SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

**K. J. SOMAIYA COLLEGE OF SCIENCE AND COMMERCE,**

**VIDYAVIHAR, MUMBAI 400 077**

**AUTONOMOUS- AFFILIATED TO UNIVERSITY OF MUMBAI**

# Syllabus for T. Y. B.Sc.

# Program: B.Sc.

# Course: Microbiology

# (Choice based Credit System with effect from the Academic year 2023–2024)

# Preamble

To the common man, Microbiology means the study of invisible mini wonders that only cause disease. In reality, the vast majority of microorganisms co-exist alongside us without causing any harm. On the contrary, many of them are required for our survival. Microbiology is a study of this microscopic world; it is a research-oriented subject and plays a pivotal role in our daily lives.

After introducing the basics of Microbiology in core courses in Semester I and Semester II, syllabus progresses to include the topics of Medical Microbiology, Immunology, Genetics, Biochemistry, Virology, Taxonomy in core courses in Semester III and Semester IV. A choice is offered between Environmental Microbiology (22US3MBCC3EVM) and Soil Microbiology (22US3MBCC4SOM) in Semester III and between Industrial and food Microbiology(22US4MBCC3IFM) and Diary Microbiology (22US4MBCC4DAM) in Semester IV.

Semester V and Semester VI core courses focus on the depth and applications of the above topics. Along with core courses each semester consists of two Discipline specific elective (DSE) courses, one Skill enhancement course (SEC). Semester V and Semester VI include topics of Genetics, Molecular biology, Medical Microbiology, Immunology, Biochemistry, Bioprocess technology, Advanced Virology, Bioinstrumentation, Plant and Animal cell culture, Chemotherapy, Recombinant DNA technology, Molecular Biotechnology and Society along with general electives of Introduction to Research and Biostatistics, and Microbial diversity.

As mentioned in the syllabus, all the four core courses of theory, two DSEs, 1 SEC and associated practicals are compulsory to B.Sc. Microbiology students (Semester V and VI).

The syllabi for the three-year undergraduate programme are designed to enable the students to understand and select an area of their interest to pursue further studies for post-graduation.

# Graduate Attributes

**The graduate in Microbiology would have:**

1. Sound knowledge of the fundamentals of Microbiology
2. Basic understanding of the different fields of applied Microbiology.
3. Knowledge of recent developments in the various fields of Microbiology.
4. Skill set in performing Bacteriological techniques such as aseptic techniques, enumeration of bacteria, etc.
5. Ability to analyse, think, plan, execute and review experiments and experimental results.
6. Awareness about research planning and ethical considerations in all the fields.
7. Entrepreneurial skills as an offshoot of interaction with several Industry experts.
8. Expertise in Communication skills
9. Acquired life skills such as team work, leadership, patience as a result of group project participation.

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**Syllabus -T. Y. B.Sc. Microbiology Semester V 6 units**

| Semester V | Course Number | Course Title | Course code | Credits | Hours | Periods (50 min) | Unit/ Module | Lectures (50 minutes) per Unit/ module | **Examination** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Internal Marks | External Marks | Total Marks |
| **THEORY** | | | | | | | | | | | |
| **Core courses** | | | | | | | | | | | |
| | I | Genetics and Molecular Biology | 23US5MBCC1GMB | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | II | Medical Microbiology and Immunology - I | 23US5MBCC2MMI | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | III | Microbial Biochemistry-I | 23US5MBCC3MBI | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| | IV | Bioprocess Technology- Upstream Processes | 23US5MBCC4BTU | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| **Discipline Specific Electives** | | | | | | | | | | | |
| DSE | I | Analysis of Biomolecules | 23US5MBDS1ANB | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | II | Plant and Animal Biotechnology | 23US5MBDS2PAB | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | III OPTIONAL | Research Project | 23US5MBDS3RCH | Kindly refer the credits allotted in the practical section | | | | | | | |
| **Skill Enhancement Electives** | | | | | | | | | | | |
| SEC | I | Antimicrobial Chemotherapy | 23US5MBSE1CMT | 1.5 | 23 | 28 | 2 | 14 | | 60 | 60 |
| **PRACTICALS** | | | | | | | | | | | |
| **CORE COURSES** | | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | Genetics and Molecular Biology | 23US5 MBCCP 1 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | II | Medical Microbiology and Immunology - I | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | III | Microbial Biochemistry- I | 23US5 MBCCP 2 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | IV | Bioprocess Technology- Upstream Processes | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| **Discipline Specific Electives** | | | | | | | | | | | |
| **DSE** | 1 | Analysis of Biomolecules | 23USSMBDSP3 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | II | Plant and Animal Biotechnology | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | III (Optional) | Research Project | 23USSMBDS3RCH | 3 | 6 | 7.2 | | | 150 | | |
| **Skill Enhancement Electives** | | | | | | | | | | | |
| **SEC** | | Antimicrobial Chemotherapy | 23USSMBSEP | 0.5 | 1 | 1.2 | | | 10 | 30 | 40 |

**Syllabus - T. Y. B.Sc. Microbiology Semester V 3 units**

| Semester V | Course Number | Course Title | Course code | Credits | Hours | Periods (50 min) | Unit/ Module | Lectures (50 minutes) per Unit/ module | **Examination** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Internal Marks | External Marks | Total Marks |
| **THEORY** | | | | | | | | | | | |
| **Core courses** | | | | | | | | | | | |
| | I | Genetics and Molecular Biology | 23US5MBCC1GMB | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | II | Medical Microbiology and Immunology - I | 23US5MBCC2MMI | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| SEC | I | Antimicrobial Chemotherapy | 23US5MBSE1CMT | 1.5 | 23 | 28 | 2 | 14 | | 60 | 60 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRACTICALS** | | | | | | | | | | | |
| **CORE COURSES** | | | | | | | | | | | |
| | I | Genetics and Molecular Biology | 23US5MBCCP1 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | II | Medical Microbiology and Immunology - I | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Skill Enhancement Electives** | | | | | | | | | | | |
| **SEC** | | Antimicrobial Chemotherapy | 23US5MBSEP | 0.5 | 1 | 1.2 | | | 10 | 30 | 40 |

# T.Y. B. Sc. (MICROBIOLOGY) SEMESTER V

## Course – I

## COURSE TITLE: Genetics and Molecular Biology

## COURSE CODE: 23US5MBCC1GMB

## [CREDITS - 02]

**Course Learning Outcomes:** After the successful completion of the Course, the learner will be able to:

1) Identify the human genetic traits using pedigree analysis.
2) Apply the concepts of Population Genetics to analyse population structure.
3) Describe the steps and enzymology of prokaryotic replication.
4) Investigate the mechanisms of prokaryotic transcription and translation.

| Module | TITLE AND CONTENT | NO OF LECTURES - 12 |
|---|---|---|
| 1 | **Classical and Population Genetics**<br>**Learning Objectives:**<br>1) To state the branches of Genetics.<br>2) To explore the characteristics of model organisms in Genetics.<br>3) To describe the human Eukaryotic chromosome structure.<br>4) To apply the Hardy-Weinberg rule to the study of population structure.<br><br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) Comprehend the branches of Genetics.<br>2) List the characteristic features of model organisms.<br>3) Describe different structural attributes of eukaryotic chromosomes.<br>4) Construct a pedigree analysis chart.<br>5) Calculate different genetic frequencies in a population study. | |
| 1.1<br><br>1.1.a<br>1.1.b<br>1.1.c | **Classical and Population Genetics**<br>**Branches of Genetics**<br>**Introduction to the following terms:**<br>Transmission genetics<br>Molecular genetics<br>Population genetics | 1L |

| | | |
|---|---|---|
| 1.1.d | Quantitative genetics | |
| 1.2 | **Model Organisms** | 1L |
| 1.2.a | Listing the characteristics and studies undertaken of model organisms in Genetics. | |
| 1.3 | **Introduction to Human Genetics** | 5L |
| 1.3.a | Eukaryotic Chromosome structure: Levels of chromosome packaging, histones and non-histone, euchromatin and heterochromatin (types) | |
| 1.3.b | Mendelian genetics in humans- pedigree analysis<br>Human genetic traits recessive and dominant (examples) | |
| 1.3.c | Sex- linked traits (examples) | |
| 1.4. | **Population Genetics** | 3L |
| 1.4.a | Genetic structure of population, genotype and allelic frequencies.<br>Introduction to Hardy- Weinberg Law and problems based on it. | |
| 1.4.b | **Genetic variation in the natural population**<br>Change in genetic structure of population: mutation, genetic drift, migration, natural selection | 2L |

2

**DNA Replication**

**Learning Objectives:**

1) To describe the terminology, concepts and detailed process of DNA replication in prokaryotes.
2) To state a few significant features of replication in eukaryotes and phages.

**Learning Outcomes:** After the successful completion of the module, the learner will be able to:

1) Interpret the results of Meselson and Stahl experiment.
2) Describe process of DNA replication in prokaryotes.
3) List the various proteins and enzymes involved in replication and explain their significance.
4) Differentiate between the process of DNA replication in prokaryotic and eukaryotic cells and some phages.
5) Evaluate the role of telomerase.
6) Explain rolling circle mode of replication.

| | | |
|---|---|---|
| | **DNA Replication** | |
| 2.1 | **DNA Replication features**<br>Conservative, Dispersive, Semi-conservative Bidirectional and semi-discontinuous | 2L |
| 2.2 | **List contributions of**:<br>Reiji and Tuneko Okazaki, J Cairns and Gyurasits and Wake Meselson and Stahl experiment | 2L |
| 2.3 | **Prokaryotic DNA replication**<br>Details of molecular mechanism involved in Initiation, Elongation and Termination. | 3L |
| 2.4 | **Enzymes and proteins associated with DNA replication**<br>Primase, Helicase, Topoisomerase, SSB, DNA polymerases, Ligases, Ter and Tus proteins. | 2L |
| 2.5 | **Differences between prokaryotic and eukaryotic DNA**<br>Consequences of telomere shortening, mechanism and role of telomerase | 2L |
| 2.6 | **Rolling circle (σ)mode of replication** | 1L |
| 3 | **Transcription and Translation**<br>**Learning Objectives:**<br>1) To explain the structure of gene to be transcribed.<br>2) To describe the molecular mechanism of transcription and translation.<br>3) To list the roles of different proteins involved in transcription and translation.<br>4) To investigate the mode of action of inhibitors of RNA polymerase.<br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) Describe the molecular mechanism of Transcription and Translation.<br>2) Explain the different types of post-translational modification of proteins. | |
| | **Transcription and Translation** | |
| 3.1 | **Transcription** | |
| 3.1.a | **Structure of prokaryotic and eukaryotic promoters**<br>**DNA dependent synthesis of RNA**:<br>RNA Polymerase- structure and role. | 1L |
| 3.1.b | **Stages in Transcription:**<br>Initiation, Elongation and Termination in prokaryotes in detail.<br>Introduction to transcription in eukaryotes<br>Role of rho protein in transcription -Termination in prokaryotes | 3L<br>1L |
| 3.1.c | Inhibition of DNA dependent RNA polymerase | 1L |

| | | |
|---|---|---|
| 3.2<br>3.2.a<br>3.2.b | **Translation**<br>**Structure of prokaryotic and eukaryotic ribosomes**<br>**Stages in Translation:**<br>Initiation, Elongation and Termination in prokaryotes in detail.<br>Formation of peptide bond.<br>Introduction to translation in eukaryotes | 4L |
| 3.2.c | **Post-Translational Modifications (PTM) of proteins**<br>Types of PTMs with one example each.<br>Phosphorylation.<br>Adenylation<br>Glycosylation<br>Formation of disulphide bonds | 2L |

## References:

1) Peter J. Russell (2006), *i*Genetics-A molecular approach, 2nd edition.
2) Benjamin A. Pierce (2008), Genetics a conceptual approach, 3rd edition, W. H. Freeman and company.
3) R. H. Tamarin, (2004), Principles of genetics, Tata McGraw Hill.
4) M. Madigan, J. Martinko, J. Parkar, (2009), Brock Biology of microorganisms, 12th edition Pearson Education International.
5) Robert Weaver (2011), Molecular biology, 5th edition. McGraw Hill international edition.
6) Nancy Trun and Jaine Trempy (2004), Fundamental bacterial genetics Blackwell Publishing.
7) D Nelson and M Cox, (2005), Lehninger's Principles of Biochemistry, 4th edition Macmillan worth Publishers.
8) James Watson (2004), Molecular biology of the gene, 5th edition Pearson.
9) James Watson (2017), Molecular biology of the gene, 7th edition, Pearson.

## Evaluation Pattern: Theory

For course I

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

## Internal Evaluation - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

## SEMESTER V - Practical

## Course-I

## COURSE CODE: 23US5MBCCP1

## [CREDITS - 01]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Isolation of genomic DNA of *E. coli* | 10 |
| 2 | Cultivation of model organism–*Drosophila melanogaster* | 15 |
| 3 | Problems on Population Genetics | 05 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.
Internal evaluation: 20 marks

## Course – II

## COURSE TITLE: Medical Microbiology and Immunology-I

## COURSE CODE: 23US5MBCC2MMI

## [CREDITS - 02]

**Course Learning Outcomes:**
After successful completion of the Course, the learner will be able to:

1) Evaluate the components of nonspecific host defence system.
2) Identify the aetiological agents responsible for respiratory and urinary tract infections.
3) Describe the role of Cytokines, APC, MHC and Complement in immune defence mechanism.

| Module | TITLE AND CONTENT | NO OF LECTURES: 12 |
|---|---|---|
| 1 | **Non-specific Host Defense Mechanism**<br>**Learning Objectives:**<br>1) To describe non-specific host defence system.<br>2) To explain the role of anatomic barriers, chemical mediators, and phagocytosis in host defence system.<br>**Learning outcomes:**<br>After successful completion of the module, the learner will be able to:<br>1) Describe the different cells, tissues and organs involved in immune response.<br>2) Evaluate the factors contributing to non-specific host defence mechanism. | |
| | **Non-Specific Host Defense Mechanisms** | |
| 1.1 | **First Line of Host Defense**<br>Physical and Mechanical Barriers: Skin, Mucous membranes Respiratory System Gastrointestinal Tract Genitourinary Tract | 4L |
| 1.2 | **Antimicrobial Peptides**<br>Cationic Peptides, and Acute Phase Proteins. Interferons, Cytokines, therapeutic uses of cytokines & interferons, | 4L |
| 1.3 | **Phagocytosis**<br>Pathogen Recognition, Toll like Receptors, Intracellular Digestion | 2L |

| | | |
|---|---|---|
| 1.4 | **Acute Inflammatory Response** | 2L |
| 2 | **Respiratory and Urinary Tract Infections**<br>**Learning Objectives:**<br>1) To describe the causative agents of respiratory and urinary tract infections.<br>2) To give an account of the clinical manifestations of the infections<br>3) To apply the Laboratory Diagnostic procedures to identify the causative agent/s.<br>**Learning outcomes:**<br>After successful completion of the module, the learner will be able to:<br>1) Describe the virulence properties of pathogens causing respiratory tract and urinary infections.<br>2) Identify the aetiological agents associated with respiratory tract and urinary infections. | |
| | **Respiratory and Urinary Tract Infections**<br>Aetiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis, and Treatment for: | |
| 2.1<br>2.1.a<br>2.1.b | **URT (Upper Respiratory Tract infections)**<br>Streptococcal Pharyngitis<br>Diphtheria | 4L |
| 2.2.<br>2.2.a<br>2.2.b<br>2.2.c | **LRT (Lower Respiratory Tract infections)**<br>Tuberculosis<br>Bacterial pneumonia<br>Influenza | 4L |
| 2.3.<br>2.3.a<br>2.3.b<br>2.3.c | **UTI (Urinary Tract infections) caused by:**<br>*Proteus*<br>*Pseudomonas*<br>*E. coli, Staphylococcus* | 4L |
| 3 | **Components of the immune system**<br>**Learning Objectives:**<br>1) To describe the mechanism of action of different components of the immune system.<br>2) To state the significance of components of the immune system.<br>**Learning Outcomes:**<br>After the successful completion of the module, the learner will be able to<br>1) Explain the role of cytokines, Antigen presenting cell, MHC and complement system in immune mechanism.<br>2) Assess the biological consequences of complement system. | |

| | | |
|---|---|---|
| | **Components of the immune system** | |
| 3.1 | **Cytokines** | 3L |
| 3.1.a | Properties and functions | |
| 3.1.b | Cytokines secreted by Th1 and Th2 | |
| 3.2 | **Antigen Presenting cells** | 3L |
| 3.2.a | Antigen presentation (Professional and non-professional) | |
| 3.2.b | Antigen processing pathways (Cytosolic and Endocytic Pathway) | |
| 3.3 | **MHC Complex and MHC molecules** | 3L |
| 3.3.a | Organization of MHC genes | |
| 3.3.b | Structure of class I and class II molecules | |
| 3.3.c | T-cell antigen receptors and MHC molecule | |
| 3.4 | **Complement System** | 3L |
| 3.4.a | Complement component and notation | |
| 3.4.b | Complement activation (Classical, Alternate and Lectin Pathway) | |
| 3.4.c | Biological consequence of complement system | |

## References:

1) Ananthanarayan and Paniker, (2009), Textbook of Microbiology, 8th Edition. Universal Press

2) Koneman (1992) Diagnostic Microbiology, 4th Edition. J.B. Lippincott Company

3) Thomas J. Kindt, Richard A. G, Barbara A. Osburne Kuby (2007) Immunology: W. H. Freeman and Company, New York.

4) Fahim Halim Khan (2009), The elements of Immunology, Pearson Education.

5) Pathak, S., Palan U (2012), Immunology Essential and Fundamental. Pareen publications, Bombay.

6) Ian R. Tizard (2005) Immunology, An Introduction, 4th Edition, Saunders College.

# Evaluation Pattern: Theory

For course II

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

# SEMESTER V - Practical

## Course-II

## COURSE CODE: 23US5MBCCP1

## [CREDITS - 01]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Study of Diagnostic cycle for:<br>Upper Respiratory tract infection<br>Lower Respiratory tract infection | 15 |
| 2 | Study of Diagnostic cycle for:<br>Urinary tract infection | 10 |
| 3 | Acid fast staining | 5 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 20 marks

## Course – III

## COURSE TITLE: Microbial Biochemistry-I

## COURSE CODE: 23US5MBCC3MBI

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Evaluate the different types of solute transport mechanisms of a living cell.
2) Apply principles of bioenergetics to metabolic pathways.
3) Elucidate the convergence of different catabolic pathways in carbohydrate metabolism.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Biological membrane and Solute Transport**<br>**Learning Objectives:**<br>1) To describe the different models of biological membrane.<br>2) To distinguish between simple diffusion, facilitated, active and passive transport.<br>3) To state different methods of studying solute transport.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Illustrate the use of proteoliposomes in solute transport.<br>2) Describe the mechanism of group translocation.<br>3) Distinguish between different types of solute transport. | |
| 1.1 | **Biological membrane and Solute Transport**<br>**Structure and function of biological membrane**<br>Fluid Mosaic Model, lipid rafts, Integral and peripheral proteins. Model membranes. | 2L |
| 1.2 | **Method of studying solute transport**<br>Preparation and use of proteoliposomes | 2L |
| 1.3 | **Role of membrane in solute transport** | |
| 1.4 | **Different mechanisms for uptake of solutes with one example each:** | |
| 1.4. a | Passive diffusion | 2L |
| 1.4. b | Facilitated diffusion | |

| | | |
|---|---|---|
| 1.4. c | **Active transport**<br>Primary active transport: Binding proteins, Shock sensitive system (eg. Histidine uptake model, Maltose uptake)<br>Secondary active transport: (Uniport, Antiport, Symport) | 4L |
| 1.4.d | **Mechanism of Group translocation**<br>Phosphotransferase system | 1L |
| 1.4. e | **Other examples of transport**<br>Introduction to Siderophores- Iron Transport | 1L |
| 2 | **Bioenergetics**<br>**Learning Objectives:**<br>1) To understand functioning of electron transport system in cells.<br>2) To familiarize with mechanism of ATP generation.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Describe the composition and functions of electron transport system.<br>2) Schematically describe electron transport in mitochondria and *E. coli.*<br>3) Differentiate between prokaryotic and eukaryotic electron transport system.<br>4) Describe the chemiosmotic hypothesis.<br>5) Explain the structure and mechanism of ATP synthase.<br>6) Analyse the difference between the shuttle systems.<br>7) Calculate energetics of TCA and EMP pathways. | |
| | **Bioenergetics** | |
| 2.1 | **Components, complexes and functions of Electron transport chain**<br>Mitochondrial ETC,<br>Bacterial ETC– *E. coli* -aerobic and anaerobic. | 3L |
| 2.2 | **Oxidative phosphorylation**<br>Chemiosmotic coupling hypothesis<br>Inhibitors and uncouplers | 3L |
| 2.3 | **Structure of Mitochondrial ATP synthase**<br>Mechanism by Rotational catalysis | 2L |
| 2.4 | **Generation of electrochemical energy**<br>Bacteriorhodopsin<br>ATP hydrolysis | 2L |
| 2.5 | **Shuttle systems**<br>Malate aspartate shuttle<br>Glycerol -3- phosphate shuttle. | 1L |

| | | |
|---|---|---|
| 2.6 | **Calculations of energetics**<br>Glycolysis and TCA, Balance sheet to be given with efficiency calculation. | 1L |
| 3 | **Catabolism of Carbohydrates**<br>**Learning Objectives:**<br>1) To study details of catabolic pathways of selected carbohydrates.<br>2) To analyse the multifunctional role of central metabolic pathways.<br>3) To identify the ways by which complex substrates converge to central metabolic pathways.<br>4) To define the concept of fermentation.<br><br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) Differentiate between various structures of glucose polymers and their breakdown.<br>2) Demonstrate the use of radio respirometry to identify simple biochemical pathways e.g. EMP and ED.<br>3) Schematically represent pathways with structures of intermediates and enzymes.<br>4) Compare the various catabolic pathways for glucose catabolism.<br>5) Analyse the differences between the metabolic pathways of different fermentations. | |
| | **Catabolism of Carbohydrates** | |
| 3.1 | **Breakdown of polysaccharides**<br>Glycogen, starch, cellulose<br>**Breakdown of oligosaccharides**<br>Lactose, maltose, sucrose (by phosphorolysis)<br>**Utilization of monosaccharides**<br>Fructose, galactose | 3L |
| 3.2<br>3.2.a<br>3.2.b<br>3.2.c<br>3.2.d | **Major pathways-**<br>Glycolysis (EMP), TCA,<br>Pentose phosphate pathway, ED pathway<br>Use of radio-respirometry with reference to EMP & ED.<br>Anaplerotic reactions of TCA, glyoxylate bypass | 6L |
| 3.3 | **Modes of fermentations in microorganisms:**<br>Lactic acid (homo, hetero fermentative pathway, bifidum pathway) mixed acid, butanediol, Butyrate and Acetone-butanol fermentations. | 3L |

## References:

1) Stanier. R.Y., Ingraham, J.L., Wheelis, M.L., Painter, R.R, (1987) General Microbiology, 5th edition, The Macmillan press Ltd.

2) Conn Stumpf, P. K., Bruening, G. R. H. (1987) Outlines of Biochemistry, 5thedition, John Wiley & sons.

3) Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag.

4) White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rdedition, Oxford University Press

5) Nelson, D, Cox, M, (2005), Lehninger Principles of biochemistry,4th edition, W. H. Freeman and Company.

6) Mathews (2000), Biochemistry 3rd edition, Van Holde, Pearson Education.

7) Voet, D &Voet, J. G., (2004), Biochemistry, 3rd edition, John Wiley& Sons Inc

8) Zubey, G. L (1996), Biochemistry, 4th edition, Wm. C. B Brown publishers.

## Evaluation Pattern: Theory

For course III

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

## SEMESTER V - Practical

## Course-III

## COURSE CODE: 23US5MBCCP2

## [CREDITS - 01]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Phosphatase –Qualitative detection and quantitative | 06 |
| 2 | Detection of amylase activity | 02 |
| 3 | Study of homo and hetero fermentations | 14 |
| 4 | Isolation of mitochondria and assay for ETC activity | 05 |
| 5 | Enrichment and isolation of cellulose digestors | 03 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 20 marks

## Course – IV

## COURSE TITLE: Bioprocess Technology-Upstream Processes

## COURSE CODE: 23US5MBCC4BTU

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Comprehend the need for strain improvement.
2) Illustrate the sterilization methods used in industrial fermentation processes.
3) Evaluate the fermenter design most suitable for optimum production of a microbial product.
4) Assess the different methods of monitoring and control of fermentation parameters.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Strain Improvement and Sterilization**<br>**Learning Objectives:**<br>1) To describe the need for strain improvement.<br>2) To explore the different approaches for strain improvement.<br>3) To evaluate the methods of sterilization.<br>4) To illustrate filtration as an effective method of sterilization of media, air and exhaust air.<br><br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Comprehend different methods of Strain improvement.<br>2) Assess the advantages and disadvantages of batch and continuous sterilization methods.<br>3) Differentiate between Depth and Absolute filters.<br>4) Establish the process steps for filter sterilization of media. | |

| | | |
|---|---|---|
| | **Strain Improvement and Sterilization** | |
| 1.1 | **Strain Improvement** | |
| 1.1.a | **Improvement of industrial microorganisms:**<br>Selection of induced mutants synthesizing improved levels of primary metabolites (with one example of each method) | 3L |
| 1.1.b | Isolation of induced mutants producing improved yields of secondary metabolites (with one example of each method) | 2L |
| 1.1.c | **Use of recombination systems for the improvement of industrial microorganisms**<br>The applications of the Parasexual cycle | 1L |
| 1.2. | **Sterilization:** | |
| 1.2.a | Consequences of invasion in a fermentation by a foreign organism. | 1L |
| 1.2.b | **Sterilization criterion**<br>Definition and significance. | 1L |
| 1.2.c | **Methods of sterilization**<br>Batch and Continuous sterilization. | 2L |
| 1.2.d | **Filter sterilization**<br>Mechanisms of filtration<br>Depth and Absolute filters<br>Sterilization of fermentation media, air and fermenter exhaust air | 2L |
| 2 | **Types of Bioreactors**<br>**Learning Objectives:**<br>1) To describe the constructional variations of different fermenters.<br>2) To outline the fermenter designs diagrammatically.<br>3) To relate the need for different parts in a fermenter to the type of product.<br><br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Characterise the different fermenter designs | |

| | | |
|---|---|---|
| | 2) Relate the design of the fermenter to the conditions needed for optimum product formation<br>3) Evaluate the fermenter design with respect to economy of process and product formation<br>4) Justify the need for modified fermenter designs for Animal cell culture | |
| 2.1<br><br><br><br>2.1.a<br>2.1.b<br>2.1.c<br><br><br>2.2<br><br><br><br><br>2.3<br><br><br>2.4 | **Types of Bioreactors**<br>**Typical constructional features and their importance**<br>Types of fermenters based on Power Input for mixing (mechanical, hydrodynamic and pneumatic)<br>**Mechanical**: Waldhof fermenter<br>**Hydrodynamic**: Deep jet fermenter, trickling generator<br>**Pneumatic**: Air-lift fermenter, bubble-cap fermenter, acetator, cavitator.<br><br>**Animal cell culture reactors**<br>Stirred fermenters, Air-Lift fermenters, Radial flow fermenters, Microcarriers, Encapsulation, Hollow fibre chambers, Packed glass bead reactors, Perfusion Cultures.<br>**Photo-bioreactor, tower and packed tower fermenters, Biofilters and Fixed film processes**<br><br>**Solid State fermenters, Membrane fermenters and Single use disposable fermenters** | 4L<br><br>4L<br><br>2L<br><br>2L |
| 3 | **Fermentation Parameter- Monitoring and control**<br>**Learning Objectives:**<br>1) To assess the requirement for monitoring of fermentation parameters.<br>2) To evaluate the limitations of different methods of monitoring fermentation parameters.<br>3) To explain the control mechanisms for parameters.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Categorise different types of sensors.<br>2) Evaluate the different methods of monitoring fermentation parameters.<br>3) Derive the ways to control the fermentation parameters.<br>4) Analyse the output of monitoring devices<br>5) Differentiate between manual and automatic control of parameters | |
| 3.1 | **Fermentation Parameter- Monitoring and control**<br>**Different types of sensors based on location and in relation to its application for process control.** | 1L |

| | | |
|---|---|---|
| 3.2 | **Temperature Monitoring and Control** | |
| 3.2.a | Mercury-in-glass thermometers | 1L |
| 3.2.b | Electrical resistance thermometers | |
| 3.2.c | Thermistors | |
| 3.2.d | Temperature control | |
| | | |
| 3.3. | **Flow measurement and control** | |
| 3.3.a | Gases | 1L |
| 3.3.b | Liquids | |
| 3.3.c | Control of flow of gases and liquids | |
| | | |
| 3.4. | **Pressure measurement and control** | |
| 3.4.a | Bourdon tube pressure gauge | 1L |
| 3.4.b | Nested diaphragm-type pressure sensor | |
| 3.4.c | Pressure bellows, Strain Gauge, Piezoelectric transducer | |
| 3.3.d | Pressure control | |
| | | |
| 3.5 | **Foam sensing and control** | 1L |
| 3.6 | **Measurement and control of dissolved oxygen** | 2L |
| 3.6.a | Galvanic and Polarographic electrodes | |
| 3.6.b | Fluorometric Oxygen sensor | |
| 3.6.c | Control of dissolved oxygen. | |
| | | |
| 3.7 | **Inlet and exit gas analysis** | 2L |
| 3.7.a | Deflection type paramagnetic oxygen analyser | |
| 3.7.b | Thermal-type paramagnetic oxygen analyser | |
| 3.7.c | Infrared analyser | |
| | | |
| 3.8 | **pH measurement and control** | 1L |
| | | |
| 3.9 | **Control systems** | 2L |
| 3.9.a | Manual Control | |
| 3.9.b | Automatic control | |
| | Two- position controllers | |

## References:

1) Patel A.H. (1996), Industrial Microbiology. 1st edition, Macmillan India Limited.
2) Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001), Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell.
3) Crueger W and Crueger A. (2000), Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
4) Stanbury PF, Whitaker A and Hall SJ. (2006), Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5) Stanbury PF, Whitaker A and Hall SJ. (2017), Principles of Fermentation Technology. 3rd edition, Elsevier Science Ltd.
6) Walsh Gary, (2011), Pharmaceutical Biotechnology. 1st edition, Wiley-India edition.
7) E.M.T.El-Mansi and A.R. Allman (2012), Fermentation Microbiology and Biotechnology. 3rd edition. CRC Press.

## Evaluation Pattern: Theory

For course IV

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

Piktochart

## SEMESTER V - Practical

## Course-IV

## COURSE CODE: 23US5MBCCP2

## [CREDITS - 01]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Gradient plate technique for isolation of mutants | 6 |
| 2 | Study of fermenter parts and demonstration of its working | 14 |
| 3 | Enrichment methods for mutants-Penicillin | 10 |

### Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course
Internal evaluation: 20 marks

## Discipline Specific Elective DSE-I

## COURSE TITLE: Analysis of Biomolecules

## COURSE CODE: 23US5MBDS1ANB

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Estimate the concentration of biomolecules by colorimetry and UV-Visible spectrophotometry.
2) Apply chromatographic techniques for separation of biomolecules.
3) Apply technique of electrophoresis and centrifugation to separate macromolecules

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Estimation of Biomolecules and Spectrophotometry**<br><br>**Learning objectives:**<br>1)To evaluate the composition of microbial cells.<br>2) To describe the various methods to estimate biomolecules.<br>3) To state the basic concepts of Spectrophotometry.<br><br>**Learning outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Estimate the concentration of biomolecules in microbial cells.<br>2) Compare and contrast between different methods of estimation of Macromolecules.<br>3)Describe the basic components and working of the Spectrophotometer. | |
| 1.1 | **Estimation of Biomolecules and Spectrophotometry**<br>Macromolecular composition of a microbial cell, estimation of biomass by wet weight and dry weight. | 1L |
| 1.2<br>1.2.a<br>1.2.b<br>1.2.c | **Methods of elemental analysis**<br>Carbon by Van Slyke's method<br>Nitrogen by Micro-kjelhdahl method<br>Phosphorus by Fiske Subbarow method | 1L |

| | | |
|---|---|---|
| 1.3<br>1.3.a<br>1.3.b | **Estimation of Carbohydrates**<br>Phenol method<br>DNSA method | 1L |
| 1.4<br>1.4.a<br>1.4.b | **Estimation of Proteins**<br>Biuret method<br>Folin-Lowry's method | 2L |
| 1.5 | **Estimation of Amino acids**<br>Ninhydrin method | 1L |
| 1.6<br>1.6.a<br>1.6.b | **Estimation of Nucleic acids**<br>DPA method<br>Orcinol method. | 1L |
| 1.7 | **Extraction and estimation of Lipids**<br>Soxhlet method | 1L |
| 1.8 | **Colorimetry**<br>Basic instrumentation and applications | 2L |
| 1.9 | **Spectrophotometry**<br>UV-Visible spectrophotometry<br>Instrumentation: Monochromator, Cuvettes, photocells, slits.<br>Applications: Qualitative and quantitative analysis | 2L |
| 2 | **pH meter and Chromatography**<br>**Learning objectives:**<br><br>1) To describe the basic components and working of a pH meter.<br>2) To explain the basic concepts and working of different chromatographic techniques.<br><br>**Learning outcomes:**<br>After the successful completion of the module, the learner will be able to:<br><br>1) Understand the applications of pH meter in biological experiments.<br>2) Apply chromatographic techniques for separation of biomolecules. | |

| | | |
|---|---|---|
| | **pH meter and Chromatography** | 3L |
| 2.1 | **pH Meter** | |
| 2.1a | Standard Hydrogen electrode | |
| 2.1b | Reference electrode, | |
| 2.1c | Glass electrode, measurement of pH | |
| 2.2 | **Concepts of Chromatography** | 2L |
| 2.2.a | Distribution co-efficient | |
| 2.2.b | Modes of chromatography (Tabulation-TLC, Column and Paper) | |
| 2.2.c | Basic Column chromatography components | |
| 2.3 | **Chromatographic Techniques: Principle, working and Applications of:** | 7L |
| 2.3.a | Adsorption Chromatography | |
| 2.3.b | Partition Chromatography -Normal phase and Reverse phase | |
| 2.3.c | Ion-exchange Chromatography: | |
| 2.3.d | Molecular Size-Exclusion Chromatography: | |
| 2.3.e | Affinity Chromatography | |
| 2.3.f | High Performance Liquid Chromatography | |
| 2.3.g | Gas Chromatography | |
| 3 | **Centrifugation and Electrophoresis**<br>**Learning objectives:**<br>1) To explain the principle and working of centrifugation.<br>2) To describe the technique of electrophoresis for the separation of macromolecules.<br><br>**Learning Outcomes:**<br>After successful completion of the module, the learner will be able to:<br>1) Explain the principle and applications of Centrifugation techniques.<br>2) Apply technique of electrophoresis to separate macromolecules. | |
| | **Centrifugation and Electrophoresis** | |
| 3.1 | **Centrifugation** | 1L |
| 3.1.a | Basic Principle of Sedimentation, Concepts of Applied Centrifugal field, angular velocity, and sedimentation coefficient. | |

| | | |
|---|---|---|
| 3.1.b | **Types of rotors**<br>Swinging Bucket and fixed angle | 1L |
| 3.1.c | **Preparative centrifugation**<br>Differential centrifugation<br>Density-gradient centrifugation<br>Nature of gradient materials, practical applications | 1L<br><br>2L |
| 3.1.d | Applications of Analytical ultracentrifugation**:**<br>Determination of relative molecular mass and purity | 1L |
| 3.2<br>3.2.a | **Electrophoresis-**General principle<br>**Support media**<br>Agarose and polyacrylamide gels | 2L |
| 3.2.b | **Electrophoresis of Proteins**<br>SDS PAGE, and Native gels | 2L |
| 3.2.c | **Electrophoresis of Nucleic acid**<br>Agarose gel Electrophoresis, DNA sequencing gels and RNA electrophoresis | 2L |

## References:

1. Wilson and Walker. (2009). Principles and Techniques of Biochemistry and Molecular Biology. 7th edition.
2. H. R. Bolliger, M. Brenner. (2013). Thin Layer Chromatography, A Laboratory Handbook. Springer Verlag.
3. Norris and Robbins VA. (1971). Methods in Microbiology. New York: Academic Press London.
4. Jayaraman (2011) Laboratory Manual in Biochemistry, 2nd edition, New Age International Publisher.

# Evaluation Pattern: Theory

For course: DSE-I

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation -** (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

# SEMESTER V - Practical

## DSE Course-I

## COURSE CODE: 23US5MBDSP3

## [CREDITS - 01]

| Experiment Sr. no. | Title | Number of hours |
|---|---|---|
| 1 | Estimation of protein by Biuret method | 4 |
| 2 | Quantitative Estimation of DNA by DPA method | 4 |
| 3 | Preparation of Buffers and standardization of pH meter | 4 |
| 4 | Paper chromatography of amino acids | 4 |
| 5 | Column chromatography | 4 |
| 6 | Study of Centrifuge, Density gradient centrifugation (Yeast and bacteria) | 4 |
| 7 | Agarose gel electrophoresis | 6 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 20 marks

## Discipline Specific Elective DSE-II

## COURSE TITLE: Plant and Animal Biotechnology

### COURSE CODE: 23US5MB DS2PAB

## [CREDITS - 02]

**Course Learning outcomes:** After successful completion of the Course, the learner will be able to:

1) Demonstrate the set-up of plant tissue culture laboratory and culture techniques.
2) Describe the set-up of animal tissue culture laboratory and culture techniques.
3) Evaluate the applications of transgenic crops and transgenic animals.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Plant Tissue Culture**<br>**Learning Objective:**<br>1) To explain the basic set-up of plant tissue culture laboratory.<br>2) To familiarize the students with the basic techniques of plant tissue culture. biotechnology.<br>3) To introduce the recombinant and non-recombinant approaches to plant breeding.<br>**Learning outcomes**: After successful completion of the module, the learner will be able to:<br><br>1) Explain the set-up of plant tissue culture laboratory.<br>2) Establish and maintain plant cells in tissue culture.<br>3) Evaluate the physical, chemical and biological methods of gene transfer in plants. | |
| 1.1 | **Plant Tissue Culture**<br>**Laboratory organization**<br>Washing & storage facilities, cleaning glassware, using plastic labware, media preparation room, transfer area, culture room, data collection area & specialised facilities | 1L |
| 1.2 | **Media**<br>Media composition, inorganic nutrients, carbon & energy source, organic supplements, growth regulators, | 1L |

| | | |
|---|---|---|
| 1.3 | solidifying agents, pH, media preparation, selection of new medium<br><br>**Plant growth & development**<br>Plant tissue culture, cell culture, organ culture, regeneration of plants, anther & pollen culture | 3L |
| 1.4<br>1.5<br>1.6 | **Large scale plant propagation**<br>**Plant germplasm banks**<br><br>**Biotechnology & plant breeding**<br>a. Non-recombinant approach:<br>Somaclonal variation, Protoplast fusion, Ancillary techniques<br>b. Recombinant approaches:<br>Plant viruses as vectors, Ti plasmids as vectors, Physical & chemical methods (Microprojectile and particle bombardment) | 2L<br><br>5L |
| 2 | **Animal Tissue culture**<br>**Learning objectives:**<br><br>1. To describe the requirements and laboratory set-up for animal cell culture.<br>2. To explain the media components required for animal cell culture.<br><br>**Learning outcomes:** After the successful completion of the module, the learner will be able to:<br><br>1. Culture animal cells.<br>2. Apply methods to avoid microbial contamination. | |
| 2.1 | **Animal Tissue culture**<br>**Introduction to Tissue culture**<br><br>Historical background, advantages of tissue culture<br><br>Types of tissue culture: Organ, Explant, dissociated cell, organotypic | 1L |
| 2.2 | **An overview of laboratory design** | 1L |

| | | |
|---|---|---|
| | Tissue culture lab with adjacent preparation room (diagrammatic representation) | |
| 2.3 | **Equipment's and Materials**<br><br>A brief description of Laminar air flow cabinet, pipette controllers, $CO_2$ incubator, Inverted microscope | 1L |
| 2.4 | **Defined Media and Supplements**<br><br>A brief description of physico-chemical properties: pH, $CO_2$, buffering, oxygen, temperature, osmolality, balanced salt solutions | 2L |
| 2.4. | **Complete media**<br><br>Amino acids, vitamins, salts, glucose, organic supplements, hormones and growth factors, antibiotics, serum-advantages and disadvantages | 2L |
| 2.5 | **Culture vessels and substrates**<br><br>Substrate for attachment and growth: A brief description of common substrate materials, treated surfaces and non-adhesive substrates, choice of culture vessel | 2L |
| 2.6 | **Primary culture**<br><br>A brief description of initiation of a primary cell culture, isolation of the tissue, types of primary culture, options for primary culture<br><br>Sub-culture and cell lines: Terminology, subculture and propagation | 2L |
| 2.7 | **Microbial contamination**<br><br>Sources of contamination<br><br>Types of contamination<br><br>Monitoring for contamination | 1L |

| | | |
|---|---|---|
| 3 | **Applications of Plant and Animal cell cultures**<br>**Learning Objective:**<br>To describe applications of transgenesis in plant and animal biotechnology.<br>**Learning outcomes:**<br>After the successful completion of the module, the learner will be able to:<br><br>1. Demonstrate application of transgenesis in getting resistant varieties of crops.<br>2. Demonstrate application of transgenesis in getting improved livestock and poultry. | |
| | **Applications of Plant and Animal cell cultures** | |
| 3.1 | **Transgenics in crop improvement** | 5L |
| 3.1.a | Insect resistance: *Bacillus thuringiensis* insecticidal toxin, Increasing expression of Bt protoxin | |
| 3.1.b | Herbicide resistance: Biological manipulations, Glyphosate resistant plants | |
| 3.1.c | Salt and drought stress resistant plants | |
| 3.1.d | Plants as Bioreactors | 1L |
| 3.1.e | Edible vaccines | 1L |
| 3.2 | **Transgenic animals** | 1L |
| 3.2.a | Introduction | 3L |
| 3.2.b | **Transgenic Livestock**<br>Production of pharmaceuticals<br><br>Production of Donor organs<br><br>Disease resistant livestock<br><br>Improving milk Quality<br><br>Improving animal production traits | |
| 3.2.c | Transgenic Poultry | 1 L |

| | | |
|---|---|---|
| | | |

## References:

1) S.S. Bhojwani and M.K. Razdan, Elsevier, Amsterdam, (1996). Plant tissue Culture: Theory and Practice
2) Primrose (2016), Principles of Gene Manipulation 8th edition.
3) H. C. Chawla, Oxford and IBH, (2002), An Introduction to Plant Biotechnology
4) I. Potrykus and G. Spangenberg (1997), Gene Transfer to Plants by, Springer Lab Manual, Springer Verlag,
5) R. I. Freshney (2010), Culture of Animal Cells – A manual of basic technique and specialized applications, 6th edition, Wiley-Blackwell.
6) Sudha Gangal (2007), Animal Tissue culture. Second edition. University Press (India) Pvt. Ltd. Hyderabad.

## Evaluation Pattern: Theory

For course: DSE-II

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)
Probable options:
Plickers
Testmoz
Google form
Moodle
Objective-MCQ
Short answer test

## SEMESTER V - Practical

## DSE Course-II

## COURSE CODE: 23US5MBDSP3

## [CREDITS - 01]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | MS media preparation | 6 |
| 2 | Establishment and maintenance of callus culture | 8 |
| 3 | Preparation of Artificial seeds | 7 |
| 4 | Case study on transgenic animals and transgenic plants | 9 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 10 marks

## SEC – I

## COURSE TITLE: ANTIMICROBIAL CHEMOTHERAPY

## COURSE CODE: 23US5MBSE1CMT

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Evaluate the mode of action of different antimicrobial agents.

2) Apply different tests for determining inhibitory activity of antibiotics.

| Module | TITLE AND CONTENT | NO OF LECTURES:14 |
|---|---|---|
| 1 | **Mode of action of antimicrobial agents**<br>**Learning objectives:**<br>1. To explain basic concepts of Chemotherapy<br>2. To describe different modes of action of antimicrobial agents.<br>**Learning outcomes:**<br>After the successful completion of the module, the learner will be able to:<br>1.Explain different terms associated with Chemotherapy<br>2. Describe the mode of action of different types of antimicrobial agents. | |
| 1.1.<br>1.1.a | **Mode of action of antimicrobial agents**<br>The development of Chemotherapy<br>General characteristics of antimicrobial drugs | 1L |
| 1.2<br>1.2. a | **Principles of antimicrobial action**<br>**Mode of action of antibacterial agents**<br>**Inhibitors of cell wall synthesis:**<br>Beta-lactam antimicrobial agents-Penicillin | 2L |
| 1.2. b | **Inhibitors of cell membrane function-Polymyxin** | 2L |
| 1.2. c | **Inhibitors of protein synthesis:** | 2L |

| | | |
|---|---|---|
| | Aminoglycosides-Streptomycin<br>Tetracyclines | |
| 1.2. d | **Inhibitors of DNA and RNA synthesis**<br>Metronidazole<br>Rifampin | 2L |
| 1.2. e | **Inhibitors of other metabolic processes**<br>Sulfonamides<br>Trimethoprim | 2L |
| 1.3 | **Mechanisms of antibiotic resistance**<br>Principles<br>Biologic vs clinical resistance<br>Environmentally mediated antimicrobial resistance<br>Microorganism mediated antimicrobial resistance:<br>Intrinsic and acquired resistance<br>Introduction to the new generations of antibiotics | 3L |
| 2. | **Tests for antimicrobial agents**<br>**Learning objective:**<br>1.To evaluate methods of testing of antimicrobial agents.<br>**Learning outcomes:**<br>After the successful completion of the module, the learner will be able to:<br>1.Apply different methods of testing of antimicrobial agents. | |
| 2.1 | **Tests for antimicrobial agents**<br>**Tests for determining inhibitory activity of antibiotics**<br>Indications<br>Choice of test | 2L |

| | | |
|---|---|---|
| | Selection of antimicrobial agents<br><br>Standardization and its limitations | |
| 2.2 | **Conventional testing methods** | 4L |
| 2.2.a | General considerations, procedure, inoculation, incubation and interpretation of results, advantages and disadvantages: | |
| 2.2.b | Broth dilution | |
| 2.2.c | Agar dilution-disk diffusion-Kirby-Bauer and Stokes method | |
| 2.2.d | **Agar dilution derivations**<br><br>Diffusion in agar derivations-E-test<br><br>Selection of antibiotics to be reported<br><br>Macro dilution broth susceptibility test<br><br>Micro dilution broth susceptibility test<br><br>Agar dilution broth susceptibility test<br><br>Disk dilution broth susceptibility test<br><br>Testing of antibiotic combinations | 8L |

## References:

1) Bailey and Scott (2007), Diagnostic Microbiology 12th edition, Mosby Elsevier.

2) Koneman (1992) Diagnostic Microbiology, 4th Edition. J.B. Lippincott Company Thomas J. Kindt, Richard A. G, Barbara A. Osburne Kuby (2007) Immunology: W. H. Freeman and Company, New York.

3) Collins and Lyne's (2004) Microbiological methods, 8th edition, Hodder Arnold.

## Evaluation Pattern: Theory

For course: SEC -I

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 40 | 30 |
| 2 | II | 40 | 30 |

# SEC Course-I

**COURSE CODE: 23US5MBSEP**

## [CREDITS – 0.5]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Antimicrobial susceptibility test-Kirby- Bauer and Stokes method | 5 |
| 2 | E-test | 2 |
| 3 | Synergistic action of drugs | 4 |
| 4 | MIC of antibiotic-Streptomycin | 4 |

## **Evaluation pattern: Practical** (40M)

Internal evaluation: 40 Marks practical examination at the end of each semester.

SOMAIYA VIDYAVIHAR
K J Somaiya College of Science & Commerce
Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

# Syllabus -T. Y. B.Sc. Microbiology Semester VI 6 units

| Semester VI | Course Number | Course Title | Course code | Credits | Hours | Periods (50 min) | Unit/ Module | Lectures (50 minutes) | Examination | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Internal Marks | External Marks | Total Marks |
| **THEORY** | | | | | | | | | | | |
| **Core courses** | | | | | | | | | | | |
| | I | Mutation and Genetic Exchange | 23US6MBCC1MGE | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | II | Medical Microbiology and Immunology-II | 23US6MBCC2MEI | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | III | Microbial Biochemistry-II | 23US6MBCC3MBC | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | IV | Bioprocess Technology-Downstream Processing and Fermentations | 23US6MBCC4BPD | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Discipline Specific Electives** | | | | | | | | | | | |
| DSE | I | Recombinant DNA Technology and Advanced Virology | 23US6MBDS1RDV | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | II | Advances in Immunology and Medical Microbiology | 23US6MBDS2AIM | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | **III OPTIONAL** | Research Project | 23US6MBDS3RCH | Kindly refer to the section under practical | | | | | | | |
| **Skill Enhancement Electives** | | | | | | | | | | | |
| SEC | I | Molecular Biotechnology and Society | 23US6MBSEMBS | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| **PRACTICALS** | | | | | | | | | | | |
| **CORE COURSES** | | | | | | | | | | | |
| | I | Mutation and Genetic Exchange | 23US6MBCCP1 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | II | Medical Microbiology and Immunology-II | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | III | Microbial Biochemistry-II | 23US6MBCCP2 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | IV | Bioprocess Technology- Downstream Processing and Fermentations | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |

| **Discipline Specific Electives** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **DSE** | I | Recombinant DNA Technology and Advanced Virology | 23US6MBDSP3 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | II | Advances in Immunology and Medical Microbiology | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |
| | III | Research Project | 23US6MBDS3RCH | 3 | 6 | 7.2 | | | 150 | | |

SOMAIYA VIDYAVIHAR
K J Somaiya College of Science & Commerce
Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

# Syllabus -T. Y. B.Sc. Microbiology Semester VI 3 units

| Semester VI | Course Number | Course Title | Course code | Credits | Hours | Periods (50 min) | Unit/ Module | Lectures (50 minutes) | Examination | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Internal Marks | External Marks | Total Marks |
| **THEORY** | | | | | | | | | | | |
| **Core courses** | | | | | | | | | | | |
| | I | Mutation and Genetic Exchange | 23US6MBCC1MGE | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| | II | Medical Microbiology and Immunology-II | 23US6MBCC2MEI | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| **Skill Enhancement Electives** | | | | | | | | | | | |
| SEC | I | Molecular Biotechnology and Society | 23US6MBSEMBS | 2 | 30 | 36 | 3 | 12 | 40 | 60 | 100 |
| **PRACTICALS** | | | | | | | | | | | |
| **CORE COURSES** | | | | | | | | | | | |
| | I | Mutation and Genetic Exchange | 23US6MBCCP1 | 1 | 2 | 2.4 | | | 20 | 30 | 50 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | II | Medical Microbiology and Immunology-II | | 1 | 2 | 2.4 | | | 20 | 30 | 50 |

## Course – I

## COURSE TITLE: Mutation and Genetic Exchange

## COURSE CODE: 23US6MBCC1MGE

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Describe the molecular mechanisms of different mutations.
2) Describe the molecular machinery and mechanisms associated with plasmids, transposable elements and recombination.
3) Summarize the molecular mechanisms of Transformation, Conjugation and Transduction.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Mutation**<br>**Learning Objectives:**<br>1) To define mutation and its different types.<br>2) To determine the causative molecular mechanisms for different mutations.<br>3) To detect the mutants.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) State the role of mutation in evolution.<br>2) List different types and agents of mutation.<br>Use various techniques for detection of mutants. | |
| 1.1.a | **Mutation**<br>**Terminology**<br>Alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germ-line mutation, gene mutation, chromosome mutation, phenotypic lag, hotspots and mutator genes. | 2L |
| 1.1.b | **Fluctuation test (Adaptation versus Mutation theory)** | 1L |
| 1.1.c | **Types of mutations**<br>Point mutation, reverse mutation, suppressor mutation, frame shift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutation | 3L |

| | | |
|---|---|---|
| 1.1.d | **Causes of mutations**<br>Natural/spontaneous mutation-DNA replication error,<br>depurination, deamination | 2L |
| 1.1.e | **Induced mutation**<br>**Principle and mechanism with illustrative diagrams for:**<br>Chemical mutagens- base analogues, nitrous acid, hydroxyl amine, NTG<br>Intercalating agents and alkylating agents | 2L<br>1L |
| 1.1.f | Radiations- Ionizing and Non-ionizing radiations | |
| 1.2.a | **Detection of environmental mutagens-** Ames test | 1L |
| 1.2.b | **Detection of mutants –** Visible mutants, Nutritional mutants, Conditional mutants, Resistant mutants | |

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| **2** | **Plasmids, Transposons and Recombination**<br><br>**Learning Objectives:**<br>1) To illustrate the steps in plasmid DNA extraction and separation.<br>2) To characterize the different types of plasmids.<br>3) To describe the different types of transposons.<br>4) To investigate the processes of transposition and recombination.<br><br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) Summarize the steps and investigate the use of reagents in plasmid DNA extraction and separation.<br>2) Present an outline of the process of conjugative plasmids.<br>3) Identify the role of different types of plasmids.<br>4) Compare and contrast between composite and non-composite transposons.<br>5) Schematically represent transposition and recombination. |

| | | |
|---|---|---|
| | **Plasmids, Transposons and Recombination** | |
| 2.1 | **Plasmids** | |
| 2.1.a | **Physical nature of plasmids**<br>Modular organization and types of plasmids | 4L |
| 2.1.b | **Detection and isolation of plasmids**<br>Separation methods on the bases of size and conformation of plasmid DNA.<br>Plasmid incompatibility and Plasmid curing | |
| 2.1.c | **Cell to cell transfer of plasmids** | |
| 2.1.d | **Types and features of following plasmids**<br>Resistance Plasmids<br>Plasmids encoding Toxins and other Virulence characteristics<br>Col factor<br>Degradative plasmids<br>Metabolic plasmids | |
| 2.2 | **Transposable Elements in Prokaryotes** | 4L |
| 2.2.a | **Insertion sequences**<br>Structure and properties | |
| 2.2.b | **Transposons**<br>Types: Composite and non-composite with one example each<br>Structure and properties<br>General mechanism of integration of plasmids into chromosome<br>Mechanism for Co-integrate formation for replicative transposition | |
| 2.3 | **Recombination in bacteria** | 3L |
| 2.3.a | **General/Homologous recombination**<br>Molecular mechanism of following models<br>Holliday model of recombination<br>DSB (Double Strand Break) model of recombination | |
| 2.3.b | **Conservative Site –specific recombination-CSSR**<br>Types of CSSR: Insertion, Inversion and Deletion | |
| 2.4 | **Introduction to Integrons** | 1L |

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|---|---|---|
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| **3** | **Genetic Exchange**<br>**Learning Objectives:**<br>1)<br>2) To investigate the role of F plasmid in conjugation.<br>3) To describe the molecular mechanisms of Transformation, Conjugation and Transduction.<br><br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) Compare and contrast natural and artificial transformation.<br>2) Illustrate the steps to induce artificial transformation.<br>3) Apply the conjugation process to map the bacterial genes.<br>4) Differentiate between the generalized and specialised transduction. | |
| | **Genetic Exchange** | |
| 3.1 | **Transformation** | 4L |
| 3.1.a | Introduction and History | |
| 3.1.b | Types of transformation in prokaryotes-Natural transformation in *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Bacillus subtilis* | |
| 3.1.c | Mapping of bacterial genes using transformation | |
| 3.1.d | Problems based on transformation | |
| 3.2 | **Conjugation** | 4L |
| 3.2.a | Discovery of conjugation in bacteria (Lederberg and Tatum experiment) | |
| 3.2.b | Properties of F plasmid/Sex factor | |
| 3.2.c | The conjugation machinery | |
| 3.2.d | Hfr strains, their formation and mechanism of conjugation. | |
| 3.2.e | F` factor, origin and behaviour of F` strains, Sex-duction | |
| 3.2.f | Mapping of bacterial genes using conjugation (Interrupted mating experiment) | |
| 3.2.g | Problems based on conjugation | |

| | | |
|---|---|---|
| 3.3 | **Transduction** | 4L |
| 3.3.a | Introduction and discovery | |
| 3.3.b | Generalized transduction | |
| 3.3.c | Use of Generalized transduction for mapping genes | |
| 3.3.d | Specialized transduction | |
| 3.3.e | Problems based on transduction | |

## References:

1) Peter J. Russell (2006), *i*Genetics-A molecular approach, 2nd edition.
2) Benjamin A. Pierce (2008), Genetics a conceptual approach, 3rd ed., W. H. Freeman and company.
3) R. H. Tamarin, (2004), Principles of genetics, Tata McGraw Hill.
4) Prescott, Harley and Klein, Microbiology (2001), 5th edition McGraw Hill international edition.
5) Primrose and Twyman (2001), Principles of gene manipulation and genomics, 6th ed, Blackwell Publishing.
6) Nancy Trun and Jaine Trempy (2004), Fundamental bacterial genetics Blackwell Publishing.
7) D Nelson and M Cox, (2005) Lehninger Principles of Biochemistry, 4th edition Macmillan worth Publishers.
8) James Watson (2004), Molecular biology of the gene, 5th edition Pearson.
9) James Watson (2017), Molecular biology of the gene, 7th edition, Pearson.

# Evaluation Pattern: Theory

For course I

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)
Probable options:
Plickers
Testmoz
Google form
Moodle
Objective-MCQ
Short answer test

# SEMESTER VI - Practical

## Course-I

## COURSE CODE: 23US6MBCCP1

## [CREDITS - 01]

| Experiment Sr. No. | Titles and Number of Credits | Number of hours |
|---|---|---|
| 1 | Preparation of competent cells and transformation | 04 |
| 2 | Genetics problems on Transformation, Conjugation and Transduction | 05 |
| 3 | UV survival curve – determination of exposure time leading to 90% reduction | 08 |
| 4 | Isolation of mutants using UV mutagenesis | 08 |
| 5 | Replica plate technique for selection & characterization of auxotrophic mutants | 05 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 20 marks

## Course – II

## COURSE TITLE: Medical Microbiology and Immunology-II

## COURSE CODE: 23US6MBCC2MEI

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Summarize the pathogenesis of organisms causing GI tract, Skin and CNS infections and control measures.

2) Discuss protozoal and viral infections and sexually transmitted diseases.

3) Describe the ontogeny, differentiation and killing mechanism associated with T cells and B cells.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Infections of the Gastrointestinal tract, Skin and CNS**<br>**Learning objectives:**<br>1) To describe aetiological agents of infections, their transmission and pathogenesis.<br>2) To explain the clinical manifestations and laboratory diagnostic procedures of the infections.<br>**Learning outcomes:**<br>After the successful completion of the module the learners will be able to:<br>1) Differentiate between the types of Gastrointestinal tract infections and Skin infections.<br>2) Describe the virulence properties of pathogens causing Gastrointestinal tract infections and Skin infections | |
| | **Infections of the Gastrointestinal tract, Skin and CNS**<br>Aetiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis and Treatment of: | |
| 1.1 | **GI (Gastrointestinal Tract Infections)**<br>*Escherichia coli*<br>*Salmonella spp*<br>*Shigella spp* | 6L |
| 1.2<br>1.2.a<br>1.2.b | **Skin Infections**<br>Pyogenic Streptococcal infections, *Pseudomonas*<br>Opportunistic diseases: Ringworm | 3L |

| | | |
|---|---|---|
| 1.3 | **CNS (Central Nervous System Infections)**<br>Rabies<br>Bacterial Meningitis- Neisseria meningitidis | 3L |
| 2 | **Protozoal, Viral and Sexually Transmitted diseases**<br>**Learning objectives:**<br>1) To describe the protozoal and viral infections.<br>2) To explain the clinical manifestations and laboratory diagnostic procedures of Sexually Transmitted diseases.<br><br>**Learning outcomes:**<br>After the successful completion of the module the learners will be able to:<br>1) Discuss the life-cycle of protozoal and viral agents causing infections.<br>2) Elaborate the diagnosis and treatment of Emerging and re-emerging infections.<br>3) Summarize the clinical manifestations of and control measures for Sexually transmitted diseases. | |
| | **Protozoal, Viral and Sexually Transmitted diseases** | |
| 2.1 | **Protozoal infections**<br>Malaria, Amoebiasis (*Entamoeba*) | 3L |
| 2.2<br>2.2.a | **Viral Infections**<br>Dengue, Hepatitis A | 3L |
| 2.2.b | **Emerging and re-emerging infections**<br>SARS, Zika, Nipah virus | 2L |
| 2.3 | **Sexually Transmitted Diseases**<br>HIV infection<br>Syphilis<br>Gonorrhoea | 4L |
| 3 | **Cells of immune system and their role in Immune response**<br>**Learning Objectives:**<br>1) To describe how T cells and B cells are generated from primary lymphoid organs.<br>2) To explain the effector mechanism of T cells and B cells.<br>**Learning Outcomes:**<br>After successful completion of the module, the learner will be able to<br>1) Explain generation of T cells and B cells from primary lymphoid organs.<br>2) Describe the effector mechanism of T cells and B cells. | |

| | | |
|---|---|---|
| | **Cells of immune system and their role in Immune response** | |
| 3.1 | **T cell** | 3L |
| 3.1.a | Receptor: Structure and organization | |
| 3.1.b | T cell development and maturation, positive, negative selection T cell activation and differentiation | |
| 3.2 | **Cell mediated effector response** | 3L |
| 3.2.a | Generation and target destruction by cytotoxic T cells | |
| 3.2.b | Killing mechanism of NK cells | |
| 3.2.c | Antibody dependent cell cytotoxicity | |
| 3.3 | **B cell** | 3L |
| 3.3.a | Receptor, structure and organization | |
| 3.3.b | B cell development and maturation | |
| 3.3.c | B cell activation and differentiation | |
| 3.4. | **Humoral response** | 3L |
| 3.4.a | Induction of humoral response, primary and secondary immune response | |
| 3.4. b | Germinal centres and antigen induced B cell differentiation | |

## References:

1) Ananthanarayan and Paniker, (2009), Textbook of Microbiology, 8th Edition. Universal Press.
2) Koneman (1992) Diagnostic Microbiology, 4th Edition. J.B. Lippincott Company.
3) Teri Shors (2008) Understanding Viruses Jones and Bartlett Publisher.
4) Thomas J. Kindt, Richard A. G, Barbara A. Osburne Kuby (2007) Immunology: W. H. Freeman and Company, New York.
5) Fahim Halim Khan (2009), The elements of Immunology, Pearson Education.
6) Pathak, S., Palan U (2012), Immunology Essential and Fundamental. Pareen publications, Bombay.
7) Ian R. Tizard (2005) Immunology, An Introduction, 4th Edition, Saunders College publishing.
8) Bailey and Scott (2007) Diagnostic Microbiology, 12th edition, Elsevier.

## Evaluation Pattern: Theory

For course II

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

**SEMESTER VI - Practical**

**Course-II**

**COURSE CODE: 23US6MBCCP1**

**[CREDITS - 01]**

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Study of Diagnostic cycle for:<br>Gastrointestinal tract | 10 |
| 2 | Study of Diagnostic cycle for:<br>CNS | 10 |
| 3 | Study of Diagnostic cycle for:<br>Skin | 08 |
| 4 | Case study on viral/protozoal infections | 02 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.
Internal evaluation: 20 marks (proposed)

## Course – III

## COURSE TITLE: Microbial Biochemistry-II

## COURSE CODE: 23US6MBCC3MBC

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Explain the metabolic pathways of nucleic-acids, proteins and lipids.
2) Evaluate the different regulatory mechanisms for metabolic pathways of a living cell.
3) Describe the anabolic processes for carbohydrates with detailed study of bacterial photosynthesis.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Metabolism of Nucleic-acids, Proteins and Lipids**<br>**Learning Objectives:**<br>1) To describe the metabolic pathways of Nucleic acids, proteins and lipids.<br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) List different proteolytic enzymes and state their mode of action.<br>2) State the metabolic precursors of amino acids.<br>3) Describe the metabolic pathways associated with proteins, nucleotides and lipids.<br>4) Differentiate between glucogenic and ketogenic amino acids. | |
| 1.1<br>1.1.a<br>1.1.b | **Metabolism of Nucleic acids, Proteins and Lipids**<br>**Anabolism of proteins**<br>Schematic representation of amino acid families<br>Synthesis of amino acids of Serine family<br>Examples – Serine, Cysteine, Glycine | 2L |
| 1.2.<br>1.2.a<br>1.2.b<br>1.2.c | **Catabolism of proteins**<br>Enzymatic degradation of proteins in prokaryotes and eukaryotes<br>Metabolic fate of amino acids (schematic only) glucogenic and ketogenic amino acids<br>Metabolism of single amino acids –Deamination, decarboxylation, and transamination | 3L |

| | | |
|---|---|---|
| 1.2.d | Fermentation of single amino acids<br>Glutamate by *Clostridium tetanomorphum* | |
| 1.2.e | Fermentation of pair of amino acids (Stickland reaction) | |
| 1.3 | **Anabolism of nucleotides**<br>Synthesis of ribonucleotides and deoxyribonucleotides- De-novo pathways | 2L |
| 1.4.<br>1.4.a<br>1.4.b<br>1.4.c | **Catabolism of nucleotides**<br>Degradation of purine nucleotides up to uric acid formation<br>Degradation of pyrimidine nucleotides<br>Recycling of purine and pyrimidine nucleotides by salvage pathway | 2L |
| 1.5 | **Anabolism of Lipid**<br>Synthesis of Palmitic acid and Polyhydroxybutyrate (PHB) | 2L |
| 1.6 | **Catabolism of Lipids**<br>Beta oxidation and energetics of palmitic acid<br>Omega oxidation | 1L |
| 2 | **Metabolic Regulation**<br>**Learning Objectives:**<br>1) To analyse the regulation and co-ordination between metabolic pathways.<br>2) To familiarize with the basic concepts of different types of regulatory mechanisms acting at various cellular levels.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Define various terms associated with cellular regulation.<br>2) Describe significance of allosteric proteins and enzymes with the specific example of ATCase.<br>3) Explain the concept of operons with the example of lac operon.<br>4) Compare the various end-product inhibitions.<br>5) Explain types of covalent modifications with details of glutamine synthetase.<br>6) Discuss regulation by proteolytic cleavage with examples. | |

| | | |
|---|---|---|
| 2.1 | **Metabolic Regulation**<br>**Processes that affect the cellular concentration of a protein** | 1L |
| 2.2 | **Concepts**<br>Repression and Induction, inhibition and activation, house-keeping genes | 2L |
| 2.3 | **Allosteric proteins**<br>Role as enzymes (ATCase) and regulatory proteins (Lac repressor, CAP). | 2L |
| 2.4 | **Regulation of gene expression**<br>Three types of proteins that regulate transcription<br>Specificity factors, multiple sigma factors<br>Enhancers and Activators | 2L |
| 2.5 | Introduction to operon model and positive and negative regulation of operons | 1L |
| 2.6 | DNA binding proteins in positive and negative regulation of Lac operon, Catabolite repression | 1L |
| 2.7<br>2.8 | **Regulation of enzyme activity**<br>(Enzyme inhibition /activation)<br>Mechanism of End-Product Inhibition<br>End-Product Inhibition in branched pathways-Iso-functional enzymes, Concerted, Sequential, Cumulative, Combined activation and inhibition | 1L |
| 2.9 | **Covalent modification of regulatory enzymes**<br>Glutamine synthetase system of *E. coli* in detail | 1L |
| 2.10 | **Regulation by proteolytic cleavage**<br>Regulation of EMP & TCA | 1L |
| 3 | **Anabolism of carbohydrates**<br>**Learning Objectives:**<br>1) To introduce the concepts of photosynthesis in different groups of bacteria.<br>2) To explain light-dependent and light-independent reactions in bacteria.<br>3) To describe bacterial cell wall and glycogen synthesis in prokaryotes and eukaryotes.<br>4) To describe gluconeogenesis and its role in metabolism. | |

| | | |
|---|---|---|
| | **Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br><br>1) Describe features of various photosynthetic bacteria.<br>2) Describe photosynthetic apparatus and light reactions.<br>3) Compare cyclic and noncyclic photophosphorylation.<br>4) Differentiate between photosynthetic systems in green bacteria, purple bacteria and cyanobacteria.<br>5) Differentiate between Calvin Benson and reductive TCA cycle.<br>6) Describe the biosynthesis of bacterial cell-wall and glycogen in prokaryotes and eukaryotes.<br>7) Interpret different bypass reactions in gluconeogenesis.<br>8) Evaluate the biochemical significance of gluconeogenesis. | |
| 3.1<br>3.1.a<br>3.1.b<br><br>3.1.c<br><br><br>3.1.d<br><br>3.2<br>3.2.a<br>3.2.b<br>3.2.c | **Anabolism of carbohydrates**<br>**Anabolism of glucose: Prokaryotic photosynthesis**<br>The phototrophic prokaryotes (Oxygenic phototrophs, Anoxygenic phototrophs examples only)<br>Photosynthetic pigments and photosynthetic apparatus<br>Light reactions of purple photosynthetic bacteria, green sulphur bacteria (only schematic) and cyanobacteria (with details)<br>Dark reaction: Calvin Benson cycle and reductive-TCA<br><br>**Anabolism of Carbohydrate polymers**<br>Gluconeogenesis<br>Biosynthesis of glycogen in prokaryotes and eukaryotes.<br>Biosynthesis of Peptidoglycan | 4L<br><br><br><br>2L<br><br><br>2L<br>2L<br>2L |

## References:

1) Stanier R.Y., Ingraham, J.L., Wheelis, M.L., Painter, R.R (1987) General Microbiology, 5th edition, The Macmillan press Ltd.
2) Conn, Stumpf, P. K., Bruening, G. R. H. (1987) Outlines of Biochemistry, 5thedition, John Wiley and Sons.
3) Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
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5) Nelson, D, Cox, M, (2005), Lehninger Principles of biochemistry,4th edition, W. H. Freeman and Company
6) Voet, D & Voet, J. G., (2004), Biochemistry, 3rd edition, John Wiley& Sons Inc
7) Zubey, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers.

## Evaluation Pattern: Theory

For course III

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

**SEMESTER VI - Practical**

**Course-III**

**COURSE CODE: 23US6MBCCP2**

**[CREDITS - 01]**

| Experiment Sr. No. | Titles and Number of Credits | Number of hours |
|---|---|---|
| 1. | Estimation of chlorophyll in cells | 5 |
| 2. | Estimation of β-galactosidase activity in induced and non-induced cells of E. coli | 5 |
| 3. | To study catabolite repression in *E. coli* by diauxic growth curve | 10 |
| 4 | Estimation of uric acid | 10 |

**Evaluation pattern: Practical**

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 20 marks

## Course – IV

## COURSE TITLE: Bioprocess Technology- Downstream Processing and Fermentations

## COURSE CODE: 23US6MBCC4BPD

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Predict the use of downstream processes for efficient recovery of fermentation products.

2) Validate the purity of the product and the process steps.
3) Plan a logical flow for treatment of industrial wastes.
4) Describe the production of important microbial fermentation products.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Recovery and Purification of Fermentation products**<br>**Learning Objectives**:<br>1) To understand the principle of methods employed for product recovery.<br>2) To explore the different downstream processes in relation to the product to be isolated.<br>3) To formulate an appropriate plan for product recovery and purification.<br><br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Analyse the criteria for the recovery processes.<br>2) Formulate the steps in the recovery of the given microbial product based on its physical, chemical and biological characteristics.<br>3) Logically plan the downstream processes in sequence with respect to a product. | |
| 1.1<br>1.2<br>1.2.a<br>1.2.b | **Recovery and Purification of Fermentation products**<br>**Criteria for choice of recovery process**<br>**Biomass separation from fermentation media**<br>Foam Separation<br>Precipitation | 1L<br>3L |

| | | |
|---|---|---|
| 1.2.c | Filtration, filter aids, plate-frame and rotary vacuum filters | |
| 1.2.d | Centrifugation - Cell aggregation and flocculation, Range of centrifuges | 2L |
| 1.3 | **Cell Disruption for intracellular products** | |
| 1.3.a | Physico-mechanical methods | 1L |
| 1.3.b | Chemical methods | |
| 1.4 | **Liquid –liquid extraction** Solvent recovery, two phase aqueous extraction, Reversed Micelle extraction | 1L |
| | Supercritical fluid extraction | 1L |
| 1.5 | **Adsorption and removal of volatile products** | |
| 1.6 | **Chromatography** | 1L |
| | Ion Exchange chromatography for Streptomycin extraction | |
| 1.7 | **Membrane processes** | 1L |
| 1.7.a | Filtration-Ultra filtration, Microfiltration and Nano filtration | |
| 1.7.b | Reverse osmosis | |
| 1.7.c | Liquid membranes | |
| 1.8 | **Drying** | 1L |
| 1.9 | **Crystallization and Whole broth processing** | |
| 2 | **Product analysis and Treatment of Industrial Wastes**<br>**Learning Objectives:**<br>1) To assess the product quality.<br>2) To integrate the waste treatment methods for efficient and safe disposal of industrial waste.<br>3) To review the treatment of pharmaceutical industry waste.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Verify the product quality and validate its purity.<br>2) Choose the appropriate treatment process based on the constituents of the industrial waste.<br>3) Evaluate the quality of the waste by specific chemical and biological methods. | |
| | **Product analysis and Treatment of Industrial Wastes** | |
| 2.1 | **Product analysis (Pharmaceutical product)** | 5L |
| 2.1.a | Protein –Based contaminants | |
| 2.1.b | Detection of Protein based product impurities | |
| 2.1.c | Immunological approaches to detection of contaminants | |
| 2.1.d | Endotoxin and other pyrogenic contaminants | |
| | Pyrogen detection | |

| | | |
|---|---|---|
| | Microbial and viral contaminants | |
| 2.1.e | Miscellaneous contaminants | |
| 2.1.f | Validation studies | |
| | | |
| 2.2 | **Treatment of Industrial Wastes** | 2L |
| 2.2.a | Methods for determination of organic matter content in waste waters: Dissolved oxygen, PV test, BOD, COD<br>Total Organic carbon<br>Total solids: Total suspended solids, Total dissolved solids, Volatile suspended solids | |
| 2.2.b | **Wastes from major industries- an overview** | 2L |
| 2.2.c | **Systems for the treatment of wastes**<br>Aerobic breakdown of raw waste waters<br>Activated sludge system and its modifications<br>Trickling filter<br>Rotating discs | |
| 2.2.d | **Anaerobic breakdown of sludge** | 2L |
| 2.2.e | **Waste water disposal in pharmaceutical industry** | 1L |
| 2.2.f | **Government Regulatory Bodies (EPA)** | |
| 3 | **Industrial Fermentations**<br>**Learning Objectives:**<br>1) To chart out microbial fermentation processes.<br>2) To integrate the upstream processing, fermentation proper and downstream processing as a whole unit.<br>3) To predict the consequences of deviation from optimum parameters set.<br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) Illustrate the microbial productions.<br>2) Analyse the effect of various physical and chemical parameters on fermentation.<br>3) Schematically represent the microbial fermentation processes. | |
| | **Industrial Fermentations** | |
| 3.1 | Baker's and Brewer's Yeast | 1L |
| 3.2 | Alcohol from molasses | 1L |
| 3.3 | Beer –Ale and Lager | 2L |
| 3.4 | Wine | 1L |
| 3.5 | Penicillin and semisynthetic penicillins | 2L |
| 3.6 | Vitamin $B_{12}$ from *Propionibacterium* | 1L |
| 3.7 | Citric acid and Vinegar | 2L |
| 3.8 | Amylase | 2L |

## References:

1) Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2) Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3) Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4) Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5) Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6) Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7) Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
8) Stanbury PF, Whitaker A and Hall SJ. (2017). Principles of Fermentation Technology. 3rd edition, Elsevier Science Ltd.
9) Walsh Gary, (2011). Pharmaceutical Biotechnology. 1st edition, Wiley-India edition.
10) E.M.T. El-Mansi and A.R. Allman (2012). Fermentation Microbiology and Biotechnology. 3rd edition. CRC Press.

## Evaluation Pattern: Theory

For course IV

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

Chart preparation using ICT tools

# SEMESTER VI - Practical

## Course-IV

### COURSE CODE: 23US6MBCCP2

### [CREDITS - 01]

| Experiment Sr. No. | Titles and Number of Credits | Number of hours |
|---|---|---|
| 1. | Estimation of BOD | 4 |
| 2. | Estimation of COD | 3 |
| 3. | Fermentation efficiency of alcohol fermentation<br>Sugar tolerance<br>Alcohol tolerance<br>Sugar estimation by Cole's ferricyanide method<br>Alcohol estimation | 6 |
| 4. | Bioassay of Penicillin | 6 |
| 5. | Bioassay of Vitamin $B_{12}$ | 6 |
| 6. | Visit to a fermentation industry-Report writing | 5 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 20 marks

**Discipline Specific Elective DSE-I**

**COURSE TITLE: Recombinant DNA Technology and Advanced Virology**

**COURSE CODE: 23US6MBDS1RDV**

**[CREDITS - 02]**

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Describe the role of different tools and the methods associated with recombinant DNA technology.
2) Analyse the applications of recombinant DNA technology.
3) Enumerate virus particles.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Introduction to Recombinant DNA Technology**<br>**Learning Objectives:**<br>1) To describe the steps in gene cloning.<br>2) To explain different methods adopted to obtain and process DNA.<br>3) To state characteristics of different vectors.<br>4) To discuss the process of transformation of the host.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Define the basic terms associated with recombinant DNA technology.<br>2) Describe the steps to use vectors to clone gene segments.<br>3) Compare and contrast between genomic and cDNA library.<br>4) Evaluate the properties of an ideal host and a vector. | |
| | **Introduction to Recombinant DNA Technology** | |
| 1.1 | **Basic terminology**<br>Concept of recombinant DNA, gene cloning, chimeric DNA | 1L |
| 1.1.a | **Tools required**<br>Different enzymes and proteins required in gene cloning, Restriction endonucleases and its types | 2L |
| 1.1.b | Modification of cut ends- use of Linkers and Adaptors | |
| 1.1.c | **Basic steps of gene cloning**<br>Genomic and cDNA library<br>Concept and preparation | 1L |

| | | |
|---|---|---|
| 1.1.d | **Methods of generating DNA fragments**<br>Restriction digestion, Mechanical shear, PCR, Chemical synthesis, properties of an ideal host and a vector | 2L |
| 1.1.e | **Vectors used in Recombinant DNA Technology**<br>Cloning and Expression vectors | 1L |
| 1.2 | **Cloning and selection in following vectors**<br>Plasmids: pBR322 and pUC-19 vector.<br>Phage: Lambda phage<br>Cosmids<br>Shuttle vectors<br>BAC and YAC | 3L |
| 1.3 | **Integration of DNA insert into vector**<br>**Different situations:**<br>Both sides cohesive and compatible<br>Both ends cohesive and separately matched<br>Both ends cohesive and unmatched<br>Both ends blunt<br>One end cohesive and compatible, the other end blunt | 1L |
| 1.4 | **Introduction of recombinant DNA into a suitable host**<br>**Methods of transformation of host:**<br>Increased competence by Calcium chloride treatment<br>Infection by recombinant DNAs packaged as virions | 1L |
| 2 | **Screening, selection of recombinant clones and Applications of Recombinant DNA Technology**<br>**Learning Objectives:**<br>1) To explain the different methods of screening and selection of recombinant clones.<br>2) To describe the applications of recombinant DNA technology.<br>**Learning Outcomes:** After the successful completion of the module, the learner will be able to:<br>1) Evaluate different strategies to screen and select recombinant clones.<br>2) Describe different applications of recombinant DNA technology. | |
| 2.1 | **Screening, selection of recombinant clones and Applications of Recombinant DNA Technology**<br>**Selection of recombinant clones containing recombinant DNA**<br>Reporter genes<br>Elimination of non-recombinant DNA | 1L |

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|---|---|---|
| | Identification of clones having recombinant DNAs | |
| 2.2 | **Selection of clone containing a specific DNA insert** | |
| 2.2.a. | **Sequence dependent screening:**<br>Colony hybridization<br>Gene tagging<br>Screening by PCR | 2L |
| 2.2.b. | **Screening of expression protein product:**<br>Unique gene products<br>Antibodies specific to a protein product<br>FACS<br>South-Western and North-Western screening | 2L |
| 2.3.<br>2.3.a.<br><br>2.3.b.<br><br>2.3.c.<br><br>2.3.d. | **Applications of Recombinant DNA Technology**<br>Site-directed mutagenesis<br>Method and application<br>Yeast two-hybrid system<br>Protein-protein interaction<br>DNA fingerprinting<br>Method and application<br>DNA polymorphism<br>Types and detection: SNP, STR and VNTR | 7L |
| 3 | **Advanced Virology**<br>**Learning Objectives:**<br>1) To describe the different methods for cultivation of viruses.<br>2) To explain the methods for visualization and enumeration of virus particles.<br>3) To state the characteristics of prions and viroids.<br>**Learning Outcomes**: After the successful completion of the module, the learner will be able to:<br>1) Implement different methods for the cultivation of viruses.<br>2) Describe methods to visualize and enumerate virus particles.<br>3) List the characteristics of prions and viroids. | |
| | **Advanced Virology** | |
| 3.1 | **Cultivation of viruses**<br>Cell culture techniques, embryonated egg, laboratory animals, CPE and inclusion bodies. | 2L |
| 3.2 | **Visualization and enumeration of virus particles** | 1L |

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|---|---|---|
| 3.3 | **Measurement of infectious units**<br>Plaque assay<br>Fluorescent focus assay<br>Infectious centre assay<br>Transformation assay<br>Endpoint dilution assay<br>Efficiency of plating | 4L |
| 3.4 | **Measurement of virus particles and their components**<br>Electron microscopy<br>Atomic force microscopy<br>Hemagglutination<br>Measurement of viral enzyme activity | 3L |
| 3.5 | Introduction to Prions and Viroids | 2L |

## References:

1) Peter J. Russell (2006), iGenetics-A molecular approach, 2nd ed.
2) Benjamin A. Pierce (2008), Genetics a conceptual approach, 3rd ed., W. H. Freeman and company.
3) R. H. Tamarin, (2004), Principles of genetics, Tata McGraw Hill.
4) M. Madigan, J. Martinko, J. Parkar, (2009), Brock Biology of microorganisms‖,12th ed., Pearson Education International.
5) Fairbanks and Anderson, (1999), Genetics, Wadsworth Publishing Company.
6) Edward Wagner and Martinez Hewlett, (2005) Basic Virology, 2nd edition, Blackwell Publishing
7) Teri Shors (2009), Understanding viruses, Jones and Bartlett publishers.
8) Primrose and Twyman, (2006), Principles of gene manipulation and genomics, 7th ed, Blackwell Publishing.

## Evaluation Pattern: Theory

For course: DSE-I

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)
Probable options:
Plickers
Testmoz
Google form
Moodle
Objective-MCQ
Short answer test

## SEMESTER VI - Practical

## COURSE: DSE I

## COURSE CODE: 23US6MBDSP3

## [CREDITS - 01]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Enrichment of coliphages, phage assay | 13 |
| 2 | Restriction enzyme digestion analysis (Demonstration) | 05 |
| 3 | PCR (Demonstration) | 12 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.

Internal evaluation: 20 marks

## Discipline Specific Elective DSE-II

## COURSE TITLE: Advances in Immunology and Health Care Biotechnology

## COURSE CODE: 23US6MBDS2AIM

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1) Summarize production and applications of monoclonal antibodies.
2) Evaluate the need for vaccination.
3) Explain different types of hypersensitivity reactions, autoimmune disorders and transplantation.

4) Explain the various methods for detecting genetic disease, drug designing and use of DNA fingerprinting in forensic science.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Monoclonal Antibodies, Immunohematology, Vaccines**<br>**Learning Objectives:**<br>1) To describe production and application of monoclonal antibodies.<br>2) To describe human blood group systems.<br>3) To explain different types of active-passive immunization.<br><br>**Learning Outcomes:**<br>After the successful completion of module, the learner will be able to:<br>1) Discuss the use of monoclonal antibodies in different areas of research.<br>2) Recognize different blood group systems.<br>3) Describe role of vaccines in human health. | |
| | **Monoclonal Antibodies, Immunohematology, Vaccines** | |
| **1.1** | **Monoclonal antibodies**<br>Principle of Hybridoma technology-<br>Production by cell culture<br>and applications of Monoclonal antibodies | 3L |
| **1.2** | **Immunohematology**<br>Human blood group system, ABO secretors and non-secretors, Rhesus system and list of other blood group | 4L |

| | | |
|---|---|---|
| | systems, Haemolytic disease among new born, Coombs test | |
| **1.3** | **Vaccines** | 5L |
| 1.3.a | Active, passive immunization | |
| 1.3.b | Types of vaccines: Killed and attenuated vaccines, whole organism vaccine, purified macromolecules as vaccine, DNA vaccine | |
| 1.3.c | Use of adjuvant in vaccine | |
| 1.3.d | New vaccine strategies | |
| 1.3.e | Ideal vaccines | |
| 1.3. f | Route of vaccine administration schedule and failure in clinical vaccine | |
| 2 | **Hypersensitivity, Autoimmunity, Transplantation**<br>**Learning Objectives:**<br>1) To describe the mechanism and manifestations of hypersensitivity.<br>2) To explain different types of autoimmune responses.<br>3) To describe different types of transplantation, its immune mechanism and methods for preventing its rejections.<br>**Learning Outcomes:**<br>After the successful completion of module, the learner will be able to:<br>1) Explain the hypersensitivity reaction and its mechanism.<br>2) Describe various autoimmune disorders.<br>3) Elaborate on different types of transplantations. | |
| | **Hypersensitivity, Autoimmunity, Transplantation** | |
| 2.1 | **Hypersensitivity** | 5L |
| 2.1.a | Coombs and Gell's classification | |
| 2.1.b | Type I to Type IV hypersensitivity mechanism and manifestation | |
| 2.2 | **Introduction to Autoimmunity** | 3L |
| 2.2.a | Definition of immune tolerance; immune suppression and auto immunity | |
| 2.2.b | Examples of autoimmune disorders | |
| 2.2.c | Possible mechanisms | |
| 2.3 | **Transplantation** | 4L |
| 2.3.a | Terms used to denote different types of transplantation | |
| 2.3.b | Mechanisms of graft rejection | |
| 2.3.c | Methods of increasing the acceptance of allograft | |

| | | |
|---|---|---|
| **3** | **Health Care Biotechnology**<br>**Learning objectives:**<br>1) To familiarize with newer disease diagnostic techniques.<br>2) To introduce the methods of detecting and treating genetic diseases.<br>3) To describe applications of DNA fingerprinting in Forensic medicine.<br><br>**Learning outcomes:** After the successful completion of the module the learner will be able to:<br>1) Justify the role of recent methods of diagnosis and detection of genetic diseases.<br>2) Elaborate drug designing, delivery and targeting.<br>3) Explain the concept of Gene therapy.<br>4) Apply the use of DNA fingerprinting technique in forensic medicine. | |
| | **Health Care Biotechnology** | |
| 3.1. | **Disease diagnosis** | 2L |
| 3.1.a | DNA/RNA Probe | |
| 3.1.b | Autoantibodies | |
| 3.1.c | Commercial potential of Diagnostics | |
| 3.2 | **Detection of genetic diseases** | 2L |
| 3.2.a | Obtaining foetal cells | |
| 3.2.b | Disease detection | |
| 3.2.c | Identification of genes causing genetic diseases | |
| 3.3 | **Disease treatment** | 3L |
| 3.3.a | Products from non-recombinant organisms | |
| 3.3.b | Products from Recombinant organisms | |
| 3.3.c | Interferons | |
| 3.3.d | Growth factors | |
| 3.3.e | Artificial tissues/organs | |
| 3.3.f | Therapeutic oligonucleotides | |
| 3.4 | **Drug designing, Drug delivery and targeting** | 1L |
| 3.5 | **Gene therapy** | 2L |
| 3.5.a | Types of gene therapy<br>Augmentation gene therapy<br>Targeted gene transfer | |
| 3.5.b | Ethical issues | |

| | | |
|---|---|---|
| 3.6 | **DNA fingerprinting in forensic medicine**<br>VNTR loci and alleles<br>Preparation of the DNA sample<br>DNA profiling | 2L |

## References:

1) Thomas J. Kindt, Richard A. G, Barbara A. Osburne (2007) Kuby Immunology: W. H. Freeman and Company, New York.

2) Pathak S.S. and Palan U. (1997). Immunology essential and Fundamentals, Pareen publications, Bombay.

3) Ian R. Tizard (2005), "Immunology- An introduction" 4th edition, Saunders College publishing.

4) Fahim Halim Khan (2009) "The Elements of immunology "Pearson Education, India.

# Evaluation Pattern: Theory

For course: DSE -II

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 30 | 20 |
| 2 | II | 30 | 20 |
| 3 | III | 30 | 20 |

**Internal Evaluation** - (40 M)
Probable options:
Plickers
Testmoz
Google form
Moodle
Objective-MCQ
Short answer test

## SEMESTER VI - Practical

## COURSE: DSE II

## COURSE CODE: 23US6MBDSP3

## [CREDITS - 01]

| Experiment Sr. no. | Title and Number of Credits | Number of hours |
|---|---|---|
| 1 | Blood grouping, direct and reverse typing | 5 |
| 2 | Major- Minor compatibility test | 4 |
| 3 | Determination of isoagglutinin titre | 4 |
| 4 | Coomb test- direct method and indirect method | 5 |
| 5 | Preparation of heat killed vaccine and sterility testing | 5 |
| 6 | a) Visit to Microbiological Diagnostic laboratory<br>b) Visit to Forensic laboratory | 7 |

## Evaluation pattern: Practical

External evaluation: 30 Marks practical examination at the end of each semester per course.
Internal evaluation: 20 marks

## SEC – I

## COURSE TITLE: MOLECULAR BIOTECHNOLOGY AND SOCIETY

## COURSE CODE: 23US6MBSEMBS

## [CREDITS - 02]

**Course Learning Outcomes:** After successful completion of the Course, the learner will be able to:

1. Practise regulatory guidelines pertaining to Biotechnology.
2. Summarize the safety aspects pertaining to genetically modified foods.
3. Elaborate the environmental impacts of genetically modified organisms.

| Module | TITLE AND CONTENT | NO OF LECTURES:12 |
|---|---|---|
| 1 | **Regulations for use of Biotechnology**<br>**Learning Objectives:**<br>1. To familiarize the students with the regulations pertaining to recombinant DNA technology.<br>2. To assess the impact of production of food ingredients from genetically modified organisms.<br>**Learning Outcomes:** After the completion of this module learner will be able to:<br>1. Evaluate the production of food ingredients from genetically modified organisms.<br>2. Describe the regulations related to recombinant DNA technology. | |
| 1.1 | **Regulations for use of Biotechnology**<br>Concerns about safety, ethics, NIH & RAC guidelines<br>Deliberate release of genetically modified microorganisms (Field trials of *Pseudomonas syringae*) | 4L |
| 1.2. | Food ingredients produced by genetically engineered organisms<br>Chymosin<br>Tryptophan<br>Bovine Somatotropin | 3L |
| 1.3 | Genetically modified crops | 2L |
| 1.4 | Genetically engineered lifestock | 2L |

| | | |
|---|---|---|
| 1.5 | Introduction to terms: US FDA GRAS and European food safety authority | 1L |
| **2** | **Safety of genetically modified foods**<br>**Learning Objective:**<br>1) To provide insight about the concerns regarding the consumption of genetically modified foods.<br>**Learning Outcomes:** After completion of this module, the learner will able to:<br>1. Compare between the products obtained from cloned and conventionally bred organisms.<br>2. Describe the procedures followed by different countries for labelling GMOs. | |
| | **Safety of genetically modified foods** | |
| 2.1.a | Concerns about the safety of genetically modified foods | 1L |
| 2.1.b | Alteration of nutritional content of food | 4L |
| 2.1.c | Potential of introducing toxins or allergens into food<br>Transgenic potato<br>Bt -brinjal<br>Bt – rice | 2L |
| 2.1.d | Potential of transferring transgene from food to human or intestinal microorganisms | 2L |
| 2.1.e | Controversy about the labelling of genetically modified foods | 3L |
| 3 | **Environmental impact and patent laws**<br>**1) Learning Objectives:**<br>1) To sensitize the students about the impact of GMOs on the environment and Biodiversity.<br>2) To introduce the learner to the concept of patenting.<br>**Learning Outcomes:** After completion of this module the learner will be able to:<br>1. To explain the criteria required for patenting any invention.<br>2. Elaborate on the negative and positive impacts of GMOs on the environment and Biodiversity. | |
| | **Environmental impact and patent laws** | |
| 3.1 | **Biotechnology and patent law** | 4L |
| 3.1.a | Categories of patentable invention | |
| 3.1.b | Patenting plants and animals | |
| 3.1.c | Uncertainty of patent law | |
| 3.2 | **Environmental impacts** | 6L |
| 3.2.a | Impact of Bt - toxin on nontarget insects | |
| 3.2.b | Impact on Biodiversity | |
| 3.2.c | Environmental benefits of GMO | 2L |

| | | |
|---|---|---|
| 3.3 | **Economic issues** | |

## References:

1. Bernard. R. Glick (2017), Jack J. Pasternak, Cherly L. Patten, Molecular Biotechnology-Principles and Applications - 4th Edition.
2. S. B. primrose (2016) Principles of gene manipulation, 8th edition.

## Evaluation Pattern: Theory

For course: SEC I

**External Evaluation** – Semester End Examination (60 M) - Duration: 2 hours

Paper Pattern

| Question No | Module | Marks with Option | Marks without Option |
|---|---|---|---|
| 1 | I | 40 | 30 |
| 2 | II | 40 | 30 |

**Internal Evaluation** - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test