**KARNATAK UNIVERSITY, DHARWAD**
**ACADEMIC (S&T) SECTION**

**ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ**
**ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ**

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/ 612 Date: 27 JUL 2024

**ಅಧಿಸೂಚನೆ**

ವಿಷಯ: ಸರಕಾರದ ಆದೇಶ ದಿನಾಂಕ: 08.05.2024 ಅನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕ ಪದವಿಗಳಿಗೆ NEP ಅಡಿಯಲ್ಲಿ ಪ್ರೋಗ್ರಾಂ ವಿನ್ಯಾಸ (Curriculum Structure)ದಂತೆ ಪರಿಷ್ಕೃತ ಪಠ್ಯಕ್ರಮದ ಅನುಷ್ಠಾನ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ಸರ್ಕಾರದ ಪ್ರಧಾನ ಕಾರ್ಯದರ್ಶಿಗಳು, ಉನ್ನತ ಶಿಕ್ಷಣ ಇಲಾಖೆ ಇವರ ಆದೇಶ ಸಂಖ್ಯೆ: ಇಡಿ 166 ಯುಎನ್ಇ 2023, ದಿ: 08.05.2024.
2. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯಗಳ ಸಂ:2, 3, 4, 5, 6, 7, 8 & 9, ದಿ:16.07.2024.
3. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 27/07/2024

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ಮೇಲ್ಕಾಣಿಸಿದ ವಿಷಯ ಹಾಗೂ ಉಲ್ಲೇಖಗಳನ್ವಯ, ಉಲ್ಲೇಖ–01ರ ಸರಕಾರ ಆದೇಶಾನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಈ ಕೆಳಗಿನ ಎಲ್ಲ ಸ್ನಾತಕ ಪದವಿಗಳ NEP ಅಡಿಯ ಪ್ರೋಗ್ರಾಂ ವಿನ್ಯಾಸ (Curriculum Structure)ದಂತೆ ಪರಿಷ್ಕೃತ ಪಠ್ಯಕ್ರಮ ರಚನೆ ಕುರಿತಾಗಿ ಸಂಬಂಧಿಸಿದ ಅಭ್ಯಾಸಸೂಚಿ ಮಂಡಳಿ ಹಾಗೂ ನಿಕಾಯಗಳ ಶಿಫಾರಸ್ಸನಂತೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದಿತ ಪದವಿಗಳ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದೆ. ಸದರ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲದಿಂದ ಡೌನಲೋಡ ಮಾಡಿಕೊಳ್ಳಲು ಸೂಚಿಸುತ್ತ ವಿದ್ಯಾರ್ಥಿಗಳು ಹಾಗೂ ಸಂಬಂಧಿಸಿದ ಎಲ್ಲ ಬೋಧಕರ ಗಮನಕ್ಕೆ ತಂದು ಅದರಂತೆ ಕಾರ್ಯಪ್ರವೃತ್ತರಾಗಲು ಕ.ವಿ.ವಿ.ಯ ಎಲ್ಲ ಅಧೀನ ಹಾಗೂ ಸಂಲಗ್ನ ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ ಸೂಚಿಸಲಾಗಿದೆ.

| ಅ.ನಂ. | ಪದವಿ | | | | ಸೆಮಿಸ್ಟರ್ |
|---|---|---|---|---|---|
| 1 | 1 | B.A | 8 | BTTM | 1 ರಿಂದ 6ನೇ ಸೆಮಿಸ್ಟರ್ |
| | 2 | BSW | 9 | B.Sc | |
| | 3 | B.Sc. (H.M) | 10 | BCA | |
| | 4 | B.Com | 11 | B.Com (CS) | |
| | 5 | B.Com (E-Commerce Operation) | 12 | B.Com (Retail Operations) | |
| | 6 | B.Com (Banking Financial Services & Insurance) | 13 | B.Com (Logistics) | |
| | 7 | BBA | 14 | BBA (Logistics Management) | |
| 2 | 1 | B.Sc (Data Science) | 2 | B.Sc (Artificial Intellgence & Machinery Learning) | 1 ಮತ್ತು 2ನೇ ಸೆಮಿಸ್ಟರ್ |
| 3 | 1 | BASLP | 3 | BPA | 1 ರಿಂದ 8ನೇ ಸೆಮಿಸ್ಟರ್ |
| | 2 | BVA | 4 | B.Sc. Pulp & Paper | |

ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,
ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ವ್ಯಾಪ್ತಿಯಲ್ಲಿ ಬರುವ ಎಲ್ಲ ಅಧೀನ ಹಾಗೂ ಸಂಲಗ್ನ ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ. (ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ ಹಾಗೂ ಮಿಂಚಂಚೆ ಮೂಲಕ ಬಿತ್ತರಿಸಲಾಗುವುದು)

ಪ್ರತಿ:
1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು / ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು / ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ, ಸಂಬಂಧಿಸಿದ ಕೋರ್ಸುಗಳ ವಿಭಾಗಗಳು ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ / . ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ನೊಡಲ್ ಅಧಿಕಾರಿಗಳು, ಯು.ಯು.ಸಿ.ಎಂ.ಎಸ್. ಘಟಕ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ಎನ್.ಇ.ಪಿ. ನೊಡಲ್ ಅಧಿಕಾರಿಗಳು, ಸಿ.ಡಿ.ಸಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

# KARNATAK UNIVERSITY, DHARWAD

# B.Sc. Microbiology

## SYLLABUS

**With Effect from 2024-25**

**DISCIPLINE SPECIFIC CORE COURSE (DSC) FOR SEM I -VI,**

**SKILL ENHANCEMENT COURSE(SEC)FOR SEM IV/V/VI**

**and ELECTIVE COURSES FOR SEM V AND VI**

**AS PER NEP (Revised):2024**

# Karnatak University, Dharwad

B.Sc. in Microbiology

Effective from 2024-25

| Sem. | Type of Course | Theory/ Practical | Course Code | Course Title | Instruction hour/ week | Total hours / sem | Duration Of Exam | Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Formative | Summative | Total | |
| I | DSC-1 | Theory | **C1MCB1T1** | Basics of Microbiology and Microbial Techniques | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-2 | Practical | **C1MCB1P1** | Basics of Microbiology and Microbial Techniques | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| II | DSC-3 | Theory | **C2MCB1T1** | Microbial Physiology and Genetics | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-4 | Practical | **C2MCB1P1** | Microbial Physiology and Genetics | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| III | DSC-5 | Theory | **C3MB1T1** | Molecular Biology and Genetic Engineering | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-6 | Practical | **C3MCB1T1** | Molecular Biology and Genetic Engineering | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| 1V | DSC-7 | Theory | **C4MCB1T1** | Environmental and Agricultural Microbiology | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-8 | Practical | **C4MCB1P1** | Environmental and Agricultural Microbiology | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| *V | DSC-9A | Theory | **C5MCB2T1** | Food and Industrial Microbiology | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-10A | Practical | **C5MCB2P1** | Food and Industrial Microbiology | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| | DSC-9B | Theory | **C5MCB2T2** | Microbial Biotechnology and Bioinformatics | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-10B | Practical | **C5MCB2P2** | Microbial Biotechnology and Bioinformatics | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| VI | DSC-11A | Theory- | **C6MCB2T1** | Immunology and Medical Microbiology | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-12A | Practical | **C6MCB2P1** | Immunology and Medical Microbiology | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| | DSC-11B | Theory- | **C6MCB2T2** | Advances in Microbiology and Biostatistics | 04hrs | 60 | 03hrs | 20 | 80 | 100 | 04 |
| | DSC-12B | Practical | **C6MCB2P2** | Advances in Microbiology and Biostatistics | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |
| V | OEC-1 | Theory | **C5MCB5T1** | Fundamental Microbiology | 03hrs | 45 | 03hrs | 20 | 80 | 100 | 03 |
| VI | OEC-2 | Theory | **C6MCB5T1** | Applied Microbiology | 03hrs | 45 | 03hrs | 20 | 80 | 100 | 03 |
| IV/V/ VI | Skill | Practical | **C0MCB6P1** | Microbial Quality Control in Industries | 04hrs | 56 | 03hrs | 10 | 40 | 50 | 02 |

*student shall either DSC 9A and DSC10A or DSC 9B and DSC10B in $5^{th}$ semester. Similarly, DSC 11A and DSC12A or DSC 11B and DSC12B in $6^{th}$ semester.

** Student shall study Skill of this subject either in $4^{th}$ / $5^{th}$ / $6^{th}$ but not in all the semester.

**Karnatak University, Dharwad**
**B.Sc. Microbiology**

## Programme Specific Outcomes (PSO):

**On completion of the 03 years Degree in Microbiology students will be able to:**

- Demonstrate, solve and understand the major concepts in all the disciplines of --.
- Understand practical skills so that they can assess risks and work safely and competently in the laboratory.
- Apply standard methodology to the solutions of problems in Microbiology
- Provide students with the ability to plan and carry out experiments independently and assess the significance of outcomes.
- Develop in students the ability to adapt and apply methodology to the solution of unfamiliar types of problems.
- Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of Microbiology.
- Build confidence in the candidate to be able to work on his own in industry and institution of higher education.
- Develop an independent and responsible work ethics.
- Exploring the microbial world and analyzing the specific benefits and challenges.
- Applying the knowledge acquired to undertake studies and identify specific remedies
- Face the challenges in health, agriculture, and food sectors.
- Gain thorough knowledge and application of good laboratory and good manufacturing skills
- Practices in microbial quality control.
- Understanding biochemical and physiological aspects of microbes.
- Apply broader perspective to identify innovative solutions for present and future challenges posed by microbes.
- Understanding the application of microbial principles in forensic science and working, knowledge about clinical microbiology. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology

## B.Sc. Semester–I
## Discipline Specific Course (DSC)
## Course Title:- Basics of Microbiology and Microbial Techniques
**Course Code:C1MCB1T1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-1** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Students will get the knowledge of Microbiology, historical Background of Microbiology, where they learn about Contribution and discoveries of different scientist in Microbiology field

CO2: Students will get Knowledge about the general characters and classification of Microorganisms, Viz-Bacteria, Fungi, algae, protozoa and virus Comprehend evolutionary importance and economic significance of microorganisms

CO3: Understanding the microbiological techniques, cultivation and detection of microorganisms.

CO4: Learning and practicing professional skills in handling microbes. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.

| Unit | Title: Basics of Microbiology and Microbial Techniques (Credits: Theory-4, Practicals-2) | 60 hrs/sem |
|---|---|---|
| Unit I | **History and Scope of microbiology**<br><br>Over view of origin of life. Theory of Endosymbiosis. Concept of Abiogenesis and biogenesis. Branches and significance of Microbiology, Contributions of Scientists in the field of microbiology - Antony van Leeuwenhoek, Francesco Redi, John Needham, Lazzaro Spallanzani Louis Pasteur, Robert Koch Edward Jenner, Joseph Lister, Alexander Fleming, Iwanowsky, Ananda Chakraborty etc.. Scope and applications of Microbiology as Modern Science. Glimpse of carrier opportunities in Microbiology. **(8hrs)**<br><br>**Microscopy**<br>Principles of Microscopy - Resolving power. Refraction and Diffraction, Numerical Aperture, focal length, Working distance, magnification, and Chromatic aberrations. Types of eye pieces and objectives. Principle and Applications of Microscopes – Compound, Dark field, Stereo microscope, Phase contrast microscope, fluorescent microscope, Electron microscope - Scanning and Transmission electron microscope. **(7hrs)** | **15 hrs** |

| | | |
|---|---|---|
| Unit II | **Stains and Staining technique**<br>Principles and types of stains – Principles of Stains and dyes. Preparation of smears and fixation. Simple staining (Positive and Negative), Differential staining (Grams staining and Acid - Fast staining) Structural staining (Cell wall, Capsule, Flagella and Endospore staining). **(5hrs)**<br>**Sterilization Techniques**<br>A) Physical Methods and their mode of action<br>i) Heat: a) Dry heat - Hot air oven.<br>b) Incineration.<br>c) Moist heat - Autoclave.<br>d) Tyndallization (Fractional sterilization)<br>ii) Filtration methods - Types of filters, Inorganic (Seitz, Chamberland, sintered glass, candle and asbestos filter) and organic filters (HEPA and Membrane filters),<br>iii) Radiations Methods - UV radiation, Ɣ-rays and cathode rays.<br>B) Chemical methods:<br>a) Definition of terms - disinfectants, antiseptics. Sanitizers, Microbicides - bactericides, virucide, Fungicide and Sporicide. Micro-biostatic – bacteriostatic and fungistatic agents.<br>b) Use and mode of action - Alcohols, aldehydes, halogens, phenols, heavy metals. Detergents: Quaternary ammonium compounds. **(10 hrs)** | **15hrs** |
| Unit III | **General Characteristics of Microorganisms**<br>General characteristics of major groups of micro-organisms - Algae, Protozoa. Fungi, Bacteria (Based on Bergey's manual of systematic Bacteriology).. General characteristics of viruses, classification of viruses – RNA viruses and DNA viruses. Viroids and Prions **(10hrs)**<br>**Microbial Taxonomy and Diversity**<br>Principles and types of classification- Haeckel's Three Kingdom system, Whittaker's Five kingdoms classifications – Monera, Protista, Fungi, Plantae and Animalia. Methods of microbial classification by Classical, Biochemical, numerical and molecular base. Comparison of the 3 domains Classification: Archaea, Bacteria and Eukarya Distribution and significance of microorganisms in air, water and soil. **(5 hrs)** | **15hrs** |
| Unit IV | **Culturing of microorganisms**<br>Culture media – Natural, Synthetic and Semi-synthetic - solid, liquid and semi solid media. Special media-Basal media, Selective, transport, differential, enrichment media. Methods of isolation of bacteria, fungi - serial dilution, pour plate, spread plate and streak plate techniques.<br>Cultivation of fastidious, non-fastidious, Anaerobic bacteria - Anaerobic jar and chamber method.<br>Maintenance of Pure Cultures, Culture Collection Centres – National and International. **(8 hrs)**<br>**Instruments**<br>Working principles and applications of Instruments: Centrifuge, pH meter, Incubator (Bacteriological, BOD and COD incubators), Autoclave, Hot air oven, Laminar air flow, Colorimeter, Spectrophotometer and membrane filter unit. Chromatography-Introduction, Working principles and applications of Paper, Thin layer, Column and Ion-Exchange Chromatography. **(7 hrs)** | 15hrs |

**Recommended books:**


1. Dubey, R. C., & Maheshwari, D. K. (2020). *Textbook of Microbiology* (2nd ed.). S Chand and Company Limited.
2. Alcamo, E. (2019). *Fundamentals of Microbiology* (10th ed.). Jones & Bartlett Learning.
3. Gunasekaran, P. (2018). *Laboratory Manual in Microbiology* (2nd ed.). New Age International Ltd.
4. Madigan, M. T., Martinko, J. M., & Bender, K. S. (2021). *Brock Biology of Microorganisms* (15th ed.). Pearson.
5. Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). W.H. Freeman.
6. Powar, C. B., & Daginwala, H. F. (2015). *Microbiology* (Vol. 1 & 2, 4th ed.). Himalaya Publishing House.
7. Salle, A. J. (2019). *Fundamental Principles of Bacteriology* (10th ed.). Tata McGraw Hill.
8. Srivastava, S., & Srivastava, P. S. (2017). *Understanding Bacteria* (2nd ed.). Springer.
9. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2019). *General Microbiology* (6th ed.). Prentice Hall.
10. Sullia, S. B., & Shantaram, S. (2015). *General Microbiology* (3rd ed.). Oxford & IBH Publishing Co.
11. Sundara Rajan, R. (2018). *Tools and Techniques of Microbiology* (2nd ed.). Anmol Publications.
12. Tortora, G. J., Funke, B. R., & Case, C. L. (2021). *Microbiology: An Introduction* (13th ed.). Pearson Education.
13. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2020). *Microbiology* (7th ed.). Tata McGraw Hill.
14. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., Stahl, D. A., & Brock, T. (2021). *Brock Biology of Microorganisms* (15th ed.). Pearson.
15. Willey, J., Sandman, K., & Wood, D. (2020). *Prescott's Microbiology* (12th ed.). McGraw-Hill Education.


| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20 Marks** |
| ***Formative Assessment as per guidelines.*** | |

**B.Sc. Semester–I**
**Discipline Specific Course (DSC)**
# Practical: Basics of Microbiology and Techniques

## Course Title: Basics of Microbiology and Microbial Techniques
## Course Code: C1MCB1P1

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summativ assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-2** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course, students will be able to:**

CO1: Develop professional skills in handling microbes and instruments.
CO2: Gain thorough knowledge about application of SOP and GLP will help students to be expertise in microbial quality control area.
CO3: Learn Culturing and Staining technique which will help in identification of microbes.
CO4: Learn the motility, micrometry and chromatographic techniques.

List of the Experiments, each will have 04Hrs / Week

1. General safety rules and regulations followed in handling of microbiological samples, hazards chemicals, and glassware at microbiology laboratory.
2. Study of Structure and working principles of Light microscope and their maintenance.
3. Demonstrations of working Principles and SOP of laboratory instruments: Autoclave**,** hot air oven, incubator, Laminar Air Flow, Centrifuge, pH Meter, Colorimeter, membrane filter unit. Tools – Inoculation loop, Petri dish Drigalski spatula (L-spreader) and Variable Micro Pipettes.
4. Isolation of microorganisms from air by settle plate method.
5. Isolation of microbes from water and soil by serial dilution.
6. Study of Morphological characters of microbial colonies.
7. Simple staining techniques – Positive and Negative staining technique
8. Differential staining technique Gram's and Acid-Fast staining.
9. Fungal staining technique and Structural staining– Capsule and Endospores.
10. Study of the Protozoa, Fungi Algae and Cyanobacteria by preparing temporary mounts.
11. Study of Bacterial Motility by Hanging drop method.
12. Measurement of microbes by Micrometry.
13. Illustration of microbes by Camera Lucida.
14. Counting of yeast cells and fungal spores by Haemocytometer.
15. Demonstration of Paper Chromatography.

**Books recommended**:


1. Aneja, K. R. (2021). *Experiments in Microbiology, Plant Pathology, Tissue Culture, and Mushroom Cultivation* (6th ed.). New Age International.
2. Benson, H. J. (2020). *Microbiological Applications* (14th ed.). McGraw Hill.
3. Colwell, R. R. (2012). *Microbial Diversity* (2nd ed.). Academic Press.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2020). *Microbiology* (7th ed.). Tata McGraw Hill.
5. Sullia, S. B., & Shantaram, S. (2015). *General Microbiology* (3rd ed.). Oxford & IBH Publishing Co.
6. Sundara Rajan, R. (2018). *Tools and Techniques of Microbiology* (2nd ed.). Anmol Publications.
7. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2019). *General Microbiology* (6th ed.). Prentice Hall of India.

## B.Sc. Semester– II
## Discipline Specific Course (DSC)

**Course Title:- Microbial Physiology and Genetics**
**Course Code: C2MCB1T1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-3** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO 1: Develop thorough knowledge in understanding the concepts of Biochemistry, enzymes, microbial metabolism, growth, bioenergetics and physiology
CO 2: Become efficient in managerial skills by learning the Enzyme kinetics and regulation.
CO 3: Employ analytical reasoning, problems solving, interpretation and documentation of laboratory experiments at a level suitable to succeed at an entry- level position in Microbiology.
CO 4: Acquire thorough knowledge on replication, genetic recombination, mendelian genetics and Transposable elements.

| **Unit** | **Title: Microbial Physiology and Genetics (Credits: Theory-4, Practicals-2)** | **60 hrs/ sem** |
|---|---|---|
| Unit I | **Biomolecules**<br>Introduction, structure, functions significance of biomolecules, properties and importance of Water, pH, buffers, chemical bonding, properties, general characters, structures, classification and biological importance of Carbohydrates, Protein, Lipids and Nucleic Acids. **(5 hrs)**<br>**Enzymes, Kinetics and Regulation**<br>**Enzymes:** Introduction, Nomenclature, structures, classification, properties, mode and mechanism of enzyme action – lock and key hypothesis, induced fit hypothesis. Cofactors, coenzymes, ribozymes and their importance, clinical importance of enzymes.<br>**Enzyme kinetics and regulation:** Michaeli's and Menten equation, Lineweaver Burk plots, Factors affecting enzyme action. Competitive and non-competitive inhibition and allosteric enzymes, kinetics of immobilized enzymes and multienzyme complex. **(10 hrs)** | **15 hrs** |

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|---|---|---|
| Unit II | **Bio-energetics and Bacterial Photosynthesis**<br>**Thermodynamics:** Laws of thermodynamics, Free energy, ATP and its production, other high-energy compounds, Oxidation and reduction reactions.<br>**Microbial Metabolism:** EMP, TCA cycle, Electron transport chain Oxidative phosphorylation, E D Pathway, Pentose Phosphate Pathway, HMP Pathway. uncouplers and inhibitors, Fatty acid Oxidation (Beta, Alpha, and Omega oxidation pathway). Amino acid degradation (Transamination. Deamination and Decarboxylation). Brief account on Nitrogen metabolism and Biosynthesis of lipids. Concept of Anaerobic respiration- fermentation: Alcoholic, Lactic (homolactic and heterolactic), acetic acid fermentation and Pasteur effect. **(12 hrs)**<br>**Bacterial Photosynthesis:** Types of bacterial photosynthesis, Photosynthetic pigments. Light reactions. Dark reaction, Comparison of photosynthesis in green plants and bacteria, Oxygenic and Anoxygenic Photosynthesis. **(3 hrs)** | **15 hrs** |
| Unit III | **Microbial Nutrition:**<br>Nutritional requirements, modes of nutrition – Autotrophs, Heterotrophs, Phototrophs. chemotrophs, methanotrophs, organotrophs and saprotrophs.<br>**Microbial Growth:** Growth Rate, generation time and growth curve - phases of growth and their significance, physical and chemical factors affecting growth - Temperature, Light. pH, Oxygen and saline requirements. Measurement of growth by cell number, cell mass and cell viability. **(6 hrs)**<br>**Microbial Genetics**<br>**Mendelian and Classical genetics:** Concepts, principles inheritance, dominance and segregation, Classical genetics: Chromosomal basis of inheritance and theory of heredity and Chromosomal abbreviations.<br>Structure properties and types of DNA and RNA<br>Genetic Code: Features, triplet code, wobble hypothesis, codons and evolution of genetic code. Genomic organization in Prokaryotes and Eukaryotes. **(9 hrs)** | **15 hrs** |
| Unit IV | **DNA Replication, Genetic Recombination in Prokaryotes**<br>**Overview of DNA replication:** initiation, elongation and termination, unidirectional and bidirectional replication, replication fork, origin of replication. primosomes, replisomes. Enzymes of DNA replication. Nick translation and proof reading. Different modes of DNA replication, rolling circle model of replication, Semiconservative replication , Meselson –Stahl experiment, and Regulation of bacterial chromosome replication. Inhibitors of DNA replication. **(6 hrs)**<br>Brief account on horizontal gene transfer among bacteria — transformation, transduction and conjugation<br>**DNA damage and repair:** photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, and SOS<br>**Mutation** : spontaneous and induced mutation, types of point mutation, consequences of point mutation, molecular basis of spontaneous and induced mutation, Base analogues, chemical mutagens, Ames test, significance and harmful effects of mutations. | **15hrs** |

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|---|---|---|
| | **Transposable genetic elements**: structure of transposon, IS sequences, bacterial transposon, composite transposon, Tn3 transposon, phage Mu, replication and maturation of Mu DNA, mechanism and significance of transposition: duplication of a target sequences at an insertion sequences, replicative transposition, non replicative transposition,. **(9 hrs)** | |

**Recommended books:**


1. Becker, W. M., Kleinsmith, L. J., Hardin, J., & Bertoni, G. P. (2020). *The World of the Cell* (9th ed.). Pearson Benjamin Cummings.
2. Caldwell, D. R. (2015). *Microbial Physiology and Metabolism* (2nd ed.). Brown Publisher.
3. Colwell, R. R. (2012). *Microbial Diversity* (2nd ed.). Academic Press.
4. De Robertis, E. D. P., & De Robertis, E. M. F. (2017). *Cell and Molecular Biology* (8th ed.). Lippincott Williams & Wilkins.
5. Dawes, I. W., & Sutherland, J. W. (2010). *Microbial Physiology* (3rd ed.). Halsted Press.
6. Karp, G. (2023). *Cell Biology* (10th ed.). McGraw Hill.
7. Gottschalk, G. (2012). *Bacterial Metabolism* (3rd ed.). Springer Verlag.
8. Jain, J. L. (2019). *Fundamentals of Biochemistry* (6th ed.). S. Chand Publisher.
9. Karp, G. (2021). *Cell and Molecular Biology: Concepts and Experiments* (8th ed.). John Wiley & Sons.
10. Moat, A. G., & Foster, J. W. (2019). *Microbial Physiology* (5th ed.). John Wiley & Sons.
11. Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). W.H. Freeman.
12. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2020). *Microbiology* (7th ed.). Tata McGraw Hill.
13. Reddy, S. R., & Reddy, S. M. (2018). *Microbial Physiology* (3rd ed.). Scientific Publishers India.
14. Voet, D., & Voet, J. G. (2021). *Biochemistry* (5th ed.). John Wiley & Sons.
15. Dale, J. W. (2019). *Molecular Genetics of Bacteria* (4th ed.). John Wiley & Sons.
16. Freifelder, D. (2018). *Microbial Genetics* (5th ed.). Narosa Publishing House.
17. Gupta, P. K. (2020). *Cytology and Genetics* (4th ed.). Rastogi Publications.
18. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2020). *Principles of Genetics* (9th ed.). Wiley-India.
19. Hartwell, L. H., et al. (2020). *Genetics: From Genes to Genomes* (6th ed.). McGraw Hill.
20. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2021). *Lewin's Essential Genes* (4th ed.). Jones & Bartlett Learning.
21. Snustad, D. P., & Simmons, M. J. (2020). *Principles of Genetics* (7th ed.). John Wiley & Sons.
22. Strickberger, M. W. (2019). *Genetics* (4th ed.). Prentice Hall of India.
23. Watson, J. D., et al. (2020). *Molecular Biology of the Gene* (8th ed.). Pearson.


| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20 Marks** |
| ***Formative Assessment as per guidelines.*** | |

**B.Sc. Semester–II**
**Discipline Specific Course (DSC)**
**Practical: Microbial Physiology and Genetics**

**Course Title: Microbial Physiology and Genetics**
**Course Code: C2MCB1P1**

| Type of Course | Theory /Practical | Credits | Instruction/hour/week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-4** | **Practical** | **02** | **04** | **56 hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course, students will be able to:**

After completion of course (Practical), students will be able to

CO 1: Develop thorough knowledge and understanding of concepts of Biochemistry, enzymes, microbial metabolism, growth, bioenergetics and physiology
CO 2: Become efficient in managerial skills by learning the Enzyme kinetics and regulation experiments at degree level.
CO 3: Employ analytical reasoning, problems solving, interpretation and documentation of laboratory experiments at a level suitable to succeed at an entry- level position in Microbiology.
CO 4: Learn qualitative and quantitative analysis of biomolecules thoroughly same can be useful for their industry jobs.

List of the Experiments, each will have 04Hrs / Week

1. Qualitative tests for the detection of Carbohydrates: Molisch's test, Anthrone test, Iodie test, Benedict's test, Fehling's test, Picric acid test, Barfoeds test, Selwinoffs test and Bials test.
2. Qualitative tests for Proteins and Amino acids: Biuret test. Ninhydrin test. Millons test Xanthoproteic test, Ehrlich's, Lead sulphide test, Sodium nitroprusside test, Sakaguchi and Hopkins Cole test.
3. Qualitative tests for Lipids: Acrolein test. Sudan III test, emulsification test and solubility test.
4. Colorimetric estimation of sugar by DNS method.
5. Colorimetric estimation of protein by Biuret method.
6. Study of Bacterial Growth curve and Measurement of growth by cell mass using turbidometer/ photocolorimeter/ spectrophotometer.
7. Estimation of Saponification value of oils.
8. Fermentation of glucose, sucrose and lactose - Acid and gas production.
9. Biochemical tests for the identification of bacteria
    a) IMViC tests
    b) Starch hydrolysis
    c) Gelatin hydrolysis
    d) Catalase test
    e) Oxidase test
10. Effect of pH and temperature on bacterial growth.
11. Assay of amylase by DNSA method.
12. Determination of specific activity.

13. Effect of temperature and pH on enzyme activity
14. Demonstration of Thin layer chromatography.
15. Cultivation of Cyanobacteria from pond/lake/river/sea water samples.
16. Cultivation of Actinomycetes from different soil.

## B.Sc. Semester–III
## Discipline Specific Course (DSC)

**Course Title:-Molecular Biology and Genetic Engineering**
**Course Code: C3MB1T1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessmet Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-5** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Understand concepts involved in transcription, translation, regulation of gene expression in Prokaryotes and Eukaryotes.

CO2: Students will understand the process of molecular basis, Mutations, DNA repair mechanisms and protein synthesis.

CO3: Understand the protein synthesis in eukaryotes, translation process and regulation mechanisms in bacteria.

CO4: Students will learn tool of genetic engineering, terminologies, recombination techniques and DNA isolation, transfer and screening techniques.

| Unit | Title: Molecular Biology and Genetic Engineering (Credits: Theory-4, Practicals-2) | 60 hrs/ sem |
|---|---|---|
| Unit I | **Molecular basis of Life:** Introduction to DNA and RNA as a genetic material- Griffith experiment of Transformation, Proof that genetic information stored in DNA, Enzymatic approach to prove DNA mediates transformation by A very, MacLeod and McCarty, Hershey, and Chase experiment to prove DNA carries the genetic information in T2 bacteriophage. Organization of genes in mitochondria and chloroplast **(8 hrs)** **Regulation of transcription:** Positive and negative transcriptional control in bacteria. *lac* Operon concept, Regulation by lac repressor and CAP. *trp* operon regulation - repressor control, regulation by Gal operon in Eukaryotes **(4Hrs)** **Regulation through modification of gene structure:** DNase I hypersensitivity, histone modifications, chromatin remodelling, DNA methylation. Regulation through RNA processing and degradation. Regulation through RNA interference **(3 hrs)** | 15 hrs |
| Unit II | **Protein Synthesis in prokaryotes**: Transcription – Transcription bubble, RNA Polymerase and Translation – process of initiation, elongation and termination. **Protein Synthesis in Eukaryotes**: **Transcription**: Eukaryotic RNA polymerases - RNA polymerase I, II, III. Mechanism of RNA polymerase. Transcription factors, TATA Box, Post transcriptional modifications **(6 hrs)** **Translation**: Structure and processing of tRNA and Ribosome., Formation of initiation complex. Stages of translation - Initiation, Elongation and termination. Role of eIFs. Elongation of polypeptide - EF-Tu, EF-G, peptide bond formation, peptidyl transferase activity, translocation, eEFs. Termination. **(6 hrs)** | 15 hrs |

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|---|---|---|
| | **Post translational Modifications**- Process of Protein folding. Factors affecting the protein folding. Chaperon dependent protein folding. Protein-folding models. Protein denaturation. Outline of protein folding linked to disease. **(3 hrs)** | |
| Unit III | **Tools of genetic engineering**: Definition of genetic engineering, milestones in genetic engineering, prospects and problems of genetic engineering. **(2 hrs)**<br>**Tools in Microbial Genetic Engineering**: Restriction modification systems- Types, Mode of action, nomenclature, applications of restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases, Methylases, Terminal deoxynucleotidyl transferase, kinases, phosphatases and DNA ligases. **(4 hrs)**<br>**Cloning Vectors**: Definition and Properties. Characteristics of cloning vectors. Plasmid vectors: pBR and pUC series. Bacteriophage lambda, cosmids, BACs, YACs. Use of linkers and adaptors. **(4 hrs)**<br>**Expression vectors**: Baculovirus based vectors, mammalian SV40-based expression vectors. **(3 hrs)**<br>**Cloning host**- Escherichia coli and Saccharomyces cerevisiae as Cloning host<br>**PCR** – Working Principle and applications. **(2 hrs)** | 15 hrs |
| Unit IV | **DNA Isolation, transfer and Screening methods**<br>**Isolation and Detection of DNA**: Isolation of Genomic and Plasmid DNA, restriction digestion and ligation of DNA, Agarose gel electrophoresis, Blotting techniques- Southern blotting, Northern blotting, Western blotting. **( 4 hrs)**<br>**DNA transfer methods**: Calcium chloride mediated gene transfer, Agrobacteriutm mediated DNA transfer, Electroporation and Micro-injection. **(4 hrs)**<br>**Screening and selection of recombinant host cells**: Insertional activation - antibiotic selection. Inactivation - Blue white selection. In situ colony/DNA hybridization and in Immunological techniques **(3 hrs)**<br>**Gene Library**: Construction of Genomic library and cDNA library **(2 hrs)**<br>**DNA finger printing technique** – Principle and Applications, Merits and Demerits **(2 hrs)** | 15hrs |

**Recommended books:**


1. Karp, G., Iwasa, J., & Marshall, W. (2023). *Karp's Cell and Molecular Biology* (10th ed.). Wiley.
2. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2021). *Lewin's Genes XIII* (13th ed.). Jones & Bartlett Learning.
3. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2020). *Molecular Biology of the Gene* (8th ed.). Pearson.

4. Malacinski, G. M. (2018). *Freifelder's Essentials of Molecular Biology* (5th ed.). Jones & Bartlett Learning.
5. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). *Biochemistry* (9th ed.). W.H. Freeman.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.
7. Tropp, B. E. (2012). *Molecular Biology: Genes to Proteins* (4th ed.). Jones & Bartlett Learning.
8. Allison, E. A. (2015). *Fundamental Molecular Biology* (3rd ed.). Wiley.

| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20Marks** |
| ***Formative Assessment as per guidelines.*** | |

## B.Sc. Semester–III
## Discipline Specific Course (DSC)
## Practical: Molecular Biology and Genetic Engineering

**Course Title: Molecular Biology and Genetic Engineering**

**Course Code: C3MCB1P1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-6** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course, students will be able to:**

CO 1: Get Expertise in GLP, SOP in molecular biology experiments thoroughly.
CO 2: Get hands on Expertise in the field of molecular biology Experiments such bacterial genome extraction, isolation, plasmid isolation.
CO 3: Serve as platform for molecular biology field and explore the knowledge in molecular biology research.
CO 4: Expertise in DNA, RNA estimation, Studying semiconservative model of replication, mutant selection by Replica plate method and DNA fingerprinting techniques.

List of the Experiments, each will have 04Hrs / Week

1. Good Laboratory Practices and Safety Measures of Biohazard materials.
2. Study of Micropipette operation and calibration.
3. Standard operating procedure for molecular biology tools/equipment's.
4. Preparation of Buffers and Reagents.
5. Isolation of Bacterial Genomic DNA.
6. Isolation of Plasmid from *E. Coli* Cells.
7. Detection of DNA by gel electrophoresis.
8. Estimation of DNA by DPA colorimetric/spectrophotometric method.
9. Estimation of RNA by orcinol colorimetric/ spectrophotometric method.
10. Estimation of Total free Amino acids.
11. Extraction and estimation of protein from Microbial/Animal/plant source by salt precipitation and organic solvent method.
12. Study of semi-conservative replication of DNA through micrographs / schematic representations
13. DNA fingerprinting technique through micrographs / schematic representations
14. Identifying Mutants by Replica plate technique.
15. Study of Plasmids by Chart

    a) pBR322

    b) pUC18and19

    c) SV40

    d) Bacteriophages

**Books recommended**:


1. Brown, T. A. (2023). Genetics: A molecular approach (4th ed.). Cdn. Stancly Phonics Ltd.
2. Colwell, R. R. (2012). Microbial diversity (2nd ed.). Academic Press.
3. Davis, R. W., Bolstein, D., & Roth, J. R. (1980). A manual for genetic engineering. Cold Spring Harbor Laboratory.
4. De Robertis, E. D. P., & De Robertis, E. M. F. (2017). Cell and molecular biology (8th ed.). Lea & Febiger.
5. Karp, G. (2023). Cell biology (10th ed.). McGraw Hill.
6. American Society for Microbiology. (2020). Recombinant DNA (3rd ed.). American Society for Microbiology.
7. Nicholl, D. S. T. (2020). An introduction to genetic engineering (4th ed.). Cambridge University Press.
8. Peters, P. (2015). A guide to genetic engineering (3rd ed.). WMC Brown.
9. Salle, A. J. (2019). Fundamental principles of bacteriology (10th ed.). Tata McGraw Hill.
10. Smith, J. (2018). Molecular biology (6th ed.). Faber and Faber Publications.
11. Stanier, R. Y., & Ingraham, J. L. (2019). General microbiology (6th ed.). Prentice Hall of India.
12. Watson, J. D. (2020). Recombinant DNA (4th ed.). Scientific American Books.

## B.Sc. Semester–IV
## Discipline Specific Course (DSC)

# Course Title:-Environmental and Agricultural Microbiology

**Course Code: C4MCB1T1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-7** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO 1: Develop thorough knowledge and understanding of concepts of Microbiology of Air, water and soil, Bioremediation and Bioleaching of minerals.

CO 2**:** Become efficient in Agricultural and soil microbiology.

CO 3**:** Get knowledge of Biofertilizers production and marketing.

CO 4**:** Learn about microbes importance in agriculture sustainability, microbes in plant diseases and biopesticides.

| Unit | Title: Environmental and Agricultural Microbiology (Credits: Theory-4, Practicals-2) | 60 hrs/ sem |
|---|---|---|
| Unit I | **Microbiology of air**<br>Microbes and atmosphere: Atmospheric layers, air as habitat for microbes, air microflora of indoor and outdoor environment, space microbes, factors affecting air microflora, significance and management of airborne microbes. Techniques of trapping airborne microorganisms: Gravity slide, Petri plate exposure, liquid impingement, sieve device and filtration. Air borne diseases: allergens, pathogens, significance of microorganisms in air. Control of air borne microorganisms. **(7hrs)**<br><br>**Microbiology of water**<br>**Sources of water:** surface and ground water and their microflora. Water as a habitat for microbes. Water pollution - sources, water borne diseases-viral (Jaundice), bacterial (Cholera,) and protozoan (amoebiasis), biological indicators of water pollution. Determination of sanitary quality of water: SPC tests for coliform and E.coli. MPN. IMViC tests, membrane filter technique. Water purification in municipal water supply. **(8 hrs)** | 15 hrs |
| Unit II | **Microbiology of waste water**<br>Source of waste water - domestic, agricultural and industrial, physical, chemical and microbiological characteristics of waste water. Waste water treatment: Single dwelling unit - Septic tank; municipal waste water treatment - Primary (Screening, coagulation and Sedimentation). Secondary **(**trickling filter, activated sludge process, Osmosis, oxidation pond), Tertiary (reverse Ion exchange method and dialysis), reclamation of waste water and solid waste recycling. Waste as Resource (organic compost): Biogas production and composting. **(8 hrs)** | 15 hrs |

| | | |
|---|---|---|
| | **Bioremediation and Bioleaching**: Introduction, types, mechanism, scope and applications of Bioremediation. Factors affecting the microbes in heavy metal tolerance Different microbial groups in bioremediation of environment pollution. Biodegradation of Petroleum (Hydrocarbons), pesticides (2,4-D and DDT), different microbial groups in bioremediation of environment. Role of Biosurfactants in bioremediation of pollutants.<br>**Bioleaching:** Scope, organisms involved, economic importance, mechanism of bioleaching of Cu and Fe. **(7 hrs)** | |
| Unit III | **Microbiology of soil**<br>Introduction: Type, soil profile, physical and chemical characters. Soil as habitat for microbes. Soil Microorganisms: Bacteria, fungi, actinomycetes. algae, protozoa and viruses. Role of Microbes in soil process: Biogeochemical cycles - Carbon, Nitrogen, Sulphur and Phosphorous. Biodegradation: Pectin. Cellulose and lignin. Rhizosphere Microorganisms: Rhizosphere and rhizoplane, Interactions among microorganisms -Neutralism, Mutualism, Commensalism. Antagonism and Parasitism. Plant-microbe interaction: Mycorrhizae. **(8hrs)**<br>**Microorganisms in Agriculture**<br>**Bio-fertilizers:** Types (Bacterial, fungal, phosphate solubilizers. BGA. Plants-Azolla*)*. **Mechanism of Nitrogen fixation:** Phosphate solubilizing and Cellulolytic micro organisms, Mass production, mode of applications, advantages and limitations of bacterial inoculants *(Rhizobium, Azotobacter, Azospirullum* and Cyanobacteria). **(7 hrs)** | 15 hrs |
| Unit IV | **Microbes as plant pathogens**<br>A brief account of the causative agent. Symptoms and control of the following plant diseases: Fungal *(Puccinia, Plasmopara, Cercospora, Pyricularia)* Bacterial *(Xanlhomonas oryzae)*, Mycoplasma - Sandal spike. Grassyshoot. Viruses (TMV. Tomato leaf curl).Brief account of post-harvest pathology and Integrated Pest Management. **(12 hrs)**<br>**Bio-pesticides:** Types (Bacteria- *Bacillus thuringienes,* viral- NPV. *Fungal (Trichoderma)*, mode of action, factors influencing and target pests. **(3 hrs)** | 15hrs |

**Recommended books:**


1. Alexander, M. (2019). *Introduction to soil microbiology* (6th ed.). John Wiley & Sons.
2. Atlas, R. M., & Bartha, R. (2021). *Microbial ecology: Fundamentals and applications* (4th ed.). Benjamin Cummings.
3. Brock, T. D. (2015). *Principles of microbial ecology* (3rd ed.). Prentice Hall.
4. Colwell, R. R. (2012). *Microbial diversity* (2nd ed.). Academic Press.
5. Grant, W. D., & Long, P. E. (2018). *Environmental microbiology* (2nd ed.). Thomson Litho Ltd.
6. Hurst, C. J. (2020). *Environmental microbiology* (3rd ed.). ASM Press.
7. Mehrotra, R. S. (2017). *Plant pathology* (5th ed.). Tata McGraw Hill.
8. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2019). *Microbiology* (6th ed.). McGraw Hill.
9. Mitchell, R. (2018). *Introduction to environmental microbiology* (4th ed.). Prentice Hall.
10. Powar, C. B., & Daginwala, H. F. (2015). *General microbiology* (Vol. 1, 4th ed.). Himalaya Publishing House.
11. Powar, C. B., & Daginwala, H. F. (2015). *General microbiology* (Vol. 2, 4th ed.). Himalaya Publishing House.
12. Prescott, L. M., Harley, J. P., & Klein, D. A. (2021). *Microbiology* (11th ed.). McGraw Hill.
13. Mitchell, R. (2020). *Environmental microbiology* (4th ed.). Wiley.
14. Rangaswamy, G. (2019). *Diseases of crop plants in India* (4th ed.). Prentice Hall of India.
15. Rangaswamy, G., & Bagyaraj, D. J. (2017). *Agricultural microbiology* (3rd ed.). Prentice Hall of India.
16. Rao, M. N., & Datta, A. K. (2018). *Wastewater treatment* (3rd ed.). Oxford & IBH.
17. Rheinheimer, G. (2016). *Aquatic microbiology* (5th ed.). John Wiley & Sons.
18. Salle, A. J. (2019). *Fundamental principles of bacteriology* (10th ed.). Tata McGraw Hill.
19. Singh, D. P., & Dwivedi, S. K. (2018). *Environmental microbiology and biotechnology* (2nd ed.). New Age Industrial Publishers.
20. Stanier, R. Y., & Ingraham, J. L. (2019). *General microbiology* (6th ed.). Prentice Hall of India.
21. Stewart, W. D. P. (2017). *Nitrogen fixation in plants* (4th ed.). The Alhione Press.
22. Subba Rao, N. S. (2019). *Soil microorganisms and plant growth* (5th ed.). Oxford & IBH.
23. Subba Rao, N. S. (2018). *Biofertilizers in agriculture* (3rd ed.). Oxford & IBH.


| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20 Marks** |
| ***Formative Assessment as per guidelines.*** | |

**B.Sc. Semester–IV**
**Discipline Specific Course (DSC)**
**Practical: Environmental and Agricultural Microbiology**

**Course Title: Environmental and Agricultural Microbiology**
**Course Code: C4MCB1P1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-8** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO 1 Develop thorough knowledge of Experiments in Microbiology of Air, water and soil.
CO 2: Become efficient in managerial skills in water microbiological analysis chemical and biological tests.
CO 3: Able to employ analytical reasoning, problems solving, interpretation and documentation of laboratory experiments at a level suitable to succeed at an entry- level position in Microbiology.
CO 4: Get expertise in Biofertilizer and biopesticides production, techniques to detect plant pathogens from diseased plants.

List of the Experiments, each will have 04Hrs / Week

1. Isolation of microorganisms from soil, air and water.
2. Isolation and enumeration of microorganisms from different water samples.
3. MPN tests and Membrane filtration Techniques for Coliform and E. coli from potable water samples.
   Rapid methods to detect Coliform and E. coli from drinking water samples.
4. Estimation of TSS (Total Suspended Solids) and TDS (Total Dissolved Solids) in sewage samples.
5. Estimation of dissolved oxygen, BOD, COD and chloride.
6. Bioremediation of industrial wastes (Soil and Water) by using indigenous microbes.
7. Isolation and enumeration of bacteria and fungi from Rhizosphere and Rhizoplane. Study of Antagonism between soil microorganisms by plate method.
8. Isolation of *Rhizobum* using yeast extract Mannitol Agar and Isolation of *Azotobacter* using Ashby's Mannitol Agar from soil.
9. Study of Rhizobium from Legume root nodules through gram staining.
10. Mass of cultivation of Rhizobium Biofertilizer (liquid/solid) using carrier material.
11. Isolation of Actinomycetes from soil using different agar medias.
12. Demonstration of water purification process: Flocculator, Clarifier, Sand filter, back wash chlorometer and chloroscope), sewage treatment plants - Trickling filter, Imhoff tank, Septic tank and sewage treatment
13. Demonstration of air samplers – vertical cylinder spore trap. Rotarod samples, Hirst spore trap. Anderson samples liquid impingement method (Bead Bubbler).
14. Plant Pathology: Study of plant pathogens (Two diseases each from Bacteria, Fungi and Virus). Demonstration of caking of grains.
15. Visit to Municipal water treatment/water treatment plant /sewage treatment plant. Report should be written and submitted along with practical record.

**B.Sc. Semester–V**
**Discipline Specific Course (DSC)**
**Student shall select DSC 9A & 10 A or 9B & 10 B for 06 credits only**

**Course Title:- Food and Industrial Microbiology**
**Course Code: C5MCB2T1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-9A** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Understand the association of microbes in food and industrial, quality testing of food and industrial products
CO2: Understand the preservation and food safety protocols
CO3: Understand the methods of spoilage of food and the diseases associated with it
CO4: Learn the properties of milk and the types of preservation of milk.
CO5: Learn the industrial microbes, fermentation, scale up processes and its significance in industry.

| Unit | Title: Food and Industrial Microbiology (Credits: Theory-4, Practicals-2) | 60 hrs/ sem |
|---|---|---|
| Unit I | **Microbes and Food**<br>**Food as a substrate for microorganisms:** Intrinsic and extrinsic parameters affecting the growth of microbes. Microorganisms in food and their sources (molds, yeast and bacteria).<br>**Food borne infections and Intoxication:** Causative agents, foods involved, symptoms and preventive measures for Salmonella, Shigella, *Yersinia enterocolitica Staphylococcus, Clostridium. Salmonella, Bacillus cereus, Brucella, Listeria monocytogens,* Mycotoxin, Phycotoxins.<br>**Fermented Food:** Prebiotics, Probiotics and Synbiotics and Fermented vegetable- sauerkraut, pickles. Meat- sausage. Beverages kombucha. Sourdough. Microbes as food- SCP, SCO. Nutraceuticals and Functional Foods. | 15 hrs |
| Unit II | **Spoilage of Food, Preservation and Food safety**<br>**Spoilage of Food:** Principles of food spoilage, Sources and Types of food spoilage. Spoilage of meat and poultry, Fish and seafoods. Spoilage cereals, fruits and vegetables, Spoilage of canned food.<br>**Food Preservation**: Principles of food Preservation. Physical (temperature, drying, irradiation), chemical (Class I and Class II). Canning, Bio preservation. Food Packaging- Types of packaging materials, properties and benefits.<br>**Quality control in Food**-Food Sampling, preparation and handling, Surface and environmental monitoring in food industry, basic physical and chemical analysis of food, Microbiological analysis of food and food products, Rapid and molecular methods to detect food pathogens.<br>**Food Sanitation and Safety:** Good Hygiene practices, GLP, GMP (Waste treatment disposal methods), Food Safety HACCP, FSSAI and Food safety and Standard act 2006.Food control agencies and their regulation. | 15 hrs |

| | | |
|---|---|---|
| Unit III | **Introduction to Industrial Microbiology:**<br>History, scope and development of industrial microbiology. Isolation and screening (Primary and Secondary) of industrially important microorganisms, Strain improvement methods. Preservation of industrially important microbes. Basic features; design and components of a bioreactor, Specialized bioreactors and their applications: tubular bio reactors, fluidized bed reactor, packed bed reactors, membrane bioreactors, Photo-bioreactors and anaerobic bioreactors.<br>Role of industrial microorganisms for recovery of Minerals (Bioleaching) and Petroleum (Microbial Enhanced Oil Recovery-MEOR). Role of microbes in production of biofuel by bacteria and algae ( Third generation biofuel). | 15 hrs |
| Unit IV | **Fermentation Process and Scale up process:**<br>Types of fermentation process: Submerged fermentation, Solid state fermentation (Koji), batch fermentation, continuous fermentation, Growth kinetics of fermentation process. Inoculum preparation. Media components and formulation (Crude media components, Anti-foam agents, Precursors, Inducers, Inhibitors and Buffering agents). Sterilization of media and raw materials and maintenance of Sterility at critical points during fermentation.<br>**Scale up of Fermentation:** Upstream and Downstream processing, Objectives and significance of downstream processing: Overview of steps in extraction and purification of products (Antibiotic, Enzyme, Hormones, Anti-cancerous compounds); Precipitation Filtration and centrifugation; cell disruption- Physical, chemical and biological methods; Product extraction; product purification, recovery drying, crystallization and product testing. Merits and demerits. Immobilization of cells and enzymes –Types, advantages and applications in fermentation industry. | 15hrs |

**Recommended books:**


1. Adams, M. R., & Moss, M. O. (2016). *Food Microbiology* (4th ed.). Royal Society of Chemistry.
2. Ananthanarayanan, R., & Paniker, C. K. J. (2021). *Textbook of Microbiology* (12th ed.). Orient Longman.
3. Banwart, G. J. (2012). *Basic Food Microbiology* (3rd ed.). CBS Publishers & Distributors.
4. Hobbs, B. C. (2015). *Food Microbiology* (6th ed.). Arnold-Heinemann.
5. Casida, L. E. (2018). *Industrial Microbiology* (3rd ed.). New Age International Publishers.
6. Frazier, W. C., & Westhoff, D. C. (2018). *Food Microbiology* (5th ed.). Tata McGraw Hill.
7. Hammer, B. W., & Babal, R. (2019). *Dairy Microbiology* (4th ed.). Prentice Hall.
8. Chandra, J. (2017). *Textbook of Medical Mycology* (4th ed.). Orient Longman.
9. Jawetz, E., Melnick, J. L., & Adelberg, E. A. (2020). *Medical Microbiology* (28th ed.). McGraw Hill.
10. Jay, J. M. (2019). *Modern Food Microbiology* (8th ed.). Springer.
11. Reed, G. (2017). *Industrial Microbiology* (4th ed.). MacMillan Publications.
12. Robinson, R. K. (2018). *Dairy Microbiology* (3rd ed.). Elsevier.
13. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of Fermentation Technology* (3rd ed.). Elsevier.
14. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2019). *General Microbiology* (6th ed.). Prentice Hall of India.
15. Varnam, A. H., & Evans, M. G. (2017). *Foodborne Pathogens* (3rd ed.). Springer.

| Formative Assessment for Theory | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20 Marks** |
| ***Formative Assessment as per guidelines.*** | |

**B.Sc. Semester–V**
**Discipline Specific Course (DSC)**
**Practical: Food and Industrial Microbiology**

**Course Title: Food and Industrial Microbiology**
**Course Code: C5MCB2P1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSE-10A** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Understand the association of microbes in food and industrial, quality testing of food and industrial products
CO2: Understand the preservation techniques, SOP and food safety protocols HACCP.
CO3: Understand the methods of spoilage of food and the diseases associated with it
CO4: Learn MBRT, SPC, DMC, fat estimation, wine fermentation and production of enzymes techniques and will be helpful for the industrial exploration of knowledge.

List of the Experiments, each will have 04Hrs / Week

1. Isolation and enumeration of Aerobic Plate count and yeast and moulds from infected fruits and vegetables, ready to eat and cooked foods and fermented foods.
2. Enumeration of *E.coli, S.aureus, Salmonella, Shigella* and *Bacillus cereus* form ready to eat/cooked food using selective culture medias.
3. Reductase tests-MBRT, Resazurin and Litmus milk test.
4. Estimation of Fat - Gerber's method
5. Bacterial examination of milk by SPC, DMC.
6. Production of fermented foods.
7. Detection of Mastitis milk.
8. Preparation of wine from different fruits by fermentation techniques.
9. Estimation of Alcohol by Specific gravity method.
10. Production and estimation of citric acid by *Aspergillus brasilensis.*
11. Production of enzyme (amylase/protease) by submerged fermentation).
12. Production of enzyme cellulose /invertase
13. Immobilization of cells and enzymes by solid entrapment.
14. Preservation of microbes with glycerol/soil/oil/sand.
15. Visit to Food industries, Research institutes, Sugar Distillery, Alcoholic beverages industry and report should be written and submitted along with the practical record.

**B.Sc. Semester–V**
**Discipline Specific Course (DSC)**
**Course Title:- Microbial Biotechnology and Bioinformatics**
**Course Code: C5MCB2T2**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSE-9B** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Understand the association of microbes in Microbial biotechnology and commercial applications, microbial industrial products and their Recovery.
CO2: Understand the concept of biofuels production and applications.
CO3: Understand the different bioremediation techniques for removal of pollutants from environment.
CO4: Learn the Bioleaching process of mineral recovery and microbes importance in leaching.
CO5: Learn the fundamentals and basics of bioinformatics and their applications in handing biological data.
CO6: Understand the biological databases and their use in protein structure predictions.

| Unit | Title: Microbial Biotechnology and Bioinformatics (Credits: Theory-4, Practicals-2) | 60 hrs/ sem |
|---|---|---|
| Unit I | **Introduction to Microbial Biotechnology**<br>Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. Genetically engineered microbes for industrial application: Bacteria and yeast.<br>**Applications of Microbial Biotechnology**<br>Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors. | 15 hrs |
| Unit II | **Microbial Products and their Recovery**<br>Microbial product purification, filtration, ion exchange & affinity chromatography techniques. Immobilization methods and their application: Whole cell immobilization.<br>**Microbes for Bio-energy and Environment**<br>**Biofuels:** Introduction, types, production of third generation biofuel, Bio-ethanol and bio-diesel production. Commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Advances in microbial production of biofuels.<br>**Microbial Bioremediation:** Introduction, types of bioremediation and mechanism. Factors affecting the bioremediation. Degradation of heavy metals and other pollutants. Bio-removal of heavy metals from industrial /aqueous effluents.<br>**Bioleaching:** Introduction, Bioleaching of minerals from ores, types, mechanisms, and applications. | 15 hrs |

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|---|---|---|
| Unit III | **Introduction to Computer Fundamentals**<br>RDBMS - Definition of relational database. Mode of data transfer (FTP, SFTP SCP), advantage of encrypted data transfer.<br>**Introduction to Bioinformatics and Biological Databases**: Biological databases nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Gene bank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, PDB. | 15 hrs |
| Unit IV | **Applications of bioinformatics**<br>Sequence Alignments, Phylogeny and Phylogenetic trees: Pairwise (Local and Global) Sequence alignment and multiple sequence alignment. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood. Genome organization and analysis.<br>**Protein Structure Predictions**<br>Hierarchy of protein structure - primary, secondary and tertiary structures, modelling Structural Classes, Motifs, Folds and Domains. Protein structure prediction in presence and absence of structure template. | 15 hrs |

**Recommended books:**


1. Glazer, A. N., & Nikaido, H. (2018). *Microbial Biotechnology* (3rd ed.). Cambridge University Press.
2. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2022). *Molecular Biotechnology* (5th ed.). ASM Press.
3. Gupta, P. K. (2017). *Elements of Biotechnology* (3rd ed.). Rastogi Publications.
4. Lesk, M. A. (2019). *Introduction to Bioinformatics* (4th ed.). Oxford University Press.
5. Pradeep, & Sinha, P. (2018). *Foundations of Computing* (5th ed.). BPB Publications.
6. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2021). *Prescott, Harley, and Klein's Microbiology* (11th ed.). McGraw Hill.
7. Primrose, S. B., & Twyman, R. M. (2016). *Principles of Genome Analysis & Genomics* (4th ed.). Wiley-Blackwell.
8. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2019). *Bioinformatics: Methods and Applications, Genomics, Proteomics and Drug Discovery* (4th ed.). Prentice Hall India.
9. Ratledge, C., & Kristiansen, B. (2017). *Basic Biotechnology* (4th ed.). Cambridge University Press.
10. Saxena, S. (2019). *A First Course in Computers* (5th ed.). Vikas Publishing House.
11. Swartz, J. R. (2021). Advances in Escherichia coli production of therapeutic proteins. *Current Opinion in Biotechnology*, 12, 195–201.


| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20 Marks** |
| ***Formative Assessment as per guidelines.*** | |

**B.Sc. Semester– V**
**Discipline Specific Course (DSC)**
**Practical: Microbial Biotechnology and Bioinformatics**

**Course Title: Microbial Biotechnology and Bioinformatics**
**Course Code: C5MCB2P2**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSE-10B** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course, students will be able to:**

CO1: Understand the techniques in Microbial biotechnology and commercial applications, microbial industrial products and their Recovery.
CO2: Learn the concept of Bioinformatics tools for exploring biological databases.
CO3: Understand the process of sequence alignment and phylogenetic tree construction.
CO4: Expertise in techniques for primer designing and protein structure prediction tools.

List of the Experiments, each will have 04Hrs / Week

1. Study yeast cell immobilization in calcium alginate gels.
2. Study enzyme immobilization by sodium alginate method.
3. Pigment production from fungi (*Trichoderma / Aspergillus / Penicillium*).
4. Isolation of xylanase or lipase producing bacteria.
5. Study of algal Single Cell Proteins.
6. Literature database- PUBMED
7. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB.
8. Sequence retrieval using BLAST.
9. Sequence alignment & phylogenetic analysis using ClustalW & phylip.
10. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction).
11. Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Gene tool.
12. Protein structure prediction: primary structure analysis, secondary structure prediction using spired, homology modelling using Swiss model.
13. Molecular visualization using JMOL.
14. Protein structure model evaluation (PROCHECK).
15. Prediction of different features of a functional gene.

**B.Sc. Semester–VI**
**Discipline Specific Course (DSC)**
**Student shall select DSC 11B & 12 B or DSC 11A & 12A for 06 credits only**

**Course Title:- Medical Microbiology and Immunology**
**Course Code C6MCB2T1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative Assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-11B** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Learn and understand the fundamental concepts of immunity, and the contributions of the organs and cells in immune responses.

CO 2: Learn how the MHC molecule's function and host encounters an immune insult.

CO 3: Understand the antibodies and complement system of immune system.

CO 4: Understand the medical microbiology concepts and about diseases epidemiology.

| Unit | Title: Medical Microbiology and Immunology (Credits: Theory-4, Practicals-2) | 60 hrs/ sem |
|---|---|---|
| Unit I | **Human Microbiome**: Normal microflora of skin, throat, small intestine and large intestine and birth canal. Microbiome in early life, Factors affecting microbial diversity and functions of microbiome: -age, genetics, environment, diet, anatomy, physiology, immunity, and psychology of host (human). Outline of Dysbiosis and diseases.- Diabetes, obesity, inflammatory bowel disease. Debate on "nature" vs. "nurture". **(7hrs)**<br>**Infection** - Invasive and non-Invasive. Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. Sample collection, transport and diagnosis. **(4hrs)**<br>**Antibacterial agents**: General characteristics and mode of action Antibacterial agents: Inhibitor of nucleic acid synthesis;<br>Inhibitor of cell wall synthesis; Inhibitor of cell membrane function;<br>Inhibitor of protein synthesis; Inhibitor of metabolism<br>Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin<br>Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine **( 4hrs)** | 15 hrs |
| Unit II | **Medical Bacteriology**<br>The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control **Respiratory diseases**: *Streptococcus pyogenes, Mycobacterium tuberculosis*<br>**Gastro Intestinal Diseases**: *Escherichia coli, Salmonella typhi, Vibrio cholerae,*<br>Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*<br>**Medical Virology, parasitology and Mycology**<br>The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control measures<br>**Viral Disease** : Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Corona, Influenza, | 15 hrs |

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|---|---|---|
| | swine flu, Ebola, Chikungunya, Japanese Encephalitis<br>**Protozoan diseases**: Malaria, Kala-azar, Entamoeba<br>**Fungal infections**- Cutaneous mycoses: Tinea, pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis.<br>**Vaccines:** Types, properties, functions and schedules. | |
| Unit III | **Historical perspective and scope of immunology**; Edward Jenner, Luis Pasteur, Types of Immunity; Natural (active and passive) and artificial (active and passive) with example Innate and acquired, Humoral and cell mediated immunity. Immunological memory, Major Histocompatibility complex, outline of Autoimmunity Clonal selection theory, Immunological tolerance<br>**Cells, tissue and organs of immune system**: Hematopoiesis, cytokines, properties and functions of B and T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils and Basophils), Monocytes and macrophages, Dendritic cells and Mast cells.<br>**Primary lymphoid organs**; Bone marrow and Thymus.<br>**Secondary lymphoid organs and tissues**; Spleen and Lymph nodes, payers patches, MALT.<br>**Complement system**: Functions of complement components, Complement activation by classical, alternative and lectin pathway to develop membrane attack complex (MAC). | 15 hrs |
| Unit IV | **Antigen**: Immunogenicity and antigenicity, epitopes, haptens. Properties of antigen contribute to immunogenicity; Chemical nature (proteins, carbohydrates, lipids and nucleic acids), degree of foreignness, molecular weight, chemical composition and complexity, degradability. Adjuvants (alum, freunds incomplete and complete) and their importance. B and T cell epitopes.<br>**Antibody**: Basic structure of antibody, light and heavy chain, variable and constant region, hinge region, Fab and Fc. Structure and functions of different types of antibodies (IgM, IgG, IgA, IgE, and IgD).<br>Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype.<br>Monoclonal antibody production by hybridoma technology<br>**Principles and applications of antigen-antibody interactions**:<br>Definition of affinity and avidity. Immunoprecipitation; Radial (Mancini) and double (Ouchterlony) immunodiffusion.<br>**Agglutination reactions:** Hemagglutination, Bacterial agglutination, passive agglutination, and agglutination inhibition. Enzyme linked immune-sorbent assay (ELISA): Direct, indirect, sandwich and competitive ELISA. Radioimmunoassay (RIA). Immunofluorescence. Complement mediated opsonization, complement fixation test.<br>**Hypersensitive reactions:** Classification, Humoral Immunity mediated hypersensitivity; Type I (IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity Type IV (DTH). | 15hrs |

**Books recommended:**


1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2022). *Cellular and Molecular Immunology* (10th ed.). Elsevier.
2. Ananthanarayan, R., & Paniker, C. K. J. (2021). *Textbook of Microbiology* (12th ed.). Orient Longman.
3. Douglas, J. W., & Sleigh, J. D. (2019). *Medical Bacteriology* (4th ed.). Churchill Livingstone.
4. Goldsby, R. A., Kindt, T. J., Osborne, B. A., & Kuby, J. (2021). *Kuby Immunology* (8th ed.). W.H. Freeman.
5. Gupte, S. (2019). *The Short Textbook of Medical Microbiology* (10th ed.). Jaypee Brothers Medical Publishers.
6. Hughes, W. T., & Moffet, H. L. (2018). *Clinical Microbiology* (5th ed.). J.B. Lippincott.
7. Jawetz, E., Melnick, J. L., & Adelberg, E. A. (2020). *Medical Microbiology* (28th ed.). McGraw Hill.
8. Kenneth, J. R. (2019). *Medical Microbiology: Introduction to Infectious Diseases* (6th ed.). Prentice Hall International.
9. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2020). *Microbiology* (7th ed.). McGraw Hill.
10. Bhatra, R. (2021). *Essentials of Medical Microbiology* (2nd ed.). Jaypee Brothers Medical Publishers.
11. Roitt, I. M. (2017). *Essentials of Immunology* (12th ed.). Blackwell Scientific Publishers.


| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20 Marks** |
| ***Formative Assessment as per guidelines.*** | |

**B.Sc. Semester–VI**
**Discipline Specific Course (DSC)**
**Practical: Medical Microbiology and Immunology**

**Course Title: Medical Microbiology and Immunology**
**Course Code: C6MCB2P1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-12B** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course, students will be able to:**

CO1: Learn to manage the medical sample for isolation

CO2: Learn about identification of pathogens

CO3: Get aware of diagnostics tools and techniques

CO4: Understand concepts of blood grouping and cell count and isolation and identification of causative agents.

List of the Experiments, each will have 04Hrs / Week

1. Identify pathogenic bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus* and *Bacillus*) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, $H_2S$ production, Nitrate reduction, Urease production and catalase tests.
2. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, MacConkey agar, Mannitol salt agar, TCBS, Cetrimide agar.
3. Study of bacterial flora of skin through swab sampling method by serial dilution.
4. Perform antibacterial sensitivity by Kirby-Bauer method (Disk/well and MIC).
5. Acid fast staining technique for Mycobacterium sps.
6. Study of dermatophytes – Ring worn and Malassezia.
7. Identification of human blood group and calculation of allelic frequency.
8. Perform Differential Leukocyte Count blood.
9. Separation of serum from the blood sample (demonstration).
10. Demonstration of immunodiffusion by ODD.
11. Demonstration of Immune electrophoresis.
12. Demonstration of ELISA test.
13. Demonstration of VDRL and WIDAL test.
14. Study symptoms and control measures of the diseases by photographs: Anthrax, chicken pox, HPV warts, AIDS and candidiasis.
15. Study of various stages of Malarial parasite in RBCs using permanent mounts.

**B.Sc. Semester–VI**
**Discipline Specific Course (DSC)**
**Student shall select DSC 11B & 12 B or DSC 11A & 12A for 06 credits only**

**Course Title:- Advances In Microbiology And Biostatistics**
**Course Code: C6MCB2T2**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-11B** | **Theory** | **04** | **04** | **60hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Understand the advance concepts of molecular biology

CO 2: Role of microbiology in Pharmaceutical sectors

CO 3: Understand the genomics and its applications

CO 4: Understand the role Biostatistics in biology

CO 5: Differentiate the system and synthetic biology

| Unit | Title: Advances in Microbiology and Biostatistics (Credits: Theory-4, Practicals-2) | 60 hrs/ sem |
|---|---|---|
| Unit I | **Evolution of Microbial Genomes**<br>Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics.<br><br>**Pharmaceutical Microbiology**<br>Introduction and application of pharmaceutical microbiology, GMP, GLP, SOP regulations. Laboratory management and design in the pharmaceutical sector. Principles and applications of selective/differential culture media, Different methods of microbial identification. Preservation and subculture techniques. Clean rooms and environment monitoring methods, microbiological challenge to the pharmaceuticals and health care. | 15 hrs |
| Unit II | **Molecular Basis of Host-Microbe Interactions**: Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance.<br>**Systems and Synthetic Biology**: Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses. | 15 hrs |

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|---|---|---|
| Unit III | **Introduction to biostatistics:** Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions.<br>**Statistical methods:** Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test | 15 hrs |
| Unit IV | **Intellectual Property rights**: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications, importance of IPR, patentable and non-patentable, patenting life-legal protection of biotechnological inventions, World Intellectual Property Rights Organization (WIPO).<br>**Grant of Patent and Patenting Authorities**: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. | 15hrs |

**Books recommended:**


1. Bare Act. (2023). Indian Patent Act 1970 Acts & Rules. Universal Law Publishing Co. Pvt. Ltd.
2. Bouarab, K., Brisson, N., & Daayf, F. (2010). Molecular Plant-Microbe Interaction. CABI.
3. Caetano-Anollés, G. (2021). Evolutionary Genomics and Systems Biology (2nd ed.). John Wiley & Sons.
4. Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in Health Sciences (11th ed.). John Wiley & Sons.
5. Edmondson, A., & Druce, D. (2021). Advanced Biology Statistics (2nd ed.). Oxford University Press.
6. Fraser, C. M., Read, T. D., & Nelson, K. E. (2019). Microbial Genomes (2nd ed.). Humana Press.
7. Primrose, S. B., & Twyman, R. M. (2016). Principles of Genome Analysis & Genomics (4th ed.). Wiley-Blackwell.
8. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2019). Bioinformatics: Methods and Applications, Genomics, Proteomics and Drug Discovery (4th ed.). Prentice Hall India.
9. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2021). Prescott, Harley, and Klein's Microbiology (11th ed.). McGraw Hill.
10. Hughes, W. T., & Moffet, H. L. (2018). Clinical Microbiology (5th ed.). J.B. Lippincott.

| Formative Assessment for Theory | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 05 |
| Internal Assessment Test2 | 05 |
| Assignment | 10 |
| **Total** | **20Marks** |
| ***Formative Assessment as per guidelines.*** | |

**B.Sc. Semester–VI**
**Discipline Specific Course (DSC)**
**Practical: Advances in Microbiology and Biostatistics**

**Course Title: Advances in Microbiology and Biostatistics**
**Course Code: C6MCB2P2**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **DSC-12B** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course, students will be able to:**

Role of microbiology in Pharmaceutical sectors.

CO 1: Understand the concept of validation.

CO 2: Get hands on experience with PCR technique.

CO 3: Learn to analysis of the biological date.

CO 4: Learn the biological assay of drugs.

List of the Experiments, each will have 04Hrs / Week

1. Laboratory instruments validation
2. Chart based study of different BSL cabinets
3. Bioburden test
4. Growth Promotion test (GPT) assay
5. Sterility testing
6. Agar plate diffusion assay
7. Total Bacterial count (TBC),
8. Total yeast and mould count (TYMC)
9. Assay of antibiotics by Turbidometer (or Nephelometric) methods
10. Study of Thermocycler and PCR
11. Measure of central tendency (Mean, Mode, Median)
12. Standard Deviation and Coefficient of Variation.
13. Skewness and Kurtosis.
14. Study of Correlation
15. Study of Regression.

## B.Sc. Semester– V
## Open Elective Course (OEC)
## It is for other combination students

## Course Title : Fundamental Microbiology
## Course Code: C5MCB5T1

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No .of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **OEC-1** | **Theory** | **03** | **04** | **45hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): At the end of the course students will be able to:**

CO1: Acquire knowledge of Microbiology, historical Background of Microbiology, where they learn about Contribution and discoveries of different scientist.

CO 2: Understand the concept of stains, staining techniques and working principle and applications of equipment's.

CO 3: Understand knowledge about the general characters and types of classification of Microorganisms, Viz-Bacteria, Fungi, algae, protozoa and virus Comprehend evolutionary importance and economic significance of microorganisms

CO 4: Learn the microscopy, culture medias, microbial nutrition and sterilization techniques which are helpful for industrial applications.

| Unit | Title: **Fundamental Microbiology** | 45 hrs/ sem |
|---|---|---|
| Unit I | **History of microbiology**: Theory of abiogenisis abd biogenisis. Scope and branches of Microbiology. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner Branches of microbiology. Scope and applications of microbiology in different areas.<br>**Systems of classification**: Whittaker's five kingdom classification and Carl Woese's three domain classification. Classical and molecular characteristic used in microbial taxonomy.<br>**General characteristics of different groups**<br>Acellular microorganisms-Viruses, Viroids, Prions.<br>Cellular microorganisms-Prokaryotes: Bacteria, Cyanobacteria, Archaebacteria.<br>Eukaryotes: Algae, Fungi and Protozoa; with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. | 15 hrs |
| Unit II | **Microbiological techniques -**<br>**Microscopy**<br>Principle and Applications of Microscopes – Compound, Dark field, Stereomicroscope, Fluorescent microscope, Electron microscopes.<br>**Stains and Staining techniques –** Principles of Stains and dyes. Preparation of smears and fixation. Simple staining (Positive and Negative). Differential staining<br>**Nutrition and Culturing of Microbes** -Nutritional requirements of microorganisms: Nutritional requirement-Water, Micronutrients, Macronutrien.s | 15 hrs |

| | | |
|---|---|---|
| | Fastidious and Non Fastidious orgnisms Culture media: components of media natural and synthetic media chemically defined media complex media, selective, differential, enriched Conditions required for growth of the microorganisms. Preservation of pure cultures | |
| **Unit III** | **Sterilization techniques** - Control of Microorganisms, Definitions of- Sterilization, Disinfection, Antiseptic, Germicide, Microbiostasis, Antisepsis, Sanitization.<br>Physical agents for control of microorganisms-Temperature, Dry heat, Moist heat, Radiations - U.V and Gamma rays.<br>Chemical Agents for control of microorganisms: Mode of action, application - Phenol and Phenols and Halogen compounds and Heavy metals (Cu and Hg).<br>**Instruments**<br>Working principles and applications of Instruments: Autoclave, Hot air oven, Laminar air flow, Centrifuge, pH meter, Incubator, Colorimeter | 15 hrs |

**Recommended books:**


1. Brock, T. D., & Madigan, M. T. (2021). *Biology of Microorganisms* (15th ed.). Pearson.
2. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2020). *Principles of Genetics* (9th ed.). Wiley-India.
3. Gottschalk, G. (2012). *Bacterial Metabolism* (3rd ed.). Springer Verlag.
4. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2019). *Concepts of Genetics* (12th ed.). Pearson.
5. Lansing, M., Prescott, J., Ohn, P., Harley, J. P., & Klein, D. A. (2019). *Microbiology* (10th ed.). McGraw Hill.
6. Madigan, M. T., & Martinko, J. M. (2021). *Brock Biology of Microorganisms* (16th ed.). Pearson.
7. Moat, A. G., & Foster, J. W. (2019). *Microbial Physiology* (5th ed.). John Wiley & Sons.
8. Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). W.H. Freeman.
9. Pierce, B. A. (2020). *Genetics: A Conceptual Approach* (7th ed.). Macmillan Higher Education.
10. Primrose, S. B., & Twyman, R. M. (2016). *Genomics: Applications in Human Biology* (4th ed.). Wiley-Blackwell.
11. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2019). *General Microbiology* (6th ed.). Pearson.
12. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2021). Prescott's Microbiology (11th ed.). McGraw Hill.
13. Caetano-Anollés, G. (2021). Evolutionary Genomics and Systems Biology (2nd ed.). John Wiley & Sons.
14. Bouarab, K., Brisson, N., & Daayf, F. (2010). Molecular Plant-Microbe Interaction. CABI.
15. Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in Health Sciences (11th ed.). John Wiley & Sons.
16. Edmondson, A., & Druce, D. (2021). Advanced Biology Statistics (2nd ed.). Oxford University Press.
17. Fraser, C. M., Read, T. D., & Nelson, K. E. (2019). *Microbial Genomes* (2nd ed.). Humana Press.

| Formative Assessment for Theory | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test 1 | 10 |
| Internal Assessment Test 2 | 10 |
| **Total** | **20 Marks** |
| ***Formative Assessment as per guidelines.*** | |

# B.Sc. Semester– VI

**Open Elective Course (OEC)**

## Course Title:- Applied Microbiology

**Course Code: - C6MCB5T1**

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **OEC-2** | **Theory** | **03** | **04** | **45hrs.** | **3hrs.** | **20** | **80** | **100** |

**Course Outcomes (COs): Attend of the course students will be able to:**

CO1: Overview various food and water born diseases

CO 2: Demonstrate entrepreneurial skills

CO 3 : Acquire knowledge on mass productions

CO 4 : Acquire knowledge on Communicable disease

| Unit | Title: Applied Microbiology | 45 hrs/ sem |
|---|---|---|
| Unit I | **Microbes and Environment**<br>Microbes of Air: Atmospheric layers and sources of microorganisms, air microflora of indoor and outdoor environment.<br>Microbes of Water: Biological indicators of water pollution. Determination of sanitary Quality of water: SPC tests for coliform. MPN. IMViC reactions, membrane filters technique. Source of waste water - Domestic, agricultural and industrial, physical, chemical and microbiological characteristics of waste water.<br>Microbes of Soil: Rhizosphere and rhizoplane, Interactions among microorganisms - Neutralism, Mutualism, Commensalism. Antagonism and Parasitism.<br>Microbes of Food: Food as substrate for microbes and sources of contamination, Spoilage of food and milk –, Gassy fermentation, Proteolysis. Lipolysis, Ropiness and canned foods, cereals, fruits, vegetables. Meat and fish. | 15 hrs |
| Unit II | **Microbial Entrepreneurship**<br>Microbial entrepreneurship - Introduction and scope, Business development, product marketing, HRD, Biosafety and Bioethics. Outline of copy right and patent laws.<br>Microbiological Industries - Mass production, mode of applications of Bio fertilizers Plant (Azolla) bacteria (*Rhizobium*) and Bio pesticides – *Tricoderma*<br>Concept of Prebiotics, Probiotics and Synbiotics –Production of Fermented foods sauerkraut and SCP.<br>Productions of Alcoholic and Beverages, Mushroom Cultivation and biogas production. | 15 hrs |
| Unit III | **Microbiomes and Human Health** :<br>**Human Microbiome**: Normal microflora of skin, throat, intestine and Factors affecting microbial diversity and functions of microbiome: - age, genetics, environment, diet, physiology, immunity of host<br>**Types of Immunity**; Introduction to immunity. Natural (active and passive) and artificial (active and passive) with example Innate and acquired, Humoral and cell mediated immunity. Out line of organs and cells of immune cells. | 15 hrs |

| | | |
|---|---|---|
| | **The pathogenesis, diagnosis and control measures of**<br>**Bacterial Disease** – Cholera Botulism, Salmonellosis.<br>**Fungal Disease** - Tinea, pedis (Athlete's foot), and Mycotoxins<br>**Viral disease** - Dengue, AIDS, Corona, Jaundice<br>**Protozoan diseases**: Malaria and amebiasis<br>**Antibiotics** – Types, functions and antibiotic therapy<br>**Vaccines** – Types, properties, functions and schedules | |

**Recommended books:**


1. Ananthanarayan, R., & Paniker, C. K. J. (2021). *Textbook of Microbiology* (12th ed.). Orient Longman.
2. Dubey, R. C., & Maheshwari, D. K. (2020). *A Textbook of Microbiology* (3rd ed.). S Chand & Co.
3. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2020). *Microbiology* (7th ed.). Tata McGraw Hill.
4. Prescott, L. M., Harley, J. P., & Klein, D. A. (2021). *Microbiology* (11th ed.). McGraw Hill.
5. Modi, H. A. (2018). *Elementary Microbiology* (Vol. I, 2nd ed.). Ekta Prakashan.
6. Sateesh, M. K. (2020). *Bioethics and Biosafety* (3rd ed.). IK International Pvt Ltd.
7. Dubey, R. C. (2019). *A Textbook of Biotechnology* (5th ed.). S Chand Publications.
8. Singh, B. D. (2021). *Expanding Horizons in Biotechnology* (4th ed.). Kalyani Publication.
9. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2021). *Prescott, Harley, and Klein's Microbiology (12th ed.). McGraw Hill.*
10. *Madigan, M. T., & Martinko, J. M. (2021). Brock Biology of Microorganisms (16th ed.). Pearson.*
11. *Caetano-Anollés, G. (2021). Evolutionary Genomics and Systems Biology (2nd ed.). John Wiley & Sons.*
12. *Bouarab, K., Brisson, N., & Daayf, F. (2010). Molecular Plant-Microbe Interaction. CABI.*
13. *Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in Health Sciences (11th ed.). John Wiley & Sons.*
14. *Edmondson, A., & Druce, D. (2021). Advanced Biology Statistics (2nd ed.). Oxford University Press.*
15. *Fraser, C. M., Read, T. D., & Nelson, K. E. (2019). Microbial Genomes (2nd ed.). Humana Press.*


| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| Internal Assessment Test1 | 10 |
| Internal Assessment Test2 | 10 |
| **Total** | **20Marks** |
| ***Formative Assessment as per guidelines.*** | |

# B.Sc. Semester–IV/ V/VI

**Skill Enhancement Course (SEC)**

**Student shall study SEC in any one of the Semesters either in IV or V or VI semester**

**College shall decide to allot the students**

## Course Title: Microbial Quality Control in Industries

## Course Code: C0MCB6P1

| Type of Course | Theory /Practical | Credits | Instruction hour per week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| **SEC-1** | **Practical** | **02** | **04** | **56hrs.** | **3hrs.** | **10** | **40** | **50** |

**Course Outcomes (COs): At the end of the course, students will be able to:**

**CO1**: Expertise skills of food sampling, handling and homogenization in food and pharma industry.

**CO2**: Develop knowledge of laboratory safety procedures and protocols and Acquire skills in handling and maintaining laboratory equipment and instruments.

**CO3**: Operate analytical equipment and instruments as per standard operating procedures (SOP).

**CO4**: Gain knowledge about major activities of the Microbial industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.

List of the Experiments, each will have 04Hrs / Week

1. SOP for Swab and food sampling, handling and homogenization in food industry.
2. Guidelines and procedure for GLP, GMP and GDP in quality control food and pharma industries.
3. SOP for cleaning, disposal, decontamination glassware's and culture medias.
4. SOP sanitation, fumigation and sterility in Microbiology laboratory.
5. Monitoring and validation of autoclave process by chemical and biological indicators in quality control
6. microbiology.
7. Media preparation and its importance in pharmaceutical and food industries.
8. Pure cultures maintenance techniques in quality control microbiology.
9. Growth Promotion Test (GPT) to verify the fertility of culture media.
10. Physical and chemical analysis of raw water used in food and pharma industries.
11. Enumeration of Total Viable Count (TVC), Total Yeast and Mould Count (TYMC).
12. Enumeration of specified pathogens from water by membrane filtration techniques in pharma industries.
13. Enumeration of Total Coliforms and E. coli form drinking, raw and DM water by membrane filtration techniques.
14. Environmental monitoring of Surface and personal hygiene swabs in industries.
15. Demonstration of BET and MLT sterility tests in pharma industries.
16. Visit to Pharma, Food and food processing, alcoholic beverage industries. Tour Report should be submitted.

**Books recommended**:


1. Baird, R. M., Hodges, N. A., & Denyer, S. P. (2021). *Handbook of Microbiological Quality Control in Pharmaceutical and Medical Devices* (2nd ed.). CRC Press.
2. Garg, N., Garg, K. L., & Mukerji, K. G. (2019). *Laboratory Manual of Food Microbiology* (2nd ed.). I K International Publishing House Pvt. Ltd.
3. Harrigan, W. F. (2013). *Laboratory Methods in Food Microbiology* (4th ed.). Academic Press.
4. Jay, J. M., Loessner, M. J., & Golden, D. A. (2021). *Modern Food Microbiology* (8th ed.). Springer.
5. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2021). *Prescott, Harley, and Klein's Microbiology* (12th ed.). McGraw Hill.
6. Madigan, M. T., & Martinko, J. M. (2021). *Brock Biology of Microorganisms* (16th ed.). Pearson.
7. Caetano-Anollés, G. (2021). *Evolutionary Genomics and Systems Biology* (2nd ed.). John Wiley & Sons.
8. Bouarab, K., Brisson, N., & Daayf, F. (2010). *Molecular Plant-Microbe Interaction*. CABI.
9. Daniel, W. W., & Cross, C. L. (2018). *Biostatistics: A Foundation for Analysis in Health Sciences* (11th ed.). John Wiley & Sons.
10. Edmondson, A., & Druce, D. (2021). *Advanced Biology Statistics* (2nd ed.). Oxford University Press.

# B.Sc. programme: 2024-25

GENERAL PATTERN OF **THEORY** QUESTION COURSE FOR DSC/ EC

(80 marks for semester end Examination with 3 hrs duration)

**Part-A**

1. Question number 1-10 carries 2 marks each. : 20 marks

**Part-B**

**2.** Question number 11- 18 carries 05Marks each. Answer any 06 questions : 30 marks

**Part-C**

**3.** Question number 19-22 carries 10 Marks each. Answer any 03 questions : 30 marks

(Minimum 1 question from each unit and 10 marks question may have sub questions for 7+3 or 6+4 or 5+5 if necessary)

**Total: 80 Marks**

**Note: Proportionate weight age shall be given to each unit based on number of hours Prescribed**