# UNIVERSITY OF DELHI

## DEPARTMENT : MICROBIOLOGY

## COURSE NAME: BSc. Hons.

## (SEMESTER -I)

Based on

Undergraduate Curriculum Framework 2022 (UGCF)

(Effective from Academic Year 2022-23)

**DSC & GE**

| Course Title | Nature of the Course | Total Credits | Components | | | Eligibility Criteria/ Prerequisite | **Contents of the course and reference is in** |
|---|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | | |
| Introduction to the Microbial World | DSC (Core) | 4 | 3 | 0 | 1 | Class XII pass with Biology/ Biotechnology/ Biochemistry | Annexure-I |
| Basic Bacteriology | DSC (Core) | 4 | 3 | 0 | 1 | -do- | |
| Biochemistry of Carbohydrates and Lipids | DSC (Core) | 4 | 3 | 0 | 1 | -do- | |
| Introduction and Scope of Microbiology | GE | 4 | 2 | 0 | 2 | None | Annexure-II |
| Microbes in Health and Hygiene | GE | 4 | 2 | 0 | 2 | Class XII pass with Biology/ Biotechnology/ Biochemistry | |
| Food Fermentation and Preservation Techniques | GE | 4 | 2 | 0 | 2 | -do- | |
| Microbial Quality Control and Testing | GE | 4 | 2 | 0 | 2 | -do- | |
| Microbes in Animal Health | GE | 4 | 2 | 0 | 2 | -do- | |

Annexure-1

**MICROB-DSC101**

**INTRODUCTION TO THE MICROBIAL WORLD**

**Marks: 100 (Theory = 75 marks**
**Practicals = 25 marks)**

**Duration: Theory = 45 hours (3 credits)**
**Practicals = 30 hours (1 credit)**

**Course Objectives:**

The main objective of this course is to introduce students to the world of microorganisms. Students will be made familiar with the major milestones that led to the shaping of microbiology as a distinct discipline of science. Students will gain insights into the diversity of microorganisms, understand their structural features, and appreciate the role of microorganisms in our day-to-day lives as well as in the sustenance of life on earth.

**Pre-requisite**: Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard

**Course Learning Outcomes:**
Upon successful completion of the course, the students will be able to:

CO1: Discuss the developments that led to the emergence of microbiology as a scientific discipline.

CO2: Understand current systems of classification being used for microorganisms and learn about cell organization in microorganisms.

CO3: Discourse on acellular forms of life such as viruses, viroids and prions.

CO4: Converse actively on the diversity, distribution, cell structure, reproduction and economic importance of protists.

CO5: Deliver information on the diversity, distribution, structure, life cycles and economic importance of fungi.

CO6: Appreciate the extensive and impressive impact of microorganisms in our day-to-day life and become aware of the vast scope of microbiology and its allied fields.

**Contents:**

**Theory:** **45 hours**

**Unit 1: The Evolution of Microbiology as a Discipline of Science:** The discovery of microorganisms, contributions of Anton van Leeuwenhoek, spontaneous generation vs. biogenesis, the germ theory of disease, the golden era of microbiology and major developments in the different fields of Microbiology in the late 20$^{th}$ century. Key contributions of the following scientists: Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, Elie Metchnikoff, Ronald Ross, Dmitri Ivanovsky, Martinus Beijerinck, Stanley Prusiner, Paul Ehrlich, Alexander Fleming, Selman Waksman, Sergei N Winogradsky and Anand Mohan Chakraborty. **9**

**Unit 2: Classification Systems:** Whittaker's five kingdom classification system and Carl Woese's three domain classification system. Overview of acellular (viruses) and cellular micro-organisms (eubacteria, archaea, protista, fungi). Prokaryotic and Eukaryotic cell structure**.** **3**

**Unit 3: Acellular microorganisms and protista:**

Brief introduction to viruses: Structure (genetic material, capsid symmetry, envelope), host range, cultivation, bacteriophages (lytic and lysogenic). General characteristics of viroids and prions.

Algae: General characteristics including occurrence and thallus organization. Criteria for classification of algae: cell wall composition, pigments, flagellation, food reserves. Cell structure and reproduction of *Chlamydomonas* and *Chlorella*. Economic importance of algae.

Protozoa: General characteristics of protozoa with a reference to cell structure, modes of locomotion, modes of nutrition, and modes of reproduction. Morphology and importance of *Entamoeba histolytica, Tetrahymena* and *Giardia*. Ecological importance of protozoa.

Acellular and Cellular slime molds: a brief account **14**

**Unit 4: Fungi:** General characteristics: morphology, cell structure, nutritional requirements, cultivation, preservation and reproduction (asexual and sexual cycles). Structure, life cycle and economic importance of *Saccharomyce*s, *Rhizopus, Aspergillus,* and *Agaricus*. **9**

**Unit 5: The scope of microbiology: an overview.** Food and dairy industry: fermented foods, single cell protein. Human health and medicine: human microbiome, probiotics, vaccines, phage therapy. Microbes in environment: bioremediation, bioleaching, waste management, biogas, bioethanol, carbon sequestration. Microbes in agriculture: biocomposting, biofertilizers, biopesticides. Industrially important microbial products: organic acids, amino acids, antibiotics, enzymes, polysaccharides. Space microbiology: Current developments. **10**

**Practicals: 30 hours**

**Unit 1: Principles of Good Laboratory Practice (GLP**) **and Introduction to aseptic techniques**: Principles of Good Microbiological Laboratory Practices (GMLP). Concept of biosafety levels (BSLs). Work practices, safety equipment and protective measures to be used in laboratories of the different categories of biosafety levels BSL-1 to BSL-4. Microorganism risk groups: BSL-1 to BSL-4 microorganisms. Methods of disposal of microbial cultures. Sterilization by moist heat, mechanical (filtration), irradiation (UV), chemical (alcohol). Instruments for sterilization: Principle, working and applications of autoclave and hot air oven.

**15**

**Unit 2: Study of eukaryotic microorganisms:** To study the morphological features and reproductive structures of the following using permanent slides/photographs: Fungi: *Rhizopus*, *Aspergillus, Penicillium, Saccharomyces.* Algae: *Chlamydomonas*, *Chlorella, Spirogyra.* Protozoa: *Amoeba, Paramecium, Entamoeba histolytica, Giardia.* To prepare temporary mounts of any two fungi and two algae from those mentioned above. **15**

**Suggested Reading:**

***Theory:***

1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.

2. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.

3. Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.

4. Algal Biotechnology: Products and Processes. Edited by Bux F. and Chisti Y. 1st edition. Springer, Switzerland. 2016.

5. Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA.1997.

6. Microbiology by M. J. Pelczar, E. C. S. Chan and N. R. Krieg. 5th edition. McGraw Hill,USA. 1993.

***Practicals:***

1. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.

2. Basic Lab Manual of Microbiology, Biochemistry and Molecular Biology by A. Ray and R. Mukherjee. Taurean Publisher, India. 2019.

3. Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.

4. Manual of Microbiology: Tools & Techniques by A.K. Sharma. 1st edition. Ane Books, India. 2007.

**Facilitating the achievement of course learning objectives**

| S. No. | Course learning outcomes | Teaching and learning activities | Assessment tasks* |
|---|---|---|---|
| 1. | Discuss the developments that led to the emergence of microbiology as a scientific discipline | Discussion on the discovery of microorganisms and the controversy over spontaneous generation, discoveries in the golden age of microbiology and developments in the field in late 20th century. | Quiz, match the following, and identification of scientists through photographs |
| 2. | Understand current systems of classification being used for microorganisms and learn about cell organization in microorganisms | Interactive lectures on different systems of classification, prokaryotic and eukaryotic cell structure, acellular and cellular microorganisms using visual aids and power point presentations. | Multiple choice questions and diagrammatic representations. |
| 3. | Discourse on acellular forms of life such as viruses, viroids and prions. | Interactive lectures on helical, icosahedral and complex capsid symmetry of viruses, host range and cultivation of viruses. Differences between viroids and prions. | Diagrammatic depiction of various symmetry types, and identification using electron micrographs. |

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| 4. | Converse actively on the diversity, distribution, cell structure, reproduction and economic importance of protists of protists | Detailed discussion on the general characteristics and economic importance of algae, protozoa, and slime molds. | Class test on definitions and short notes. |
| 5. | Deliver information on the diversity, distribution, structure, life cycles and economic importance of fungi | Interactive lectures on cell structure and reproduction in fungi with the help of charts and visual aids. Group discussion on the economic importance of common fungi. | Drawing diagrams of morphology and life cycles of common fungal genera. Quiz on the economic importance of fungi and fungal associations. |
| 6. | Appreciate the extensive and impressive impact of microorganisms in our day-to-day life and become aware of the vast scope of microbiology and its allied fields. | Discussion on the the scope of microbiology in various fields, taking practical examples from day-to-day life. | Essay writing and poster making on scope of microbiology highlighting latest interesting findings of practical importance. |

***Assessment tasks listed here are indicative and may vary**

## MICROB-DSC102
## BASIC BACTERIOLOGY

**Marks: 100 (Theory = 75 marks**
**Practicals = 25 marks)**

**Duration: Theory = 45 hours (3 credits)**
**Practicals = 30 hours (1 credit)**

**Course Objectives:**

The main objective of this course is for students to acquire in-depth knowledge of bacterial cell structure and organization, cultivation methods and growth patterns, and reproduction. Further, the student gains insights into the vastness of bacterial diversity and its significance.

**Pre-requisite**: Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard

**Course learning Outcomes:**

Upon successful completion of the course the students will be able to:

CO1: Evaluate the morphological features and cellular organization of bacteria and archaea, and distinguish between cell wall and cell membrane compositions of gram positive bacteria, gram negative bacteria, and archaea. Will gain insights into the roles of enzymes and antibiotics affecting cell wall structure as well as the formation of spheroplasts, protoplasts, and L forms.

CO2: Isolate pure bacterial cultures and enumerate bacteria using serial dilution and plating techniques. Will learn about various culture media and methods employed to maintain bacterial cultures and preserve bacteria.

CO3: Discourse on the different phases of bacterial growth, and will understand the consequences of binary fission as a means of reproduction. Will learn about various nutritional and physical factors affecting bacterial growth.

CO4: Prepare various types of media; understand the use of membrane filtration to sterilize heat sensitive media components; have hands-on experience of isolating bacteria and fungi from air.

CO5: Streak bacterial cultures on nutrient medium, prepare bacterial slants and stabs, and enumerate bacteria by different plating methods.

**Contents:**

**Theory:** **45 hours**

**Unit 1: Structure and organization of the bacterial cell wall and appendages:** Shapes, sizes and arrangements of bacterial cells. Cell wall and cell membrane organization: Structure of cell wall in Eubacteria and Archaea, difference between cell wall structure and composition of Gram positive versus Gram-negative bacterial, structure of outer membrane, difference between eubacterial and archaeal cell membranes. Bacteria lacking cell walls, action of antibiotics and enzymes on bacterial cell wall, formation of protoplasts, spheroplasts and L forms. Cell envelope layers outside the cell wall: capsule, slime layer, glycocalyx, S-layers. External appendages**:** flagella, fimbriae and pili. **15**

**Unit 2: Cytoplasmic organelles**: ribosomes, mesosomes, nucleoid, chromosome and plasmids, intracytoplasmic membranes, inclusions (storage inclusions: PHB, polyphosphate granules, sulfur globules, cyanophycin granules; micro-compartments: Carboxysome; other inclusions: magnetosome, gas vacuole). **10**

**Unit 3: Bacteriological techniques:** Culture media: Chemical types (synthetic and complex), Functional types (supportive and enriched, selective and differential). Cultivation of aerobes and anaerobes, concept of viable but non culturable bacteria (VBNC). Culturing and Preservation methods: Streaking of bacterial culture, spread-plating, serial dilution plating, counting viable cells. Enrichment culture technique. Preservation of bacteria and maintenance of stock cultures. Microbial culture collection centers (ATCC and MTCC). **8**

**Unit 4: Bacterial growth and reproduction:** Different phases of bacterial growth in a batch culture**,** determination of generation time, analysis of growth rate. Factors affecting bacterial growth: Nutritional and physical factors. Endospore: Structure, formation, stages of sporulation and germination of endospore. Methods of asexual reproduction: budding, fission and fragmentation. **12**

**Practicals:** **30 hours**

**Unit 1: Introduction to bacterial growth and analysis:** Principle, working and applications of instruments used in cultivation and morphological analysis of microorganisms: bacteriological and BOD incubators, light microscope (using simple staining of bacteria). Concept of laminar flow: biological safety cabinets of levels 1 to 4.

Preparation of media and capture of aeroflora: Preparation of Synthetic medium (minimal medium) and Complex media (nutrient agar, potato dextrose agar, MacConkey agar). Capture of aero-microflora on nutrient agar and potato dextrose agar plates.

**15**

**Unit 2: Isolation, preservation and quantitation of bacteria:** Isolation of pure cultures of bacteria by Quadrant streaking method on nutrient agar plates. Preparation of bacterial culture slants and stabs on nutrient agar. Preservation of bacterial cultures by preparation of glycerol stocks. **15**

**Suggested Reading:**

***Theory:***

1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.

2. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.

3. Microbiology: Principles and Explorations by J.G. Black and L.J. Black. 10th edition. Wiley, USA. 2019.

4. Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.

5. Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA.

1997.

6. Microbiology by M. J. Pelczar, E. C. S. Chan and N. R. Krieg. 5th edition. McGraw Hill, USA. 1993.

***Practicals:***

1. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.

2. Basic Lab Manual of Microbiology, Biochemistry and Molecular Biology by A. Ray and R. Mukherjee. Taurean Publisher, India. 2019.

3. Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.

4. Manual of Microbiology: Tools & Techniques by A.K. Sharma. 1st edition. Ane Books, India. 2007.

**Facilitating the achievement of Course Learning Outcomes**

| S. no. | Course Learning Outcomes | Teaching and Learning activity | Assessment Tasks |
|---|---|---|---|
| 1. | Evaluate the morphological features and cellular organization of bacteria and archaea, and distinguish between cell wall and cell membrane compositions of gram positive bacteria, gram negative bacteria, and archaea. Will gain insights into the roles of enzymes and antibiotics affecting cell wall structure as well as the formation of spheroplasts, protoplasts, and L forms | PowerPoint presentations/ videos, pictures showing bacterial cells and their components. Explaining differences between Gram+ve and Gram-ve bacteria; eubacterial and archaebacterial structures with the help of diagrams and discussion of the action of antibiotics and enzymes on cell wall. | Test based on diagrams ofvarious cell components and their differences. |
| 2. | Isolate pure bacterial cultures and enumerate bacteria using serial dilution and plating techniques. Will learn about various culture media and methods employed to maintain bacterial cultures and preserve bacteria. | Demonstration of various techniques for isolation and culturing of bacteria. Discussion for comparing of methods of preservation of bacteria. | Evaluation of streaking/spread plate / serial dilution plating techniques. |

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| 3. | Discourse on the different phases of bacterial growth, and will understand the consequences of binary fission as a means of reproduction. Will learn about various nutritional and physical factors affecting bacterial growth. | Class lectures on mathematical and graphical expression of changes in bacterial populations by asexual reproduction. Calculation of generation time and growth rate to be explained. | MCQ /Quiz based on examples of asexual reproduction and growth curve. |
| 4. | Prepare various types of media; understand the use of membrane filtration to sterilize heat sensitive media components; have hands-on experience of isolating bacteria and fungi from air. | Weighing media components, dissolving them, setting pH and sterilization of media using autoclave along with learning about the abundance of microbes in air | Testing for sterile media preparation and membrane filtration technique |
| 5. | Streak bacterial cultures on nutrient medium, prepare bacterial slants and stabs, and enumerate bacteria by different plating methods. | Preparation of serial dilution, plating methods will enable students get good practice in inoculating/subculturing bacteria | Testing efficacy of working under aseptic conditions to minimize contaminations of culture plates, observing purity of cultures and learning to purify mixed cultures |

*__Assessment tasks are indicative and may vary__

## MICROB-DSC103
## BIOCHEMISTRY OF CARBOHYDRATES AND LIPIDS

**Marks: 100 (Theory = 75 marks**
**Practicals = 25 marks)**

**Duration: Theory = 45 hours (3 credits)**
**Practicals = 30 hours (1 credit)**

**Course Objectives:**

The major objective of this course is to enable the students to develop a clear understanding of the structures and properties of biomolecules: proteins, lipids, carbohydrates and nucleic acids, and lays the foundation for a basic understanding of cellular processes. The students will gain an understanding of the principles of thermodynamics and bioenergetics, and will be introduced to the basic concepts of enzymes and enzyme kinetics. This course will empower the students with essential knowledge to support learning in subsequent courses offered in the program.

**Pre-requisite**: Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard

**Course Learning Outcomes:**

Upon successful completion of the course, the student will be able to:

CO1: Explain the principles of thermodynamics as applied to biological systems and will be able to comment on the rate constants and feasibility of biochemical reactions by calculating free energy changes.

CO2: Describe the structures and properties of various types of carbohydrates and will be able to relate the structures of simple and complex carbohydrates to their wide range of functions. Will gain knowledge of the role of sugars and their derivatives in formation of macromolecules /supramolecular complexes.

CO3: Converse on the building block of lipids: fatty acids and their properties. Will acquire a clear understanding of the structures, properties and functions of storage and membrane lipids. Will learn of different types of lipid aggregates and their applications.

CO4: Prepare buffers and solutions of different molarity and normality and will be adept in the use of fine weighing balances and pH meter.

CO5: Analyze foodstuff for their microchemical composition, and will be able to detect the presence of carbohydrates and fats in samples by performing qualitative tests. Will become familiar with the use of spectrophotometer.

**Contents:**

**Theory** **45 hours**

**Unit 1: Bioenergetics and thermodynamics**: Laws of thermodynamics. Gibbs free energy: exergonic and endergonic reactions. Enthalpy: exothermic and endothermic reactions. Entropy, standard free energy change and actual free energy change, equilibrium constant and spontaneous reactions. Coupled reactions and additive nature of standard free energy change. Energy rich compounds: ATP, BPGA, Acetyl

CoA. **9**

**Unit 2: Carbohydrates**: Introduction to mono-, di- and poly-saccharides. Monosaccharides: aldoses and ketoses. Stereoisomers: enantiomers, epimers, diastereoisomers, mutarotation and anomers. Fischer and Haworth formulae of sugars. Sugar derivative: O-,N-glycosides. Disaccharides: Structures and properties of maltose, lactose, and sucrose reducing and non- reducing sugars. Polysaccharides: storage polysaccharides (starch and glycogen), structural polysaccharides (cellulose, chitin, peptidoglycan, pectin). **15**

**Unit 3: Storage Lipids:** Introduction to storage and structural lipids. Storage lipids: triacylglycerols, building blocks, fatty acids structure and properties, essential fatty acids, saponification.

**8**

**Unit 4: Structural Lipids:** Membrane lipids: phosphoglycerides (building blocks, structure of phosphatidylethanolamine and phosphatidylcholine). Sphingolipids: building blocks, structure of sphingosine, ceramide, general structure and functions of sphingomyelin, cerebroside and ganglioside. Lipid functions. Lipid aggregates: micelles, monolayers, bilayers and liposomes.

**13**

**Practicals: 30 hours**

**Unit 1: Preparation of buffers and solutions:** Concepts of molarity versus normality. Preparation of simple stock solutions of different molarities: sodium chloride, potassium permanganate, magnesium chloride solutions. Concept of pH. Role of buffers in biochemical reactions. Buffers of different pH ranges. Commonly used buffers in biochemical assays. Principle, calibration and use of pH meter. Preparation of two commonly used buffers: phosphate buffer, citrate buffer. Preparation of complex buffered stock solutions. Preparation of working solutions. **14**

**Unit 2: Qualitative biochemical analyses:** The use of pipettes and micropipettes. Cleaning and calibration of micropipettes. Principles and performance of qualitative tests for the detection of reducing and non-reducing sugars: Benedict's Test, Fehling's Test, Molisch Test; and starch: Iodine Test. Detection of lipids using Solubility Test, Osmic acid Test, Acrolein Test, Sudan III Test.

**16**

**Suggested readings:**

***Theory*:**

1. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman and Company, UK. 2021.

2. Biochemistry by J.M. Berg, J.L.Tymoczko, G.J. Gatto, and L. Stryer. 9th edition. W.H. Freeman and Company, UK. 2019.

3. Biochemistry by T.A. Brown and S.N. Mukhopadhyay. 1st edition. Viva Books, India. 2018.

4. Fundamentals of Biochemistry by D. Voet, J.G. Voet and C.W. Pratt. 5th edition. John Wiley and Sons, UK. 2016.

***Practicals:***

**1.** Practical Biochemistry by R.C. Gupta and S. Bhargava. 5th edition. CBS Publishers and Distributors, India. 2018.

**2.** An Introduction to Practical Biochemistry by D. Plummer. 3rd edition. McGraw Hill Education, India. 2017.

**3.** Introduction to Practical Biochemistry (ebook) by G. Hegyi, J. Kardos, M. Kovacs, A. Malnasi-Csizmadia, L. Nyitray, G. Pal, L. Radnai, A. Remenyi and I. Venekei. Eotvos Lorand University. 2013.

**4.** Modern Experimental Biochemistry by Rodney Boyer. 3rd edition. Pearson, India. 2002.

**Facilitating the achievement of Course Learning Outcomes:**

| S. No. | Course Learning Outcomes | Teaching and Learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1. | Explain the principles of thermodynamics as applied to biological systems and will be able to comment on the rate constants and feasibility of biochemical reactions by calculating free energy changes | Classroom lectures on laws of thermodynamics, bioenergetics, numericals on standard free energy changes of coupled reactions | Problems on free energy change and standard free energy change and determination of equilibrium constant from data provided. |
| 2. | Describe the structures and properties of various types of carbohydrates and will be able to relate the structures of simple and complex carbohydrates to their wide range of functions. Will gain knowledge of the role of sugars and their derivatives in formation of macromolecules /supramolecular complexes | Pictorial presentations of carbohydrates, mono, di-, and polysaccharides, including starch, glycogen, cellulose, and peptidoglycan.<br>Use of flow charts for teaching structures and reactions. | Drawing the structures of carbohydrates. Multiple choice questions-type<br>quiz on identification of anomers, epimers, enantiomers of sugars. |

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| 3. | Converse on the building block of lipids: fatty acids and their properties. Will acquire a clear understanding of the structures, properties and functions of storage and membrane lipids. Will learn of different types of lipid aggregates and their applications. | Lecture on lipids' structure, characteristic features and different types of "formations". Discussion on essential fatty acids and their significance in human nutrition. | Pictorial quiz on identification of biomolecules forming different types of lipids. Practice sessions for writing biochemical structures of different examples from lipid classes. |
| 4. | Prepare buffers and solutions of different molarity and normality and will be adept in the use of fine weighing balances and pH meter. | Calibration and use of pH meter. Students in groups will prepare citrate buffers , phosphate buffer and acid of given molarities. Preparation of the stock solution of a given substance in group and its dilutions individually. | Students are required to write a report for all the exercises in a record book They will submit the practical's record on a specified date and will be assessed for it. |
| 5. | Analyze foodstuff for their microchemical composition, and will be able to detect the presence of carbohydrates and fats in samples by performing qualitative tests. Will become familiar with the use of spectrophotometer. | Use of micropipettes and testing their accuracy Qualitative tests for the presence of reducing and non-reducing sugars, proteins, and lipids and resolving the composition of unknown samples. | May be given lab sheets with a write up leaving sections like observations and error analysis, for the students to complete. Students will perform and record in their lab books and assessed on the basis of their reporting. Students will be observed while performing lab work and will be assessed for their technical performance. They are encouraged to |

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| | | | keep their lab books up to date which will be sampled a number of times during the semester. |

***Assessment tasks are indicative and may vary.**

Annexure-H

## MICROB-GE-1

### INTRODUCTION AND SCOPE OF MICROBIOLOGY

**Marks: 100 (Theory = 50 marks**
**Practicals = 50 marks)**

**Duration: Theory = 30 hours (2 credits)**
**Practicals = 60 hours(2 credits)**

**Course objectives:**

The main objective of the course is to give students an overview of three major themes: History and scope of Microbiology, microbial diversity (prokaryotes, eukaryotes, and viruses), and the role of microbes in human lives. Students will gain insights into how microorganisms affect the everyday lives of humans in both beneficial and harmful ways. Students will become familiar with the techniques used in isolation and cultivation of microorganisms, and will learn how to identify microorganisms in the laboratory.

**Pre-requisite:** None.

**Course Learning Outcomes:**

Upon successful completion of the course the student :

CO1: Will become familiar with the history of Microbiology, and understand how Microbiology developed as a distinct discipline of science during the golden era of microbiology. Will become familiar with some of the later developments of the 21$^{st}$ century.

CO2: Will acquire an understanding about the placement of microorganisms in the tree of life. Will know about key differences between prokaryotic and eukaryotic organisms. Will also be acquainted with structure of viruses, general characteristics and importance of algae, fungi and protozoa.

CO3: Will understand the importance of microbe-human interactions, becoming aware of microorganisms as agents of human diseases. Will become aware of the important role that microorganisms play in food, agriculture, industry, biofuel and in the clean-up of the environment.

CO4: Will become aware of good microbiological laboratory and safety practices, and be acquainted with the working of basic microbiological equipment routinely used in the laboratory. Will also be acquainted with the aseptic techniques used for culturing bacteria and fungi.

CO5: Will gain hands-on experience in isolation of bacteria and fungi from air and will be acquainted with staining techniques used for observing bacteria, algae and fungi. Will learn the use of compound microscope.

CO6: Will get acquainted with different shapes and arrangement of bacteria. Will be able to identify algae, fungi, protozoa using permanent slides/photographs. Will be able to understand the structure of viruses using electron micrographs.

**Contents:**

**Theory:** **30 hours**

**Unit 1: History of Microbiology:** Some key milestones in the field of microbiology: Contributions of Antonie van Leeuwenhoek. Controversy over spontaneous generation. Louis

Pasteur and concept of pasteurization. Robert Koch and germ theory of diseases, and concept of pure culture. Edward Jenner and cowpox immunization. Ivanovsky & Beijerinck and the discovery of viruses. Winogradsky and the development of soil microbiology. Golden era of Microbiology. **8**

**Unit 2: Microbial Diversity:** Position of microorganisms in the living world. Whittaker's five kingdom classification. Carl Woese's three domain classification. Detailed characteristics of prokaryotic and eukaryotic organisms with examples of *E. coli* (bacterium) and *Saccharomyces* (yeast). Acellular organisms: structure and genome of Tobacco mosaic virus, polio virus and bacteriophage T4. General characteristics, habitat and economic importance of algae, fungi and protozoa. **12**

**Unit 3: The impact of microorganisms on humans:** Causal organism and transmission of common human diseases: typhoid, tuberculosis, cholera, malaria, gastroenteritis, influenza. Microorganisms and their applications in agriculture: nitrogen fixers and mycorrhiza. Role of microorganisms in the environment: microbial remediation of pollutants. Applications of microorganisms in food and industry: fermented foods and probiotics, biofuel (biogas), antibiotics and enzymes. **10**

**Practicals: 60 hours**

**Unit 4: Microbiological laboratory practices, and equipment:** Good Microbiology laboratory practices and general safety measures while working with microbes. Physical and chemical hazards and immediate first aid. Principle, working and applications of instruments: autoclave, hot air oven, biosafety hood, incubator and light and compound microscope. Demonstration and performance of aseptic technique for culturing of bacteria and fungi. **24**

**Unit 5: Cultivation, isolation and staining of cellular microorganisms:** Study of aero microflora by exposing nutrient agar plate at different locations and comparing diversity on the basis of colony morphology. Demonstration of bacterial smear preparation from suitable sample/culture followed by Gram staining and observation under oil immersion objective. Preparation of stained temporary mounts of any one fungus (*Rhizopus*/ *Penicillium*) and any one alga (*Chlamydomonas*/ *Spirogyra*). **16**

**Unit 6: Study of microorganisms:** Study of shape and arrangement of following bacteria / bacterial structures using permanent slides: bacillus, coccus, spirillum and endospore. Study of vegetative and reproductive structures of following algae using permanent slides: *Chlamydomonas*, *Spirogyra* and *Polysiphonia*/Fucus. Study of vegetative and reproductive structures of following fungi and protozoa using permanent slides: Fungi: *Rhizopus, Penicillium* and *Agaricus*. Protozoa: *Amoeba*, *Paramecium, and Giardia*. Study of structure of the following viruses using electron micrographs: Tobacco mosaic virus, T4 bacteriophage and poliovirus. **20**

**Suggested Reading:**

1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and B. Stahl.16th edition. Pearson, USA. 2021.

2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.

3. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.

4. Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
5. Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.
6. Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA.1997.
7. Microbiology by M. J. Pelczar, E. C. S. Chan and N. R. Krieg. 5th edition. McGraw Hill,USA. 1993.

**Facilitating the Achievement Of Course Learning Objectives**

| Unit | Course learning outcomes | Teaching and learning activities | Assessment tasks* |
|---|---|---|---|
| 1. | Will become familiar with the history of Microbiology, and understand how Microbiology developed as a distinct discipline of science during the golden era of microbiology. Will become familiar with some of the later developments of the 21st century. | Classroom lectures on the discovery of microorganisms, controversy over spontaneous generation, discoveries in the golden age of microbiology and latest developments in 21st century. | Identification of scientists through photographs related to development of Microbiology. Home assignment on historical developments that led to the development of germ theory of disease, pure culture technique and immunization. |
| 2. | Will acquire an understanding about the placement of microorganisms in the tree of life. Will know about key differences between prokaryotic and eukaryotic organisms. Will also be acquainted with structure of viruses, general characteristics and importance of algae, fungi and protozoa. | Lecture on classification of living organism with emphasis on placement of microorganisms. Presentations on prokaryotic and eukaryotic microbial cell structure, structure of virus and economic importance of algae, fungi and protozoa. | Assignments on acellular and cellular microbes with examples; comparative account of prokaryotic and eukaryotic cell structure. Quiz on economic importance of algae, fungi and protozoa. |
| 3. | Will understand the importance of microbe-human interactions, becoming aware of microorganisms as agents of human diseases. Will become | Presentations on common human diseases with their causative agents and mode of transmission. Interactive sessions on the role of different microorganisms in human welfare. | Quiz on common human diseases and their agents. Poster making on microorganisms used in making of foods, biofuels, enzymes, |

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| | aware of the important role that microorganisms play in food, agriculture, industry, biofuel and in the clean-up of the environment. | | biofertilizers, and antibiotics. |
| 4 | Will become aware of good microbiological laboratory and safety practices, and be acquainted with the working of basic microbiological equipment routinely used in the laboratory. Will also be acquainted with the aseptic techniques used for culturing bacteria and fungi. | Discussion on the importance of safety measures and good laboratory practices including disposal and proper handling of microbial cultures. Discussion and demonstration of working and applications of basic microbiological equipment. Demonstration of aseptic culture technique. | Making posters on good microbiology laboratory practices, comparative account of various biosafety levels (BSL1 to BSL4), safety in laboratories and immediate assistance in case of injury. Viva/quiz on functions of different components, and applications of instruments. |
| 5. | Will gain hands-on experience in isolation of bacteria and fungi from air and will be acquainted with staining techniques used for observing bacteria, algae and fungi. Will learn the use of compound microscope. | Laboratory sessions for studying microbial flora of the air and practicing isolations by aseptic transfer of microorganisms. Demonstration of preparation of bacterial smears followed by Gram staining. Practical session for staining fungi and algae for observing under microscope. | Students are required to write a report for all the exercises in a record book. They will submit the practical record on a specified date and will be assessed for their laboratory work and the practical record work separately. |
| 6. | Will get acquainted with different shapes and arrangement of bacteria. Will be able to identify algae, fungi, protozoa using permanent slides/photographs. Will be able to understand the structure of viruses using electron micrographs. | Observing permanent slides/photographs/ electron micrographs of various microorganisms for characteristic identifying features . | Recording salient features of various microorganisms alongwith well labelled diagrams in their practical files to be submitted at an informed time and assessing the record work. |

***Assessment tasks are indicative and may vary.**

## MICROB-GE-2

### MICROBES IN HEALTH AND HYGIENE

**Marks: 100 (Theory = 50 marks**
**Practicals = 50 marks)**

**Duration: Theory = 30 hours (2 credits)**
**Practicals = 60 hours(2 credits)**

**Course objectives:**

The main objective of this course is to introduce the students to the role of microorganisms in human health. Students will be exposed to the importance of microbe-human interactions when learning about the human microbiome. They will become aware of common diseases caused by microorganisms and will develop an understanding of probiotics and their importance in human health. They will be introduced to bacteriophages and their application in treatment/control of bacterial infections.

**Pre-requisite:** Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard.

**Course Learning Outcomes:**

Upon successful completion of the course, the student:

CO1: Will be acquainted with the importance of the human microbiome including the benefits as well as possible harmful effects. They will have a fair knowledge of various types of microorganisms surviving on/in the human body.

CO2: Will have gained knowledge about the spectrum of diseases caused by bacteria, viruses, protozoa and fungi. They will be familiar with the methods of transmission and control of various diseases.

CO3: Will understand the role of probiotics in human health. They will have learnt about the characteristics of probiotic microorganisms and have a fair idea of prebiotics and synbiotics. They will also have an overview of bacteriophages and their role in therapy.

CO4: Will have hands-on training on isolation of microorganisms from skin and staining of microorganisms collected from oral cavity, and will be able to check the efficacy of the sanitizer and antimicrobial action of heavy metals.

CO5: Will become aware of various probiotic products available in the market and the organisms included in these products. They will receive hands-on training for evaluation of various probiotic products and microbial strains.

CO6: Will have a fair understanding of bacteriophage typing and will also have hands on training in the isolation of bacteriophages from sewage samples.

**Contents:**

**Theory:** **30 hours**

**Unit 1: Role of microbiome in human health:** Importance of human microbiome in health. Factors affecting the survival and colonization of microorganisms on various organs including skin, throat and upper respiratory tract, gastrointestinal tract and genitourinary tract. Understanding the human microbiome using animal model systems: *C. elegans*, mice, zebrafish. Strengths and weaknesses of using these systems for human microbiome studies. Technologies for assaying the human microbiome: direct observation methods, molecular

profiling techniques, sequencing methods, strengths and weaknesses of the technologies. **8**

**Unit 2: Microorganisms in human diseases:** A concise overview of aetiology, symptoms, transmission and control of some common diseases: bacterial (tuberculosis, cholera, typhoid, diphtheria), viral (rabies, hepatitis, zika, COVID , polio, AIDS), protozoan (malaria, kala azar) and fungal diseases (dermatophytoses, candidiasis, aspergillosis). **12**

**Unit 3: Microbes for maintaining human health:** Brief description and distinction between prebiotics, probiotics and synbiotics. Probiotics for maintaining human health: prerequisite characteristics of probiotic strains, common probiotic bacterial strains, modes of action of probiotics, probiotic supplementation for disease management. Bacteriophage therapy: concept and challenges. A brief account of bacteriophage therapy for various diseases. **10**

**Practicals:** **60 hours**

**Unit 4. Study of human microflora:** Isolation of microorganisms from skin by swab method using specific media: nutrient agar, mannitol salt agar, potato dextrose agar. Gram staining of bacterial isolates and lactophenol staining for fungal isolates. Gram staining of dental scrapings/plaques. Checking the efficacy of sanitizer on skin. study of the oligodynamic effect of metals on bacterial cultures. **Student group project**: multiple methods for sampling microbial biomass specimens for oral, skin, gut and respiratory microbiomes. **25**

**Unit 5. Study of probiotics: Student group project:** Conduction of a market survey to identify different probiotic products available in the market. Isolation and basic characterization of bacteria from probiotic products. Bacterial cell surface hydrophobicity (CSH) test to estimate bacterial adherence. Performance of acid and bile resistance test on bacterial strains. **25**

**Unit 6. Bacteriophage isolation and typing:** Principle, process and limitations of bacteriophage typing. Isolation of bacteriophages from sewage sample using double layer technique. **Student group project**: Phage therapy in India. **10**

**Suggested Reading:**


1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.
2. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
3. Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 10th edition.Universities Press, India. 2017.
4. Jawetz, Melnick and Adelberg's Medical Microbiology by K.C. Carroll, S.A. Morse, T.A. Mietzner and S. Miller. 27th edition. McGraw Hill Education. 2016.
5. Microbiology: An Introduction by G.J. Tortora, B.R. Funke and C.L. Case. 9thedition.Pearson Education, USA. 2007.
6. Cappucino, J. and Sherman, N. (2014). Microbiology: A Laboratory Manual. 10th edition. Pearson Education, India.

7. Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A. (2007). Mackie and Mccartney Practical Medical Microbiology. Elsevier 14th edition 1996.

8. Randhawa, V.S., Mehta, G. and Sharma, K.B. (2009). Practicals and Viva in Medical Microbiology. 2nd edition. Elsevier, India.

9. Fuller, R. (2012). Probiotics: The Scientific Basis. Springer Netherlands.

10. Dhanasekaran, D. and Sankarnarayanan, A (2021). Advances in Probiotics, Microorganisms in Food and Health. Academic Press.

**Facilitating the achievement of Course Learning Outcomes**

| Unit no. | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks |
|---|---|---|---|
| 1. | Will be acquainted with the importance of the human microbiome including the benefits as well as possible harmful effects. They will have a fair knowledge of various types of microorganisms surviving on/in the human body | Class room lectures on human microbiome. Pictorial representation of various organ systems with the corresponding microflora. | Test and quiz on human microbiome. |
| 2. | Will have gained knowledge about the spectrum of diseases caused by bacteria, viruses, protozoa and fungi. They will be familiar with the methods of transmission and control of various diseases. | Class room lectures on the aetiology, symptoms, transmission and control of various diseases. Pictorial representation of various signs and symptoms of diseases. | Test and quiz on symptoms, transmission and control of various diseases. Match the following type quiz on disease and causative agent. Identification of disease based on photographs of specific disease presentation. |
| 3. | Will understand the role of probiotics in human health. They will have learnt about the characteristics of probiotic microorganisms and have a fair idea of prebiotics and synbiotics. They will also have an overview of | Class room lectures and videos on probiotics and bacteriophages. | Test and quiz on role of probiotics, prebiotics, synbiotics and bacteriophages. |

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| | bacteriophages and their role in therapy. | | |
| 4. | Will have hands-on training on isolation of microorganisms from skin and staining of microorganisms collected from oral cavity, and will be able to check the efficacy of the sanitizer and antimicrobial action of heavy metals. | Class room lecture and hands-on practical of isolation of bacteria from skin surface and staining of bacteria from oral cavity. Determination of sanitizer efficacy on skin. | Demonstration of practicals. Quiz on various aspects of practicals including principle, observations, result and precautions. |
| 5. | Will become aware of various probiotic products available in the market and the organisms included in these products. They will receive hands-on training for evaluation of various probiotic products and microbial strains. | Online and offline survey of probiotic products and types of probiotic organisms. Practical demonstration of isolation of probiotics and study of various properties. | Demonstration of practicals. Quiz on various aspects of practicals including principle, observations, result and precautions. |
| 6. | Will have a fair understanding of bacteriophage typing and will also have hands on training in the isolation of bacteriophages from sewage samples. | Classroom lecture on bacteriophage typing. Practical performance of isolation of bacteriophages from sewage. | Quiz on various aspects of practicals including principle, observations, result and precautions. |

*** Assessment tasks are indicative and may vary.**

## MICROB-GE-3

### FOOD FERMENTATION AND PRESERVATION TECHNIQUES

**Marks: 100 (Theory = 50 marks**
**Practicals = 50 marks)**

**Duration: Theory = 30 hours (2 credits)**
**Practicals = 60 hours(2 credits)**

**Course objectives:**

The major objective of this paper is to develop clear understanding about the microorganisms important in food and various factors affecting their growth. The students will gain in depth knowledge about food fermentation, their benefits and the processes involved in production of fermented foods. The concept of probiotic, prebiotic and synbiotics will also be discussed. The course also deals with the principle and the techniques involved in processing and preservation of food substances. The students will also be trained and be given hands on training in various microbiological techniques involved in food fermentation and food preservation. The course on completion can open many career options.

**Pre-requisite:** Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard.

**Course learning outcomes:**

Upon successful completion of the course, the student:

CO1: Will be familiar with the microbes important in food, their morphological, cultural, and physiological characteristics, and factors influencing their growth

CO2: Will have got an overview of fermented foods and their health benefits. Also, will be acquainted with the microbes and their processes involved in production of fermented foods.

CO3: Will have learnt about the causes of food spoilage and be aware of different preservation techniques used to increase the shelf life of food products.

CO4: Will have gained hands on experience in isolating and characterizing microbes from food.

CO5: Will have become familiar with the principle of food fermentation by production of fermented foods in the laboratory.

CO6: Will have an insight into various microbiological and biochemical testing techniques used for assessing the efficacy of various food preservation techniques.

**Contents:**

**Theory:** **30 hours**

**Unit 1: Microorganisms in Food Microbiology:** Introduction to microorganisms important in foods: morphological, cultural and physiological characteristics of moulds (*Aspergillus, Rhizopus*), yeast (*Saccharomyces)*, and bacteria (*Lactobacillus, Acetobacter),* Factors affecting microbial growth in foods- intrinsic (pH, water activity, mechanical barriers and redox potential) and extrinsic (temperature, gaseous atmosphere). **6**

**Unit 2: Food Fermentation:** History, definition and benefits of fermented foods. Types of food

fermentations (acid-, yeast-, solid state-, oriental and indigenous fermented foods). Production and maintenance of microbial cultures involved in food fermentation, starter culture and its problems. Production of dairy (dahi, yoghurt, kefir, cheese) and non-dairy fermented foods (dosa, kanji, sauerkraut, tempeh, soy sauce), beverages (beer, wine) and concept of pre-, pro- and syn- biotics. **12**

**Unit 3: Principles of food preservation:** Definition and causes of food spoilage. Classification of food by ease of spoilage. General principles of food preservation. Preservation by low temperature: freezing & refrigeration. Preservation by high temperature: pasteurisation and canning. Preservation by moisture control: drying and dehydration. Preservation by radiation: Gamma, microwaves and UV rays. Preservation by added food preservatives: salt, sugar, benzoate, nitrite and nitrate, wood smoke, nisin. Preservation by developed preservatives, modified atmosphere packaging. **12**

**Practicals: 60 hours**

**Unit 4: Isolation and characterisation of microbes important in food:** Isolation and microscopic examination of fungi from a spoiled bread. Isolation of lactic acid bacteria from curd using MRS medium and microscopic characterisation by Gram's staining. Effect of different temperatures/ salt concentration on microbial growth. **24**

**Unit 5: Food fermentation:** Preparation of kefir using kefir grains/ fermented cabbage (sauerkraut). Viability test for yeast using methylene blue. Survey on the availability and usage of various probiotic foods from market. **12**

**Unit 6: Food Preservation:** Effect of blanching on food preservation. Incubation test for cans/ tetrapack to determine sterility. Alkaline phosphatase test to check efficiency of pasteurization of milk: principle, performance of the test with various pasteurized milk samples, evaluation of milk quality based on results obtained. Assessment of efficiency of sterilisation of milk: principle and performance of Turbidity Test and evaluation of milk quality based on obtained results. **24**

**Suggested Readings:**

1. Food processing and preservation by H. Naik and T. Amin. CRC Press. 2022.
2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3. Microbiology and Technology of fermented foods by R. Hutkins. 2nd edition. Wiley Blackwell, UK. 2019.
4. Food Microbiology by W.C. Frazier, D.C. Westhoff, and N.M. Vanitha. 5th edition. TataMcGraw-Hill Publishing Company Ltd, India. 2017.
5. Handbook of fermented functional foods by F. Edward. 2nd Edition. CRC press, UK. 2016.
6. FSSAI Manual of methods of analysis of foods. Food safety and standards Authority of India, Ministry of Health and Family Welfare, Government of India, 2015.
7. Advances in Fermented Foods and Beverages by W. Holzapfel. 1st edition. Woodhead Publishing, USA. 2014.

8. Handbook of food and beverage fermentation technology by Y. Hui, L. Meunier-Goddik, J. Josephsen, W. Nip and P. Stanfield. 1st edition. CRC Press, UK. 2004.

**Facilitating the achievement of Course Learning Outcomes**

| S. No. | Course Learning Outcomes | Teaching and Learning Activity | Assessment Tasks |
|---|---|---|---|
| 1. | Will be familiar with the microbes important in food, their morphological, cultural, and physiological characteristics, and factors influencing their growth | Interactive sessions with power point presentations on the morphological, cultural, and physiological characteristics of microbes important in food | Assignment and quiz on the characteristics of microbes associated with food and factors influencing their growth |
| 2. | Will have got an overview of fermented foods and their health benefits. Also, will be acquainted with the microbes and their processes involved in production of fermented foods | Classroom lectures and detailed discussion on the fermentation process through flow charts, power point presentations and relevant online videos | Students to collect samples of various fermented foods available commercially and do market survey on their consumption. Class test / Assignment on MFC and types of starter cultures |
| 3. | Will have learnt about the causes of food spoilage and be aware of different preservation techniques used to increase the shelf life of food products. | Teaching of various preservation techniques through power point presentations and online videos | Class tests, Quiz and MCQs on the various preservation methods |
| 4. | Will have gained hands on experience in isolating and characterizing microbes from food. | Media preparation and sterilization, isolation & identification of various microbes in food. Also understanding the importance of various physical- chemical factors on growth | Drawing well labelled diagrams of microscopic observations of isolated fungi and bacteria from food |
| 5. | Will have become familiar with the principle of food fermentation by production of fermented foods in the laboratory. | Hands on training on the laboratory preparation of fermented foods and survey on the consumption pattern of fermented foods | Compilation of report on the survey done by the students to understand the availability and acceptance of fermented foods |
| 6. | Will have an insight into various microbiological and biochemical testing techniques used for assessing the efficacy of various food preservation techniques. | Laboratory training in processing and preservation protocols for different food products | Viva voce, multiple choice questions and spotting |

***Assessment tasks listed here are indicative and may vary**

## MICROB-GE-4

### MICROBIAL QUALITY CONTROL AND TESTING

**Marks: 100 (Theory = 50 marks**
**Practicals = 50 marks)**

**Duration: Theory = 30 hours (2 credits)**
**Practicals = 60 hours(2 credits)**

**Course objectives:**

The main objective of the course is to underscore the importance of microbiological quality control in various sectors. Students will gain in-depth knowledge about criteria and procedures for safety in quality assurance in water, food and pharmaceutical sector. They will become proficient in various microbiological techniques used for quality testing of samples will be discussed. They will gain hands-on training in basic microbiological techniques used for quality testing.

**Pre-requisite:** Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard.

**Course Learning Outcomes:**

Upon successful completion of the course, the students:

CO1: Will have acquired knowledge about microbiological quality through Good Microbiological laboratory Practices (GMLP), biosafety levels, quality control of microbiological culture media, sterilization and antimicrobial susceptibility test.

CO2: Will have learnt methods to assess potability of drinking water, and become aware of Hazard analysis critical control point (HACCP) for food safety, as well as microbial limits in food and pharmaceutical products. Will be familiar with various microbiological standards and certifications by accredited certification bodies.

CO3: Will have gained insights into various microbiological, biochemical, molecular and immunological testing techniques used for assessing quality of drinking water and food products.

CO4: Will be capable of assessing the potability of water by performing various microbiological tests.

CO5: Will be capable of performing various biochemical and microbiological tests used to evaluate the quality of milk, packaged foods, pharmaceutical formulation and will gain knowledge about using phenol coefficient test for assessing quality of disinfectants.

CO6: Will learn to design HACCP plan for any food product manufacture like milk processing and packaging.

**Contents:**

**Theory:** **30 hours**

**Unit 1: Safety practices and quality control in microbiology:** Principles of Good microbiological laboratory practices (GMLP), Concept of biosafety levels (BSLs), Safety equipment and protective measures used in different categories of biosafety levels laboratories. Examples of microorganisms that are classified as BSL-1 to BSL-4. Quality control of microbiological culture media, sterilization, antimicrobial susceptibility test. **6**

**Unit 2: Quality control and assurance in water, food and pharmaceutical sector:** Water potability: criteria and procedures for quality assurance of drinking water, recommended quality control strains for water testing, recommendations of Environmental Protection Agency (EPA) for drinking water quality. Food safety and microbiology: overview of health hazards related to food, Hazard analysis of critical control point (HACCP) for food safety. Role of Codex Alimentarius Commission (CAC) in safety of food and agriculture products. BIS standards, FSSAI standards, ISO certification. Sterility testing of food and pharmaceutical products: importance and objectives, microbial limits. **10**

**Unit 3: Microbial quality control tests:** Collection and processing samples for testing. Detection of microorganisms and sample testing by culture and microscopic methods: direct microscopic counts (fluorescence-based), standard plate count method, selective media (*Salmonella-Shigella* agar, mannitol salt agar, EMB agar, McConkey agar), Bioburden testing, Most Probable Number (MPN), membrane filtration test, phenol coefficient test. Detection of microorganisms and sample testing by molecular methods: nucleic acid probes, PCR-based detection. Biosensors. Detection of microorganisms and sample testing by biochemical and immunological methods: Endotoxin testing by Limulus lysate test, pyrogen testing, rapid detection methods by Clot-on-Boiling Test **(**COB), Resazurin assay. **14**

**Practicals: 60 hours**

**Unit 4: Water potability:** Testing potability of water samples by standard procedures: Most Probable Number method (MPN) /presumptive test, confirmed test, completed test for faecal contamination: principles of the methods, performance of the tests with various water samples using differential and selective media, evaluation of the water quality based on the results obtained. Testing water potability by using standard kits. **20**

**Unit 5: Food quality control and assurance:** Assessment of the microbiological quality of raw versus pasteurized milk by Methylene Blue Dye Reduction Test (MBRT), evaluation and grading of milk quality based on the results obtained. Clot on boiling (COB) test of milk samples: principle, performance of the test with milk samples, and evaluation of milk quality based on results obtained. Sterility testing of canned food, tetra pack drinks and any pharmaceutical formulation (eye drops/ injection ampules) by either using the membrane filtration test or by standard plate count method. Detection of microorganisms in food samples through any one differential and selective medium. Demonstration of phenol coefficient test to evaluate efficacy of disinfectants using standard kits. **28**

**Unit 6: HACCP: Student research study project:** Designing of HACCP plan for milk processing and packaging or any other food product: product description, flowchart of production, assessing hazards and risks associated with different steps of production till consumption, identification of critical control points (CCP) and critical limits, suggestive procedures to monitor CCPs and corrective actions, effective record keeping to document the HACCP plan, and procedures for verification. **12**

**Suggested Reading:**

1. Analytical Food Microbiology: A Laboratory Manual by A.E. Yousef, J.G. Waite-Cusic and J.J. Perry. 2nd edition. Wiley Publishers, UK. 2022.

2. Laboratory Manual of Food Microbiology by N. Garg, K.L. Garg and K.G. Mukerji. Dreamtech Press, India. 2021.

3. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition.

Pearson Education, USA. 2020.

4. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.

5. Food Safety & Quality Control by P. Mathur. Orient Black Swan Pvt. Ltd., India. 2018.

6. Manuals of methods of analysis of foods and water by Food safety and standards authority of India, Ministry of health and family welfare, Government of India, 2016.

7. Food Microbiology by W.C. Frazier, D.C. Westhoff, and N.M. Vanitha. 5th edition. TataMcGraw-Hill Publishing Company Ltd, India. 2013.

8. Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices by R.M. Baird and S.P. Denver. 1st edition, CRC Press, U.K. 2000.

9. Microbiological Analysis of Food and Water: Guidelines for Quality Assurance by N.F. Lightfoot and E.A. Maier. Elsevier Science. 1998.

10. Essentials of Food Microbiology by J.H. Garbutt. 2nd edition. Hodder Arnold Publishers. 1997.

**Facilitating the achievement of course learning objectives**

| Unit No. | Course learning outcomes | Teaching and learning activities | Assessment tasks* |
|---|---|---|---|
| 1. | Will have acquired knowledge about microbiological quality through Good Microbiological laboratory Practices (GMLP), biosafety levels, quality control of microbiological culture media, sterilization and antimicrobial susceptibility test. | Classroom lectures on biosafety and Good Microbiological Laboratory Practices (GMLP). | Assignment on Biosafety, Good Microbiological Laboratory Practices (GMLP). |
| 2. | Will have learnt methods to assess potability of drinking water, and become aware of Hazard analysis critical control point (HACCP) for food safety, as well as microbial limits in food and pharmaceutical products. Will be familiar with various microbiological standards and certifications by accredited certification | Detailed discussion on control, regulation and inspection measures of water and food products that ensure the consumer receives products of good microbiological quality. | Class test and quiz on quality assurance and control. |

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| | bodies. | | |
| 3. | Will have gained insights into various microbiological, biochemical, molecular and immunological testing techniques used for assessing quality of drinking water and food products. | Teaching various microbiological examination techniques and tools through flow charts, powerpoint presentations and relevant online videos. | Quiz and MCQ's on various tests and techniques for microbiological assessment of water and food products. |
| 4. | Will be capable of assessing the potability of water by performing various microbiological tests. | Hands on training to assess the quality of various water samples by using kits and by preparing and inoculating different differential, selective and biochemical media eg. Lactose fermentation broth, EMB agar, peptone water, glucose peptone broth and Simmons citrate agar. | Viva and quiz on various differential and selective media and biochemical tests. |
| 5. | Will be capable of performing various biochemical and microbiological tests used to evaluate the quality of milk, packaged foods, pharmaceutical formulation and will gain knowledge about using phenol coefficient test for assessing quality of disinfectants. | Practical laboratory sessions on the evaluation of microbiological quality of milk, various packaged foods and pharmaceutical products. Insight into the testing of bactericidal efficacy of various disinfectants using phenol coefficient test. | A short report on the microbiological quality of packaged food items available in the college canteen. |
| 6. | Will learn to design HACCP plan for any food product manufacture like milk processing and packaging. | Guiding students in the preparation of a document in accordance with the principles of HACCP system for a food chain from primary production to final consumption. | Posters/charts on HACCP plan. |

***Assessment tasks are indicative and may vary.**

## MICROB-GE-5

## MICROBES IN ANIMAL HEALTH

**Marks: 100 (Theory = 50 marks**
**Practicals = 50 marks)**

**Duration: Theory = 30 hours (2 credits)**
**Practicals = 60 hours(2 credits)**

**Course objectives:**

The main objective of this course is to introduce the students to the importance of microorganisms in animal health. Students will learn about the interactions of microbes with various types of livestock and pet animals. Students will be introduced to various bacterial, fungal, viral and protozoan diseases of animals. They will be introduced to various types of microorganisms residing in rumen, and learn about various methods for obtaining blood, rumen fluid and milk samples from animals. They will be introduced to principles of various diagnostic methods used in lab diagnosis of animal infections. Students will learn about the vaccination schedule followed for cattle and poultry.

**Pre-requisite:** Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard.

**Course Learning Outcomes:**

Upon successful completion of the course, the student:

CO1: Will be acquainted with various types of livestock and pet animals, rumen microflora, and their advantages and disadvantages.

CO2: Will have gained knowledge about the spectrum of diseases caused by bacteria and fungi in animals, becoming familiar with the symptoms, transmission mode, treatment, prevention and control of various bacterial and fungal diseases.

CO3: Will understand the symptoms, transmission, treatment, prevention and control of various diseases caused by viruses and protozoa.

CO4: Will be familiar with various methods of sampling of blood and rumen fluid. Will have had hands-on training for the detection of mastitis by testing milk samples.

CO5: Will be aware of the principles of serological tests based on agglutination, precipitation, haemagglutination inhibition, ELISA and lateral flow assays for diagnosis of animal diseases/infection.

CO6: Will have a fair understanding of vaccination schedule followed for cattle, buffalo and poultry. They will learn the concept of differentiation between the vaccinated and infected animals.

**Contents:**

**Theory:** **30 hours**

**Unit 1. Introduction to livestock and rumen microflora:** A brief introduction of various types of livestock and pet animals: cattle, sheep, goat, dogs, cats and poultry. Different types of microbes in rumen along with their functions: archaebacteria (methanogens), bacteria, protozoa, fungi (cellulolytic and proteolytic). **8**

**Unit 2. Bacterial and fungal diseases of animals:** A concise overview of aetiological agent, symptoms, transmission, treatment, prevention and control of the following bacterial and fungal diseases: anthrax, brucellosis, mastitis, Johne's disease, campylobacteriosis, black quarter, haemorrhagic septicemia (HS), aspergillosis and mucormycosis. **12**

**Unit 3. Viral and protozoan diseases of animals:** An overview of aetiological agent, symptoms, transmission, treatment, prevention and control of following viral diseases: foot and mouth disease (FMD), rinderpest/PPR, blue tongue disease, avian influenza, canine distemper, rabies, babesiosis, theileriosis and trypanosomiasis. **10**

**Practicals: 60 hours**

**Unit 4. Sampling methods for obtaining blood, rumen fluid and milk:** Sampling of blood from cattle, sheep, goat, dog, cat, mice and poultry by virtual lab. Sampling of rumen fluid: syringe, rumenotomy by virtual lab/video. Sampling of milk: California mastitis test. **15**

**Unit 5. Serological tests for diagnosis of infectious agent:** Principle and working method of**:** Agglutination, precipitation, haemagglutination inhibition assay, ELISA, and Lateral flow assay for antigen detection. **30**

**Unit 6. Vaccination of livestock animals:** Concept of differentiation between infected and vaccinated animal (DIVA test) for FMD and brucellosis. **Student group project**: Research study and review of the vaccination schedules for cattle, buffalo and poultry. **15**

**Suggested Reading:**


1. Brock Biology of Microorganisms by M.T. Madigan, K.S. Bender, D.H. Buckley, W.M. Sattley and D.A. Stahl. 16th edition. Pearson Education, USA. 2021.
2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020
3. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
4. Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
5. Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 10th edition.Universities Press, India. 2017.
6. Jawetz, Melnick and Adelberg's Medical Microbiology by K.C. Carroll, S.A. Morse, T.A.Mietzner and S. Miller. 27th edition. McGraw Hill Education. 2016.
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**Facilitating the achievement of Course Learning Outcomes**

| Unit no. | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks |
|---|---|---|---|
| 1. | Will be acquainted with various types of livestock and pet animals, rumen microflora, and their advantages and disadvantages. | Class room lectures on livestock, pet animals and rumen microflora. Pictures of various animal breeds. | Test and quiz on livestock, pet animals and rumen microflora. |
| 2. | Will have gained knowledge about the spectrum of diseases caused by bacteria and fungi in animals, becoming familiar with the symptoms, transmission mode, treatment, prevention and control of various bacterial and fungal diseases. | Class room lectures on the aetiology, symptoms, transmission, treatment, prevention and control of bacterial and fungal diseases in animals. Pictorial representation of various signs and symptoms of diseases. | Test and quiz on symptoms, transmission and control of various diseases. Match thefollowing type quizon disease and causative agent. Identification of disease based on photographs of specific disease presentation. MCQson causation of disease and prevention and control. |
| 3. | Will understand the symptoms, transmission, treatment, prevention and control of various diseases caused by viruses and protozoa. | Class room lectures on the aetiology, symptoms, transmission, treatment, prevention and control of viral and protocoan diseases in animals. Pictorial representation of various signs and symptoms of diseases. | Test and quiz on symptoms, transmission and control of various diseases. Match thefollowing type quizon disease and causative agent. Identification of disease based on photographs of specific disease presentation. |

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|---|---|---|---|
| | | | MCQson causation of disease and prevention and control. |
| 4. | Will be familiar with various methods of sampling of blood and rumen fluid. Will have had hands-on training for the detection of mastitis by testing milk samples. | Various sampling methods through virtual lab / videos. Performance of California test for diagnosing mastitis. | Quiz on various aspects of the practicals. Recording of principle, observations, result and precautions in practical records. |
| 5. | Will be aware of the principles of serological tests based on agglutination, precipitation, haemagglutination inhibition, ELISA and lateral flow assays for diagnosis of animal diseases/infection. | Various diagnostic methods through virtual lab / videos. Performance of ELISA/lateral flow assay. | Quiz on various aspects of the practicals. Recording of principle, observations, result and precautions in practical records |
| .6. | Will have a fair understanding of vaccination schedule followed for cattle, buffalo and poultry. They will learn the concept of differentiation between the vaccinated and infected animals. | Student group research study and group discussion on vaccination for various diseases and concept of differentiation of infectious and vaccinated animals (DIVA). | Quiz on various vaccines and concept of DIVA. |

*** Assessment tasks are indicative and may vary.**