics. Epigenetics – Definition and Mechanisms in Bacteria – Role of DNA Methylation.

**UNIT V** **23 Hours**

Gene Transfer Mechanisms - Conjugation and its uses. Transduction- Generalized and Specialized, Transformation–Natural Competence and Transformation. Transposition and Types of Transposition reactions. Recombination- Homologous recombination- Double Strand Break Repair model, Site-specific Recombination.

**RECOMMENDED TEXT BOOKS**

1. Friefelder D. (2008). Molecular Biology. 4th edn. Narosa Publishing House, New Delhi.
2. Trun N. and Trempy J. (2004). Fundamental Bacterial Genetics. 1st edn. Blackwell Science Ltd., Oxford.
3. Paolella P. (1998). Introduction to Molecular Biology. 2nd edn. McGraw-Hill.

**REFERENCE BOOKS**

1. Russell P.J. (2009). Genetics- A Molecular Approach. 3th edn. Pearson international
2. Old R.W. and Primrose S.B. (1985) Principles of Gene Manipulation. 4th edn. Blackwell Scientific Publication, London.
3. Hays W. (1969).The Genetics of Bacteria and Viruses. 2nd edn. Blackwell Scientific Publication, London.
4. Dubey R.C. and Maheshwari D.K. (2007). A Textbook of Microbiology. 1st revised edn, S.Chand and Company Ltd.
5. Prescott Harley Klein, (2009), Microbiology. 8th edn. McGraw- Hill International edn.

**JOURNALS**

1. International Journal of Current Biotechnology.
2. Journal of Genetics and Genomics.

**E-LEARNING RESOURCES**

1. https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/
2. ttps://www.nature.com/scitable/topicpage/operons-and-prokaryotic-gene-regulation 992/
3. https://www.eolss.net/Sample-Chapters/C03/E6-51-04-03.pdf
4. https://microbeonline.com/key-information-regarding-gene-transfer-mechanism bacteria/
5. https://mmbr.asm.org/content/70/3/830
6. https://geneticeducation.co.in/what-is-transcriptomics/

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Analyse the significance of DNA and elucidate the replication mechanism. |
| CO 2 | Infer the causes and types of DNA mutation and summarize the DNA repair mechanisms. |
| CO 3 | Explain the ideas and concepts of gene expression in prokaryotes. |
| CO 4 | Evaluate the importance of phages in genetics. |
| CO 5 | Analyse gene transfer and recombination methods |

**MAPPING OF CO WITH PSO**

| CO / PO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 1 | 3 | 3 | 1 | 2 | 2 |
| **CO 2** | 2 | 3 | 3 | 2 | 3 | 3 |
| **CO 3** | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 4** | 2 | 1 | 2 | 3 | 1 | 2 |
| **CO 5** | 2 | 2 | 3 | 3 | 2 | 2 |
| **Average** | **2.0** | **2.4** | **2.8** | **2.4** | **2.0** | **2.2** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online platform, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER IV

## ALLIED–ESSENTIALS OF COMPUTERS AND BIOINFORMATICS

**TOTAL HOURS: 60** **COURSE CODE: MB21/4A/ECB**
**CREDITS: 4** **LT P: 3 1 0**

**COURSE OBJECTIVES**

1. Learn the basics and operation of Computers.
2. Explain the importance of computers in biological sciences.
3. Equip the students with basic knowledge in biological databases.
4. Teach how to use bioinformatics tools in sequence analysis.
5. Impart the fundamentals of genome analysis, gene prediction and *in-silico* drug discovery.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Introduction to Computer, User Interface with the Operating System, Binary Coding System and Network Terminologies. Working with Windows and MS Office Software concerning Word Processing, Spreadsheets and Presentation Software.

**UNIT II** **10 Hours**

Internet and ICT with its Applications, IT Act, System Security (Virus/Firewall). Cloud Computing- using Google Docs, Google Scholar, Google Sheets, Google Meet, MS Teams and Zoom Scheduling. Overview of Life Science Oriented Software, their usage in Laboratories (Python, MATLAB and others) and Healthcare (Azure, Holo Lens, Etc.).

**UNIT III** **10 Hours**

Forms of Biological information and the need for storage. General introduction to Biological Databases- Nucleic Acid Databases (NCBI, DDBJ, and EMBL). Protein Databases (PIR, Uniprot). Specialized Genome Databases (SGD and Microbial Genome Database-MGDB). Structure Database-PDB.

**UNIT IV** **20 Hours**

Retrieval methods for Nucleic Acid and Protein Sequences. Use of Bioinformatic Tools - Sequence Homology- Substitution Matrices- PAM and BLOSUM. Pairwise Alignment (Global and Local) Using BLAST. Multiple Sequence Alignment Using Clustal Omega.

**UNIT V** **10 Hours**

Methods of Genome analysis- Shot Gun and Hierarchical methods. Gene Prediction using GENEMARK. Phylogenetic Tree Construction by MEGA (Molecular Genetic Evolutionary Analysis). Protein Structure Visualization Tool- Rasmol and Molmol.

**RECOMMENDED TEXT BOOKS**

1. Norton P. (2008). Introduction to Computer, 6th edn. Tata McGraw Hill Publications.
2. Xiong J, (2011). Essential Bioinformatics, First South Indian Edition, Cambridge University Press.
3. Rastogi S.C., Mendiratla N. and Rastogi P. (2013). Bioinformatics Methods and Applications- Genomics, Proteomics and Drug Discovery. 4th edn. Prentice Hall India.

**REFERENCE BOOKS**

1. Rajaraman V. (2003). Fundamentals of Computers, 4th edn. PHI.
2. Millard C. (2013). Cloud computing law, 2nd edn. Oxford University press.
3. Attwood T.K. and Parry-Smith D.J. (1999). Introduction to Bioinformatics.1st edn. Addision Wesley Longman Limited, England.
4. Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2nd edn. CBS Publishers, New Delhi.
5. Baxevanis A.D. Francis Ouellette B. F. (2012) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 3rd edn. Wiley and Sons.

**JOURNALS**

1. Journal of Computers.
2. BMC Bioinformatics.

**E-LEARNING RESOURCES**

1. https://azure.microsoft.com/en-in/overview/what-is-cloud-computing/
2. http://etec.ctlt.ubc.ca/510wiki/Google_Products_in_the_Classroom
3. https://biochem.slu.edu/bchm628/handouts/Exercise3_tutorials_2020.pdf
4. https://www.ebi.ac.uk/Tools/msa/clustalo/
5. https://bioinformaticsreview.com/20200915/tutorial-constructing-phylogenetic-tree-using-mega7/

**COURSE OUTCOME**

| | |
|---|---|
| 1 | Acquire basic skills in operation of computers and MS programs. |
| 2 | Apply the computer skill in communication, cloud computing and scheduling meetings. |
| 3 | Utilize the fundamentals of bioinformatics in retrieving and analysing sequences |
| 4 | Perform pairwise and multiple alignment in identifying homology and phylogeny. |
| 5 | Utilize genome analysis and gene prediction for functional annotation. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 1 | 1 | 3 | 1 |
| **CO 2** | 2 | 2 | 2 | 2 | 3 | 1 |
| **CO 3** | 2 | 2 | 2 | 2 | 3 | 1 |
| **CO 4** | 2 | 2 | 2 | 2 | 3 | 1 |
| **CO 5** | 2 | 2 | 2 | 2 | 3 | 1 |
| **Average** | **2** | **2** | **1.8** | **1.8** | **3** | **1** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY:**
Lecture by chalk and talk, Flipped Learning, Online Platforms, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight) (**One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER IV

## IMMUNOLOGY AND MICROBIAL GENETICS PRACTICAL

**TOTAL HOURS: 90** **COURSE CODE: MB21/4C/PR2**
**CREDITS: 4** **L T P: 0 0 3**

**COURSE OBJECTIVES**

1. Learn basic concepts of immunological and molecular techniques.
2. Analyze the morphology and count of blood cells.
3. Understand the principles of various antigen and antibody reactions.

**COURSE OUTLINE**

1. Collection of Blood – Demonstration.
2. Hemagglutination - Blood grouping ABO and Rh – typing- Slide method.
3. Total count of RBC.
4. Total count of WBC.
5. Differential count of Blood cells.
6. Separation of Buffy coat –Ficoll Hypaque method.
7. Agglutination- ASO.
8. Agglutination – RA.
9. Agglutination-HCG.
10. Agglutination-CRP.
11. Flocculation – RPR.
12. WIDAL - Slide method.
13. WIDAL - Tube method.
14. Precipitation Reaction – Immunodiffusion - Ouchterlony patterns.
15. Precipitation Reaction – Immunodiffusion – SRID.
16. Immunoelectrophoresis –Double Immunodiffusion.
17. Serum immunoelectrophoresis.
18. Counter Immunoelectrophoresis.
19. Coomb's test.
20. ELISA – Demonstration.
21. Dot Blot Technique.
22. Isolation of genomic DNA - Demonstration.
23. Agarose Gel Electrophoresis - Demonstration.
24. Polyacrylamide Gel Electrophoresis - Demonstration.

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Analyse the morphology and total count of blood cells by complete blood count test. |
| CO 2 | Appraise and detect various diseases by agglutination and precipitation reactions. |
| CO 3 | Confirm the presence of infection by WIDAL, ELISA, Dot Blot and molecular methods. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 3 | 3 | 2 | 2 |
| **CO 2** | 3 | 2 | 3 | 3 | 2 | 2 |
| **CO 3** | 3 | 2 | 3 | 3 | 2 | 2 |
| **Average** | **3** | **2** | **3** | **3** | **2** | **2** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**
Demonstration, Experimentation, Videos on Protocols and Virtual labs

**QUESTION PAPER PATTERN**:

**Time: 6 Hours** **(3 Hours, Two days)** **Max Marks: 60**

**Major Practical : 25 marks**
**Minor Practical : 15 marks**
**Spotters (5 x 2) : 10 marks**
**Record : 10 marks**

**SEMESTER IV**
**BIOSTATISTICS, ESSENTIALS OF COMPUTERS AND BIOINFORMATICS PRACTICAL**

**TOTAL HOURS: 60** **COURSE CODE: MB21/4A/PR1**
**CREDITS: 2** **LT P: 0 0 2**

**COURSE OBJECTIVES**

1. Use statistical representation of data.
2. Imbibe knowledge on application of biostatistics and computers.
3. Equip the students with basic knowledge in biological database retrieval and analysis.

**COURSE OUTLINE**

1. Representation of statistical data by (a.) Histograms (b) Ogive curve c) Pie diagrams.
2. Determination of Statistical Averages / Central Tendency.
   (a) Arithmetic Mean (b) Median (c) Mode
3. Determination of measures of dispersion
   (a) Mean Deviation (b) Standard Deviation (c) Standard error.
4. Tests of significance – application of following;
   (a) Chi Square test (b) t –test
5. Applications of Computer in Biology using MS – Office (a) MS – Word (b) MS – Excel (c) Power Point.
6. Creating, merging and splitting of files.
7. Resizing of images and comprising documents to desired size.
8. Creating an e- mail account. Sending and receiving mails.
9. An introduction to Internet, Search Engines, Websites. Browsing, Downloading and security systems.
10. Basics of working with audio and video files.
11. Web page designing and video publishing.
12. Retrieval of nucleotide sequences and protein sequences from NCBI, EBI and SWISS PROT.
13. BLAST analysis.
14. FASTA analysis.
15. DOT plot analysis.
16. Multiple sequence alignment- CLUSTAL omega.
17. Visualization of protein structure in PDB.

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Utilize measures of central tendency and dispersion to solve statistical problems. |
| CO 2 | Appreciate operation of computer and its application in research. |
| CO 3 | Analyse biological data for alignment and homology detection. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 3 | 3 | 2 |
| **CO 2** | 3 | 2 | 2 | 3 | 3 | 1 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 2 |
| **Average** | **3** | **2.6** | **2.3** | **3** | **3** | **1.6** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Hands on training, use of software applications, online tools.

**QUESTION PAPER PATTERN**

**(Time-3 hours, One day)** **Max Marks-60**

**Major Practical : 30 marks**
**Minor Practical : 20 marks**
**Record : 10 marks**

**SEMESTER – IV**
**NON MAJOR ELECTIVE PAPER**
**HOME GARDENING**
**(For other discipline students)**

**TOTAL HOURS: 30** **COURSE CODE: MB21/4N/HGA**
**CREDITS : 2** **LT P : 2 0 0**

**COURSE OBJECTIVES**

1. Analyse the benefits of home gardening
2. Describe the plants suitable for home gardening
3. Understand the essentials and merits of kitchen gardening
4. Enlist the methods and operations of roof gardening
5. Elaborate the techniques of growing plants in pots and indoor.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Definition and Characteristics of a Home Garden, Key Benefits of Home Gardening – Social, Economic and Environmental benefits, Constraints, Essential Tools and Requirements for Home Gardening. Types of Potting mixture and manure.

**UNIT II** **10 Hours**

Definition and Advantages of Kitchen Gardening. Requirements, Crops suitable for Kitchen Garden, Types – Container Garden, Raised Beds, In Ground Garden, Layout, Planting And Maintenance.

**UNIT 3** **10 Hours**

Plants and Vegetables Suitable for Pot and Roof Gardening, Soil, Sun and Water Requirements, Methods - Containers, Raised Beds, Vertical Gardening, Soilless Gardening, Planting And Maintenance. Indoor Gardening – Indoor Plant Varieties, Light requirements, Containers and Care.

**RECOMMENDED TEXTBOOKS**


1. Chakrabarty S. (2018).Organic Home Gardening Made Easy. 1st edn. India, Notion Press.
2. Agarwal V. and Bharghava P. (2018). Home Gardening 1st edn. India, Pustak Mahal.
3. Batth A.S. (2016). Home Gardeners' Guide Indian Garden Flowers, 1st edn. Fingerprint Publishing.


**REFERENCE TEXTBOOKS**


1. Espiritu K. (2019).Field Guide to Urban Gardening: United Kingdom.1st edn.Cool Springs Press.
2. Morrow E. (2015).Container Gardening for Beginners.1st edn. Mihails Konoplovs.
3. Mehra P. (2019).Teach Yourself Gardening India, Hind Pocket Books.
4. Bora, T (2021).How Not to Kill Your Houseplants 1st edn. Ebury Press Penguin Random House.
5. Latha A.M (2016).Steps for starting a low budget organic vegetable Terrace garden. 2nd edn. India, Green House India Publisher.

**E-LEARNING RESOURCES**

1. https://www.researchgate.net/publication/306030847_A_farmer's_guide_to_home_gardening_How_to_establish_and_manage_home_gardens
2. https://www.nestle.com/sites/default/files/assetlibrary/documents/nutrition_health_wellness/vegetable-gardening-booklet.pdf
3. https://ati.da.gov.ph/ati-car/sites/default/files/URBAN_GARDENING_WITH_UPLAND_VEG_PROD.pdf
4. https://www.almanac.com/sites/default/files/webform/pdf/almanac-start-a-garden.pdf
5. https://www.agriculturenigeria.com/manuals/research/articles/an-introduction-to-home-gardening/

**JOURNALS**

1. Journal of Applied Horticulture.
2. Journal of Horticulture and Plant Research.

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Recall the basics of plant growing and its benefits |
| CO 2 | Describe the planting methods of kitchen garden and its maintenance. |
| CO 3 | Infer the requirements and techniques involved in container and indoor gardening |

**MAPPING OF CO WITH PO**

| CO / PO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 1 | 1 | 3 | 3 |
| **CO 2** | 2 | 2 | 2 | 2 | 3 | 2 |
| **CO 3** | 2 | 2 | 2 | 2 | 2 | 3 |
| **Average** | **2** | **2** | **1.6** | **1.6** | **2.6** | **2.6** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Teaching by showing garden and plant specimens, LCD projector, Assignment, Quiz, Seminar,

**QUESTION PAPER PATTERN**

**End Semester Examination**

| Bloom's Category | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| K1, K2 | A – 10x 5Marks (12 Questions will be given) | 200 | 50 | 50 |

## SEMESTER V COURSE PROFILE-PROGRAMME OF STUDY

| COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS /WK | TOTAL HOURS | L-T-P | CA | SE | TOTAL |
|---|---|---|---|---|---|---|---|---|
| MB21/5C/BAV | Bacteriology and Virology | 4 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21/5C/SAM | Soil and Agricultural Microbiology | 4 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21/5C/FMB | Food Microbiology | 4 | 4 | 60 | 3-1-0 | 40 | 60 | 100 |
| MB21/5E/NBT (or) MB21/5E/ BEY | Nanobiotechnology / Bioenergy | 5 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21/5E/WMT (or) MB21/5E/MCT | Waste Management / Mushroom Cultivation | 5 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21/6C/PR3 | Medical Microbiology Practical | - | 3 | 45 | 0-0-3 | 40 | 60 | 100 |
| MB21/6C/PR4 | Applied Microbiology Practical | - | 3 | 45 | 0-0-3 | 40 | 60 | 100 |
| Self-Study Paper | Forensic Science and Crime Investigation* | 2 | | | | | | 100 |
| | **TOTAL CREDITS** | **22 + 2 (For Advanced Learners)** | | | | | | |

## SEMESTER V
## BACTERIOLOGY AND VIROLOGY

**TOTAL HOURS: 75** **COURSE CODE: MB21/5C/BAV**
**CREDITS: 4** **LT P: 3 2 0**

**COURSE OBJECTIVES**

1. Impart basic concepts in Bacteriology and Virology and study the virulence factors contributing to pathogenicity.
2. Explain several bacterial and viral diseases, pathogenesis and their clinical features.
3. Teach various zoonotic and nosocomial infections, ways to tackle them and use biosafety precautions
4. Train various techniques of sample collection, transport and processing for laboratory diagnosis of bacterial and viral diseases.
5. Study appropriate immunological and serological methods for early detection of viruses and bacteria and employ antibiotics and antiviral drugs to combat them.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Normal Human Microbiota and Microbiome. Morphology, Replication and Cultivation of Bacteria and Viruses. Virulence factors involved in Bacterial and Viral Pathogenesis.

**UNIT II** **20 Hours**

Bacterial infections- Gram Positive- *Staphylococcus aureus, Streptococcus pyogenes and Clostridium sp.* Gram Negative- *Escherichia coli, Salmonella, Vibrio cholerae, Neisseria Sp.* Slow growing and non-cultivable bacteria- *Mycobacterium leprae, Treponema pallidum, Helicobacter pylori* and *Chlamydia trachomatis.*

**UNIT III** **15 Hours**

Viral Infections- DNA Virus- HSV, Varicella Zoster and HBV. RNA Viruses- Polio, Influenza, Mumps, Measles, Rubella and HIV. Arthropod Borne diseases- Dengue, Chikungunya.

**UNIT IV** **15 Hours**

Principles of Zoonotic infections- Anthrax, Plague, Rabies and Nipah. Role of Virus in Oncogenesis- HPV, EBV and HCV. Emerging and Reemerging Bacterial and Viral infections- Tuberculosis, Corona-SARS-CoV-2 and ZIKA. Nosocomial infections- Factors, Organisms- Pseudomonas, MDR- Klebsiella, MRSA and Control measures.

**UNIT V** **15 Hours**

Clinical Bacteriology and Virology - Collection, Handling and Processing of Specimens for Detection of Bacteria and Viruses- Bacterial and Viral transport media, Culture, Serology and Molecular Techniques. Prevention and Control- Vaccines, Interferons, Antibiotics and Antiviral drugs.

**RECOMMENDED TEXT BOOKS**


1. Ananthanarayanan R. and Panicker C.K.J. (2017). Textbook of Microbiology, 10$^{th}$edn. Orient Longman.
2. Murray P.R., Rosenthal K.S. and Pfaller M.A. (2013). Medical Microbiology, Philadelphia: 7$^{th}$ edn. Elsevier/Saunders.
3. Goering R.V. and Cedric A. (2008). Mim's Medical Microbiology, 7$^{th}$edn. Elsevier Ltd.

**REFERENCE BOOKS**


1. Jawetz E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology, 19th edn. Lange Medical Publications, U.S.A.
2. Collee J.C., Duguid J.P., Fraser A.C. and Marimon B.P. (1996). Mackie and McCartney Practical Medical Microbiology, 14th edn. Churchill Livingstone, London.
3. Ryan K.J. Ray C.G (2003). Sherris Medical Microbiology- An introduction to Infectious Diseases, 4th edn. McGraw Hill, New York.
4. Timbury, M.C, (1994). Medical Virology 10th edn. Churchill Livingston.
5. Greenwood D., Slack R.B. and Peutherer J.F. (2002). Medical Microbiology, 14th edn. Churchill Livingston London.


**JOURNALS**

1. Indian Journal of Medical Microbiology.
2. Journal of Bacteriology.

**E-LEARNING RESOURCES**

1. https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(OpenStax)/15%3A_Microbial_Mechanisms_of_Pathogenicity
2. https://www.healthcare.uiowa.edu/path_handbook/Appendix/Micro/micro_spec_collection.html
3. http://www.textbookofbacteriology.net/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4196475/
5. https://viralzone.expasy.org/656
6. https://www.researchgate.net/publication/21284929_Antiviral_drugs
7. https://www.clinmedjournals.org/articles/ijva/international-journal-of-virology-and-aids-ijva-7-067.pdf
8. https://www.ijidonline.com/article/S1201-9712(20)30045-X/fulltext
9. https://www.researchgate.net/publication/312584686_Nosocomial_infections_Epidemiology_prevention_control_and_surveillance
10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5672523/

**COURSE OUTCOME**

| | |
|---|---|
| 1 | Analyse the structure and factors contributing to pathogenicity of bacteria and virus, acquire knowledge on importance of human microbiome in preventing infectious diseases |
| 2 | Assess the role of pathogenic bacteria in infections and diagnose them in laboratory |
| 3 | Evaluate the etiology, pathogenesis and clinical features of viral infections. |
| 4 | Assess the impact of zoonotic, nosocomial and emerging infections in public health and devise strategies to prevent and manage them |
| 5 | Identify the appropriate cultivation and diagnostic techniques and use appropriate prophylactic and antimicrobial therapy |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 3 | 3 | 2 | 2 |
| **CO 2** | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO 3** | 2 | 3 | 3 | 2 | 2 | 2 |
| **CO 4** | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 5** | 1 | 3 | 3 | 3 | 2 | 2 |
| **Average** | **2.2** | **2.6** | **3** | **2.6** | **2** | **2** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, Flipped Learning, Online Platforms, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | One or Two Sentences | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight) (**One to be taken from each unit.Remaining 3 questions can be from any 3 units) | 500 | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | 1200 | **40** | |

## SEMESTER V

## SOIL AND AGRICULTURAL MICROBIOLOGY

**TOTAL HOURS: 75** **COURSE CODE: MB21/5C/SAM**
**CREDITS: 4** **LTP: 3 2 0**

**COURSE OBJECTIVES**

1. Demonstrate the role and contribution of microorganisms in soil.
2. Discuss the benefits resulting from interactions of soil microbes.
3. Explain the nutrient cycling and biological nitrogen fixation.
4. Outline the etiology and pathogenesis of plant pathogens.
5. Assess the use of soil microbes as fertilizers and bio pesticides.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Soil Microbiology – Physical and Chemical Properties of Soil. Soil Profile, Diversity and Distribution and Role of Bacteria, Actinomycetes, Algae, Fungi and Viruses in Soil. Soil Microcosm- Definition and its Uses.

**UNIT II** **20 Hours**

Microbial Interactions - Mutualism, Commensalism, Amensalism, Synergism, Competition, Parasitism. Rhizosphere- Rhizosphere effect- Benefits to Plants and Rhizobacteria, Phyllosphere, Mycorrhizae, Endophytes, PGPR- PGPR traits and Quorum sensing.

**UNIT III** **10Hours**

Biogeochemical Cycles - Carbon Cycle, Nitrogen cycle and Sulphur Cycle. Biological Nitrogen fixation- Chemistry and Genetics of BNF, Leguminous, Non-leguminous and Endophytic BNF, $N_2$ fixing Microorganisms and Quantification methods. Nitrogen Fixation Engineering.

**UNIT IV** **20 Hours**

Plant Pathology - Microbial Diseases of Plant-Bacterial - Citrus Canker, Soft Rot in Carrot, Bacterial Blight of Paddy, Fungal – Red Rot of Sugar Cane, Tikka Disease of Groundnut, Fusarial Wilt in Cotton, Damping off disease of Vegetables. Viral - Mosaic Disease in Tobacco, Bunchy top Disease of Banana, Parasite - Root knot Nematode in tomato. Prevention and Control of Plant Diseases.

**UNIT V** **15 Hours**

Soil Fertility - Soil nutrient requirement for Agriculture- Macro and Micro nutrients. Production, Application and Uses of Biofertilizers - VAM, *Rhizobium, Azotobacter, Azospirillum* and Cyanobacteria. Biofilmed Biofertilizer, New formulations and delivery methods. Biopesticides-Bacterial, Fungal and Viral.

**RECOMMENDED TEXTBOOKS**

1. Atlas R.M. and Bartha R. (1998). Microbial Ecology Fundamentals and Applications, 3rd edn. Benjamin Cummings. Redwood City. C. A.
2. Subbarao N.S. (1995). Biofertilizers in Agriculture and Forestry, 3rdedn. Oxford and IBH Publishing co. Pvt Ltd.
3. Rangaswami G. (2005). Diseases of Crop Plants in India. 4thedn. Prentice Hall of India Pvt. Ltd., New Delhi.

**REFERENCE BOOKS**

1. Singh H. B., Sharma B. K. and Keswani C. (2017). Advances in PGPR Research. 2ndedn. CABI Publishing. DOI10.1079/9781786390325.0000
2. Paul E.A. and Clark F.E, (1996). Soil Microbiology and Biochemistry. 2ndedn. Academic Press, London.
3. Agrios G. (2005). Plant Pathology, 5thedn. Reed Elsevier India Private Limited, New Delhi, India.
4. Lucas J.A. (1998). Plant Pathology and Plant Pathogens. 3rdedn. Blackwell Science, Oxford.
5. Geger M.J. and Stence M.J. (2001). Biotic Interactions in Plant Pathogen association. 1stedn. CAB-International, United Kingdom.

**E-LEARNING RESOURCES**

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6273255/
2. https://www.researchgate.net/publication/332551331_Plant_Growth_Promoting_RhizobacteriaA_review
3. https://scialert.net/fulltext/?doi=ajps.2007.203.213
4. https://www.researchgate.net/publication/338993827_Transfer_of_Nitrogen_Fixation_nif_Genes_to_Non-diazotrophic_Hosts
5. https://www.researchgate.net/publication/225865218_Quorum_Sensing_and_Quorum_Quenching_in_Soil_Ecosystems

**JOURNALS**

1. Indian Journal of Agricultural Research
2. Journal of Plant Pathology and Microbiology

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Perceive the contribution and activity of soil microbes in enhancing soil fertility. |
| CO 2 | Critically analyse the beneficial effects resulting from microbial interactions in soil. |
| CO 3 | Appraise the crucial events involved in microbe-mediated transformation of elements in the ecosystem. |
| CO 4 | Examine the mode of survival of pathogens on plants and assess its impact on crop production. |
| CO 5 | Accredit the economic usage of beneficial soil microbes for better plant growth and yield. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO 2** | 3 | 3 | 1 | 2 | 1 | 1 |
| **CO 3** | 3 | 3 | 2 | 3 | 1 | 2 |
| **CO 4** | 3 | 1 | 1 | 3 | 2 | 2 |
| **CO 5** | 3 | 3 | 2 | 3 | 2 | 2 |
| **Average** | **3** | **2.6** | **1.6** | **2.8** | **1.6** | **1.6** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, e-content, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

**SEMESTER V**
**FOOD MICROBIOLOGY**

**TOTAL HOURS: 60** **COURSE CODE: MB21/5C/FMB**
**CREDITS: 4** **LTP: 3 1 0**

**COURSE OBJECTIVES**

1. Examine the role of microbes in growth and spoilage of food and apply specific preservation techniques.
2. Assess spoilage of various food products and food borne illness caused by microbes.
3. Detection of food pathogens with reference to microbiological and immunological techniques and prevent food related outbreaks.
4. Learn the food quality analysis techniques and production of fermented milk products.
5. Implement good hygiene practices, introduce to food laws and recent trends in food industries.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Introduction to Food Microbiology –.Microorganisms in Food - Bacteria and Fungi. Factors (Extrinsic and Intrinsic) Affecting Microbial Growth in Food. Contamination of Foods. Principles of Preservation - Asepsis, High Temperature, Low Temperature, Drying, Irradiation and Food Additives.

**UNIT II** **10 Hours**

Spoilage of Food- Fruits, Vegetables, Fresh Meat, Processed meat, Poultry, Fish and Sea foods, Canned foods. Food borne Bacterial illness- *Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Listeria.* Food borne Poisoning and Infections - Nematodes, Protozoa, Algae, Fungi and Viruses. Food Poisoning by Chemicals.

**UNIT III** **15 Hours**

Detection methods used for identifying Food Borne Pathogens -Culture, Microscopic, and Sampling Method for Detecting Microbes, Modified and Conventional Automated Methods, Immunological Methods, DNA Based methods and Biosensors. Investigation of Food Borne outbreaks- Laboratory testing and Preventive Measures.

**UNIT IV** **10 Hours**

Microbiology of Milk-Microbes in Milk, Milk Borne Infections. Fermentation of Milk-Souring, Lactic Acid Fermentation, Colour and Flavours, Gassy Fermentation and Proteolysis. Quality Control Tests – Phosphatase, Resazurin and Reductase Tests. Microbial food fermentations-Alcoholic fermentation and Lactic acid Fermentation. Fermented Dairy Products- Production of Cheese, Yogurt, Buttermilk, Kumis, Kefir, Acidophilus milk, Probiotics and Fermented Vegetables – Sauerkraut.

**UNIT V** **15 Hours**

Good Hygiene Practices, Sanitation in Manufacture and Retail Trade, Hazard Analysis and Critical Control Points (HACCP), GMP, Plant Sanitation-Employees' Health Standard. Waste Treatment and Disposal. Quality Control, Food Control Agencies and their Roles, Bureau of Indian Standards. Food Laws and Standards in India (FSS). Recent Trends and Development in Food Technologies in India.

**RECOMMENDED TEXT BOOKS**


1. Frazier W.C. and Westoff D.C. (1988). Food Microbiology, 4th edn. Tata McGraw Hill Publishing Company Ltd. New York.
2. Jay J.M. (2005).Modern Food Microbiology 4th edn. CBS Publishers and Distributors. New Delhi
3. Reed G. (1982). Prescott and Dunn's Industrial Microbiology, 4th edn. CBS Publishers and Distributors.


**REFERENCE BOOKS**


1. Robinson R. K. (2000). Dairy Microbiology 3rd edn. Elsevier Applied Science, London.
2. Adams M.R, and Moss M.D, (2005). Food Microbiology4th edn. New Age International Pvt. Ltd., Publishers.
3. Banwarst. G.J. (2003).Basic Food Microbiology 2nd edn. CBS Publishers and distributors.
4. Hobbs, B.C. and Roberts, D, (1968). Food Poisoning and Food Hygiene 7th edn. Edward Arnold: London.
5. Vijaya R. K. (2004). Food Microbiology, 1st edn. MJP Publishers, Chennai.


**JOURNALS**

1. International Journal of Food Microbiology.
2. Indian Journal of Microbiology and Research.

**E-LEARNING RESOURCES**

1. https://www.researchgate.net/publication/15326559_A_Dynamic_Approach_to_Predicting_Bacterial-Growth_in_Food/link/5a1d2e02aca2726120b28eba/download
2. https://www.fda.gov/food/laboratory-methods-food/bam-food-samplingpreparation-sample-homogenate
3. https://scialert.net/fulltext/?doi=ajft.2011.87.102
4. https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-_A_review
5. https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter_Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/download
6. https://www.fda.gov/food

**COURSE OUTCOMES**

| | |
|---|---|
| CO1 | Determine the role of microorganisms in food industries, preservation techniques, spoilage of food and to check quality control of food. |
| CO2 | Examine and identify the role of pathogens in food borne infections and food poisoning. |
| CO3 | Detect food pathogens based on physical, chemical and immunological methods and choose appropriate preservative techniques and prevent food borne outbreaks. |
| CO4 | Assess the techniques in checking milk quality, fermentation of milk and to perform production of fermented milk foods on a large scale level. |
| CO5 | Implement hygiene practice and sanitation, apply hazard analysis, Food laws and standards for good quality in food production. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 1 | 3 | 1 | 2 |
| **CO 2** | 2 | 2 | 3 | 3 | 2 | 2 |
| **CO 3** | 2 | 2 | 1 | 3 | 2 | 2 |
| **CO 4** | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO 5** | 2 | 2 | 2 | 3 | 2 | 2 |
| **Average** | **2** | **2** | **2** | **3** | **2** | **2** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, Flipped Learning, online platforms, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

**SEMESTER V**
**NANOBIOTECHNOLOGY**

**TOTAL HOURS: 75** **COURSE CODE: MB21/5E/NBT**
**CREDITS: 5** **L T P: 3 2 0**

**COURSE OBJECTIVE**

1. Acquire an insight on history and developments in Nanobiotechnology.
2. Introduce various nanoparticles structure and properties.
3. Learn the different methods of nanoparticle synthesis and characterization.
4. Attain adequate knowledge on the wide spread applications of nanoparticles.
5. Expose them to the various toxic effect of nanoparticles on human and nature.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Introduction and history Nanobiotechnology. Classification on Nanoparticles. Nanomaterial in Biotechnology - Nanoparticles, Quantum dots, Nanotubes and Nanowires. Physical, Chemical and Biological Nature of Nanomaterial - Cell – Nanostructure Interactions

**UNIT II** **15 Hours**

Synthesis of Nanoparticles - Chemical methods- Sol-gel Synthesis, Micro emulsions, Solvo Thermal synthesis, Physical methods- Inert gas condensation, Ion sputtering and Pyrolysis.

**UNIT III** **15 Hours**

Biological methods of Nanoparticle Synthesis- Microbial synthesis- Bacteria- *Rhodopseudomonas capsulate* and *Corynebacterium glutamicum.* Fungi - *Trichoderma reesei* and *Rhodosporidium diobovatum* (Yeast). Algae- *Chlorococcum infusionum.* Virus- Tobacco mosaic and Bacteriophages. Phytosynthesis- Geranium extract and Aloe Vera extract. Zoo synthesis- Marine sponge *Acanthella elongate* and Silkworm *Bombyx mori.*

**UNIT IV** **15 Hours**

Separation of Nanoparticles- Physical and Chemical methods. Purification of Silver, Gold, Colloidal Cadmium Telluride (CdTe) and Colloidal Zinc Oxide Nanoparticles. Characterization of nanoparticles- X-ray diffraction, TEM, FTIR, UV Visible Spectroscopy and Atomic Absorption Spectroscopy.

**UNIT V** **15 Hours**

Applications of Nanoparticles in Medicine- Detection of Infectious and Chronic diseases, Cancer Detection and Therapy. Food- Food Safety and Biosecurity, Detection of Food Borne Pathogens and Food packaging. Environment- Environmental Monitoring, Remediation and Waste Water Treatment. Nanotoxicology- Challenges faced in Nanobiotechnology- Health hazards and Environmental Impacts caused by Nanoparticles. Detection methods.

**RECOMMENDED TEXT BOOKS**


1. Abdullaeva Z. (2017). Synthesis of Nanoparticles and Nanomaterials, 1st edn. Springer International Publishing.
2. Niemeyer C.M. and Mirkin C.A. (2004). Nanobiotechnology: Concepts, Applications and Perspectives, 1st edn. Wiley Publishers.
3. Kumar V., Dasgupta N. and Ranjan S. (2018). Nanotoxicology- Toxicity Evaluation, Risk Assessment and Management, 1st edn. CRC press.

## REFERENCES


1. Fan M., Huang C.P. Bland A.E., Wang Z.H., Sliman R. and Wright I. (2010). Environanotechnology. 1st edn. Elsevier.
2. Hornyak G.L., Dutta J., Tibbals H.F. and Rao A.K. (2008). Introduction to Nanoscience, 1st edn. CRC Press.
3. Fulekar M.H. (2010). Nanotechnology: Importance and Application, 1st edn. IK International.
4. Kumar C. (2006). Nanosystem characterization tools in the life sciences 1st edn. Wiley-VCH.
5. Pradeep T. (2012). A Textbook of Nanoscience and Nanotechnology, 2nd edn. Tata McGraw Hill Education Pvt. Ltd.


## JOURNALS

1. Journal of Nanoscience and Nanotechnology.
2. Journal of Nanobiotechnology.

## E-LEARNING RESOURCES

1. https://www.intechopen.com/books/engineered-nanomaterials-health-and-safety/preparation-of-nanoparticles
2. https://ec.europa.eu/health/scientific_committees/opinions_layman/en/nanotechnologies/l-2/6-health-effects-nanoparticles.htm
3. https://www.nanoscience.com/techniques/nanoparticle-synthesis/#:~:text=%5D%20for%20example).-,Colloidal%20nanoparticle%20synthesis,other%20materials%20from%20the%20particles.
4. https://www.google.co.in/books/edition/Nanotechnology_in_Industrial_Wastewater/MUsBQAAQBAJ?hl=en&gbpv=1&dq=Separation+of+nanoparticles+by+centrifugation&printsec=frontcover

## COURSE OUTCOME

| CO No. | CO Statement |
|---|---|
| CO 1 | Analyse the structure and classification of nanoparticles. |
| CO 2 | Utilize physical and chemical methods in nanoparticle synthesis. |
| CO 3 | Assess various methods of biological synthesis of nanomaterials. |
| CO 4 | Explain the stages in separation, purification and characterization of Nanomaterial |
| CO 5 | Acquire knowledge about the positive and negative impact of nanoparticles on human and environment |

## MAPPING OF CO WITH PSO

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO 2** | 2 | 2 | 2 | 2 | 3 | 2 |
| **CO 3** | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO 4** | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO 5** | 2 | 2 | 3 | 1 | 2 | 3 |
| **Average** | **1.8** | **2.2** | **2.2** | **1.6** | **2** | **2** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online Platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

**SEMESTER- V**

**BIOENERGY**

**TOTAL HOURS: 75** **COURSE CODE: MB21/5E/BEY**

**CREDITS : 5** **LT P 3 2 0**

**COURSE OBJECTIVES**

1. Acquire an insight on environmental aspects of bioenergy.
2. Learn the biomass types and characteristics for energy application.
3. Understand bioenergy systems and environmental implications.
4. Give an understanding on biofuels, their production technologies and applications in various energy utility routes.
5. Create an understanding on bio-refinery concept for conversion of biomass to modern biofuels.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Introduction to Bioenergy, The Need for Alternative Fuels, Types of Bioenergy Products and generations of Feed Stock, Potential Benefits of Replacing Fossil Fuels with Biofuel. Economic, Social and Ecological Impacts of Bioenergy at Local, National and Global Levels. Current and Emerging Challenges to Bioenergy Development.

**UNIT II** **15 Hours**

Overview of Biomass as Energy Source- Biomass Resources, Types of Biomass. Biomass Composition and Energy Content. Biomass Conversion Routes- Biochemical, Chemical, Thermochemical and Physical Processes. Biomass Conversion to Biofuels, Types of Biofuels.

**UNIT III** **15 Hours**

Formation of Bio-Methane / Biogas; Energy Crops and Manure; Biogas Digester Design; Biogas Slurry Utilization and Management, Biogas Applications; Cost Benefit Analysis of Biogas for Cooking. Alcohol Production from Biomass- Ethanol Production from Sugarcane and Molasses. Bioethanol Production from Starch. Ethanol Blending Programme in India.

**UNIT IV** **15 Hours**

Biodiesel- Introduction to Biodiesel, Biodiesel Feedstocks. Using Biodiesel as a Fuel and Biodiesel safety. Biodiesel production from Palm and Jatropha. Biodiesel Processing-Trans-esterification, Esterification and Feedstock issues, Environmental Impacts of Bio-diesel. Biodiesel blends- Green diesel from Vegetable oil-Biodiesel production from Grease, Waste oils and Algae.

**UNIT V** **15 Hours**

Modern Biofuel and Bio-refinery: Next generation Biofuel production- Biochemical, gasification, hydrogenation, Bio-butanol, Bio-propanol and Bio- hydrogen production. Environmental Impacts of Biofuel production. Environmental Impact – Policies and Future R&D Biofuel Economics.

**RECOMMENDED TEXT BOOKS**

1. Mukunda H. S. (2011). Understanding Clean Energy and Fuels from Biomass, 1st edn. Wiley India.
2. Sorensen B. (2010). Renewable Energy, 4thedn. Academic press.
3. Pandey. A. (2011). Biofuels Alternative Feedstocks and Conversion Processes. 1stedn. Academic Press.

**REFERENCE BOOKS**

1. Klass D. L. (1998). Biomass for Renewable Energy, Fuels, and Chemicals. 1stedn. Academic Press, USA.
2. Higman C. and Burgt M.V.D (2003). Gasification, 1stedn. Elsevier Science, USA.
3. Stassen H.E. Quaak P. and Knoef H. (1999). Energy from Biomass: A Review of Combustion and Gasification Technologies, World Bank Publication.
4. Mittal K. M. (1996). Biogas systems: Principles and Applications, 1stedn. New Age International.
5. Calle F.R. and Francisco R. (2007).The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment, 1stedn. Earth scan.

**JOURNALS**

1. Biofuel Research Journal.
2. International Journal of Renewable Energy and Biofuels.

**E-LEARNING RESOURCES**

1. http://www.sciencedirect.com/science/book/9780124109506
2. http://www.maggiolieditore.it/9788838759697-sistemi-a-biomasse-progettazione-e-valutazione-economica.html
3. http://www.springer.com/cn/book/9789811001482
4. http://www.springer.com/us/book/9781461410393
5. https://www.sae.org/images/books/toc_pdfs/BELS069.pdf

**COURSE OUTCOME**

| CO NO. | CO Statement |
|---|---|
| CO 1 | Analyse bioenergy systems and their potential in future energy supply. |
| CO 2 | Determine important fuel properties of biomass; understand the concept of first generation, second generation and advance biofuels. |
| CO 3 | Familiarize with characterization of biomass feedstock for biogas and ethanol production |
| CO 4 | Appreciate the concept of a bio refinery system and be able to develop major unit operations of an integrated bio refinery. |
| CO 5 | Familiarize with the environmental policies and follow the same. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO 3** | 3 | 3 | 3 | 3 | 1 | 3 |
| **CO 4** | 3 | 3 | 3 | 3 | 2 | 1 |
| **CO 5** | 2 | 2 | 3 | 2 | 2 | 1 |
| **Average** | **2.8** | **2.8** | **3** | **2.8** | **1.8** | **2** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online Platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

**SEMESTER V**
**WASTE MANAGEMENT**

**TOTAL HOURS: 75** **COURSE CODE: MB21/5E/WMT**
**CREDITS: 5** **L TP: 3 2 0**

**COURSE OBJECTIVES**

1. Analyse the principles and concepts of waste management
2. Describe the concepts of integrated waste management
3. Enlist municipal solid waste management practices
4. Define biomedical and hazardous management strategies.
5. Discuss environmental protection laws and regulations.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Definition, Approaches to Waste Management (Waste Hierarchy Pyramid, 7R's of Waste management - Refuse, Reduce, Repurpose, Reuse, Recycle, Rot, Rethink) Classification and types of wastes, Common sources of Solid wastes, Special Wastes.

**UNIT II** **15 Hours**

Functional elements of Solid Waste Management System - Waste Generation, Waste handling at source, Collection, Transfer and Transport, Separation, Processing and Transformation of Solid waste, Disposal, ISWM and Case Studies.

**UNIT III** **15 Hours**

Municipal Solid Waste – Definition, Types, Management strategies - Collection, Recovery for recycling, Composting methods - Types, Compost Phases, Windrow and In-vessel compost systems, Combustion – Incinerable Wastes and Incineration Technologies, Landfilling – Landfilling methods, Landfill gas. Vermicomposting –Types.

**UNIT IV** **15 Hours**

Biomedical Waste- Definition, Types and Sources. Categorization and Color coding of Biomedical Wastes, Management – Segregation, Collection and Storage, Transportation, Treatment and Disposal. Hazardous waste- Types and Sources, Treatment – Physical, Chemical and Biological, Health and Environmental Effect.

**UNIT V** **15 Hours**

Regulatory Framework of Environmental Protection in India - Ministry of Environment and Forests (MoEF) and Pollution Control Board - CPCB and SPCB - Powers and Functions. Major Environmental Laws in India.

**RECOMMENDED TEXT BOOKS**


1. Tchobanoglous G. *et al*, (1993) "Integrated Solid Waste Management" 2nd edn. McGraw– Hill.
2. Henry J. GandHeinke G.W. (2004). "Environmental Science and Engineering", 2nd edn. Prentice Hall of India.
3. Bhide A.D. and Sundaresan B.B. (2001) "Solid Waste Management – Collection, Processing and disposal" Mudrashilpa Offset Printers, 1st edn. Nagpur.

## REFERENCE BOOKS


1. Pichtel J. (2005). Waste Management Practices. 1st edn. CRC Press, Taylor and Francis Group.
2. Verma P.S. and Agarwal V.K. (1989). Principles of Ecology. 4th edn. S.Chand and Company (Pvt) Ltd.
3. Atlas R. M and Bartha R. (1998). Microbial Ecology Fundamentals and Applications. 3rd edn. Benjamin Cummings. Redwood City, CA.
4. Maier R.M., Pepper I.L. and Gerba C.P. (2008). Environmental Microbiology, 2nd edn Academic Press.
5. Chery P.M. (2017). Solid and Hazardous Waste Management. 1st edn. CBS Publishers.


## JOURNALS

1. International Journal of Environment and Waste Management.
2. Waste Management and Research.

## E-LEARNING RESOURCES

1. https://www.researchgate.net/publication/311161719_The_Concept_of_Waste_and_Waste_Management
2. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W2/Solid_waste_management_UNEP_2005.pdf
3. https://celitron.com/en/types-of-biomedical-waste-definition
4. https://www.researchgate.net/publication/2883921_Hazardous_Waste_Management_In_India
5. https://www.mondaq.com/india/waste-management/624836/environment-laws-in-india

## COURSE OUTCOME

| CO No. | CO Statement |
|---|---|
| CO 1 | Recall the concepts underlying management of wastes |
| CO 2 | Summarize the functional elements of waste management and elaborate on integrated waste management. |
| CO 3 | Appreciate the methods of municipal solid waste treatment |
| CO 4 | Evaluate the handling of biomedical and hazardous wastes. |
| CO 5 | Infer various laws pertaining to waste management. |

## MAPPING OF CO WITH PSO

| CO / PO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 1 | 2 | 1 | 2 | 3 | 3 |
| **CO 2** | 2 | 1 | 2 | 2 | 3 | 3 |
| **CO 3** | 1 | 2 | 2 | 2 | 2 | 3 |
| **CO 4** | 2 | 2 | 2 | 1 | 2 | 2 |
| **CO 5** | 1 | 1 | 1 | 1 | 1 | 3 |
| **Average** | **1.4** | **1.6** | **1.6** | **1.6** | **2.2** | **2.8** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

## QUESTION PAPER PATTERN

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks (Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

**SEMESTER V**
**MUSHROOM CULTIVATION**

**TOTAL HOURS: 75** **COURSE CODE: MB21/5E/MCT**
**CREDITS: 5** **L T P: 3 2 0**

**COURSE OBJECTIVES**

1. Learn the characteristics of mushrooms and differentiate edible and poisonous mushrooms and their effects.
2. Describe the process of mushroom cultivation technology.
3. Acquire an insight on various sanitation procedures during mushroom cultivation process.
4. Outline the post-harvest practices and give an understanding on Entrepreneurial skills.
5. Analyze the pathological damage on mushrooms.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Introduction, History of Mushroom Cultivation, Biology of Mushrooms. Nutritional and Medicinal Value of Mushrooms. Importance of Mushrooms. Poisonous Mushrooms and Mushroom Poisoning. Edible Mushroom Species Cultivated in India and World.

**UNIT II** **15 Hours**

Cultivation Technology- Infrastructure, Equipments and Substrates in Mushroom Cultivation: Pure Culture Preparations and its Maintenance, Spawn- Types of Spawn, Preparation of Spawn, Mushroom Bed Preparation and Factors Affecting Mushroom Bed Preparation- Compost-Materials used for Compost Preparation, Compost Technology in Mushroom Production.

**UNIT III** **15 Hours**

Cultivation of *Agaricus bisporus* and *Pleurotus ostreatus*. Important Sanitation during various stages of Mushroom Cultivation. Management of Spent Substrates and Waste Disposal of Mushrooms.

**UNIT IV** **15 Hours**

Post Harvest Techniques – Storage, Packaging, Transport and Preservation of Mushrooms. Methods of storage of Mushroom Cultivation. Long term and Short term Storage of Mushrooms. Mushroom Research Centers/Farms- National level and Regional level, Entrepreneurial Skills and Economics for Small Enterprise.

**UNIT V** **15 Hours**

Overview of Pests and Diseases of Mushrooms-Role of Microorganisms in Compost, Anaerobiosis, Recycling, Contaminants in other Substrates- *Penicillium*, *Trichoderma*, *Aspergillus*, *Rhizopus* and other Molds. Diseases and their Control-Bacterial (Bacterial blotch), Fungal (Dry Bubble and Wet Bubble) and Viral-Weed Molds. Flies and Mites and their Control. Genetic Improvement Methods of Mushroom.

**RECOMMENDED TEXT BOOKS**

1. Singh Rand Singh U.C (2005). Modern Mushroom cultivation. 1st edn. Agrobiose Publishers. India.
2. Dubey R.C and Maheshwari. D.K. (2007). A Textbook of Biotechnology, 4th edn. S.Chand and Company
3. Nikulsingh M.C. (2013). Scientific Cultivation of Mushroom. 1st edn. Astral International Pvt.Ltd.

**REFERENCE BOOKS**

1. Kannaiyan S. (1999). Cultivation of Edible Mushrooms. 1st edn. TNAU Publication.
2. Russell S. (2003) Essential Guide to Cultivating Mushrooms. 1st edn. Storey Publishing LLC
3. Tiwari S.C and Kapoor P. (2018). Mushroom-The art of Cultivation. 1st edn. Mittal Publications.
4. EIRI Board (2007).Mushroom Cultivation processing Preservation Book, 1st edn. Engineers India Research Institute.
5. Principium Q. (2015). Magic Mushroom Grower's Guide Simple Steps to Bulk Cultivation. 1st edn. Psychonautical Society.

**JOURNALS**

1. Research and Reviews: Journal of Agriculture and Allied Sciences.
2. International Journal of Medicinal Mushrooms.

**E-LEARNING RESOURCES**

1. https://www.medicalnewstoday.com/articles/278858
2. https://www.ncbi.nlm.nih.gov/books/NBK537111/
3. https://www.researchgate.net/publication/319117708_Insect_Mite_and_Nematode_Pests_of_Commercial_Mushroom_Production_Technology_and_Applications
4. http://agridaksh.iasri.res.in/html_file/mushroom/white_button_mush.htmwww.fungi.fun.org/mushword/oyster.m/
5. www.mushroom-directory.com/

**COURSE OUTCOME**

| CO NO. | CO Statement |
|---|---|
| CO 1 | Distinguish various categories of mushrooms with nutritional values. |
| CO 2 | Demonstrate various types of mushroom cultivating technologies. |
| CO 3 | Familiarize with sanitation procedures during various stages of mushroom cultivation. |
| CO 4 | Device new methods and strategies to contribute to mushroom production. |
| CO 5 | Appreciate the diseases and Genetic improvement methods of mushroom. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 1 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO 3** | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO 4** | 3 | 3 | 2 | 3 | 1 | 3 |
| **CO 5** | 2 | 3 | 3 | 2 | 2 | 3 |
| **Average** | **2.8** | **2.8** | **3** | **2.8** | **1.6** | **2.8** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online Platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER – V

## SELF-STUDY PAPER
## FORENSIC SCIENCE AND CRIME INVESTIGATION

**COURSE CODE:** **CREDITS: 2**

**COURSE OBJECTIVES**

1. Introduce basics of forensic Science.
2. Understand crime and its causes.
3. Emphasize on crime scene investigation methods.
4. Learn about forensic toxicology.
5. Explain the emerging trends in forensic science.

**COURSE OUTLINE**

**UNIT I**

Forensic science- Definition, scope, purpose and branches. Organization set up of Forensic Science Laboratory. Structure and function of State and Central Forensic Science Laboratory and facilities provided. Directorate of Forensic Science Service.

**UNIT II**

Crime-Definition, types, causes and prevention. Difference between Blue and white collar crimes. Introduction to cybercrime, criminal behaviour, criminal profiling and criminal justice system-Police, Medico-legal expert, judicial officers.

**UNIT III**

Crime Scene Investigation-Role of investigator, evaluation, search pattern and protection of a crime scene. Photography and sketching of crime scene. Documentation in crime scene-collection, packaging, labelling and forwarding of exhibits to forensic laboratories. Preservation of evidence, health and safety protocols.

**UNIT IV**

Forensic investigation of crime scene evidences- Viscera, blood, semen, hair, saliva, vomit and other biological samples. Analytical Techniques-Finger/foot prints, DNA analysis. Anthropology- skeletal remains. Document Examination-Voice Pattern Analysis and Forensic ballistics.

**UNIT V**

Forensic toxicology and medicine-types and mode of action of poisons. Medico-legal autopsy demonstration and interpretation. Case Studies. Emerging trends in Forensic science. Ethical issue in Forensic Science, Professional Standards for Practice of Criminalistics.

**RECOMMENDED TEXT BOOKS**


1. Nanda B.B. and Tiwari R.K. (2001). Forensic Science in India: A Vision for the Twenty First Century. 1st edn. Select Publishers, New Delhi.
2. Tilstone W.J., Hastrup M.L. and Hald C. (2013). Fisher's Techniques of Crime Scene Investigation, 1st edn. CRC Press, Boca Raton.
3. James S.H. and Nordby J.J. (2005). Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd edn. CRC Press, Boca Raton.

**REFERENCE BOOKS**


1. Johll M.E. (2019). Investigating Chemistry*:* Introductory Chemistry from a Forensic Science Perspective, 4th edn. W. H. Freeman And Company, New York.
2. W.G. Eckert and R.K. Wright (1997). Introduction to Forensic Sciences, 2nd edn. CRC Press, Boca Raton.
3. Saferstein R. (2004).Criminalistics, 8th edn. Prentice Hall, New Jersey.
4. Gardener T.J. and Anderson T.M. (2001). Criminal Evidence, 4th edn. Wadsworth, Belmont.
5. Heard B.J. (1997). Handbook of Firearms and Ballistics, 1st edn. Willy and Sons, Chi Chester.


**JOURNALS**

1. Journal of Forensic Science and Criminology.
2. Journal of Forensic Research.

**E-LEARNING RESOURCES**

1. https://www.pinow.com/investigations/forensic-investigations
2. https://www.atascientific.com.au/technologies-forensic-sciences/
3. http://what-when-how.com/police-science/crime-scene-search-and-evidence-collection- police/
4. https://nij.ojp.gov/topics/articles/dna-evidence-basics-identifying-gathering-and-transporting
5. https://jguforensics.wordpress.com/2017/04/18/ethics-in-forensic-science/

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Familiarize oneself with developments and organizations in forensic science. |
| CO 2 | Acquire knowledge on types of crime and its causes as well prevention. |
| CO 3 | List the services performed by a crime investigators, crime laboratories and medical examiners. |
| CO 4 | Analyse the role of a forensic scientist in crime scene investigations. |
| CO 5 | Gather information on Forensic toxicology and ethics in forensic science. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO 2** | 1 | 1 | 2 | 1 | 2 | 2 |
| **CO 3** | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 4** | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO 5** | 2 | 2 | 2 | 2 | 2 | 2 |
| **Average** | **1.6** | **1.6** | **2** | **1.6** | **2** | **2** |

**KEY: STRONGLY CORRELATED-3 MODERATELY CORRELATED-2 WEAKLY CORRELATED-1 NO CORRELATION-0**

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER VI COURSE PROFILE-PROGRAMME OF STUDY

| COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS /WK | TOTAL HOURS | L-T-P | CA | SE | TOTAL |
|---|---|---|---|---|---|---|---|---|
| MB21/6C/MPY | Mycology and Parasitology | 4 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21/6C/EEM | Microbial Ecology and Environmental Microbiology | 4 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21/6C/RDT | Recombinant DNA Technology | 4 | 4 | 60 | 3-1-0 | 40 | 60 | 100 |
| MB21/6C/IND | Industrial Microbiology | 4 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21/6E/CMP or MB21//6E/GLT | Commercial Microbial Products/Good Laboratory Practices and Techniques | 5 | 5 | 75 | 3-2-0 | 40 | 60 | 100 |
| MB21//6C/PR3 | Medical Microbiology | 4 | 3 | 45 | 0-0-3 | 40 | 60 | 100 |
| MB21//6C/PR4 | Applied Microbiology | 4 | 3 | 45 | 0-0-3 | 40 | 60 | 100 |
| Self-Study Paper | General Aptitude for Competitive Examinations* | 2 | | | | | | 100 |
| | **TOTAL CREDITS** | **29+2 (For Advanced Learners)** | | | | | | |

## SEMESTER VI

## MYCOLOGY AND PARASITOLOGY

**TOTAL HOURS: 75** **COURSE CODE: MB21/6C/MPY**
**CREDITS: 4** **LT P: 3 2 0**

**COURSE OBJECTIVES**

1. Impart knowledge in collection, transport, cultivation of fungi and parasites and drugs to treat against their infections.
2. Perceive the importance of protozoa in the intestine, blood and tissues.
3. Summarize the general characters of cestodes, trematodes and nematodes and their significance in causing infections.
4. Investigate the medical importance of superficial and subcutaneous mycoses.
5. Summarize the biological mechanisms affecting the entire human system by systemic mycoses and reveal the importance of opportunistic infections caused by fungi.

**COURSE CONTENT**

**UNIT I** **15 Hours**

Introduction to Mycology and Parasitology–Morphology and Cultivation of Fungi and Parasites-Host Parasitic Interactions–Collection and Transport of Specimens for Isolation and Identification of Fungi and Parasites-Antifungal and Antiparasitic agents.

**UNIT II** **10 Hours**

General features, Pathogenesis, Laboratory Diagnosis and Treatment of Superficial Mycoses-*Pityriasis versicolor, Piedra* and Dermatophytoses. Subcutaneous Mycoses –Mycetoma and Sporotrichosis.

**UNIT III** **15 Hours**

General features, Pathogenesis, Laboratory Diagnosis and Treatment of Systemic Mycoses–Histoplasmosis and Coccidioidomycosis. Opportunistic Mycoses - Cryptococcosis, Candidiasis, Aspergillosis and Zygomycosis-Mucoromycosis. Mycotoxicosis and Mycetismus.

**UNIT IV** **20 Hours**

Morphology, Lifecycle, Clinical Features, Lab Diagnosis and Control of Intestinal Protozoans –*Entamoeba histolytica* and *Giardia lamblia,* Urogenital Protozoans-*Trichomonas vaginalis*, Blood and Tissue Protozoans -*Plasmodium, Leishmania donovani* and *Trypanosoma brucei.*

**UNIT V** **15 Hours**

Helminthology –Morphology, Lifecycle, Clinical features, Lab diagnosis and Control of Cestodes-*Taenia* and *Echinococcus granulosus*. Trematodes – *Schistosoma mansonii* - Nematodes – *Ascaris lumbricoides, Ancylostoma duodenale, Enterobius vermicularis* and *Wuchereria bancrofti*

**RECOMMENDED TEXT BOOKS**


1. Chander J. (2009). A Text book of Medical Mycology, 4th edn. Jaypee Brothers Medical Publishers (P) Ltd.
2. Mehrotra R.S and Aneja K.R (1990). An Introduction to Mycology, 2nd edn. New age International Publishers, New Delhi.
3. Chatterjee K.D. (2009). Medical Parasitology.13th edn. CBS Publishers, New Delhi.
4. Parija S. C. (1996). Text Book of Medical Parasitology.4th edn. Orient Longman, All India Publishers & Distributors.


**REFERENCE BOOKS**


1. Alexopolus C.J. and Mims C.W. (1995). Introductory Mycology, 4th edn. John Wiley and Sons, New York.
2. Fisher F. and Cook N.B. (1998). Fundamentals of Diagnostic Mycology, 1st edn. W.B. Saunders Company, Pennsylvania.
3. Davise H. Larone. (2002). Medically Important Fungi: A Guide to Identification, 4th edn. Washington (D.C.), ASM Press.
4. Garcia L.S (2016). Diagnostic Medical Parasitology, 6th edn. ASM Press.
5. Levanthal R. and Cheadle R.S. (2012). Medical Parasitology, 6th edn. S.A. Davies Co., Philadelphia.
6. Choidini P.L, Moody A.H and Manser D.W. (2001) Atlas of Medical Helminthology and Parasitology, 4th edn. Churchill Livingstone.


**JOURNALS**

1. International Journal of Parasitology.
2. Systemic Parasitology.
3. Medical Mycology.
4. Studies in Mycology.

**E-LEARNING RESOURCES**

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047123/
2. https://www.ncbi.nlm.nih.gov/pubmed/21722309
3. https://www.sciencedirect.com/science/article/pii/S2211753919300193
4. https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0006297
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2517378/
6. https://malariajournal.biomedcentral.com/articles/10.1186/s12936-020-03541-w

**COURSE OUTCOME**

| CO Number | CO STATEMENT |
|---|---|
| CO 1 | Obtain theoretical understanding on general aspects of fungi and parasites. Apply diagnostic methods in mycotic and parasitic infections. |
| CO 2 | Analyse the intestinal, blood and tissue protozoan infections in human beings and apply techniques for identification and isolation of organisms and in treatment. |
| CO 3 | Recognize the significance of cestodes, nematodes and trematodes as infectious agents and detection of methods in diagnosing the disease and remedy in treating the infections. |
| CO 4 | Insights on the significance of fungi affecting superficial and subcutaneous tissues. |
| CO 5 | Analyse the role of systemic and opportunistic mycoses in clinical disease and perceiving the knowledge in diagnosing and treating infections. |

**MAPPING OF CO WITH PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 2 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 2 | 2 |
| Average | 2.2 | 2.8 | 2.6 | 2.6 | 2.0 | 2.0 |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, Flipped Learning, Online Platforms, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning and Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| K 1 | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| K1, K2 | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| K3,K4 | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER VI

## MICROBIAL ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

**TOTAL HOURS: 75** **COURSE CODE : MB21/6C/EEM**
**CREDITS: 4** **LTP : 3 2 0**

**COURSE OBJECTIVES**

1. Study the basic concepts of microbial ecology.
2. Gain knowledge about microbes in extreme conditions.
3. Assess the presence and versatility of air and fresh water microflora.
4. Demonstrate the essential role of microbes in sewage treatment process.
5. Illustrate the function of microbes in biodeterioration.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Microbial ecosystem –Definition and scope, Microbial communities in Aquatic environment – Fresh water and Marine environment. Factors influencing the microbial diversity in Fresh water and Marine environment. Microbes as Components of Ecosystem as producers and decomposers.

**UNIT II** **15 Hours**

Microbial life in Extreme environment – Extremophiles- General characteristics – pH - Acidophiles and Alkaliphiles, Microbes thriving in High Temperature and Low Temperature, - Thermophiles and Psychrophiles, High hydrostatic Pressure - Barophiles, High salinity- Halophiles, Low nutrient levels – Oligotrophs, Eutrophication.

**UNIT III** **15 Hours**

Microbiology of Air, Air Microflora - Indoor and Outdoor Environment. Enumeration of microbes in Air – Settling under gravity, Centrifugal action, Filtration, Impingement in to liquid and solids and Electrostatic precipitation. Water Microbiology - Natural water bodies, Determination of the quality of Water – Multiple tube test, Membrane Filtration, Water Purification in Municipal Water Supply.

**UNIT IV** **15 Hours**

Sewage Treatment process – Primary Treatment process-Screening, Straining, Grit removal, Sedimentation, Flotation, Coagulation and Flocculation, Secondary treatment process – Aerobic-Trickling Filters, Activated Sludge Process and Oxidation Ponds , Anaerobic –Septic tanks and Imhoff tank. Tertiary treatment- Disinfection**.**

**UNIT V** **15 Hours**

Biodegradation – Lignin. Xenobiotics – DDT, Halocarbons, PCB and Synthetic polymers. Biodeterioration of Paper, Leather and Wood. Bioleaching of ores. Bioremediation- Definition, *Insitu* techniques (Bioventing, Biosparging and Bioaugmentation) and *Exsitu* techniques (Landfarming, Biopile, Composting) Biomineralisation - definitions and microbes involved.

**RECOMMENDED TEXT BOOKS**


1. Atlas R. M and Bartha R. (1998). Microbial Ecology Fundamentals and Applications. 3rdedn. Benjamin Cummings. Redwood City. CA
2. Daniel C.J. (1999). Environmental aspects of Microbiology, 1stedn. Bright Sun Publications.
3. Vijaya R K, (2004). Environmental Microbiology. 1stedn. MJP Publishers, Chennai.


**REFERENCES**


1. Mcarthur V. (2006).Microbial Ecology – An Evolutionary Approach. 1stedn. Academic Press.
2. Rheinheimer G. (2007).Aquatic Microbiology. 2nd edn. John Wiley and Son, London.
3. Buckley R.G. (2016). Environmental Microbiology 1st edn. CBS Publishing
4. Maier R.M., Pepper I.L and Gerba C.P. (2008). Environmental Microbiology, 2ndedn. Academic Press.
5. Scragg A. (2007).Environmental Biotechnology, 2ndedn. Oxford, England.
6. Allsopp D., Seal K.J and Gaylarde C.C. (2004) Introduction to Biodeterioration. 2ndedn. Cambridge University Press.


**JOURNALS**

1. Indian Journal of Environmental Protection
2. Journal of Environmental Sciences

**E-LEARNING RESOURCES**

1. https://www.healthline.com/health/airborne-diseases#prevention
2. https://www.researchgate.net/publication/322759519_Microbes_as_Indicators_of_Water_Quality_and_Bioremediation_of_Polluted_WatersA_Novel_Approach
3. http://www.fao.org/3/t0551e/t0551e05.htm
4. https://unctad.org/en/Docs/ditcted200710_en.pdf
5. https://www.biologydiscussion.com/environmental-microbiology/biodeterioration-of- various-materials-microbiology/66809
6. https://link.springer.com/article/10.1007/s11104-007-9514-z

**COURSE OUTCOME**

| CO No | CO Statement |
|---|---|
| CO 1 | Illustrate the distribution of microbes and understand basic microbial ecology. |
| CO 2 | Identify and study the diverse microflora present in extreme conditions. |
| CO 3 | Analyse the distribution of air microflora and their impact on air quality. |
| CO 4 | Appraise the microbial processes involved in the treatment of sewage and solid wastes. |
| CO 5 | Examine the microbial deterioration of natural products and biofuel production. |

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**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 1 | 1 | 2 | 1 |
| **CO 2** | 2 | 3 | 3 | 1 | 1 | 2 |
| **CO 3** | 3 | 3 | 1 | 1 | 1 | 2 |
| **CO 4** | 1 | 3 | 3 | 3 | 3 | 2 |
| **CO 5** | 3 | 3 | 2 | 3 | 1 | 2 |
| **Average** | **2.4** | **3.0** | **2.0** | **1.8** | **1.6** | **1.8** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, online platforms, e-content, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER VI

## RECOMBINANT DNA TECHNOLOGY

**TOTAL HOURS: 60** **COURSE CODE: MB21/6C/RDT**
**CREDITS: 4** **L T P: 3 1 0**

**COURSE OBJECTIVES**

1. To understand the principles of rDNA technology.
2. Illustrate the molecular tools employed in gene cloning.
3. Acquire knowledge about the concepts of tissue culture methods and transgenic organisms.
4. Learn the recent trends in genetic engineering and its application in human welfare

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Milestones in rDNA Technology- Gene Manipulation-Steps involved in Gene Cloning. Isolation of Chromosomal and Plasmid DNA. Restriction endonuclease-Discovery, Types, Mode of action-Application of Ligase, DNA Polymerase, DNA Modifying enzymes and Topoisomerases. Use of Linkers and Adapters.

**UNIT II** **15 Hours**

Artificial Gene Transfer methods - Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors – Properties and Applications - Plasmid Based Vectors- Natural Vectors-pSC101 and pMB1. Artificial Vectors- pBR322 and pUC. Phage Based Vectors- Lambda phage. Hybrid Vectors, Phagemid, Cosmid, BAC and YAC. Screening of Recombinants. Genomic DNA and cDNA library- Construction and Screening.

**UNIT III** **10 Hours**

Molecular Tools- PCR- Quantitative Real Time PCR - Gel Electrophoresis- AGE and PAGE Blotting Techniques- Southern, Western & Northern. DNA sequencing methods- Sanger's and Automated method. Recent Trends in Genetic Engineering- Targeted Genome Editing- ZFNs, TALENs, CRISPRs. Gene Targeting- Knock-in & Knock-outs. DNA Finger Printing,

**UNIT IV** **15 Hours**

Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture-Explant Culture- Micropropagation- Callus and Protoplast Culture-Production of Bio-Active Secondary Metabolites by Plant Tissue Culture -Agrobacterium and Crown Gall Tumors, Ti Plasmid and Ri Plasmid-Animal Biotechnology- Principles of Animal Cell Culture, Media and Equipment for Animal Cell Culture – Primary and Secondary Cultures- Cell Lines- Types, Establishment and Maintenance of Cell Lines.

**UNIT V** **10 Hours**

Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep-Recombinant Cytokines and their use in the Treatment of Animal infections- Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections - Human Gene Therapy-Germline and Somatic Cell Therapy- *Ex-vivo* Gene Therapy-SCID (Severe Combined Immuno Deficiency) – *In-vivo* Gene Therapy- CFTR (Cystic Fibrosis Transmembrane Regulator) - Vectorsin Gene Therapy- Viral and Non- Viral Vectors. Transgenic Plants –Bt Cotton, Bt Corn,

Round Ready soybean, Flavr Savr Tomato and Golden Rice. Bioethics. Genetic Engineering Appraisal Committee.

**RECOMMENDED TEXTBOOKS**


1. Glick B.R. and Pasternak, J.J, (2015) Molecular Biotechnology. Principles and Applications of Recombinant DNA. 5th edn. ASM Press, Washington, DC.
2. Freifelder D. (2008). Molecular Biology. 2nd edn. Narosa Publishing house, New Delhi
3. Crichton M. (2014). Essentials of Biotechnology. 1st edn. Scientific international Pvt. Ltd. New Delhi.


**REFERENCE TEXT BOOKS**


1. Brown T.A. (2001). Gene Cloning and DNA Analysis – An Introduction, 4th edn. Blackwell Science Ltd. Oxford.
2. Old R.W. and Primrose S. B. (1985). Principles of Gene Manipulation. 4th edn. Black well Scientific Publications, London.
3. Dubey R.C and Maheshwari D.K (2012). A Textbook of Biotechnology, 3rd edn. S. Chand and Company.
4. Russell P.J, (2010). Genetics-a molecular approach 3rd edn. Benjamin Cummings.
5. Sambrook J. and Russell D.W. (2001). Molecular Cloning: A Laboratory Manual. 7th edn. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.


**JOURNALS**

1. Indian Journal of Biotechnology.
2. Journal of Genetic Engineering and Biotechnology.

**E-LEARNING RESOURCES**

1. https://www.microscopemaster.com/tissue-culture.html
2. http://www.biologydiscussion.com/essay/enzymes-essay/role-of-enzymes-in-genetic-engineering-essay-genetic-engineering/84627
3. http://biology.kenyon.edu/courses/biol114/Chap08/Chapter_08a.html
4. https://www.sciencedirect.com/science/article/pii/S0734975018302064
5. https://s3-us-west-2.amazonaws.com/oww-files-public/6/6d/Molecular_Techniques.pdf

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Illustrate the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening. |
| CO 2 | Discuss the various cloning vectors and their applications. |
| CO 3 | Assess the usage and advantages of molecular tools. |
| CO 4 | Explain Plant and animal Tissue Culture protocols and gene transfer mechanism |
| CO 5 | Elucidate and understand the application of genetic engineering and gene therapy |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 2 | 2 | 2 | 3 | 3 | 3 |
| **CO 4** | 3 | 3 | 2 | 3 | 3 | 2 |
| **CO 5** | 3 | 3 | 3 | 3 | 2 | 2 |
| **Average** | **2.8** | **2.8** | **2.6** | **3** | **2.8** | **2.6** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, Flipped Learning, Online Platforms, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER VI

## INDUSTRIAL MICROBIOLOGY

**TOTAL HOURS: 75** **COURSE CODE: MB21/6C/IND**
**CREDITS: 4** **LT P: 3 2 0**

**COURSE OBJECTIVES**

1. Introduce fermentation processes and industrially important microbes.
2. Understand strain development strategies, media formulation and sterilization techniques.
3. Inform about the construction, design and operation of fermentors.
4. Gain insight into industrial downstream process and fermentation economics.
5. Knowledge on industrial production of microbial products.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Introduction to Industrial Microbiology- Components of Fermentation Process. Types of Fermentation Processes - Batch, Fed batch, Continuous, Surface, Submerged and Solid Substrate. Industrially Important Microorganisms (GRAS) and their Preservation Techniques.

**UNIT II** **15 Hours**

Strain Development strategies – Objective and Methods for Strain Improvement, Selection of different types of Mutants and Application of rDNA Technology. Components and Formulation of Fermentation Media. Inoculum development and Sterilization of Air, Fermentor and Media -Batch and Continuous Process.

**UNIT III** **15 Hours**

Design and operation of Fermentors – Basic Structure and parts of a Fermentor. Types-Stirred Aerator Fermentor, Acetator, Cavitator, Tower Fermentor and Air Lift Fermentor. Process parameters – Aeration, Agitation, Temperature, pH and Foam Regulation. Instrumentation Control, Fluid Rheology and Scale Up and Down.

**UNIT IV** **15 Hours**

Downstream Processing - Choice of Recovery process, Biomass separation from Fermentation media- Precipitation, Filtration, Centrifugation, Cell disruption for Intracellular products, Solvent Extraction and Recovery, Chromatography, Membrane processes, Drying, Crystallization and Whole Broth Processing. Industrial Effluent Treatment. Overview of Fermentation Economics.

**UNIT V** **15 Hours**

Production aspect-Primary metabolites–Vitamin (Cyanocobalamin), Amino acids (Glutamic acid and Lysine), Enzyme (Amylase), Organic acid (Vinegar), Biomass based product-SCP (Baker's yeast), Secondary metabolites-Antibiotics (Penicillin and Streptomycin), Alcoholic Beverages (Wine and Beer), Vaccines (Tetanus and Hepatitis) and Biotransformation of Steroids.

**RECOMMENDED TEXTBOOKS**

1. Stanbury, P. F., Whitaker, A., and Hall, S.T. (2017). Principles of Fermentation Technology 3rd edn. Pergamon Press.
2. Reed. G (2004). Prescott, H., and Dunn's Industrial Microbiology, 4th edn. CBS Publishers.
3. Patel A.H (2012). Industrial Microbiology. 2nd edn. Mac Millan India Pvt Ltd.

**REFERENCE BOOKS**

1. Casida L.E. (1968). Industrial Microbiology, 1st edn. John and Wiley Eastern Limited, New Delhi.
2. Sivakumar P.K., Joe M.M and Sukesh K. (2010). An Introduction to Industrial Microbiology. 1st edn. S.Chand and Company Ltd, New Delhi.
3. Chandrakant K. (2016). Pharmaceutical Microbiology. 1st edn. Nirali Publication.
4. Peppler H.J, and Periman D. (1979) Fermentation Technology, Vol 1 and 2, 2nd edn. Academic Press, London.
5. E1-Mansi, E.M.T., Bryce C.F.A., Demain A.L. and Allman A.R. (2007). Fermentation Microbiology and Biotechnology. 2nd edn. CRC press, Taylor and Francis Group.

**JOURNALS**

1. Journal of Industrial Microbiology and Biotechnology.
2. Journal of International Pharmaceutical Research.

**E-LEARNING RESOURCES**

1. https://www.generalmicroscience.com/industrial-microbiology/introduction-industrial- microbiology/
2. https://www.slideshare.net/rekharehmat/strain-improvement-technique
3. http://www.biologydiscussion.com/industrial-microbiology-2/fermentor-bioreactor-history- design-and-its-construction/55756
4. http://www.biologydiscussion.com/biotechnology/downstream-processing/stages-in-downstream- processing-5-stages/10160
5. https://sciencesamhita.com/industrial-products-from-microbes/

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Analyse various concepts in Industrial Microbiology and understand the types of fermentation process. |
| CO 2 | Gain Knowledge on Strain development strategies and industrial formulation of media. |
| CO 3 | Acquire insight on design, construction and types of fermentor. |
| CO 4 | Identify the stages in industrial downstream process and effluent treatment. |
| CO 5 | Appreciate industrial production of important microbial metabolites. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 1 | 3 | 1 | 1 |
| **CO 2** | 1 | 2 | 1 | 3 | 2 | 2 |
| **CO 3** | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO 4** | 2 | 2 | 2 | 3 | 2 | 1 |
| **CO 5** | 1 | 3 | 2 | 3 | 2 | 2 |
| **Average** | **1.6** | **2.2** | **1.6** | **3** | **1.8** | **1.6** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, Online session, Flipped Learning, Online Platforms, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit.. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER VI

## COMMERCIAL MICROBIAL PRODUCTS

**TOTAL HOURS: 75** **COURSE CODE: MB21/6E/CMP**
**CREDITS: 5** **L T P: 3 2 0**

**COURSE OBJECTIVES**

1. Acquire knowledge about various marketable products produced through microorganisms.
2. Understand the origin and production of these products.
3. Impart knowledge about the health benefits.
4. Assess the wide information about the laws and issues related to these products and their production.
5. Outline the startup and incubation approaches.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Introduction, Scope and Recent Studies on Marketable Microbial Products. Definition, Types and Nutritional Value of Microbial Fermented Products. Merits of Microbe based Commercial Products.

**UNIT II** **15 Hours**

Food products - Origin and Production process of Fermented food. Milk - Lassi, Amasi, Leben, Taette and Zincica. Cereals - Porridge (types based on cereals used), Bread, Idly, Chakuli Pitha, Kinema, Soy Sauce, Natto and Tempeh. Vegetables - Pickles, Sauerkraut, Garri, Gundruk and Kimchi - Origin and Production Process. Meat and fish based Fermented Foods - Bagoong, Cincalok, Hakarl and Kusaya.

**UNIT III** **20 Hours**

Industrial and Pharmaceutical based products. Fermented Beverages - Origin and production of Calpis, Chicha, Mageu, Salgam, Kombucha, Kvass. Single Cell Protein (SCP) - *Spirulina, Chlorella*. Biopreservatives - Biopreservative components from Lactic acid Bacteria and Yeast. Applications of Biopreservatives.

**UNIT IV** **15 Hours**

Agriculture based products- Effective Microorganisms (EM) - Origin of EM. Production of EM Liquid Concentrate and its Applications. Origin and production process of Manures - Compost, Vermicompost and Vermiwash. Economic importance of Manures. Origin, Types, Production and Applications of Biofertilizers (*Anabaena sp.* and *Rhizobium sp.*) and Biopesticides (*Bacillus thuringiensis* and NPV).

**UNIT V** **15 Hours**

National and International Quality Control Commissions (ICMSF) and Agencies for Food, Agriculture, Industrial and Pharmaceutical based Microbial Products. Government Regulations, Laws and Ethical Issues involved in Microbial Products. An overview of Startup and Incubation Approaches – BioNEST (BIRAC).

**RECOMMENDED TEXTBOOKS**

1. Wood B. (1998). Microbiology of fermented foods. 2nd edn. Blackie and Academic and Professional Publishers.
2. Roy R.C. and Montet D. (2015). Microorganisms and Fermentation of Traditional Foods. 1st edn. CRC Press.
3. Joshi V.K. (2019). Indigenous Fermented Foods of South Asia. 1st edn.

**REFERENCE BOOKS**

1. Hutkins R.W (2018). Microbiology and Technology of Fermented Foods. 2nd edn. Wiley Blackwell Publishers.
2. Tamang J.P (2016). Ethnic Fermented Foods and Alcoholic Beverages of Asia. 1st edn. Springer.
3. Sankaranarayanan A., Amaresan N. and Dhanasekaran D. (2019). Fermented Food Products. CRC Press.
4. Tamang J.P. (2009). Himalayan Fermented Foods. 1st edn. CRC Press.
5. Montet D. and Ray J.P (2016). Fermented Foods, Part I Biochemistry and Biotechnology. 1st edn. CRC Press.

**JOURNALS**

1. International Journal of Fermented Foods.
2. International Journal of Foods and Fermentation Technology.

**E LEARNING RESOURCES**

1. https://billioncheers.com/blog/fermented-foods-in-india/
2. https://onlinelibrary.wiley.com/doi/10.1002/9780470277515.ch12
3. https://www.researchgate.net/publication/268740847_Fermented_Foods_Past_Present_and_Future
4. https://en.wikipedia.org/wiki/List_of_fermented_foods
5. https://www.health.harvard.edu/staying-healthy/fermented-foods-can-add-depth-to-your-diet

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Acquire in depth knowledge about different types of fermented foods. |
| CO 2 | Illustratively study about the origin and production of various fermented foods of different parts of the world. |
| CO 3 | Appraise the health benefits of fermented foods. |
| CO 4 | Analyse the laws governing the production and marketing of fermented foods. |
| CO 5 | Elucidate the startup approaches and informations about incubation. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO 3** | 2 | 3 | 3 | 2 | 2 | 3 |
| **CO 4** | 2 | 2 | 3 | 2 | 3 | 3 |
| **CO 5** | 1 | 1 | 2 | 3 | 3 | 3 |
| **Average** | **2.2** | **2.4** | **2.8** | **2.6** | **2.4** | **3** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER VI
## GOOD LABORATORY PRACTICES AND TECHNIQUES

**TOTAL HOURS: 75** **COURSE CODE: MB21/6E/GLT**
**CREDITS: 5** **L T P: 3 2 0**

**COURSE OBJECTIVES**

1. Understand the basics of good laboratory standard and characteristics of a good technician.
2. Impart knowledge about proper management of Chemicals and handling various hazardous conditions.
3. Assess the applications of various laboratory techniques.
4. Outline biochemical and histopathological studies.
5. Acquire knowledge about various quality assessments boards.

**COURSE OUTLINE**

**UNIT I** **10 Hours**

Good Laboratory Guidelines. Elements of Good Laboratory Practices (GLP). Standard Operating Procedures (SOP) and its Importance. Laboratory Ethics Regulatory Affairs-Methods and Types of Documentation (Pre-Lab Writes, Result Recording and Post Lab Report and Interpretation of Result). Personal Protective Equipment. Characteristics of a Good Technician.

**UNIT II** **20 Hours**

Types of Labs Associated with Microbiology. Types of Chemicals (Analytical Grade, Molecular Grade) and their Arrangement. (Basic Chemicals, Solvent, Acid and Base, Fine Chemicals Like Dyes, Protein and Enzyme Storage Units), Physical and Chemical Characteristics of the Chemicals (Hygroscopic, Corrosive, Volatile Properties). Fire and Explosion Hazards. Handling Spillage. Health Hazards. Fumigation Technique. Definition and Types of Wastes - Biological and Chemical Wastes. Methods of Safe Disposal of Biological and Chemical Waste.

**UNIT III** **20 Hours**

Phlebotomy -Vein Puncture for Withdrawal of Blood and its Complications. Precautions to Prevent Hemolysis. Storage of Blood Specimens. Specimen Rejection Criteria. Measurement of Pulse and Blood Pressure. Hematology and Coagulation Studies. WBC Total Count and Differential Count. Determination of ESR by Wintrobe Method. Estimation of Haemoglobin and Peripheral Smear Study. Detection of Anemia (Iron and Vitamin Deficiency Anemia and Aplastic Anemia) and Thrombocytopenia (Idiopathic and Thrombotic). Estimation of Bleeding Time, Clotting Time, Prothrombin Time and Activated Partial Thromboplastin Time (APTT).

**UNIT IV** **10 Hours**

Clinical Biochemistry. Blood and Urine Sugar-Fasting and Post Prandial (PP). HbA1c. Renal Function Test - Urea, Creatinine and Uric acid. Liver function test-Total Bilirubin and Direct Bilirubin, SGOT, SGPT and Alkaline Phosphatase. Total Protein and Albumin. Lipid Profile-Total Cholesterol, Triglyceride, HDL, LDL and VLDL. Hormone assay – T3, TSH.

**UNIT V** **15 Hours**

Histopathology and Laboratory Quality assessment. Basic steps in Tissue processing - Fixing, Embedding, Microtome procedure, Staining (Hematoxylin Eosin stain) and Mounting methods. Autotechnicon. Laboratory Quality assessment- Quality Assurance & Quality Control, Internal

Audit Basics. Laboratory Standard Accreditation Boards - NABL ISO, BIS, CAP and HACCP standards. Errors - Pre analytical, Analytical and post analytical.

**RECOMMENDED TEXTBOOKS**


1. Sood R. (2006).Textbook of Medical Laboratory Technology. 1st edn. Jaypee - The Health Science Publishers.
2. Rashid N. and Sood R. (2013). Manual of Laboratory Safety: (Chemical, Radioactive and Biosafety with Biocides). 6th edn. Jaypee Brothers Medical Publishers Pvt Ltd.
3. Jayaswal R.P. (2019). Clinical Biochemistry-Student's Laboratory Manual. 1st edn. Notion Press.
4. Singh R.H. (2015).Shifting Trends Towards Sustainable Agriculture Pattern. 1st edn. LAP Lambert Academic Publishing.


**REFERENCE BOOKS**


1. Weinberg S. (2007). Good Laboratory Practice Regulations. 4th edn. CRC Press.
2. Slomiany M.G. (2009).The Indispensable Guide to Good Laboratory Practice GLP: 2nd edn. Pinehurst Press.
3. Nayak R. (2017).Histopathology Techniques and Its Management.1st edn. Jaypee Brothers Medical Publishers.
4. Parson K.N. (2012). Laboratory Quality Management.1st edn.Xlibris Publishers.
5. Dasgupta A. and Wahed A. (2014). Clinical Chemistry, Immunology and Laboratory Quality Control: A Comprehensive Review for Board Preparation, Certification and Clinical Practice. 1st edn. Elsevier.
6. WHO. (2007).Quality Assurance of Pharmaceuticals: A Compendium of Guidelines and Related Materials. Good manufacturing practices and inspection, (Volume-2). 2nd edn. WHO library cataloguing.
7. Somasundaram E. (2019). Principles of Organic Farming (With Theory and Practicals).1st edn. New India Publishing Agency-Nipa.


**JOURNALS**

1. International Journal of Medical Laboratory Research.
2. Journal of Medical Laboratory and Diagnosis.

**E LEARNING RESOURCES**

1. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.academia.edu/32040390/LECTURE_NOTES_For_Medical_Laboratory_Students&ved=2ahUKEwiqjca1o7jxAhXZUn0KHQbfDJ0QFjAJegQIEBAC&usg=AOvVaw0X853lUZ0Edq-h0AOtITXI
2. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.roitt.com/pdf/Online_Chapter.pdf&ved=2ahUKEwin2JnMo7jxAhVaSX0KHeikAQIQFjALegQIEhAC&usg=AOvVaw1jxPr_lYqFdVERoRqVhEeR
3. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.intechopen.com/books/histopathology-an-update/histopathology-an-old-yet-important-technique-in-modern-science&ved=2ahUKEwjFk_ho7jxAhUQcCsKHQNXAnYQFjAZegQIDxAC&usg=AOvVaw1DdDbLP_LPHzqaJKOkVrVj&cshid=1624812974680
4. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.cambridge.org/core/books/principles-and-techniques-of-biochemistry-and-molecular-biology/principles-of-clinical-biochemistry/7583046637F7C7A9163AD31B01E5209F&ved=2ahUKEwi12IT9o7jx

AhVXeH0KHfaFAhsQFjAMegQIFRAC&usg=AOvVaw2MpNgujv_o6qhWlmfL1itM&cshid=1624813078075
5. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.who.int/ihr/publications/lqms_en.pdf&ved=2ahUKEwjrkOWxpLjxAhX2lEsFHVe2AM0QFjAAegQIAxAC&usg=AOvVaw2VM0gNtb849wH-YljACQ1L
6. https://agritech.tnau.ac.in/org_farm/orgfarm_effective%20microorganism.html
7. https://www.fda.gov/inspections-compliance-enforcement-and-criminal-investigations/inspection-guides/microbiological-pharmaceutical-quality-control-labs-793

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Acquire in depth knowledge on good laboratory practices. |
| CO 2 | Appraise the concepts and factors in immunology, histopathology and clinical biochemical techniques. |
| CO 3 | Analyse and practice hazard management. |
| CO 4 | Illustratively study about laboratory techniques and instruments involved. |
| CO 5 | Elucidate the importance of quality assessment and governing bodies. |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO 2** | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 1 | 3 | 2 | 2 | 2 | 3 |
| **CO 4** | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 |
| **Average** | **2** | **2.8** | **2.8** | **2.8** | **2.8** | **3** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, LCD Classes, Online platforms, Case history analysis, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

## SEMESTER VI
## MEDICAL MICROBIOLOGY PRACTICAL

**TOTAL HOURS: 90** **COURSE CODE: MB21/6C/PR3**
**CREDITS: 4** **LT P: 0 0 3**

**COURSE OBJECTIVES**

1. Develop skills to identify medically important bacteria, fungi and parasites from the clinical samples.
2. Gain an in depth knowledge on clinical sample processing.
3. Promote diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.

**COURSE OUTLINE**

**BACTERIOLOGY**

1. General requirements for Collection and Transport of clinical specimens. Transport media - Cary Blair and Stuart's.
2. Preliminary Testing for identification of bacteria- Gram Stain, Motility, Catalase and Oxidase.
3. Sputum- Acid fast- Ziehl Neelson stain.
4. Urine analysis for Bacteriuria- Calibrated loop method.
5. Isolation and Identification of Bacterial Pathogens from Clinical Specimens and their Biochemical reactions. - Pus, Throat swab and Stool.
6. Antimicrobial Susceptibility Testing-
   (i) Disk Diffusion Method- Kirby Bauer and Stokes method (ii) MIC-Broth Dilution Method

**VIROLOGY**

1. Isolation of Coliphage from Sewage sample.
2. Demonstration of inclusion bodies – Negri bodies. Electron Micrograph pictures of Common Viruses.
3. Demonstration of Egg inoculation-CAM and Yolk Sac

**MYCOLOGY**

1. Direct Examination of fungi by KOH mount- hair, nail and skin scrapings.
2. Microscopic Examination of Fungi (LPCB Mount) causing Opportunistic mycotic Infections i) Candidiasis, ii) Aspergillosis iii) Zygomycosis. Cutaneous-Dermatophytosis – *Microsporum sp., Trichophyton sp.* and *Epidermophyton sp*.
3. Slide Culture Technique - Demonstration of morphology of Fungi.
4. Wood's lamp examination for fungal infections.
5. Cultivation of fungi- SDA with and without antibiotics, Czapek Dox and Cornmeal agar.
6. Carbohydrate Assimilation and Fermentation tests for Yeast and Germtube test for Candida.

**PARASITOLOGY**

1. Examination of Stool specimens for Parasites by Iodine Mount Techniques.
2. Concentration Methods for Stool specimens –Floatation Techniques- Saturated Salt and $ZnSO_4$.
3. Concentration Methods for Stool specimens. Sedimentation techniques- Formol Ether Method
4. Examination of Blood Smear for Malarial Parasites.
5. Examination of Permanent Slides- Scolex and Proglottid of Taenia.

**COURSE OUTCOME**

| CO NUMBER | CO STATEMENT |
|---|---|
| **CO 1** | Acquire practical skills in the design and execution of experiments to identify bacteria from clinical samples. |
| **CO 2** | Evaluate various analytical methods to cultivate and assess the virus samples. |
| **CO 3** | Demonstrate various methods for isolation, detection and identification of fungus and parasites from clinical samples. |

**CO MAPPING WITH PSO**

| CO NUMBER | PSO 1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | 3 |
| **Average** | **2.3** | **3** | **2.6** | **3** | **2** | **2.3** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Demonstration, Experimentation, Videos on Protocols and Virtual labs

**QUESTION PAPER PATTERN**:

**Time: 6 Hours (3 Hours, Two days)** **Max Marks: 60**

**Major Practical : 25 marks**
**Minor Practical : 15 marks**
**Spotters (5 x 2) : 10 marks**
**Record : 10 marks**

## MAJOR PRACTICAL- II
## APPLIED MICROBIOLOGY

**TOTAL HOURS: 90** **COURSE CODE: MB21/6C/PR4**
**CREDITS: 4** **LT P: 0 0 3**

**COURSE OBJECTIVES**

1. Enlighten the practical concept on isolation and identification of organisms from spoiled foods.
2. Outline the role of bacteria, its quantification and methods in detection, isolation and characterization from Milk and Curd.
3. Emphasizing the importance of Nitrogen fixing *Rhizobium* by its isolation from leguminous plants and demonstrating their effectiveness by seed inoculation.

**COURSE OUTLINE**

**FOOD MICROBIOLOGY**

1. Isolation and identification of microbes from spoiled foods.
2. Preparation of curd and sauerkraut.
3. Detection of number of bacteria in milk by Breed's count
4. Dye reduction test - MBRT.
5. Microbiological examination of curd - Gram staining.
6. Isolation of Lactobacilli and streptococci from curd.

**SOIL MICROBIOLOGY**

7. Enumeration of different bacteria, fungi, and actinomycetes from soil.
8. Isolation of *Rhizobium* from root nodules and seed inoculation with *Rhizobium*.
9. Study of Azolla-Anabaena relationship
10. Isolation of antibiotic producers from soil by crowded plate technique.
11. Study of Winogradsky column.
12. Screening of amylase enzyme producing organisms from soil.

**WATER AND AIR MICROBIOLOGY**

13. Microbiological water analysis for potability – Multiple tube test.
14. Demonstration of membrane filtration technique.
15. Study of airborne microorganisms (bacteria and fungi) in different places by settle plate technique.

**INDUSTRIAL MICROBIOLOGY**

16. Immobilization of microorganism using gel entrapment method.
17. Industrial Visit.

**COURSE OUTCOME**

| CO Number | CO STATEMENT |
|---|---|
| CO 1 | Master the techniques on isolation and identification of microorganisms on spoiled foods. |
| CO 2 | Apply practical knowledge to isolate bacteria present in milk and its products and studying both beneficial and harmful effects. |
| CO 3 | Imbibe the practical skills for isolation of *Rhizobium* from leguminous plants and its efficacy in plant growth and isolate antibiotic producers from soil. |

**TEACHING METHODOLOGY**

Demonstration, Experimentation, Videos on Protocols and Virtual labs

**MAPPING OF CO WITH PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 3 | 3 | 2 |
| Average | 2.3 | 2.6 | 2 | 3 | 3 | 2.6 |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORELA/TION-0**

**QUESTION PAPER PATTERN**:

**Time: 6 Hours (3 Hours, Two days)** **Max Marks: 60**

**Major Practical : 25 marks /**
**Minor Practical : 15 marks**
**Spotters (5 x 2) : 10 marks**
**Record : 10 marks**

**SELF-STUDY PAPER-UG**

**GENERAL APTITUDE FOR COMPETITIVE EXAMINATIONS**

**COURSE CODE:** **CREDITS: 2**

**COURSE OBJECTIVES**

1. Identify appropriate method to solve mathematical problems
2. Learn basic mathematics required for competitive exams.
3. Impart logical reasoning and quantitative aptitude.
4. Ability to manipulate 2D and 3D objects, spot patterns between shapes.
5. Improve knowledge in verbal aptitude and respond to spoken information.

**COURSE OUTLINE**

**UNIT I**

Numerical Reasoning – Puzzles, Ranking and Arrangement, Clock and Calendar, Directions and Distance, Coding-Decoding, Series formation and Relationship.

**UNIT II**

Numerical Ability – Trigonometry, Mensuration, Geometry, Elementary statistics and Probability, Permutation and combinations, Time & Work, Time Speed and Distance, Mixture and Alligation, Partnership, Data Interpretation.

**UNIT III**

Proportion and Variation, Ratio, Compound Interest, Simple Interest, Profit and Loss, Percentage, Logarithms, Surds and Indices, Sequence and Series, Quadratic equations, HCF and LCM, Average, Number and Simplification.

**UNIT IV**

Analytical and Spatial Aptitude-Logic- Deduction and Induction**,** Analogy. Transformation of Shapes- Translation, Rotation, Scaling, Mirroring, Assembling, and Grouping, Paper Folding, Cutting, and Patterns in 2 and 3 Dimensions.

**UNIT V**

Verbal Aptitude-Tenses, Articles, Adjectives, Prepositions, Conjunctions, Verb-Noun Agreement and Other Parts of Speech. Basic Vocabulary- Words, Idioms, and Phrases in Context. Reading and Comprehension. Verbal Analogies, Word Groups, Critical Reasoning and Narrative Sequencing.

**RECOMMENDED TEXT BOOKS**

1. Guha A. (2017). Quantitative Aptitude for All Competitive Examinations. 6$^{th}$edn. S.Chand Publications.
2. Agarwal R. S (2019). A Modern Approach to verbal and Nonverbal Reasoning. 2$^{nd}$edn. S. Chand Publications.

**REFERENCE BOOKS**


1. Sharma A. (2019). Teach Yourself Quantitative Aptitude: Useful for all competitive examinations. 2nd edn. McGraw Hill Publication.
2. Verma R. (2018). Fast Track Objective Arithmetic. 4thedn. Arihant Publisher
3. Kattar D. (2014). Quantitative aptitude for Competitive Examination, 3rdedn. Pearson Education India.
4. Dubey R. (2020). General Aptitude (Net with Gate), DIPS academy.
5. Kumar P. and Chandra P. (2019). Gate Guide Life Sciences Microbiology. 16thedn, G.K Publisher.


**JOURNALS**

1. The Journal of Experimental Education.
2. The Journal of Indian Mathematical Society.

**E- LEARNING RESOURCES**

1. https://www.graduatesfirst.com/numerical-reasoning
2. https://www.practiceaptitudetests.com/numerical-reasoning-tests/
3. https://www.test-preparation.ca/metric-conversion-practice-questions/
4. https://www.wikijob.co.uk/content/aptitude-tests/test-types/spatial-awareness-test
5. https://www.faceprep.in/verbal-ability/

**COURSE OUTCOME**

| CO NUMBER | CO STATEMENT |
|---|---|
| CO 1 | Appraise various patterns of logical reasoning and aptitude based questions which forms the important criteria in competitive examinations. |
| CO 2 | Outline the basic concepts and formulae in Mathematics |
| CO 3 | Compute problems related to proportion & variation, profit & loss, percentage etc. |
| CO4 | Solve problems based on spatial and analytical aptitude |
| CO5 | Evaluate practical verbal skills and understand concepts through words |

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO 2** | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO 3** | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO 4** | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO 5** | 1 | 1 | 1 | 1 | 2 | 2 |
| **Average** | **1** | **1** | **1** | **1** | **2** | **2** |

**KEY: STRONGLY CORRELATED-3 MODERATELY CORRELATED-2 WEAKLY CORRELATED-1 NO CORELATION-0**

**QUESTION PAPER PATTERN**

**Time: 3 Hours** **Max. Marks: 100**

**50 Objective type questions** **50x 2= 100 marks**

## II B.Sc. BIOCHEMISTRY

| COURSE CODE | TITLE OF THE PAPER | CREDITS | HOURS/WK | TOTAL HOURS | L-T-P | CA | SA | TOTAL |
|---|---|---|---|---|---|---|---|---|
| MB21/3A/AM1 | Allied Microbiology-I | 4 | 4 | 60 | 3-1-0 | 40 | 60 | 100 |
| MB21/4A/PR2 | Allied Microbiology Practical | - | 2 | - | | 40 | 60 | 100 |
| MB21/4A/AM2 | Allied Microbiology-II | 4 | 4 | 60 | 3-1-0 | 40 | 60 | 100 |
| MB21/4A/PR2 | Allied Microbiology Practical | 2 | 2 | 60 | 0-0-2 | 40 | 60 | 100 |
| | **TOTAL CREDITS** | **10** | | | | | | |

**SEMESTER III**
**ALLIED MICROBIOLOGY- I**
**(Offered to II B.Sc. Biochemistry students)**

**TOTAL HOURS: 60** **COURSE CODE: MB21/3A/AM1**
**CREDITS: 4** **L T P: 3 1 0**

**COURSE OBJECTIVES**

1. Introduce the history and development of Microbiology
2. Understand structural make up of bacteria
3. Learn staining techniques and culturing bacteria.
4. Obtain pure culture of organisms and measuring their growth.
5. Explain sterilization and preservation methodologies.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Historical Development of Microbiology-Spontaneous Generation vs. Biogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Binomial Nomenclature, Whittaker's Five Kingdom and Carl Woese's Three Domain Classification.

**UNIT II** **15 Hours**

Structural Organization of Bacteria -Cell Size, Shape and Arrangement of Bacterial Cells. Ultrastructure of a Bacterial Cell-Glycocalyx, Capsule, Flagella, Fimbriae and Pili, Cell Wall-Composition and Detailed Structure of Gram-Positive and Gram-Negative Cell Walls, Cell Membrane-Structure, Function and Chemical Composition of Bacterial Cell Membranes, Cytoplasm-Ribosomes, Mesosomes, Inclusion Bodies, Nucleoid and Plasmids. Endospore-Structure, Formation, Stages of Sporulation.

**UNIT III** **10 Hours**

Microscopy- Principles and Applications of Bright Field Microscopy. Principles and Types of Staining-Simple, Differential - Gram Staining, Spore Staining, Acid Fast Bacilli Staining Capsule Staining -Negative Staining. Bacterial Growth -Different Phases of Growth. Methods for Measuring Microbial Growth -Direct Microscopic, Viable Count and Turbidometry.

**UNIT IV** **10 Hours**

Cultivation of Microbes-Types of Culture Media-Components of Media-Natural and Synthetic Media, Chemically Defined Media, Complex Media, Selective, Differential, Enriched and Enrichment Media. Pure Culture Techniques-Serial Dilution, Pour Plate, Spread Plate and Streak Plate.

**UNITV** **10 Hours**

Sterilization- Principles and Methods-Physical Methods –Moist Heat, Dry heat Filtration-Membrane and HEPA filter, Chemical Methods - Alcohols, Phenols, Radiation - UV and Gamma Rays. Methods of Maintenance and Preservation of Microbes- Mineral Oil Method, Lyophilisation. Safe decontamination practices.

**RECOMMENDED TEXTBOOKS**

1. Pelczar M.J., Chan E.C.S. and Kreig N.R. (2010). Microbiology 5th edn. McGraw-Hill, NewYork Publications.
2. Prescott L.M, Harley J. P and Klein D.A. (2005). Microbiology 6th edn. McGraw-Hill Publications.
3. Dubey R.C. and Maheshwari D.K. (2010). Microbiology 2nd edn. S.Chand and Company Ltd. New Delhi.

**REFERENCE BOOKS**

1. Stanier R.Y, Ingraham, Wheelis M.L. Painter. (1999). General Microbiology, 5th edn. Mac Millan Press Ltd.
2. Tortora G.J., Funke B.R., and Case, C.L. (2004). Microbiology- An Introduction, 8th edn. Benjamin-Cummings Pub Co.
3. Madigan M.T., Martinko J.M. and Parker J. (2005). Brock - Biology of Microorganisms, 11th edn. Pearson Prentice Hall International, Inc.
4. Jeffrey A. Pommerville C. (2004). Fundamentals of Microbiology, 7th edn. Jones and Bartlett Publishers.
5. Atlas R.M. (1996). Principles of Microbiology, 2nd edn. Wm.C. Brown Publishers.

**JOURNALS**

1. Indian Journal of Microbiology
2. International Journal of Current Microbiology and Applied Sciences

**E-LEARNING RESOURCES**

1. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/1%3A_Introduction_to_Microbiologyhttp://textbookofbacteriology.net/structure.html
2. https://milnepublishing.geneseo.edu/suny-microbiology-lab/chapter/differential-staining-techniques/
3. http://www.biologydiscussion.com/organism/culture-organism/obtaining-pure-culture-of-microorganisms-6-methods/55042
4. https://www.studyread.com/what-is-sterilization-methods/

**COURSE OUTCOME**

| CO | CO STATEMENT |
|---|---|
| CO 1 | Outline landmark events in the history of microbiology and to classify Microorganisms into taxonomic groups. |
| CO 2 | Describe the structural and functional make up of a bacteria. |
| CO 3 | Compile various staining and cultivation techniques. |
| CO 4 | Expose to techniques for obtaining pure cultures of microorganisms with knowledge on methods of measuring microbial growth. |
| CO 5 | Get acquainted with sterilization and preservation techniques. |

**MAPPING OF CO WITH PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 2 |
| **CO5** | 2 | 3 | 2 | 2 | 1 | 1 |
| **AVERAGE** | 2.2 | 2.4 | 2.2 | 2 | 1.2 | 1.2 |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, Flipped Learning, online class through zoom and google meet platforms, Online Platforms, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

**QUESTION PAPER PATTERN**

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

**SEMESTER-IV**
**ALLIED MICROBIOLOGY- II**
**(Offered to II B.Sc. Biochemistry Students)**

**TOTAL HOURS: 60** **COURSE CODE: MB21/4A/AM2**
**CREDITS: 4** **LTP: 3 1 0**

**COURSE OBJECTIVES**
1. Investigate Microbial food spoilage, preservation and testing.
2. Analyse soil microorganisms and their applications.
3. Learn about water types, purification and water borne diseases.
4. Summarize air profile, air quality and air borne diseases.
5. Learn industrial production of beneficial microbial products for human welfare.

**COURSE OUTLINE**

**UNIT I** **15 Hours**

Food Microbiology-Classification of Foods based on Stability. Microbial Spoilage of Food - Chemical and Physical Properties of Food affecting Microbial Growth. Spoilage of Fruits, Meat Products and Canned Foods. General Preservation Techniques - High Temperature, Low Temperature. Microbiology of Milk - Common Microorganisms found in Milk. Spoilage and Preservation of Milk. Methods of Pasteurization – LTH, HTST, UHT Pasteurization and Methylene Blue Reductase Test.

**UNIT II** **15 Hours**

Soil Microbiology - Microbes in Soil - Bacteria, Fungi, Actinomycetes, Algae and Viruses. Rhizosphere Microflora and its Role in the Rhizosphere. Role of Microorganisms in Elemental Cycles in Nature - Carbon Cycle and Nitrogen Cycle. Biofertilizers -Mass Cultivation and Benefits of Rhizobium.

**UNIT III** **10 Hours**

Water Microbiology - Treatment and Safety of Drinking (Potable) Water, Methods to Detect Potability of Water Samples-Standard Qualitative Procedure - Presumptive Test/MPN Test, Confirmed and Completed Tests for Faecal Coliforms. Water Borne Diseases.

**UNIT IV** **10 Hours**

Air Microbiology - Composition of Air, Air Flora, Droplet, Droplet Nuclei, and Aerosols. Methods of Air Sampling and Types of Air Samplers- Impaction on Solids, Impingement in Liquid and Solid and Centrifugation. Air Sanitation - Physical and Chemical Methods. Air Borne Infections.

**UNIT V** **10 Hours**

Industrial Microbiology- Microbes in the Production of Organic Acids - Citric Acid, Antibiotics - Penicillin, Alcoholic Beverages – Wine and Beer. Fermented Milk Products-Cheese.

**RECOMMENDED TEXTBOOKS**

1. Pelczar M.J., Chan E.C.S. and Kreig N.R. (2010). Microbiology, 5$^{th}$edn. McGraw-Hill New York Publications.
2. Prescott L.M, Harley J. P and Klein D.A. (2005). Microbiology 6$^{th}$edn. McGraw-Hill Publications.
3. Dubey R.C. and Maheshwari D.K.(2010). Microbiology 2$^{nd}$edn, S.Chand and Company ltd.

**REFERENCE BOOKS**


1. Stanier R.Y., Ingraham J.L., Wheelis M.L. and Painter R.R (1999). General Microbiology, 5th edn. Mac Millan Press Ltd.
2. Tortora G.J., Funke B.R. and Case C.L. (2004). Microbiology-An Introduction, 8th edn. Benjamin- Cummings Pub Co.
3. Madigan M.T., Martinko J.M and Parker J. (2005). Brock - Biology of Microorganisms, 11th edn. Pearson, Prentice Hall International, Inc.
4. Jeffrey A. Pommerville C. (2004). Fundamentals of Microbiology, 7th edn. Jones and Bartlett Publishers.
5. Atlas R.M. (1996). Principles of Microbiology, 2nd edn. Wm.C.Brown Publishers.


**JOURNALS**

1. Indian Journal of Applied Microbiology (IJAM).
2. International Journal of Microbiology Research.

**E-LEARNING RESOURCES**

1. https://aggie-horticulture.tamu.edu/food-technology/food-processing-entrepreneurs/microbiology-of-food/
2. https://www.britannica.com/science/biogeochemical-cycle/
3. https://www.disabled-world.com/health/water-diseases.php
4. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/17%3A_Industrial_Microbiology
5. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5229

**COURSE OUTCOME**

| CO Number | CO STATEMENT |
|---|---|
| CO 1 | Focus on Microbial spoilage, preservation, testing and production of milk products. |
| CO 2 | Explain types of soil microbes with their role in the various bio geo cycles and their applications. |
| CO 3 | Discuss the different sources of water, their purification methods and threats of water borne diseases. |
| CO 4 | Explain the composition of air, its quality with remedial sanitary measures to combat air borne diseases. |
| CO 5 | Get insights on industrial production of human utility products. |

**MAPPING OF CO WITH PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 1 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 1 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 |
| **AVERAGE** | 3 | 2.8 | 2.6 | 2.6 | 1.2 | 2.6 |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**TEACHING METHODOLOGY**

Lecture by chalk and talk, Flipped Learning, ONLINE PLATFORMS, e-content, Problem Solving, Group Discussion, Assignment, Quiz, Peer Learning, Seminar.

## QUESTION PAPER PATTERN

| Knowledge Level | Section | Word Limit | Marks | Total |
|---|---|---|---|---|
| **K 1** | **A-10x2 marks (Compulsory)**(2 Questions from Each Unit) | **One or Two Sentences** | **20** | **100** |
| **K1, K2** | **B-5x8 marks ( Answer any Five questions out of eight)** (One to be taken from each unit. Remaining 3 questions can be from any 3 units) | **500** | **40** | |
| **K3,K4** | **C-2 x20 marks ( Answer any Two questions out of four)** (one question each from any four units) | **1200** | **40** | |

**ALLIED PRACTICAL**
**ALLIED MICROBIOLOGY**
**(Offered to II BSc. Biochemistry Students)**

**TOTAL HOURS: 60** **COURSE CODE: MB21/4A/PR2**
**CREDITS: 2** **L T P 0 0 2**

**COURSE OBJECTIVES**

1. Learn the basic concepts in Microbiology and instruments used in the laboratory.
2. Introduce staining techniques and culturing techniques.
3. Explain enumeration techniques, microscopic identification of microbes.

**COURSE OUTLINE**

1. Cleaning and preparation of Glassware.
2. Instrumentation- Incubator, Water Bath and Micropipette.
3. Microscopy - Compound Microscope - Principle, Operation, Uses and Maintenance.
4. Sterilization Techniques by Moist Heat and Dry heat method.
5. Simple staining.
6. Gram staining.
7. Capsule Staining.
8. Preparation of Liquid and solid Media – Nutrient Broth & Nutrient agar.
9. Demonstration of bacterial motility using semi solid Agar.
10. Enumeration of Bacteria from Air Samples- Standard Plate Count.
11. Enumeration of Bacteria from Soil Samples- Standard Plate Count.
12. Pure Culture Technique- Streak Plate technique.
13. Methylene Blue Reductase test.
14. Observation of Pond Water for the Presence of Microorganisms- *Volvox, Nostoc, Oscillatoria.*
15. Identification of Organisms that spoil bread by LPCB mount Technique-*Aspergillus niger and Rhizopus sp.*
16. Antibiotic Sensitivity testing - Disc Diffusion method by Kirby Bauer Method.

**COURSE OUTCOME**

| CO No. | CO Statement |
|---|---|
| CO 1 | Imbibe complete knowledge on basic techniques in microbiology |
| CO 2 | Apply staining and culturing techniques for identification of microorganisms. |
| CO 3 | Analyse the structure of bacteria, fungi and algae microscopically |

**TEACHING METHODOLOGY**

Demonstration, Experimentation, Videos on Protocols and Virtual labs

**MAPPING OF CO WITH PSO**

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 2 | 1 | 2 |
| **CO 2** | 3 | 3 | 2 | 2 | 1 | 1 |
| **CO 3** | 3 | 3 | 3 | 2 | 1 | 2 |
| **Average** | **3** | **3** | **2.3** | **2** | **1** | **1.6** |

**KEY: STRONGLY CORRELATION-3 MODERATELY CORRELATION-2 WEAKLY CORRELATION-1 NO CORRELATION-0**

**QUESTION PAPER PATTERN**

**(Time-3 Hours, One day)** **Max Marks-60**

**Major Practical : 30 marks**
**Minor Practical : 20 marks**
**Record : 10 marks**