# ST. JOSEPH'S COLLEGE (AUTONOMOUS)

# BENGALURU-27

Re-accredited with **'A++' GRADE with 3.79/4 CGPA** by NAAC
Recognized by UGC as College of Excellence

## DEPARTMENT OF MICROBIOLOGY

**SYLLABUS FOR I and II semester UNDERGRADUATE PROGRAMME**

# For Batch 2021-2024

# SUMMARY OF CREDITS IN MICROBIOLOGY

| DEPARTMENT OF MICROBIOLOGY (UG)<br>(2021-2024) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Semester 1** | **Code Number** | **Title** | **No. of Hours of Instructions** | **Number of Hours of teaching per week** | **Number of credits** | **Continuous Internal Assessment (CIA) Marks** | **End Semester Marks** | **Total marks** |
| Theory | MB-121 | Basic Microbiology & Microbiological techniques | 60 | 04 | 04 | 30 | 70 | 100 |
| Practical | MB-1P1 | Basic Microbiology & Microbiological techniques | 33 | 03 | 01 | 15 | 35 | 50 |
| **Total Number of credits:** | | | | | **05** | | | |
| **Semester 2** | **Code Number** | **Title** | **No. of Hours of Instructions** | **Number of teaching hrs /week** | **Number of credits** | **Continuous Internal Assessment (CIA) Marks** | **End Semester Marks** | **Total marks** |
| Theory | MB-221 | Biophysics, Biochemistry and Microbial diversity | 60 | 04 | 04 | 30 | 70 | 100 |
| Practical | MB-2P1 | Biophysics, Biochemistry and Microbial diversity | 33 | 03 | 01 | 15 | 35 | 50 |
| **Total Number of credits:** | | | | | **05** | | | |
| **Semester 3** | **Code Number** | **Title** | **No. of Hours of Instructions** | **Number of teaching hrs /week** | **Number of credits** | **Continuous Internal Assessment (CIA) Marks** | **End Semester Marks** | **Total marks** |
| Theory | MB-321 | Microbial physiology, growth and control of microorganisms | 60 | 04 | 04 | 30 | 70 | 100 |
| Practical | MB-3P1 | Microbial physiology, growth and control of microorganisms | 33 | 03 | 01 | 15 | 35 | 50 |
| **Total Number of credits:** | | | | | **05** | | | |
| **Semester 4** | **Code Number** | **Title** | **No. of Hours of Instructions** | **Number of teaching hrs /week** | **Number of credits** | **Continuous Internal Assessment (CIA) Marks** | **End Semester Marks** | **Total marks** |
| Theory | MB-421 | Microbial Genetics and Molecular Biology | 30 | 02 | 02 | 15 | 35 | 50 |
| Theory | MBOE-4121 | Microbial Diseases: Causes, Prevention and Cure | 30 | 02 | 02 | 15 | 35 | 50 |
| Practical | MB-4P1 | Microbial Genetics, Molecular Biology | 33 | 03 | 01 | 15 | 35 | 50 |
| **Total Number of credits:** | | | | | **03** | | | |

| **Semester 5** | **Code Number** | **Title** | **No. of Hours of Instructions** | **Number of teaching hrs /week** | **Number of credits** | **Continuous Internal Assessment (CIA) Marks** | **End Semester Marks** | **Total marks** |
|---|---|---|---|---|---|---|---|---|
| **Theory** | **MB-5121** | **Immunology and Medical Microbiology** | 45 | 03 | 03 | 30 | 70 | 100 |
| **Practical** | **MB-5P1** | **Immunology and Medical Microbiology** | 33 | 03 | 01 | 15 | 35 | 50 |
| **Theory** | **MB-5221** | **Agricultural and Environmental Microbiology** | 45 | 03 | 03 | 30 | 70 | 100 |
| **Practical** | **MB-5P2** | **Agricultural and Environmental Microbiology** | 33 | 03 | 01 | 15 | 35 | 50 |
| **Total Number of credits:** | | | | | **08** | | | |
| **Semester 6** | **Code Number** | **Title** | **No. of Hours of Instructions** | **Number of teaching hrs /week** | **Number of credits** | **Continuous Internal Assessment (CIA) Marks** | **End Semester Marks** | **Total marks** |
| Theory | MB-6121 | Food and Fermentation Technology | 45 | 03 | 03 | 30 | 70 | 100 |
| Practical | MB-6P1 | Food and Fermentation Technology | 33 | 03 | 01 | 15 | 35 | 50 |
| Theory | MB-6221 | Microbial technology | 45 | 03 | 03 | 30 | 70 | 100 |
| Practical | MB-6P2 | Microbial technology | 33 | 03 | 01 | 15 | 35 | 50 |
| **Total Number of credits:** | | | | | **08** | | | |

| **CORE COURSES (CC)** | |
|---|---|
| Course Title | Code Number |
| Basic Microbiology & Microbiological techniques | MB-121 |
| Biophysics, Biochemistry and Microbial diversity | MB - 221 |
| Microbial physiology, growth and control of microorganisms | MB - 321 |
| Microbial Genetics, Molecular Biology | MB - 421 |
| Immunology and Medical Microbiology | MB - 5121 |
| Agricultural and Environmental Microbiology | MB - 5221 |
| Food and Fermentation Technology | MB - 6121 |
| Microbial technology | MB - 6221 |

| GENERIC ELECTIVE COURSES (GSE)/ Can include open electives offered | |
|---|---|
| Course Title | Code Number |
| Microbial Diseases: Causes, Prevention and Cure | MBOE- 4121 |

| SKILL ENHANCEMENT COURSE (SEC) – Any practical oriented and software based courses offered by departments to be listed below | |
|---|---|
| Course Title | Code Number |
| Basic Microbiology & Microbiological techniques | MB-1P$_1$ |
| Biophysics, Biochemistry and Microbial diversity | MB-2P$_1$ |
| Microbial physiology, growth and control of microorganisms | MB-3P$_1$ |
| Microbial Genetics, Molecular Biology | MB-4P$_1$ |
| Immunology and Medical Microbiology | MB-5P$_1$ |
| Agricultural and Environmental Microbiology | MB-5P$_2$ |
| Food and Fermentation Technology | MB-6P$_1$ |
| Microbial technology | MB-6P$_2$ |

| VALUE ADDED COURSES (VAC) Certificate courses that add value to the core papers can be listed | |
|---|---|
| Course Title | Code Number |
| Principles of Genetic Engineering | PGE 1 MB |
| Food Technology | |
| Ethics in Life Sciences and Health care Sector | |

# Course Outcomes and Course Content

## DEPARTMENT OF MICROBIOLOGY

| | |
|---|---|
| Semester | I |
| Paper Code | **MB-121** |
| Paper Title | **Basic Microbiology and Microbiological Techniques** |
| Number of teaching hours per week | 04 |
| Total number of teaching hours per semester | 60 |
| Number of credits | 04 |

**Objective of the Paper:**
This paper introduces the students to the history, contribution of scientists, scope and the diversity of Microorganisms. It gives an overview of the microbial world and the techniques used to visualize and keep microbes in check. This paper acts as the first step to gain insight about the basics of the vast field of Microbiology.

## UNIT – I

**History and Scope of Microbiology:**

**a.** Theories of origin of life
Scope and relevance of Microbiology as a modern science
Branches of Microbiology**2**

**b. Contribution of Scientists to the field of Microbiology**:
Antony Von Leewenhoek, Francisco Redi, Edward Jenner, Louis Pasteur, Joseph Lister, Robert Koch and Alexander Flemming**.2**

**c. Microscopic examination of Microorganisms**
Light Microscopy-Bright field, Dark field, Fluorescence and Phase contrast
Electron microscopy (TEM and SEM)**7**

## UNIT – II

**General Characteristics of Microorganisms**

**a. Introduction to prokaryotic and eukaryotic cells:**
Comparative study of cellular organization of prokaryotes and eukaryotes **1**

**b. Bacteriology:**

Overview of a bacterial cell (morphology, ultra structure and function)

Structure and function of flagella, pili and capsule, cell wall (gram positive and gram negative), cell membrane, mesosomes, ribosomes, and genetic material.

Plasmid- types and function.

Inclusion bodies and reserve food materials.

Endospore – structure, function, sporulation and germination.

Reproduction in bacteria: asexual and sexual, horizontal gene transfer.

**Bacteria with unusual properties:**

Mycoplasma

Actinomycetes**14**

**c. Phycology**

General characteristics and importance.

Overview of cyanobacterial cell (Ultrastructure and functions) **2**

## UNIT – III

**d. Mycology**

Overview of fungal cell -ultra structure of Hyphal and yeast form.

Structure and function of cell wall, cell membrane, flagella, cell organelles.

Reproduction in fungi: asexual and sexual **6**

**e. Virology**

Structure, Reproduction, and Significance of:

Bacterial viruses - T4, Plant virus- TMV, Animal virus - HIV.

Cultivation of viruses.

**f. Protozoology**– General characters and type study- Paramecium (structure and reproduction).

**g. Infectious particles**- Prions &Viroids (general characteristics and diseases.)

**Emergent pathogen relevant at the time - case study**

**11**

## UNIT – IV

**Microbiological techniques**

**a. Staining Techniques:**

Simple staining (Negative staining)

Differential staining (Grams and Acid fast staining)

Structural staining (endospore, flagella and capsular staining) and fungal staining **3**

**b. Sterilization techniques:**

i) Factors affecting antimicrobial activity: -

Environment, organisms, physiological status of the organisms, inoculums concentration, intensity of concentration of the antimicrobial agent, temperature and time of action as factors affecting antimicrobial activity.

ii) Physical methods:
Moist heat (Pasteurization)
Moist heat under pressure (Autoclave)
Dry heat (incineration, hot air over)
Filtration- membrane filter, HEPA filter
Radiation (UV- rays, X- rays, ultrasonic rays)

iii) Chemicals (alcohols, formaldehyde, phenol, halogens and heavy metals): Characteristics of an ideal antimicrobial chemical agent
Evaluation of antimicrobial chemical agents- agar plate techniques,Phenol co-efficient methods. **12**

**NOTE: 8 hours of self-study will be assigned from the above units.**

## REFERENCES:


1. Jacquelyn G.Black, (2008), Microbiology Principles and explorations, JohnWiley& sons Ltd
2. Prescott, Harley & Klein's,(2008), Microbiology, Mac Graw Hill Higher education.
3. James T Staley; (2007)Microbial Life; Sinauer Associates.
4. Michael J Pelczar, JR. E.C.S Chan, Noel R. Krieg; Microbiology, TATA McGraw-Hill publication.
5. Douglas B Murphy; Fundamentals of light microscopy and electronic imaging; John Wiley and Sons.


## BLUEPRINT

Code number: **MB 121**

Title of the paper: **Basic microbiology and Microbiological techniques.**

| **Total marks for which the questions are to be asked (including bonus questions)** | | **Number of Hrs** | **Chapter number** |
|---|---|---|---|
| 19 | | 11 | Unit I |
| 27 | | 17 | Unit II |
| 27 | | 17 | Unit III |
| 23 | | 15 | Unit IV |
| **Total** | **96** | **60** | |
| **Maximum marks for the paper (Excluding bonus question)= 70** | | | |

## Practical I

### MB $1P_1$ – Basic microbiology and Microbiological techniques (11 sessions 3hr/week)

1. Safety measures in laboratory.
2. Study of compound and binocular microscopes.
3. Study of instruments- Autoclave, hot air oven, LAF, incubator, membrane filter, colony counter.
4. Preparation of media – NB, NA.
5. Isolation and identification of bacteria.
6. Pure culture techniques – pour plate, spread plate and streak plate (Simple, Continuous, Quadrant) methods.
7. Aseptic transfer techniques.
8. Staining of bacteria – Gram's, Negative, Endospore and Capsule Staining.
9. Permanent slides – *Aspergillus, Penicillium, Rhizopus and Anabaena.*

**Course outcomes (MB121)**: **At the end of the Course, the Studentwill be able to**

| | |
|---|---|
| CO1 | Appreciate contributions of Pioneers in the field of microbial research. |
| CO2 | Get acquainted with different types of microbial life forms and their basic structure and functions. |
| CO3 | Understand the basics of structural organization of a prokaryotic and eukaryotic cell. . |
| CO4 | Build a strong foundation in theoretical and practical understanding of growth and control of microorganisms |
| CO5 | Apply the knowledge gained to identify and use various laboratory aids to culture, visualize and control microorganisms. |
| CO6 | Compare and contrast the similarities and differences between different groups of microorganisms. |
| CO7 | Assess the importance of microbes in all realms of life. |
| CO8 | Apply the basic disinfection and sterilization techniques to maintain health and hygiene. |

**DEPARTMENT OF MICROBIOLOGY**

| | |
|---|---|
| Semester | II |
| Paper Code | **MB-221** |
| Paper Title | **Biophysics, Biochemistry and Microbial diversity** |
| Number of teaching hrs per week | 04 |
| Total number of teaching hrs per semester | 60 |
| Number of credits | 04 |

**Objective of the Paper:**
This paper enables students to learn about the Bio molecules present in microbial cells and the techniques used in their biophysical and biochemical analysis. It also deals with the study of the diversification of microorganisms.

## UNIT - I

Biophysics
**a.** Scope and development of Biophysics **1**

**b.** Properties and dissociation of water
Structure, properties, hydrogen bonding, water as a solvent and ionization of water **3**

**c**. pH and Buffers pH –
pH- concept and pH scale; Buffers- concept.
Henderson- Hasselbalch equation, Biological buffer systems **3**
**d.** Isotopes and Radioactivitiy
Nature of radioactivity, Atomic structure and stability, Types of radioactive emissions, Rate and half life of disintegration.Applications of radioisotopes in the biological sciences, safety measures and Autoradiography. **4**

## UNIT - II

**Analytical techniques**
Principle and applications of Chromatography (Paper chromatography, Thin layer chromatography, Column chromatography), Centrifugation and Electrophoresis (agarose gel electrophoresis and SDS-PAGE), Spectrophotometry. **7**

## UNIT - III

**Bio molecules**

Amino acids and Peptides- Classification and Properties (titration curve of amino acids). **3**

Proteins – Classification of proteins based on structure and functions, Structural organization of proteins (Primary, Secondary, Tertiary and Quaternary structures) **4**

Nucleic acids – Experiments to elucidate nucleic acids as genetic material, DNA (Watson and Crick model, types of DNA and its functions), Structure and function of mRNA, tRNA and rRNA **4**

Vitamins – Water soluble and Fat- soluble vitamins(Dietary source and deficiency disorders) **3**

Carbohydrates – Structure, Properties and Classification. **4**

Lipids – Structure, Properties and Classification. **3**

## UNIT – IV

**Enzymology**

Introduction to enzymes, Classification, Enzyme kinetics (Michaelis Menten Equation)
Factors influencing enzyme activity, co-enzymes and co-factors,
Mechanisms of enzyme regulation **7**

## UNIT – V

**Microbial Diversity**

a. Microorganisms and microbial ecology –

Classification based on temperature, pH, oxygen requirement, salt concentration and pressure (with adaptation strategies for each parameter), nutritional types **4**

b. Microbial associations (Parasitism, symbiosis, commensalism, antagonism, predator, and competition).**4**

c. Microbial systematics

Bacterial Classification Bergey's manual.

1.Brief account on- Numerical taxonomy, chemotaxonomy and genetic analyses. **4**

2.Fungal classification – Alexopolus **1**

3.Viral Classification – Baltimore **1**

**NOTE: 8 hours of self-study assigned from the above units.**

**REFERENCES:**

1.Michael M Cox, David L Nelson; Lehninger, Principles of Biochemistry; 5th edition; Worth Publishers, Inc
2.Jain and Jain; Biochemistry
3.Wilson and Walker; Principles and Techniques of Biochemistry and Molecular Biology.
4.Upadhyaya; Biophysical chemistry
5.James T Staley; (2007)Microbial Life; Sinauer Associates
6.Atlas and Bartha; Microbial Ecology.
7.Jacquelyn G.Black, (2008), Microbiology Principles and explorations, JohnWiley& sons Ltd
8.Prescott, Harley &Klein's, (2008), Microbiology, Mac Graw Hill Higher education.

## BLUEPRINT

Code number: **MB 221**

Title of the paper: **Biophysics, Biochemistry and Microbial diversity**

| **Total marks for which the questions are to be asked (including bonus questions)** | | **Number of Hrs** | **Chapter number** |
|---|---|---|---|
| 18 | | 11 | Unit I |
| 11 | | 07 | Unit II |
| 34 | | 21 | Unit III |
| 11 | | 07 | Unit IV |
| 22 | | 14 | Unit V |
| **Total** | **96** | **60** | |
| **Maximum marks for the paper (Excluding bonus question)= 70** | | | |

## Practical II

## $MB2P_1$ – Biophysics, Biochemistry and Microbial diversity
## (11 sessions 3hr/week)

1. Study of instruments: Centrifuge, pH meter, Spectrophotometer.
2. Preparation of buffer – citrate and phosphate buffer.
3. Estimation of reducing sugars by DNSA method.
4. Estimation of Protein by Lowry's method.
5. Estimation of DNA by Diphenylamine (DPA) method.
6. Estimation of RNA by Orcinol method.
7. Paper chromatography of amino acids.
8. Isolation and identification of fungi.
9. Study of microbial interactions - antagonism (Bacteria v/s Bacteria, Bacteria v/s Fungi, Fungi v/s Fungi).

**Course outcomes (MB221): At the end of the Course, the Studentwill be able to**

| | |
|---|---|
| CO1 | Gain insight into the structure and function of biomolecules and the techniques used for their analysis. |
| CO2 | Gain knowledge about the diversification of microorganisms and interactions between them. |
| CO3 | Understand the principles of various analytical techniques used to study biomolecules. |
| CO4 | Develop an understanding of the characteristics/adaptations of different types of microorganisms and methods to classify them. |
| CO5 | Estimate biomolecules in different samples |
| CO6 | Analyze microbial interactions |
| CO7 | Appreciate the importance of biomolecules in. living systems |