

# MAZHARUL ULOOM COLLEGE (AUTONOMOUS)

(Established & Managed by the Ambur Muslim Educational Society)

Accredited by NAAC with Grade 'A' CGPA 3.23 in Cycle 3

Affiliated to Thiruvalluvar University, Vellore

Ambur 635802 (Tirupattur District)



## **COURSE STRUCTURE & SYLLABUS** (For the students admitted from year 2025-2026 onwards)

**Programme:** B.Sc

**Course : MICROBIOLOGY**

| Program Outcomes (POs) |                                                                                                                                                                                                                                                                                |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PO Code                | Program Outcome Statement                                                                                                                                                                                                                                                      |
| PO1                    | <b>Disciplinary Knowledge-</b> Acquire detailed knowledge and expertise in all the disciplines of the subject.                                                                                                                                                                 |
| PO2                    | <b>Communication Skills-</b> Ability to express thoughts and ideas effectively in writing, listening and confidently Communicate with others using appropriate media.                                                                                                          |
| PO3                    | <b>Critical Thinking-</b> Students will develop aptitude Integrate skills of analysis, critiquing, application and creativity.                                                                                                                                                 |
| PO4                    | <b>Analytical Reasoning-</b> Familiarize to evaluate the reliability and relevance of evidence, collect, analyze and interpret data.                                                                                                                                           |
| PO5                    | <b>Problem Solving-</b> Capacity to extrapolate the learned competencies to solve different kinds of non-familiar problems.                                                                                                                                                    |
| PO6                    | <b>Information/Digital Literacy-</b> Capability to use ICT in variety of learning situation,demonstrate ability to access, evaluate and use a variety of relevant information sources: Use appropriate softwares for analysis of data                                          |
| PO7                    | <b>Moral &amp; Ethical Ethics awareness/reasoning-</b> Ability to embrace moral/ethical values in conducting one's life.<br><b>Life Long Learning-</b> Engage in lifelong learning work on careers enhancement and adopting changing personal, professional and societal needs |

| Program Specific Outcomes (POs) |                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSO Code                        | Program Specific Outcome Statement                                                                                                                                                                                                                                                                                                                                                                   |
| PSO1                            | Understand the fundamental principles, concepts, and theories related to Microbiology. Also, exhibit proficiency in performing experiments in the laboratory.                                                                                                                                                                                                                                        |
| PSO2                            | Exhibit ethical conduct, critical thinking, and collaborative skills in addressing scientific challenges and advancing knowledge in Microbiology.                                                                                                                                                                                                                                                    |
| PSO3                            | Analyze the concepts of microbial metabolism, microbial genetics, molecular biology, and immunology, and evaluate the role of microorganisms in clinical pathogenesis, food safety, food quality testing, agriculture, dairy technology, bioprocessing, pharmaceutical industries, microbial ethics, and preventive medicine. Develop skill enhancement in sericulture, aquaculture, and apiculture. |
| PSO4                            | Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects.                                                                                                                                                                                                                                   |
| PSO5                            | Apply communication skills, Core values and Environmental awareness, Nutrition awareness with social responsibility for Entrepreneurship and Employability. The ability to enhance entrepreneurial skills across various domains of Microbiology.                                                                                                                                                    |

| Level                         | Definition                                                                                                      | Key Actions                                                   |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| <b>K1 :<br/>Remembering</b>   | Ability to recall or recognize facts, terms, basic concepts, or answers without necessarily understanding them. | Retrieve, Memorize, Repeat, Define, Identify, Recognize       |
| <b>K2 :<br/>Understanding</b> | Comprehending the meaning of information, interpreting or translating knowledge into your own words.            | Explain, Describe, Summarize, Interpret, Paraphrase           |
| <b>K3 :<br/>Applying</b>      | Using knowledge in new situations, such as solving problems or applying theories to real-world situations.      | Use, Demonstrate, Implement, Calculate, Practice              |
| <b>K4 :<br/>Analyzing</b>     | Breaking information into parts to explore understandings and relationships; identifying motives or causes.     | Compare, Contrast, Categorize, Distinguish, Examine, Organize |
| <b>K5 :<br/>Evaluating</b>    | Making judgments based on criteria and standards, often involving checking and critiquing.                      | Judge, Critique, Justify, Assess, Prioritize, Recommend       |
| <b>K6 :<br/>Creating</b>      | Putting elements together to form a new coherent whole or original product.                                     | Design, Develop, Invent, Compose, Construct, Generate         |

| Sem          | Course Code  | Part | Course Category                    | Course Title                                                   | Ins.<br>Hrs/<br>Week | Credit    | Marks |     | Total      |
|--------------|--------------|------|------------------------------------|----------------------------------------------------------------|----------------------|-----------|-------|-----|------------|
|              |              |      |                                    |                                                                |                      |           | CIA   | ESE |            |
| Semester III |              | I    | Language–III (Tamil / Urdu)        | General Tamil-III /Urdu-III                                    | 6                    | 3         | 25    | 75  | 100        |
|              |              | II   | English-III                        | General English–III                                            | 6                    | 3         | 25    | 75  | 100        |
|              |              | III  | Core Course– III                   | Molecular Biology and Microbial Genetics                       | 5                    | 5         | 25    | 75  | 100        |
|              |              | III  | Core Course Practical– III         | <b>Practical-III-</b> Molecular Biology and Microbial Genetics | 5                    | 5         | 25    | 75  | 100        |
|              |              | III  | Elective Course-III                | Clinical Laboratory Technology                                 | 3                    | 3         | 25    | 75  | 100        |
|              |              | IV   | Skill Enhancement Course (SEC-IV)  | Organic Farming and Biofertiliser Technology                   | 1                    | 1         | 25    | 75  | 100        |
|              |              | IV   | Skill Enhancement Course (SEC-V)   | Aquaculture                                                    | 2                    | 2         | 25    | 75  | 100        |
|              |              | IV   | Compulsory                         | Environmental Studies                                          | 2                    | 2         | 25    | 75  | 100        |
|              | <b>Total</b> |      |                                    |                                                                | <b>30</b>            | <b>24</b> |       |     | <b>800</b> |
| Semester IV  |              | I    | Language–IV (Tamil / Urdu)         | General Tamil-IV/Urdu-IV                                       | 6                    | 3         | 25    | 75  | 100        |
|              |              | II   | English-IV                         | General English-IV                                             | 6                    | 3         | 25    | 75  | 100        |
|              |              | III  | Core Course–IV                     | Immunology & Immunotechnology                                  | 5                    | 5         | 25    | 75  | 100        |
|              |              | III  | Core Course Practical– 1V          | <b>Practical-IV-</b> Immunology & Immunotechnology             | 5                    | 5         | 25    | 75  | 100        |
|              |              | III  | Elective Course-IV                 | Food Processing Technology                                     | 4                    | 3         | 25    | 75  | 100        |
|              |              | IV   | Skill Enhancement Course (SEC-VI)  | Vaccine Technology                                             | 2                    | 2         | 25    | 75  | 100        |
|              |              | IV   | Skill Enhancement Course (SEC-VII) | Apiculture                                                     | 2                    | 2         | 25    | 75  | 100        |
|              | <b>Total</b> |      |                                    |                                                                | <b>30</b>            | <b>23</b> |       |     | <b>700</b> |

| Semester            | Course Code | Course Category                                 | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|-------------------------------------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                                                 |              |         | CIA                  | ESE | Total |
| III                 |             | Core Course–III                                 | 5            | 5       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Molecular Biology and Microbial Genetics</b> |              |         |                      |     |       |

| Learning Objectives |                                                                        |
|---------------------|------------------------------------------------------------------------|
| <b>LO1</b>          | Provide knowledge on structure and replication of DNA.                 |
| <b>LO2</b>          | Illustrate the significance and functions of RNA in protein synthesis. |
| <b>LO3</b>          | Explain the cause and types of DNA mutation and DNA repair mechanisms. |
| <b>LO4</b>          | Outline the role of plasmids and phages in genetics                    |
| <b>LO5</b>          | Examine mechanisms of gene transfer and recombination.                 |

| SYLLABUS   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit       | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Hours |
| <b>I</b>   | Structure & Function of gene -DNA Structure - Salient features of double helix, forms of DNA. Denaturation and renaturation. DNA topology – Supercoiling, linking number, topoisomerases. DNA organization in prokaryotes, viruses, eukaryotes and Genetic code. Replication of DNA in prokaryotes and eukaryotes - Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication. Mechanism of DNA replication – enzymes involved–DNA polymerases, DNA ligase, primase. DNA replication modes-rolling circle, D-loop modes | 15    |
| <b>II</b>  | Transcription in Prokaryotes. Concept of transcription. RNA Polymerases - prokaryotic and eukaryotic. General transcription factors in eukaryotes.. Translation in prokaryotes and eukaryotes-Translational machinery- ribosome structure in prokaryotes and eukaryotes, tRNA structure and processing. Inhibitors of protein synthesis in prokaryotes and eukaryotes. Overview of regulation of gene expression-lac,trp and ara operons as examples. Regulation of gene expression by DNA methylation                                                           | 15    |
| <b>III</b> | Mutation-Definition and types-base substitutions, frame shifts, deletions, insertions, duplications, inversions. Silent, conditional, and lethal mutations. Physical and chemical mutagens. Reversion and suppression. Uses of mutations. Repair Mechanisms - Photoreactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.                                                                                                                                                                                        | 15    |
| <b>IV</b>  | Plasmids- Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, yeast 2μ plasmid. Bacteriophage-T4, Virulent Phage – Structure and lifecycle. Lambda phage-Structure, Lytic and Lysogenic cycle. Applications of Phages in Microbial Genetics. Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number, curing of plasmids                                                                                     | 15    |
| <b>V</b>   | Gene Transfer Mechanisms- Conjugation and its uses. Transduction - Generalized and Specialized, Transformation - Natural Competence and Transformation. Transposition and Types of Transposition reactions. Mechanism of transposition: Replicative and non-                                                                                                                                                                                                                                                                                                     | 15    |

|                                                                                                                                                                                    |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| replicative transposition. Transposable elements - Prokaryotic transposable elements – insertion sequences, composite, and non-composite transposons. Uses of transposons. CRISPR. |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

### **Text Book(s):**

1. Malacinski G.M. (2008). *Freifelder's Essentials of Molecular Biology*. 4th Edition. Narosa Publishing House, New Delhi.
2. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). *Principles of Genetics*. 8th Edition. Wiley India Pvt. Ltd.
3. Trun N. and Trempy J. (2009). *Fundamental Bacterial Genetics*. 1st Edition. Blackwell Science Ltd.
4. Brown T. A. (2016). *Gene Cloning and DNA Analysis- An Introduction*. (7th Edition). John Wiley and Sons, Ltd.
5. Dale J. W., Schantz M.V. and Plant N. (2012). *From Gene to Genomes – Concepts and Applications of DNA Technology*. (3rd Edition). John Wileys and Sons Ltd.

### **Reference Book(s):**

1. Glick B. R. and Patten C.L. (2018). *Molecular Biotechnology – Principles and Applications of Recombinant DNA*. 5th Edition. ASM Press.
2. Russell P.J. (2010). *iGenetics - A Molecular Approach*, 3rd Edition., Pearson New International edn.
3. Nelson, D.L. and Cox, M.M. *Lehninger* (2017). *Principles of Biochemistry*. 7th Edition, W.H. Freeman.
4. Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). *Molecular Genetics of Bacteria*, 4th Edition, ASM Press Washington-D.C. ASM Press.
5. Primrose S.B. and Twyman R. M. (2006). *Principles of Gene Manipulation and Genomics*. (7th Edition). Blackwell Publishing

### **Web Resource(s):**

1. [PDF] *Lehninger Principles of Biochemistry* (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
2. <https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/>
3. <https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/54>
4. *Molecular Biology Notes - Microbe Notes* 5. *Molecular Biology Lecture Notes & Study Materials | Easy Biology Class*

| Course Outcomes                                                          |                                                                                     |                           |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------|
| Up on successful completion of this course, the student will be able to: |                                                                                     |                           |
| CO No.                                                                   | CO Statement                                                                        | Cognitive Level (K-Level) |
| CO1                                                                      | Analyze the significance of DNA and elucidate the replication mechanism.            | K1,K2.K3,K4               |
| CO2                                                                      | Illustrate the types of RNA and protein synthesis machinery                         | K1,K2,K3                  |
| CO3                                                                      | Infer the causes and types of DNA mutation and summarize the DNA repair mechanisms. | K1,K2.K3                  |
| CO4                                                                      | Evaluate the importance of plasmids and phages in genetics                          | K1,K2.K3,K4               |
| CO5                                                                      | Analyze gene transfer and recombination methods.                                    | K1,K2.K3,K4               |

#### Relationship Matrix:

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 2   | 2   | 3   | 2   | 2   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.41              |
| CO2                   | 3                      | 3   | 3   | 3   | 2   | 2   | 3   | 3                               | 3    | 3    | 1    | 1    | 2.50              |
| CO3                   | 3                      | 2   | 3   | 3   | 3   | 3   | 3   | 3                               | 3    | 3    | 3    | 1    | 2.75              |
| CO4                   | 3                      | 3   | 3   | 3   | 2   | 2   | 3   | 3                               | 3    | 3    | 3    | 1    | 2.75              |
| CO5                   | 3                      | 3   | 3   | 3   | 2   | 3   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.66              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.61              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

3 – Strong, 2- Medium, 1- Low

| Mean Overall Score | Correlation |
|--------------------|-------------|
| <=1                | Low         |
| >1 & <=2           | Medium      |
| >2 & <=3           | High        |

| Semester            | Course Code | Course Category                                                | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|----------------------------------------------------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                                                                |              |         | CIA                  | ESE | Total |
| III                 |             | Core Course Practical–III                                      | 5            | 5       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Practical-III- Molecular Biology and Microbial Genetics</b> |              |         |                      |     |       |

| Learning Objectives |                                                             |
|---------------------|-------------------------------------------------------------|
| <b>LO1</b>          | Provide knowledge on structure and replication of DNA.      |
| <b>LO2</b>          | Elucidate the methods of Genomic and Plasmid DNA isolation. |
| <b>LO3</b>          | Explain methods of protein separation.                      |
| <b>LO4</b>          | Explain artificial transformation method                    |
| <b>LO5</b>          | Outline the role of phages in genetics.                     |

| SYLLABUS   |                                                                                                                                                                                                                        |       |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit       | Contents                                                                                                                                                                                                               | Hours |
| <b>I</b>   | Isolation of Genomic and Plasmid DNA from E.coli and Analysis by Agarose gel electrophoresis                                                                                                                           | 15    |
| <b>II</b>  | Estimation of DNA using colorimeter (diphenylamine reagent), UV spectrophotometer (A260 measurement).                                                                                                                  | 15    |
| <b>III</b> | Resolution and visualization of proteins by polyacrylamidegel electrophoresis (SDS-PAGE) – Demonstration.UV induced auxotrophic mutant production and isolation of Mutants by replica plating technique–Demonstration. | 15    |
| <b>IV</b>  | Isolation of antibiotic resistant mutants by gradient plate method-Demonstration.                                                                                                                                      | 15    |
| <b>V</b>   | Screening and isolation of phages from sewage.Estimate RNA.                                                                                                                                                            | 15    |

| TextBook(s):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. Crichton. M. (2014). <i>Essentials of Biotechnology</i>. Scientific International PvtLtd.New Delhi.</p> <p>2. Sambrook J. and Russell D.W. (2001). <i>Molecular Cloning - A Laboratory Manual –7th Edition</i>. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.</p> <p>3. Dale J. W., Schantz M. V. and Plant N. (2012). <i>From Gene to Genomes – Conceptsand Applications of DNA Technology</i>. (3rd Edition). John Wileys and Sons Ltd.</p> <p>4. Gunasekaran P. (2007). <i>Laboratory Manual in Microbiology</i>. New Age International.</p> <p>5. James G Cappucino. and Natalie Sherman. (2016). <i>Microbiology – A laboratory manual</i>. (5th Edition). The Benjamin publishing company. New York.</p> |

**ReferenceBook(s):**

1 Glick B. R. and Patten C.L. *Molecular Biotechnology – Principles and Application of Recombinant DNA*. 5th Edition. ASM Press. 2018.

2 Russell P.J. (2010). *iGenetics - A Molecular Approach*, 3rd Edition., Pearson New International edn.

3 Nelson, D.L. and Cox, M.M. *Lehninger*(2017). *Principles of Biochemistry*. 7thEdition, W.H. Freeman.

4 Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). *Molecular Geneticsof Bacteria*, 4th edition, ASM Press Washington-D.C. ASM Press.

5 Brown T.A. (2016). *Gene Cloning and DNA Analysis*. (7th Edition). John Wiley andJones, Ltd.

**WebResource(s):**

1 <https://www.molbiotools.com/usefullinks.html>

2 (PDF) *Molecular Biology Laboratory manual* (researchgate.net)

3 <https://www.molbiotools.com/usefullinks.html>

4 <https://geneticgenie.org3>.

5 <https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5>

**Course Outcomes**

Up on successful completion of this course, the student will be able to:

| CO No. | CO Statement                                                      | Cognitive Level (K-Level) |
|--------|-------------------------------------------------------------------|---------------------------|
| CO1    | Illustrate different types of DNA                                 | K1,K2.K3,K4               |
| CO2    | Utilize hands-on training in isolation of genomic and plasmid DNA | K1,K2,K3,K4,K5            |
| CO3    | Analyze importance of experimental microbial genetics.            | K1,K2.K3,K4,K5            |
| CO4    | Apply the knowledge of molecular techniques in various fields.    | K1,K2.K3,K4,K5,           |
| CO5    | Investigate the significance of Phages.                           | K1,K2.K3,K4               |

**Relationship Matrix:**

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 3   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 3    | 1    | 2.75              |
| CO2                   | 3                      | 2   | 3   | 2   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 2    | 2.58              |
| CO3                   | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.58              |
| CO4                   | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 3    | 1    | 2.66              |
| CO5                   | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.58              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.63              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

3 – Strong, 2- Medium, 1- Low

| MeanOverallScore | Correlation |
|------------------|-------------|
| <=1              | Low         |
| >1 &<=2          | Medium      |
| >2 &<=3          | High        |

| Semester            | Course Code | Course Category                       | Hours<br>/ Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|---------------------------------------|-----------------|---------|----------------------|-----|-------|
|                     |             |                                       |                 |         | CIA                  | ESE | Total |
| III                 |             | Elective Course-III                   | 4               | 3       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Clinical Laboratory Technology</b> |                 |         |                      |     |       |

| Learning Objectives |                                                                                                                                                  |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LO1</b>          | Demonstrate ethical and professional conduct with patients, laboratory personnel, health care professionals, and the public.                     |
| <b>LO2</b>          | Explain how accurate and reliable information might be obtained about proper procurement, storage, and handling of laboratory specimens          |
| <b>LO3</b>          | Develop a sound scientific knowledge foundation that prepares them to interpret, analyze and evaluate scientific knowledge in clinical practice. |
| <b>LO4</b>          | Perform a full range of laboratory tests with accuracy and precision                                                                             |
| <b>LO5</b>          | Establish quality assurance principles and practices to ensure the accuracy and reliability of Laboratory information.                           |

| SYLLABUS   |                                                                                                                                                                                                                                                                                                                                                                                           |       |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit       | Contents                                                                                                                                                                                                                                                                                                                                                                                  | Hours |
| <b>I</b>   | <b>Introduction to Clinical Laboratory Science:</b> Basic laboratory principles - Code of conduct for medical laboratory personnel - Organization of clinical laboratory and role of medical laboratory technician – Bio Safety measures in handling of Clinical Specimen. Assessment of a patient and brief history of collection. Maintenance of Hygiene & Infection Control Practices. | 12    |
| <b>II</b>  | <b>Specimen collection and processing</b> -Blood, urine, stool, sputum, CSF, Amniotic fluid and bile. Separation of serum and plasma, Handling of specimens for testing, preservation of specimens transport of specimens and factors affecting the clinical results.                                                                                                                     | 12    |
| <b>III</b> | <b>Introduction to histopathology</b> -Methods of examination of tissues and cells, Fixation of tissues: Classification and properties of fixatives. Tissue processing -Collection of specimens, Labeling and fixation, Dehydration, Clearing, Impregnation, Embedding-Paraffin Block making, Section Cutting.                                                                            | 12    |
| <b>IV</b>  | <b>Introduction to Haematology</b> - Laboratory methods used in the investigation of coagulation disorders -Routine coagulation tests, Laboratory diagnosis of bleeding disorders. Estimation of fibrinogen, Assay of coagulation factors.                                                                                                                                                | 12    |
| <b>V</b>   | <b>Quality Standards in Health Laboratories</b> – Development and implementation of standards, Accreditation Boards –NABL, ISO, CAP, COLA, Performing quality assessment- pre analytical and post-analytical phases of testing.                                                                                                                                                           | 12    |

**TextBook(s):**

1. Mukharji, K.L. (2000). *Medical Laboratory Techniques, Vol - I, II & III, 5th Edition*. Tata McGrawHill, Delhi.
2. Ochei, A., Kolhatkar, A. (2000). *Medical Laboratory Science: Theory and Practice*, McGraw Hill Education.
3. Ramnik Sood (2015). *Concise Book of Medical Laboratory Technology: Methods and Interpretation, 2nd Edition*, Jaypee Brothers Medical Publishers, New Delhi.
4. S. Ramakrishnan, K.N. Sulochana (2012). *Manual of Medical Laboratory Techniques*, Jaypee Brothers Medical Publishers Pvt. Ltd
5. Talib V.H. (2019). *Handbook Medical Laboratory Technology, 2nd Edition*, Directorate of health services, Government of India. .

**ReferenceBook(s):**

1. Rutherford, B.H. Gradwohl, A.C. Sonnenwirth L. Jarett. Gradwohls. (2000). *Clinical Laboratory Methods and Diagnosis, Vol-I, 8th edition*, Mosby.
2. Baker, F.J., Silvertown, R.E., and Pallister, J. (1998). *An Introduction to Medical Laboratory Technology, 7th Edition*, CBS Publishers and Distributors Pvt. Ltd.
3. Godkar (2021). *Textbook of Medical Laboratory Technology, 3rd Edition*, Bhalani Publishing House.
4. M.N. Chatterjee and Rana Shinde. (2008). *Textbook of Medical Biochemistry, 7th Edition*, Jaypee Brothers Medical Publishers Pvt. Limited.
5. James G Cappuccino. and Natalie Sherman. (2016). *Microbiology – A laboratory manual. (5th Edition)*. The Benjamin publishing company. New York.

**WebResource(s):**

- 1 <https://www.jaypeedigital.com> › book
- 2 <https://www.pdfdrive.com> › wintrobess-clinical-hematology
- 3 <https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5>
- 4 <https://vlab.amrita.edu/index.php?sub=3&brch=272>
- 5 <https://nptel.ac.in/courses/102105087>

| Course Outcomes                                                          |                                                                                                                                                                                                                                                                                    |                           |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Up on successful completion of this course, the student will be able to: |                                                                                                                                                                                                                                                                                    |                           |
| CO No.                                                                   | CO Statement                                                                                                                                                                                                                                                                       | Cognitive Level (K-Level) |
| CO1                                                                      | Understand the basic laboratory principles, safety measures, and the code of conduct for medical laboratory personnel. Explain the role of a medical laboratory technician, the structure of a clinical laboratory, and the importance of hygiene and infection control practices. | K1,K2.K3,K4               |
| CO2                                                                      | Demonstrate correct techniques for specimen collection, processing, and handling (e.g., blood, urine, CSF), ensuring proper preservation and transport to maintain accurate clinical results.                                                                                      | K1,K2,K3,K4               |
| CO3                                                                      | Differentiate between various tissue processing methods, fixatives, and laboratory procedures for histopathology.                                                                                                                                                                  | K1,K2.K3,K4               |
| CO4                                                                      | Laboratory methods of hematology, including coagulation tests and diagnosis of bleeding disorders.                                                                                                                                                                                 | K1,K2.K3,K4               |
| CO5                                                                      | Assess quality standards in health laboratories, including NABL, ISO, CAP, and COLA accreditation requirements.                                                                                                                                                                    | K1,K2.K3,K4               |

#### Relationship Matrix:

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 3   | 3   | 2   | 1   | 2   | 3   | 3                               | 2    | 2    | 2    | 2    | 2.41              |
| CO2                   | 3                      | 3   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.66              |
| CO3                   | 3                      | 2   | 2   | 2   | 2   | 3   | 3   | 3                               | 2    | 3    | 2    | 1    | 2.33              |
| CO4                   | 3                      | 2   | 3   | 3   | 2   | 2   | 3   | 3                               | 2    | 2    | 2    | 1    | 2.33              |
| CO5                   | 3                      | 2   | 3   | 2   | 2   | 2   | 3   | 3                               | 3    | 1    | 2    | 3    | 2.41              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.42              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

3 – Strong, 2- Medium, 1- Low

| Mean Overall Score | Correlation |
|--------------------|-------------|
| <=1                | Low         |
| >1 & <=2           | Medium      |
| >2 & <=3           | High        |

| Semester            | Course Code | Course Category                                     | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|-----------------------------------------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                                                     |              |         | CIA                  | ESE | Total |
| III                 |             | SEC-IV                                              | 1            | 1       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Organic Farming and Biofertilizer Technology</b> |              |         |                      |     |       |

| Learning Objectives |                                                                                                                                                    |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LO1</b>          | Impart knowledge about the significance of organic farming and strategies to increase the yield to conserve environment..                          |
| <b>LO2</b>          | Encourage organic farming in urban areas                                                                                                           |
| <b>LO3</b>          | Comprehensive knowledge about bacterial biofertilizers, its advantages and future perspective                                                      |
| <b>LO4</b>          | Structure and characteristic features of Cyanobacterial and fungal biofertilizer                                                                   |
| <b>LO5</b>          | Develop the knowledge and skill to produce, analyze the quality of packaging, storage and assess the shelf life and bioefficacy of biofertilizers. |

| SYLLABUS   |                                                                                                                                                                                                                                                                  |       |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit       | Contents                                                                                                                                                                                                                                                         | Hours |
| <b>I</b>   | Principle of organic farming: principles of health, fairness, ecological balance, and care. Environmental benefits of organic farming: sustainability- reduces non-renewable energy by decreasing agrochemical need. Biodiversity-crop rotation, inter-cropping. | 6     |
| <b>II</b>  | Organic farming for urban space; Create a Sustainable Organic Garden (Backyard- Square Foot Gardening, Small Space Gardening, MiniFarming) Composting, Vermicomposting.                                                                                          | 6     |
| <b>III</b> | Biofertilizers: Introduction, advantages and future perspective. Structure and characteristic features of bacterial biofertilizers- Azoospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia                                                     | 6     |
| <b>IV</b>  | Structure and characteristic features of Cyanobacterial biofertilizers Anabaena, Spirulina - Structure and characteristic features of fungal biofertilizers- AM mycorrhiza.                                                                                      | 6     |
| <b>V</b>   | Production of Rhizobium, Azotobacter, Anabena; Biofertilizers - Storage, shelf life, quality control and marketing. Government Schemes-NPOP, NPOF, NHM, RKVY, RAFTAAR                                                                                            | 6     |

| Text Book(s):                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. A.K. Sharma (2006). <i>Hand book of Organic Farming</i>                                                                                                      |
| 2. A.C.Gaur (2017). <i>Hand book of Organic Farming and Biofertilizers</i>                                                                                      |
| 3. N.S. Subbarao (2017). <i>Bio-fertilizers in Agriculture and Forestry (4th Edition) Med tech publisher</i>                                                    |
| 4. SubbaRao, N. S. (2002). <i>Soil Microbiology. Soil Microorganisms and Plant Growth. (4th Edition), Oxford &amp; IBH Publishing Co. Pvt. Ltd., New Delhi.</i> |
| 5. Dubey, R. C. (2008). <i>A Textbook of Biotechnology. S. Chand &amp; Co., New Delhi.</i>                                                                      |

|                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ReferenceBook(s):</b>                                                                                                                                                                         |
| 1 Masanobu Fukuoka, Frances Moore Lappe Wendell Berry (2009). <i>The One-Straw Revolution: An Introduction to Natural Farming</i> , 1st edition, YRB Classics.                                   |
| 2 Sujit Chakrabarty (2018). <i>Organic Home Gardening Made Easy</i> , 1st Edition,                                                                                                               |
| 3 Singh and Purohit (2008). <i>Biofertilizer technology</i> . Agrobios, India.                                                                                                                   |
| 4 Bansal M (2019). <i>Basics of Organic Farming</i> CBS Publisher.                                                                                                                               |
| 5 Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbach L.D. (2007). <i>Manual of Environmental Microbiology</i> . (3rd Edition). American Society for Microbiology. |
| <b>WebResource(s):</b>                                                                                                                                                                           |
| 1. <a href="https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html">https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html</a>                                                   |
| 2. <a href="https://www.fao.org/organicag/oa-faq/oa-faq6/en/">https://www.fao.org/organicag/oa-faq/oa-faq6/en/</a>                                                                               |
| 3. <a href="https://www.india.gov.in/topics/agriculture/organic-farming">https://www.india.gov.in/topics/agriculture/organic-farming</a>                                                         |
| 4. <a href="https://agriculture.nagaland.gov.in/bio-fertilizer/">https://agriculture.nagaland.gov.in/bio-fertilizer/</a>                                                                         |
| 5. <a href="https://vlab.amrita.edu/index.php?sub=3&amp;brch=272">https://vlab.amrita.edu/index.php?sub=3&amp;brch=272</a>                                                                       |

| Course Outcomes                                                         |                                                                                                                                                                                              |                           |
|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Up on successful completion of this course the student will be able to: |                                                                                                                                                                                              |                           |
| CO No.                                                                  | CO Statement                                                                                                                                                                                 | Cognitive Level (K-Level) |
| CO1                                                                     | Become an Entrepreneur with wide knowledge about farming and sustainable resources                                                                                                           | K1 K2 K3, K4              |
| CO2                                                                     | Implement organic farming in urban areas with knowledge on compost.                                                                                                                          | K1 K2 K3                  |
| CO3                                                                     | Gain knowledge about the bacterial biofertilizers and its advantages                                                                                                                         | K1 K2 K3 K4               |
| CO4                                                                     | Understand the significance about Cyanobacterial and fungal biofertilizers                                                                                                                   | K1 K2 K3 K4               |
| CO5                                                                     | Understand and implement the use of bio fertilizers, Marketing of biofertilizers, and the role of government schemes such as NPOP, NPOF, NHM, RKVY, and RAFTAAR in promoting organic farming | K1 K2 K3                  |

### Relationship Matrix:

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes (PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|----------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                             | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 2   | 2   | 3   | 1   | 2   | 3   | 3                                | 2    | 3    | 2    | 3    | 2.41              |
| CO2                   | 3                      | 3   | 3   | 3   | 2   | 2   | 3   | 3                                | 2    | 3    | 2    | 3    | 2.66              |
| CO3                   | 3                      | 2   | 2   | 1   | 2   | 3   | 3   | 3                                | 2    | 3    | 2    | 3    | 2.41              |
| CO4                   | 3                      | 3   | 2   | 2   | 1   | 3   | 3   | 3                                | 2    | 3    | 2    | 3    | 2.50              |
| CO5                   | 3                      | 2   | 3   | 3   | 2   | 2   | 3   | 3                                | 2    | 3    | 2    | 3    | 2.58              |
| Mean Overall Score    |                        |     |     |     |     |     |     |                                  |      |      |      |      | 2.51              |
| Correlation           |                        |     |     |     |     |     |     |                                  |      |      |      |      | High              |

3 – Strong, 2- Medium, 1- Low

| Mean Overall Score | Correlation |
|--------------------|-------------|
| <=1                | Low         |
| >1 & <=2           | Medium      |
| >2 & <=3           | High        |

| Semester            | Course Code | Course Category    | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|--------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                    |              |         | CIA                  | ESE | Total |
| III                 |             | SEC-V              | 2            | 2       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Aquaculture</b> |              |         |                      |     |       |

| Learning Objectives |                                                                                                |
|---------------------|------------------------------------------------------------------------------------------------|
| LO1                 | Provide a deeper knowledge in aquaculture systems and methods.                                 |
| LO2                 | Explain the significance and functions of design, types and construction of aquaculture ponds. |
| LO3                 | Demonstrate the biological characteristics of various aquaculture species                      |
| LO4                 | Discuss the methods involved in post stocking management                                       |
| LO5                 | Illustrate major cultivatable species for aquaculture.                                         |

| SYLLABUS |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit     | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                             | Hours |
| I        | Aquaculture Systems and Methods - Scope and definition. Traditional, extensive, semi - intensive and intensive culture. Monoculture, polyculture, composite culture, mixed culture, mono-sexculture, cage culture, penculture, raft culture, raceway culture. Economic value of various aquaculture and Probiotic used in aquaculture                                                                                                                | 6     |
| II       | Aquaculture Engineering-Design and construction of pond, layout and design of aquaculture farm, construction, water intake system, drainage system - aeration and aerators.                                                                                                                                                                                                                                                                          | 6     |
| III      | Selection of Species - Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation. Pre-Stocking Management-Sun drying, ploughing / tilling, desilting, liming and fertilization, eradication of weed fishes. Stocking -Acclimatization of seed and release-species combinations-stock density and ratio.                                                                   | 6     |
| IV       | Post Stocking Management - Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms and microorganisms. Food conversion ratio (FCR). Growth - Measurement of growth, length-weight relationship.                                                                                                                                                                                | 6     |
| V        | Major cultivable species for aquaculture –Culture of Indian Major Carps. Culture of Giant fresh water prawn, Macrobrachium rosenbergii- seed collection formation sources. Hatchery management. Culture of tiger shrimp, Penaeus monodon and Litopenaeus Vannamei. Culture of pearl oysters. Culture of sea weeds. Methods of Crab culture. Culture of ornamental fishes. Culture of Molluscs. Microbial infection in Shrimp culture and prevention. | 6     |

| TextBook(s):                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Santhanam, R. Velayutham, P. Jegatheesan, G. A (2019). Manual of Freshwater Ecology: An Aspect of Fishery Environment. Daya Publishing House, New Delhi. |
| 2. Stickney, R.R. (2016). Aquaculture: An Introductory Text. 3rd Edition. Centre for Agriculture and Bioscience International Publishing.                   |
| 3. Ackefors H., Huner J and Konikoff M. (2009). Introduction to the General Principles of Aquaculture. CRC Press.                                           |
| 4. Mushlisin Z. A. (2012). Aquaculture. In Tech.                                                                                                            |
| 5. Akpaniteaku R.C. (2018). Basic Handbook of Fisheries and Aquaculture. AkiNik Publications                                                                |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>ReferenceBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| 1. Arumugam N. (2014). <i>Aquaculture</i> . Saras Publication.<br>2. Pillay T. V. R. and Kutty M.N. (2005). <i>Aquaculture : Principles and Practices</i> 2nd Edition. Wiley India Pvt. Ltd.<br>3. Tripathi S. D., Lakra W.S. and Chadha N.K. (2018). <i>Aquaculture in India</i> . Narendra Publishing House.<br>4. Rath R.K.(2011). <i>Fresh Water Aquaculture</i> . 3rd Edition. Scientific Publishers.<br>5. Lucas J. S., Southgate P.C. and Tucker C.S. (2019). <i>Aquaculture: Farming Aquatic Animals and Plants</i> . Wiley Blackwell.. |  |
| <b>WebResource(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
| 1. <i>Aquaculture: Types, Benefits and Importance (Fish Farming) - Conserve Energy Future</i> (conserve-energyfuture.com)<br>2. Fisheries Department - Tamil Nadu (tn.gov.in)<br>3. Aquaculture - Google Books<br>4. aquaculture   Definition, Industry, Farming, Benefits, Types, Facts, & Methods   Britannica<br>5. Fisheries & Aquaculture (investindia.gov.in)                                                                                                                                                                             |  |

| Course Outcomes                                                          |                                                                                                 |                           |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------|
| Up on successful completion of this course, the student will be able to: |                                                                                                 |                           |
| CO No.                                                                   | CO Statement                                                                                    | Cognitive Level (K-Level) |
| CO1                                                                      | Analyze the significance and importance of aquaculture                                          | K1,K2.K3,K4               |
| CO2                                                                      | Illustrate the types and construction of aquaculture ponds.                                     | K1,K2,K3,K4               |
| CO3                                                                      | Analyze the biological characteristics of species and choose the best species for aquaculture.. | K1,K2.K3,K4               |
| CO4                                                                      | Follow methods involved for optimal growth of aquaculture species                               | K1,K2.K3,K4               |
| CO5                                                                      | Summarize major species suitable for aquaculture in a particular environment.                   | K1,K2.K3,K4,K5            |

### Relationship Matrix:

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 2   | 3   | 3   | 2   | 1   | 3   | 3                               | 2    | 3    | 2    | 3    | 2.50              |
| CO2                   | 3                      | 2   | 3   | 2   | 2   | 2   | 3   | 3                               | 3    | 3    | 2    | 3    | 2.58              |
| CO3                   | 3                      | 3   | 3   | 3   | 2   | 2   | 3   | 3                               | 3    | 3    | 2    | 3    | 2.75              |
| CO4                   | 3                      | 3   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 3    | 2.83              |
| CO5                   | 3                      | 3   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 3    | 2.83              |
| Mean Overall Score    |                        |     |     |     |     |     |     |                                 |      |      |      |      | 2.69              |
| Correlation           |                        |     |     |     |     |     |     |                                 |      |      |      |      | High              |

3 – Strong, 2- Medium, 1- Low

| MeanOverallScore | Correlation |
|------------------|-------------|
| <=1              | Low         |
| >1 & <=2         | Medium      |
| >2 & <=3         | High        |

| Semester            | Course Code | Course Category                          | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|------------------------------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                                          |              |         | CIA                  | ESE | Total |
| IV                  |             | Core Course–IV                           | 5            | 5       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Immunology &amp; Immunotechnology</b> |              |         |                      |     |       |

| Learning Objectives |                                                                                          |
|---------------------|------------------------------------------------------------------------------------------|
| <b>LO1</b>          | Gain knowledge about immune system, organs of immunity and cells involved.               |
| <b>LO2</b>          | Distinguish the types of antigens and antibodies; their properties.                      |
| <b>LO3</b>          | Provide in-depth knowledge on Immuno-techniques.                                         |
| <b>LO4</b>          | Discuss the role of MHC system in transplantation; functions of Tumor specific antigens. |
| <b>LO5</b>          | Impart knowledge on immunological disorders.                                             |

| SYLLABUS   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit       | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Hours |
| <b>I</b>   | History of Immunology.Organs and Cells in Immune System and Immune Response: Primary lymphoid organs, secondary lymphoid organs, and lymphoid tissues; T – cell and B –cell membrane bound receptors – apoptosis; T - cell processing, presentation and regulation; T –cell subpopulation, properties, functions and T – cell suppression; Physiology of immune response- Innate,Acquired,Native,Passive,Humoral and Cell mediated immunity.                                 | 15    |
| <b>II</b>  | Antigen and Antibody: Antigens - Properties of haptens, epitopes, adjuvants, and cross reactivity; Antibodies- structure, properties, classes; Immunogenicity Vs Antigenicity, Complement-Classical and Alternative pathway. Antigen and Antibody Reactions: precipitation, agglutination, -complement fixation, and Flocculation. Vaccines – active and passive immunization; Classification of vaccines; Types of vaccine - antibacterial, antiviral; Vaccination schedule | 15    |
| <b>III</b> | Immunoassay and Immunotechniques - Preparation and standardization of bacterial antigens; Raising of monoclonal and polyclonal antibodies; Purification of antibodies. Immunotechniques - RIA, RAST, ELISA, Immuno fluorescence techniques and Flow cytometry                                                                                                                                                                                                                | 15    |
| <b>IV</b>  | Transplantation and Tumor Immunology - MHC Antigens - structure and function; HLA system - Regulation and response to immune system; Transplantation immunology - tissue transplantation and grafting; Mechanism of graft acceptance and rejection                                                                                                                                                                                                                           | 15    |
| <b>V</b>   | Immunological disorders and diseases - Hypersensitivity reactions (Type I, II, III and IV); acquired immunodeficiency syndrome; Auto immune disorders and diseases: organ specific and non organ specific.                                                                                                                                                                                                                                                                   | 15    |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TextBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <ol style="list-style-type: none"> <li>1. Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). <i>Immunology – A Short Course</i>. 5th Edition, Wiley-Blackwell, New York</li> <li>2. Judith A.Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). <i>Immunology</i>, 7th Edition. W. H. Freeman and Company, New York.</li> <li>3. Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. (2021). <i>Cellular and Molecular Immunology</i>, 10th Edition. Elsevier.</li> <li>4. Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frew, Cornelia M. Weyand. (2018). <i>Clinical Immunology: Principles and Practice</i>, 5th Edition. Elsevier.</li> <li>5. Pravash Sen. Gupta. (2003). <i>Clinical Immunology</i>. Oxford University Press.</li> </ol> |
| <b>ReferenceBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ol style="list-style-type: none"> <li>1. Janeway Travers. (1997). <i>Immunobiology- the immune system in health and disease</i>. Current Biology Ltd. London, New York. 3rd Edition.</li> <li>2 Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). <i>Roitt's Essential Immunology</i>, 11th Edition., Wiley-Blackwell.</li> <li>3 William R Clark. (1991). <i>The Experimental Foundations of Modern Immunology</i>. 3rd Edition. John Wiley and Sons Inc. New York.</li> <li>4 Frank C. Hay, Olwyn M. R. Westwood. (2002). <i>Practical Immunology</i>, 4th Edition. Wiley-Blackwell.</li> <li>5 Noel R. Rose, Herman Friedman, John L. Fahey. (1986). <i>Manual of Clinical Laboratory Immunology</i>. ASM. 3rd Edition.</li> </ol>                                  |
| <b>WebResource(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <ol style="list-style-type: none"> <li>1 <a href="https://www.ncbi.nlm.nih.gov/books/NBK279395/">https://www.ncbi.nlm.nih.gov/books/NBK279395/</a></li> <li>2 <a href="https://med.stanford.edu/immunol/phd-program/ebook.html">https://med.stanford.edu/immunol/phd-program/ebook.html</a>.</li> <li>3 <a href="https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall2005/pages/lecture-notes/">https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall2005/pages/lecture-notes/</a></li> <li>4 Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)</li> <li>5 Immunology - an overview   Science Direct Topics.</li> </ol>                                                                                                         |

| Course Outcomes                                                          |                                                                                                                                        |                           |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Up on successful completion of this course, the student will be able to: |                                                                                                                                        |                           |
| CO No.                                                                   | CO Statement                                                                                                                           | Cognitive Level (K-Level) |
| CO1                                                                      | Assess the fundamental concepts of immunity, contributions of the organs and cells in immune responses                                 | K1 K2 K3,K4               |
| CO2                                                                      | Investigate the structures of Ag and Ab and their Reaction-Immunization.                                                               | K1,K2,K3                  |
| CO3                                                                      | Justify the Immunoassay and Immunotechniques                                                                                           | K1,K2.K3                  |
| CO4                                                                      | Explain about the immunologic processes governing graft rejection and therapeutic modalities for immune suppression in transplantation | K1,K2.K3                  |
| CO5                                                                      | Analyze the over reaction by our immune system leading to hypersensitive conditions and its consequences                               | K1,K2.K3,K4               |

**Relationship Matrix:**

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 3   | 2   | 3   | 2   | 3   | 3   | 3                               | 2    | 3    | 2    | 1    | 2.50              |
| CO2                   | 3                      | 3   | 2   | 3   | 3   | 3   | 3   | 3                               | 2    | 3    | 2    | 1    | 2.58              |
| CO3                   | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 2    | 2.66              |
| CO4                   | 3                      | 2   | 3   | 3   | 3   | 3   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.66              |
| CO5                   | 3                      | 3   | 2   | 3   | 3   | 3   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.66              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.61              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

3 – Strong, 2- Medium, 1- Low

| MeanOverallScore | Correlation |
|------------------|-------------|
| <=1              | Low         |
| >1 &<=2          | Medium      |
| >2 &<=3          | High        |

| Semester            | Course Code | Course Category                                        | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|--------------------------------------------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                                                        |              |         | CIA                  | ESE | Total |
| IV                  |             | Core Course Practical-IV                               | 5            | 5       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Practical-IV- Immunology &amp; Immunotechnology</b> |              |         |                      |     |       |

| Learning Objectives |                                                                  |
|---------------------|------------------------------------------------------------------|
| <b>LO1</b>          | Gain hands-on knowledge to identify Blood group and typing.      |
| <b>LO2</b>          | Acquire adequate skill to perform latex agglutination reactions. |
| <b>LO3</b>          | Analyze precipitation reactions in gels.                         |
| <b>LO4</b>          | Investigate the antigen & antibody reactions in electrophoresis  |
| <b>LO5</b>          | Familiarize with Separation of Lymphocytes.                      |

| SYLLABUS   |                                                                                                                                                                                   |           |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Unit       | Contents                                                                                                                                                                          | Hours     |
| <b>I</b>   | Blood collection methods-Serum and Buffy coat separation.<br>Identification of blood group and typing and Complement Fixation Test                                                | <b>15</b> |
| <b>II</b>  | Widal Test, Differential Count, T cell identification (Demonstration) Latex Agglutination reactions- RF, ASO, CRP test and Pregnancy Test<br>Flocculation Test- VDRL and RPR Test | <b>15</b> |
| <b>III</b> | Ouchterlony's Double Diffusion Method (antigen pattern). Single Radial Immuno Diffusion Method                                                                                    | <b>15</b> |
| <b>IV</b>  | Demonstration-Electrophoresis - Serum, Counter and Immuno Electrophoresis.                                                                                                        | <b>15</b> |
| <b>V</b>   | Demonstration-Separation of Lymphocytes by gradient centrifugation method. ELISA                                                                                                  | <b>15</b> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TextBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ol style="list-style-type: none"> <li>1. Talwar. (2006). <i>Hand Book of Practical and Clinical Immunology</i>, Vol. I, 2nd edition, CBS.</li> <li>2. Asim Kumar Roy. (2019). <i>Immunology Theory and Practical</i>, Kalyani Publications.</li> <li>3. Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). <i>Immunology – A Short Course</i>. 5th Edition., Wiley-Blackwell, New York.</li> <li>4. Judith A. Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). <i>Immunology</i>, 7th Edition., W. H. Freeman and Company, New York.</li> <li>5. Pravash Sen. Gupta. (2003). <i>Clinical Immunology</i>. Oxford University Press.</li> </ol> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <b>ReferenceBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| <p>1.Frank C. Hay, Olwyn M. R. Westwood. (2008). <i>Practical Immunology</i>, 4th Edition, WileyBlackwell.</p> <p>2 Wilmore Webley. (2016). <i>Immunology Lab Manual</i>, LAD Custom Publishing.</p> <p>3 Rose. (1992). <i>Manual of Clinical Lab Immunology</i>, ASM.</p> <p>4 Janeway Travers. (1997). <i>Immunobiology- the immune system in health and disease</i>. Current Biology Ltd. London, New York. 3rd Edition.</p> <p>5 Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). <i>Roitt's Essential Immunology</i>, 11thEdition., Wiley-Blackwell</p>                                                                                                                                                                                                                  |  |
| <b>Web Resource(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| <p>1. <a href="https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual">https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual</a></p> <p>2.<a href="https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelingerlab/documents/Immunology-Lab-Manual.pdf">https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelingerlab/documents/Immunology-Lab-Manual.pdf</a></p> <p>3 <a href="https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf">https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf</a></p> <p>4 Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)</p> <p>5 Immunology - an overview   ScienceDirect Topics</p> |  |

| Course Outcomes                                                         |                                                                                                                      |                           |
|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------------|
| Upon successful completion of this course, the student will be able to: |                                                                                                                      |                           |
| CO No.                                                                  | CO Statement                                                                                                         | Cognitive Level (K-Level) |
| CO1                                                                     | Assess the blood collection methods, serum , Buffy coat separation, Blood groups and types -Complement fixation Test | K1,K2.K3,K4               |
| CO2                                                                     | Competently perform serological diagnostic tests such as RF, ASO, CRP, Pregnancy, VDRL and RPR.                      | K1,K2,K3,K4               |
| CO3                                                                     | Illustrate the antigen antibody reactions in gel.                                                                    | K1,K2.K3,K4               |
| CO4                                                                     | Compare & contrast antigens and antibodies in electrophoresis.                                                       | K1,K2.K3,K4               |
| CO5                                                                     | Examine the concept of ELISA.                                                                                        | K1,K2.K3,K4,K5            |

**Relationship Matrix:**

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| <b>CO1</b>            | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 2    | 2.66              |
| <b>CO2</b>            | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 2    | 2.66              |
| <b>CO3</b>            | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.58              |
| <b>CO4</b>            | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.58              |
| <b>CO5</b>            | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 1    | 2.58              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.61              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

**3 – Strong, 2- Medium, 1- Low**

| MeanOverallScore | Correlation |
|------------------|-------------|
| <=1              | Low         |
| >1 & <=2         | Medium      |
| >2 & <=3         | High        |

| Semester            | Course Code | Course Category                   | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|-----------------------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                                   |              |         | CIA                  | ESE | Total |
| IV                  |             | Elective Course-IV                | 4            | 3       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Food Processing Technology</b> |              |         |                      |     |       |

| Learning Objectives |                                                                        |
|---------------------|------------------------------------------------------------------------|
| LO1                 | Provide knowledge on objectives of food preservation                   |
| LO2                 | Explain the freshness criteria and quality assessment of meat and fish |
| LO3                 | Outline the methods of milk processing and fermented milk products.    |
| LO4                 | Explain the importance of fat and oil processing.                      |
| LO5                 | Discuss the methods of microbiological examination of foods.           |

| SYLLABUS |                                                                                                                                                                                                                                                                                                  |       |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit     | Contents                                                                                                                                                                                                                                                                                         | Hours |
| I        | Introduction to food preservation –objectives and techniques of food preservation. Preservation: principles of high temperature, low temperature, radiation, chemical preservatives and bio preservatives.                                                                                       | 12    |
| II       | Freshness criteria and quality assessment of meat and fish –spoilage and methods of preservation. Production of byproducts after processing waste and their utilization. Role of packaging material, types of packaging material.                                                                | 12    |
| III      | Composition of milk; assessment of milk, thermal processing of fluid milk pasteurization (LTLT, HTST&UHT techniques). Fermented milk products cheese, Butter milk, Yogurt, Kumis, Kefir and Acidophilus milk. Hygiene and sanitation requirement in food processing and fermentation industries. | 12    |
| IV       | Importance of fats and oils in Food-Extraction of fats and Oils Rendering, pressing, solvent extraction, pressing of oil- degumming, refining, bleaching, deodorization, fractionation, pyrolysis of fats, toxicity of frying oil.                                                               | 12    |
| V        | Food Sanitation, Methods for the microbiological examination of foods. Food borne illness and diseases. Microbial cultures for food fermentation. Indian Factories Act on safety, HACCP, Safety from adulteration of food. Food Standard Act -National and International act in food safety.     | 12    |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TextBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p>1. Avantina Sharma. (2006). <i>Text Book of Food Science and Technology</i>, International Book Distributing Co, Lucknow, UP.</p> <p>2. Sivasankar. (2005). <i>Food Processing and Preservation</i>, 3rd Edition.,Prentice hall of India Pvt Ltd, New Delhi.</p> <p>3 Ramaswamy H &amp; Marcotte M. (2006). <i>Food Processing: Principles &amp; Applications</i>. Taylor &amp; Francis.</p> <p>4 NIIR Board of Food and Technologist. (2005). <i>Modern Technology of Food Processing and Agrobased industries</i>, National Institute of Industrial Research, Delhi.</p> <p>5 Adams M.R. and Moss M. O (2007).<i>Food Microbiology</i>.New Age International..</p> |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>ReferenceBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| 1.Fellos PJ. (2005). Food Processing Technology: Principle &Practice 2ndEdition. CRC.<br>2 Peter Zeuthen and Leif Bogh-Sorenson. (2005). Food Preservation Techniques, WoodlandPublishing Ltd, Cambridge, England.1<br>3 Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Pilar Cano. (2004). Novel Food Processing Technologies, CRC.<br>4 Suman Bhatti, Uma Varma. (1995). Fruit and vegetable processing organizations and institutions, 1st Edition., CBS Publishing, New Delhi.<br>5 MirdulaMirajkar, Sreelatha Menon. (2002). Food Science and Processing Technology Vol-2, Commercial processing and packaging, Kanishka publishers, New Delhi. |  |
| <b>WebResource(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| 1 <a href="https://sites.google.com/a/uasd.in/ecourse/food-processing-technology">https://sites.google.com/a/uasd.in/ecourse/food-processing-technology</a><br>2 <a href="https://nptel.ac.in/courses/126105015">https://nptel.ac.in/courses/126105015</a><br>3 <a href="https://engineeringinterviewquestions.com/biology-notes-on-food-adulteration/">https://engineeringinterviewquestions.com/biology-notes-on-food-adulteration/</a><br>4 food processing   Definition, Purpose, Examples, & Facts   Britannica<br>5 Food Processing Technology   Food News & Views Updated Daily (foodprocessingtechnology.com)                                |  |

| Course Outcomes                                                          |                                                           |                           |
|--------------------------------------------------------------------------|-----------------------------------------------------------|---------------------------|
| Up on successful completion of this course, the student will be able to: |                                                           |                           |
| CO No.                                                                   | CO Statement                                              | Cognitive Level (K-Level) |
| CO1                                                                      | Assess the fundamental concepts of food preservation.     | K1,K2.K3                  |
| CO2                                                                      | Investigate the quality assessment of meat and fish.      | K1,K2,K3,K4               |
| CO3                                                                      | Design the processing of milk and milk quality assessment | K2,K3.K4                  |
| CO4                                                                      | Explain about the importance of fats and oils.            | K1,K2.K3                  |
| CO5                                                                      | Plan the food safety and adulteration detection.          | K1,K2.K3,K4               |

### Relationship Matrix:

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 3   | 2   | 3   | 2   | 3   | 3   | 3                               | 2    | 3    | 2    | 2    | 2.58              |
| CO2                   | 3                      | 2   | 3   | 3   | 3   | 3   | 3   | 3                               | 2    | 3    | 2    | 1    | 2.58              |
| CO3                   | 3                      | 2   | 3   | 3   | 2   | 3   | 3   | 3                               | 2    | 3    | 2    | 2    | 2.58              |
| CO4                   | 3                      | 3   | 2   | 2   | 2   | 2   | 3   | 3                               | 2    | 3    | 2    | 2    | 2.41              |
| CO5                   | 3                      | 3   | 3   | 3   | 3   | 2   | 3   | 3                               | 2    | 3    | 2    | 2    | 2.66              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.56              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

3 – Strong, 2- Medium, 1- Low

| MeanOverallScore | Correlation |
|------------------|-------------|
| <=1              | Low         |
| >1 & <=2         | Medium      |
| >2 & <=3         | High        |

| Semester            | Course Code | Course Category           | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|---------------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                           |              |         | CIA                  | ESE | Total |
| IV                  |             | SEC-VI                    | 2            | 2       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Vaccine Technology</b> |              |         |                      |     |       |

| Learning Objectives |                                                                                      |
|---------------------|--------------------------------------------------------------------------------------|
| <b>LO1</b>          | Provide knowledge on the basics of immunization and induction of immunity.           |
| <b>LO2</b>          | Learn the types of vaccines, its immunological effects and regulatory guidelines     |
| <b>LO3</b>          | Learn the role of rDNA in vaccine technology.                                        |
| <b>LO4</b>          | Provide the knowledge on conventional to recent technology of vaccine production     |
| <b>LO5</b>          | Learn about ethical issues and regulations in vaccine production and clinical trials |

| SYLLABUS   |                                                                                                                                                                                                                                                                                                                                                                                       |       |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit       | Contents                                                                                                                                                                                                                                                                                                                                                                              | Hours |
| <b>I</b>   | History of vaccines, Active and passive immunization; requirements for induction of immunity, Epitopes, and immunogenicity. Factors influencing immunogenicity                                                                                                                                                                                                                        | 6     |
| <b>II</b>  | Viral/bacterial/parasite vaccine differences, methods of vaccine preparation – Live, killed, attenuated, sub unit vaccines; Licensed vaccines, Viral Vaccine - Poliovirus vaccine-inactivated & Live, Rabies vaccines, Hepatitis A & B vaccines, Bacterial Vaccine - Anthrax vaccines, Cholera vaccines, Diphtheria toxoid, Parasitic vaccine - Malaria Vaccine. Vaccination schedule | 6     |
| <b>III</b> | Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, mRNA Vaccines, Plant based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines.                                                                                                                                                                                     | 6     |
| <b>IV</b>  | Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Rationale vaccine design based on clinical requirements: Scope of future vaccine strategies                                                                                                        | 6     |
| <b>V</b>   | Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Regulation of vaccines in Quality control ,vaccine research and Animal testing, Stages of clinical trials, Large scale production, Commercialization. Vaccine safety ethics and Legal issues. National and International regulation of Vaccine.                                                    | 6     |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TextBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p>1. Ronald W. Ellis. (2001). <i>New Vaccine Technologies</i>. Landes Bioscience.</p> <p>2. Cheryl Barton. (2009). <i>Advances in Vaccine Technology and Delivery</i>. Espicom Business Intelligence.</p> <p>3 Male, David. Ed. (2007). <i>Immunology</i>. 7th Edition. Mosby Publication. 47</p> <p>4 Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne. (2002). <i>Immunology</i>. 6th Edition, Freeman.</p> |

5 Brostoff J, Seaddin JK, Male D, Roitt IM. (2002). *Clinical Immunology*. 6th Edition, Gower Medical Publishing.

### ReferenceBook(s):

1. Stanley A. Plotkin, Walter Orenstein & Paul A. Offit. (2013). *Vaccines*, 6th Edition. BMA Medical Book Awards Highly Commended in Public Health. Elsevier Publication.

2 Coico, R. et al. (2003). *Immunology: A Short Course*. 5th Edition, Wiley – Liss.

3 Parham, Peter. (2005). *The Immune System*. 2nd Edition, Garland Science.

4 Abbas, A.K. et al. (2007). *The Cellular and Molecular Immunology*. 6th Edition, Sanders / Elsevier.

5 Weir, D.M. and Stewart, John (2000). *Immunology*. 8th Edition, Churchill Pvt. Ltd.

### WebResource(s):

1. <https://www.slideshare.net/adammbbs/pathogenesis-3-rd-internal-updated-43458567>

2. <https://www.bio.fiocruz.br/en/images/stories/pdfs/mpti/2013/selecao/vaccineprocesstechnology.pdf>

3. [https://www.dcvmn.org/IMG/pdf/ge\\_healthcare\\_dcvmn\\_introduction\\_to\\_pd\\_for\\_vaccine\\_production\\_29256323aa\\_10mar2017.pdf](https://www.dcvmn.org/IMG/pdf/ge_healthcare_dcvmn_introduction_to_pd_for_vaccine_production_29256323aa_10mar2017.pdf)

4. <https://www.sciencedirect.com/science/article/pii/B9780128021743000059>

5. [https://www.researchgate.net/publication/313470959\\_Vaccine\\_Scaleup\\_and\\_Manufacturing](https://www.researchgate.net/publication/313470959_Vaccine_Scaleup_and_Manufacturing)

### Course Outcomes

Up on successful completion of this course, the student will be able to:

| CO No. | CO Statement                                                                                                      | Cognitive Level (K-Level) |
|--------|-------------------------------------------------------------------------------------------------------------------|---------------------------|
| CO1    | Explain the significance of critical antigens, immunogens and adjuvants in developing effective vaccines          | K1,K2.K3                  |
| CO2    | Understand the types of vaccines.                                                                                 | K1,K2                     |
| CO3    | Construct vaccine applying rDNA technology                                                                        | K1,K2.K3,K4               |
| CO4    | Formulate the strategies for developing an innovative vaccine technology with different mode of vaccine delivery. | K1,K2.K3,K4               |
| CO5    | Evaluate the regulatory issues and guidelines for the management of vaccine production.                           | K1,K2.K3,K4               |

**Relationship Matrix:**

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 3   | 2   | 1   | 2   | 2   | 3   | 3                               | 2    | 3    | 2    | 2    | 2.33              |
| CO2                   | 3                      | 3   | 2   | 1   | 2   | 2   | 3   | 3                               | 3    | 3    | 2    | 2    | 2.41              |
| CO3                   | 3                      | 3   | 3   | 3   | 2   | 2   | 3   | 3                               | 3    | 3    | 2    | 2    | 2.66              |
| CO4                   | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 2    | 2.66              |
| CO5                   | 3                      | 2   | 3   | 3   | 3   | 2   | 3   | 3                               | 3    | 3    | 2    | 3    | 2.75              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.56              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

**3 – Strong, 2- Medium, 1- Low**

| MeanOverallScore | Correlation |
|------------------|-------------|
| <=1              | Low         |
| >1 & <=2         | Medium      |
| >2 & <=3         | High        |

| Semester            | Course Code | Course Category   | Hours / Week | Credits | Marks for Evaluation |     |       |
|---------------------|-------------|-------------------|--------------|---------|----------------------|-----|-------|
|                     |             |                   |              |         | CIA                  | ESE | Total |
| IV                  |             | SEC-VII           | 2            | 2       | 25                   | 75  | 100   |
| <b>Course Title</b> |             | <b>Apiculture</b> |              |         |                      |     |       |

| Learning Objectives |                                                                                         |
|---------------------|-----------------------------------------------------------------------------------------|
| LO1                 | Understand the biology of honey bees                                                    |
| LO2                 | Study on honey bee colony establishment.                                                |
| LO3                 | Develop knowledge on honey extraction                                                   |
| LO4                 | Understand the diseases of honey bees and their control                                 |
| LO5                 | Gain information on financial assistance and funding agencies for bee keeping industry. |

| SYLLABUS |                                                                                                                                                                                                                                                                                                                   |       |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Unit     | Contents                                                                                                                                                                                                                                                                                                          | Hours |
| I        | <b>Biology of Bees:</b> Honeybee – Systematic position – Species of Honey bees – Life history of Honey bee – behaviour – swarming – Pheromone.                                                                                                                                                                    | 6     |
| II       | <b>Social life in Bees:</b> Bee colony – Castes – natural colonies and their yield – Types of bee hives – Structure – location, care and management.                                                                                                                                                              | 6     |
| III      | <b>Bee Rearing:</b> Apiary – Care and Management – Artificial bee hives – types – construction of spaceframes – Selection of sites – Handling – Maintenance – Instruments employed in Apiary – Extraction instruments.                                                                                            | 6     |
| IV       | <b>Bee Economy:</b> Honey – Composition – uses – Bee wax and its uses – yield in national and international market – Diseases of honey bees and their control methods. Economics of bee culture. Scope and Challenges of Bee culture                                                                              | 6     |
| V        | <b>Entrepreneurship:</b> venture – Preparing proposals for financial assistance and funding agencies – Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens. Funding Opportunities of Bee culture in Various government schemes. | 6     |

| TextBook(s):                                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Dewey M. Caron. (2013). <i>Honey Bee Biology and Beekeeping. Revised Edition.</i> Wicwas Press, Kalamazoo. ISBN 10: 1878075292                      |
| 2. R. A. Morse. (1993). <i>Rearing queen honey bees.</i> Wicwas press, NY. ISBN-10 : 1878075055                                                        |
| 3. Ted Hooper. (2010). <i>Guide to Bees &amp; Honey: The World's Best Selling Guide to Beekeeping.</i> Northern Bee Books. Oxford. ISBN 10: 1904846513 |
| 4. Jayashree K. V., Tharadevi C.S. and Arumugam N. (2014) <i>Apiculture.</i> Saras Publication                                                         |

5. Raj H. (2020). Vinesh Text Book of Apiculture. S. Vinesh and Co

### Reference Book(s):

1. Dewey M. Caron. (2020). *The Complete Bee Handbook: History, Recipes, Beekeeping Basics, and More*, Rockridge Press. ISBN-10 : 1646119878

2 Joachim Petterson. (2016). *Beekeeping: A Handbook on Honey, Hives & Helping the Bees*, Weldon Owen.

3 Eva Crane. (1999). *The World History of Beekeeping and Honey Hunting*. Routledge. India. ISBN-10 : 0415924677

4 Pagar B. S. (2016). *Textbook Of Apiculture*. Sahitya Sagar.

5 Sehgal P.K. (2018). *Text Book of Sericulture, Apiculture and Entomology*. Kalayani

### Web Resource(s):

1. Bee Keeping Basics. Retrieved from: [https://denton.agrilife.org/files/2013/08/beekeeping\\_basics.pdf](https://denton.agrilife.org/files/2013/08/beekeeping_basics.pdf)

2. Beekeeping as an Entrepreneurship, Retrieved from:  
<https://lupinepublishers.com/agriculturejournal/pdf/CIACR.MS.ID.000270.pdf>

3. Raising Bumble Bees at Home: A Guide to Getting Started. Retrieved from:  
<https://www.ars.usda.gov/ARSPUserFiles/20800500/BumbleBeeRearingGuide.pdf>

4. Apiculture – Biology for Everybody (homeomagnet.com)

5. Apiculture: Introduction to Apiculture (iasri.res.in)

### Course Outcomes

Up on successful completion of this course, the student will be able to:

| CO No. | CO Statement                                                                                                             | Cognitive Level (K-Level) |
|--------|--------------------------------------------------------------------------------------------------------------------------|---------------------------|
| CO1    | Understand the systematic position and life history of honey bee.                                                        | K1,K2                     |
| CO2    | Reveal the different stages and types of bees and discuss about the care and management of apiculture.                   | K1,K2,K3,K4               |
| CO3    | Describe the practice of bee rearing process and analyze instruments employed in apiary.                                 | K1,K2,K3,K4               |
| CO4    | Compare and contrast the composition of honey and bee wax and interpret the yield in National and International markets. | K1,K2,K3,K4               |
| CO5    | Able to Assist financing and funding agencies and reveal the modern techniques employed in artificial bee hives.         | K1,K2,K3                  |

**Relationship Matrix:**

| Course Outcomes (COs) | Program Outcomes (POs) |     |     |     |     |     |     | Program Specific Outcomes(PSOs) |      |      |      |      | Mean Score of COs |
|-----------------------|------------------------|-----|-----|-----|-----|-----|-----|---------------------------------|------|------|------|------|-------------------|
|                       | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1                            | PSO2 | PSO3 | PSO4 | PSO5 |                   |
| CO1                   | 3                      | 3   | 2   | 1   | 1   | 2   | 3   | 3                               | 3    | 3    | 2    | 3    | 2.41              |
| CO2                   | 3                      | 2   | 3   | 3   | 2   | 2   | 3   | 3                               | 2    | 3    | 2    | 3    | 2.58              |
| CO3                   | 3                      | 3   | 3   | 3   | 2   | 2   | 3   | 3                               | 2    | 3    | 2    | 3    | 2.66              |
| CO4                   | 3                      | 3   | 3   | 3   | 2   | 2   | 3   | 3                               | 2    | 3    | 2    | 3    | 2.66              |
| CO5                   | 3                      | 3   | 2   | 2   | 1   | 2   | 3   | 3                               | 3    | 3    | 2    | 3    | 2.50              |
|                       | Mean Overall Score     |     |     |     |     |     |     |                                 |      |      |      |      | 2.56              |
|                       | Correlation            |     |     |     |     |     |     |                                 |      |      |      |      | High              |

**3 – Strong, 2- Medium, 1- Low**

| MeanOverallScore | Correlation |
|------------------|-------------|
| <=1              | Low         |
| >1 & <=2         | Medium      |
| >2 & <=3         | High        |