# M.Sc. MICROBIOLOGY

| SEM | COURSE CODE | COURSE | COURSE TITLE | HRS/ WEEK | CREDIT | MARKS | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | |
| I | 20PMB1CC1 | Core I | General Microbiology | 6 | 5 | 25 | 75 | 100 |
| | 20PMB1CC2 | Core II | Microbial Cell Physiology | 6 | 5 | 25 | 75 | 100 |
| | 20PMB1CC3 | Core III | Chemistry of Biomolecules | 6 | 4 | 25 | 75 | 100 |
| | 20PMB1CC4P | Core IV | General Microbiology, Microbial Cell Physiology and Chemistry of Biomolecules | 6 | 4 | 25 | 75 | 100 |
| | 20PMB1DE1 | DSE -I# | | 6 | 4 | 25 | 75 | 100 |
| **TOTAL** | | | | **30** | **22** | **125** | **375** | 500 |
| II | 20PMB2CC5 | Core V | Microbial Genetics and Molecular Biology | 6 | 5 | 25 | 75 | 100 |
| | 20PMB2CC6 | Core VI | Genetic Engineering | 6 | 5 | 25 | 75 | 100 |
| | 20PMB2CC7 | Core VII | Environmental and Agricultural Microbiology | 6 | 4 | 25 | 75 | 100 |
| | 20PMB2CC8P | Core VIII | Microbial Genetics and Molecular biology, Genetic Engineering, Environmental and Agricultural Microbiology Practical | 6 | 4 | 25 | 75 | 100 |
| | 20PMB2DE2 | DSE –II# | | 6 | 4 | 25 | 75 | 100 |
| **TOTAL** | | | | **30** | **22** | **125** | **375** | 500 |
| III | 20PMB3CC9 | Core IX | Medical Microbiology | 6 | 5 | 25 | 75 | 100 |
| | 20PMB3CC10 | Core X | Immunology and Immunotechnology | 6 | 5 | 25 | 75 | 100 |
| | 20PMB3CC11 | Core XI | Bioenergetics and Enzymology | 6 | 4 | 25 | 75 | 100 |
| | 20PMB3CC12P | Core XII | Medical Microbiology, Immunology and Immunotechnology, Bioenergetics and Enzymology Practical | 6 | 4 | 25 | 75 | 100 |
| | 20PMB3DE3 | DSE-III# | | 6 | 4 | 25 | 75 | 100 |
| | 20PMB3EC1 | Extra Credit I | Online Course (MOOC) | - | 1* | - | - | - |
| **TOTAL** | | | | **30** | **22** | **125** | **475** | 500 |
| IV | 20PMB4CC13 | Core XIII | Fermentation Technology | 6 | 5 | 25 | 75 | 100 |
| | 20PMB4CC14 | Core XIV | Food and dairy Microbiology | 6 | 5 | 25 | 75 | 100 |
| | 20PMB 4CC15 | Core XV | Bioinformatics and Biostatistics | 6 | 5 | 25 | 75 | 100 |
| | 20PMB4PW | Project Work | Project | 12 | 8 | - | 200 | 200 |
| | 20PMB4EC2 | Online Course (Compulsory) | | - | 1 | - | - | - |
| | 20PCNOC | Extra Credit-II | Microbiology for career Examinations | - | 5* | - | 100* | 100* |
| **TOTAL** | | | | **30** | **24** | **75** | **525** | **500** |
| **GRAND TOTAL** | | | | **120** | **90** | **450** | **1750** | **2000** |

*Not considered for Grand total and CGPA

**# Discipline Specific Electives**

| Semester | Subject code | Course Title |
|---|---|---|
| I | 20PMB1DE1A<br>20PMB1DE1B | Virology<br>Microbial Diversity |
| II | 20PMB2DE2A<br>20PMB2DE2B | Microbial Ecology<br>Bioremediation and Waste Management |
| III | 20PMB3DE3A<br>20PMB3DE3B | Bioinstrumentation and Bioethics<br>Endocrinology |

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External marks |
|---|---|---|---|---|---|---|---|---|
| I | 20PMB1CC1 | Core – I | GENERAL MICROBIOLOGY | 6 | 5 | 100 | 25 | 75 |

**Course Outcomes:**

1. Examine the characteristics and applications of microbial adaptations in planet.
2. Identify the group and proper name of organisms through standardized system.
3. Explain the evolutionary history, classification and distinguished features of bacteria.
4. Summarize the characteristics, structures and life cycle of fungi.
5. Acquire the relevant knowledge about the structure, life cycle and characteristics of microalgae.

**UNIT I** **18 hours**

**Microbial Planet:** Main themes of Microbiology- Impact of microbes on earth-Microbial involvement in energy and nutrient flow -Application using microorganism: versatile chemical changes, #impact on infectious human disease#.

**UNIT II:** **18 hours**

**Microbial Taxonomy:** Organizing, classifying and naming the microorganism. Levels of classification- system of presenting a universal tree of life. Basic concept of numerical taxonomy. Criteria used in bacterial identification: Classical and Molecular characteristics. Microbial kingdom concept. Classification system of prokaryotes by Bergey's manual of systematic bacteriology ($9^{th}$ edition).

**UNIT III** **18 hours**

**Bacterial profiles:** General characteristics, Structure and Reproduction of Eubacteria, Archaebacteria, #Mycoplasma# Actinomycetes, Rickettsiae, Chlamydias, Spirochaete and Cyanobacteria.

**UNIT IV** **18 hours**

**Fungal profiles:** History, general characteristics, habit, habitats and mode of nutrition. Classification of Fungi by Alexopoulos (1979). Heterokaryon- Dimorphic fungi and imperfect fungi. Morphology, structure and life cycle of *Aspergillus niger* and *Saccharomyces cerevisiae*.

**UNIT V** **18 hours**

**Microalgae**: Classification of algae based on Fritsch system- General characteristics of microalgae – Habit, Habitat, Biological and Economic importance of microalgae- Morphology, structure, life cycle of *Chlorella* and *Dunaliella*.

#.....# **Self study portion**

**Text Books:**

**T.B-1** J. Michael, J. R. Pelczar, E. C. S. Chan and N. R. Kreig, Microbiology, $5^{th}$ edition, McGraw Hill. Inc, New York, 1993.

**T.B-2** S. S. Purohit and A. K. Saluja, H. N. Kakrani, Pharmaceutical Microbiology, Mrs.Sarwathi purohit for student edition, India, 2006.

**T.B-3** K. S. Bilgrami and R. K. Sinha, Essentials of Microbiology, $1^{st}$ edition, SK Jain for CBS publishers and distributors, 2005.

**T.B-4** P. S. Bisen Kavitha Verma, Hand book of Microbiology, 2004.

| | | |
|---|---|---|
| **UNIT I** | Chapter I | **T.B-1** |
| **UNIT II** | Chapter III & V | **T.B-2** |
| | Chapter V | **T.B-3** |
| **UNIT III** | Chapter XXIII | **T.B-4** |
| **UNIT IV** | Chapter XVII | **T.B-1** |
| **UNIT V** | Chapter XVIII | **T.B-1** |

**Books for Reference:**


1. J.G. Holt, N.R. Kreig, P.H.A. Sneath, and S.T. Williams, Bergey's Manual of Systematic Bacteriology, 9th edition, Williams and Wilkins, Baltimore, 1994.

2. L. M. Prescott, J. P. Harley and D. AKlein, Microbiology, 7th edition, Mc Grow Hill, 2007.

3. M.T. Madigan, J.M. Martinko and J.Parker, Brock Biology of microorganisms, 11th edition, Pearson Education international, USA, 2006.

4. G. J. Tortora, B.R Funke and C. L. Case, Microbiology an Introduction, 8th edition, LPE-Pearson Education, Inc, 2005.


**Web Reference**:

1. https://nptel.ac.in/courses/102103015/
2. https://courses.lumenlearning.com/suny-biology2xmaster/chapter/ecology-of-fungi/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | Hours | | Credits | |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 20PMB1CC1 | | | GENERAL MICROBIOLOGY | | | 6 | | 5 | |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | | ✓ | | ✓ | ✓ | | ✓ | | ✓ |
| CO2 | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ |
| CO3 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO4 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO5 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Number of Matches= 36, Relationship : High | | | | | | | | | | |

Prepared by:
1. Dr.M.Mohamed Mahroop Raja

Checked by:
1. Dr.N.Reehana
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External marks |
|---|---|---|---|---|---|---|---|---|
| I | 20PMB1CC2 | Core – II | MICROBIAL CELL PHYSIOLOGY | 6 | 5 | 100 | 25 | 75 |

**Course Outcomes:**

1. Describe the synthesis of bacterial cell wall and its transport mechanism.
2. Observe the specific growth rate of microbes under different physicochemical conditions.
3. Determine the distribution, classification and applications of archaebacteria.
4. Acquire knowledge on photosynthesis and its pigments produced by microorganism
5. Identify the catabolic and anabolic reactions occurring in the organism.

**UNIT I** **18 hours**

**Cell structure and function:** Bacterial cell wall - Biosynthesis of peptidoglycan - outer membrane, teichoic acid – Exopolysaccharides; cytoplasmic membrane, pili, fimbriae, S-layer. Nutrient Transport mechanisms- uniport, symport and antiports- active, passive, facilitated diffusions and group translocation- Siderophore in Iron transport. Electron carriers – artificial electron donors – inhibitors – uncouplers – energy bond – phosphorylation.

**UNIT II** **18 hours**

**Microbial Growth:** Microbial Nutrition- autotroph, phototroph, heterotroph, organotroph, lithotrophs and Winogradsky column. Phases of growth curve – measurement of growth – calculations of growth rate – generation time. Diauxic growth, Synchronous growth – induction of synchronous growth, synchrony index and Continuous growth. #Factors affecting microbial growth#- Cell division- mechanisms involved in formation of Z-ring.

**UNIT III** **18 hours**

**Archaebacteria:** Characteristics, cell wall, properties, distribution, abundance and ecological niche. Thermophiles: Classification, hyperthermophilic habitats and ecological aspects. Extremely Thermophilic Archaebacteria, Thermophily, commercial aspects of thermophiles. Applications of thermozymes. Methanogens: Classification, Habitats, applications.

**UNIT IV** **18 hours**

**Microbial Photosynthesis**: Carbon assimilation- oxygenic and anoxygenic photosynthesis. Photosynthetic and accessory pigments. Fluorescences and phosphoroscenses. #bacteriochlorophyll,# rhodpsin, carotenoids, phycobiliproteins, Pulcherrimin, indigoidin, vioalecin. Defensive role of pigments. Bioluminescence mechanism – advantages.

**UNIT V** **18 hours**

Microbial Catabolism and Anabolism- Fermentation and Respiration-EMP pathway-Pasture effect, ED pathway, Glyoxalate pathway, Krebs cycle. Anabolism- Gluconeogenesis and #reverse TCA cycle#. Microbial growth on C1 Compounds (Cyanide, Methane, Methanol, methylated amines and carbon monoxide).

**#.....# Self study portion**

**Text Books:**

**T.B-1** M. L. Gupta and M. L. Jangir, Cell biology: Fundamentals and Applications, Agrobios, India, 2010.

**T.B-2** H. G. Schlegel, General Microbiology, 7th edition, Cambridge university press, 2004.

**T.B-3** Stuart Hogg, Essential Microbiology, John Wiley and sons Ltd, 2005.

**T.B-4** D. L. Nelson and M. M. Cox, Lehninger: Principles of Biochemistry, 4th edition,

W. H. Freeman and company, 2005.

**T.B-5** L. M. Prescott, J. P. Harley and D. AKlein, Microbiology, 7th edition, Mc Grow Hill, 2007.

| | | |
|---|---|---|
| **UNIT I** | Chapter III | **T.B-2** |
| **UNIT II** | Chapter V | **T.B-3** |
| **UNIT III** | Chapter XXIV, XXV | **T.B-1** |
| **UNIT IV** | Chapter XIX | **T.B-4** |
| **UNIT V** | Chapter VIII | **T.B-5** |

**Books for Reference:**

1. D.R.Caldwell, Microbial Physiology and Metabolism, W.M.C.Brown Publishers, 2nd edition, LPE-Pearson Education, Inc, 1995.

2. J.L.Ingraham and C.A.Ingraham, Introduction to Microbiology, 3rd edition, Thomson Brooks/cole publication, 2004.

3. G.Gottychalk, Bacterial Metabolism, 2nd edition, Springer- Verlag, Berlin Hissar, Agricultural University, Prentice Hall of India Pvt Ltd, Delhi, 1986.

4. H.W. Doelle, Bacterial Metabolism, 2nd edition, Academic press, Elsevier Publication, New Delhi, India, 2005.

**Web Reference:**

1. https://nptel.ac.in/courses/102103015/
2.https://courses.lumenlearning.com/microbiology/chapter/introduction-to-microbialmetabolism/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | Title of the Paper | | | Hours | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 20PMB1CC2 | | MICROBIAL CELL PHYSIOLOGY | | | 6 | | | | 5 |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO3 | ✓ | ✓ | | | | ✓ | ✓ | | | |
| CO4 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO5 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| Number of Matches= 34, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.M.Mohamed Mahroop Raja

Checked by:
1. Dr.N.Reehana
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| I | 20PMB1CC3 | Core – III | CHEMISTRY OF BIOMOLECULES | 6 | 4 | 100 | 25 | 75 |

**Course Outcomes:**

1. Acquire knowledge on living organism and its physico chemical regulation.
2. Explain the role of carbohydrates and proteins, their chemical alterations and maintenance in living cells.
3. Explain the types, structure, property, and biosynthesis regulation of lipids and nucleic acids.
4. Describe the chemical nature of hormones and vitamins in the cell.
5. Identify the types of molecules that act in cell signaling pathway.

**UNIT I** **18 hours**

**Basics of Biochemistry:** The chemical unity of diverse living organisms, composition of living matter. Macromolecules and their monomeric subunits. Structure of atoms. Principles and types of chemical bonding. Structure and properties of water, Acids and bases. Bond strength and interaction between biomolecules.# Basic concept on pH, pKa value and buffer.#

**UNIT II** **18 hours**

**Carbohydrates and Proteins**: Classification, structure and reactions of monosaccharides and disaccharides. Structure and conformation of polysaccharides - Cellulose, Amylose, Chitin- **Protein**- properties of aminoacids. Classification of proteins. Structure of Protein- primary, secondary, tertiary and quaternary structure.

**UNIT III** **18 hours**

**Lipids and Nucleic acids:** Biological importance and classification of lipids. Properties and types of fats and fatty acid - β-oxidation. #Biosynthesis of cholesterol#. **Nucleic acid** biosynthesis and degradation (de novo and salvage path way).

**UNIT IV** **18 hours**

**Vitamins and Hormones**: Definition, structure, properties and classification of vitamins- fat soluble vitamins-vitamin A, D, E and K; water soluble vitamins B12, B2, B6 group and vitamin-C. Microbial assay of vitamins and amino acids. Coenzyme activity of vitamins. Protein and peptide hormones – auxin, #gibberellins# and cytokinins.

**UNIT V** **18 hours**

**Bio signaling**: Molecular mechanism of signal transduction-gated ion channel, cell surface receptor and hormones. Signaling through G protein coupled receptor and second messengers. Protein kinase in signal transduction. Regulation of signaling pathways and #programmed cell death#.

#.....# **Self study portion**

**Text Books:**

**T.B-1** U. Satyanarayana and U. Chakrapani, Biochemistry, 3rd edition, Arunabha Sen Publisher, 2016.
**T.B-2** Eric E. Conn, Paul K. Stumpf, George Bruening and Roy H. Doi, Outlines of Biochemistry, 5th edition, Wiley India Publisher, 2006.
**T.B-3** Ajoy Paul, Text book of cell and molecular biology, 4th edition, Arunabha Sen Publisher, 2015.

| | | |
|---|---|---|
| **UNIT I** | Chapter I-III | **T.B-1** |
| **UNIT II** | Chapter II & IV | **T.B-1** |
| **UNIT III** | Chapter III,XIX | **T.B-1,2** |
| **UNIT IV** | Chapter VII | **T.B-1** |
| **UNIT V** | Chapter XV | **T.B-3** |

**Books for Reference:**


1. J. M. Berg, J. L. Tymoczko and L. Stryer, Biochemistry, 5th Edition, W.H. Freeman, New York., 2005.
2. W. B. Wood, J. H. Wilson, R. M. Benbow and L. E. Hood, Biochemistry: A problems approach, 2nd Edition, Benjamin/Cummins Publishing Company., 1981.
3. D. Voet and J. G. Voet, Biochemistry, 4th Edition, Wiley & Sons., 2011.
4. A. L Lehninger, D. L Nelson, M. M Cox, Principles of Biochemistry, CBS Publishers., 1993.


**Web Reference:**

1. https://nptel.ac.in/courses/102103015/
2. https://www.ncbi.nlm.nih.gov/books/NBK9924/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | Hours | | Credits | |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 20PMB1CC3 | | | CHEMISTRY OF BIOMOLECULES | | | 6 | | 4 | |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | |
| CO2 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO3 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| CO5 | | ✓ | | ✓ | | | ✓ | | ✓ | |
| Number of Matches= 36, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.H.Vajiha Banu

Checked by:
1. Dr.N.Reehana
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| I | 20PMB1CC4P | Core – IV | GENERAL MICROBIOLOGY, MICROBIAL CELL PHYSIOLOGY AND CHEMISTRY OF BIOMOLECULES – PRACTICAL | 6 | 4 | 100 | 25 | 75 |

**Course Outcomes:**

1. Examine the principles and methodologies for isolation and characterization of microorganisms.
2. Acquire knowledge about microorganism and its biochemical regulation.
3. Compare the factors affecting bacterial growth.
4. Report the reproducible data from biochemical experiments.
5. Apply the principles governing the structure of macromolecules and their participation in chemical reaction.

**GENERAL MICROBIOLOGY**

1. Enumeration of Bacteria and Fungi- Viable plate count.
2. Pure culture techniques- Streak plate method
3. Measurement of size of microbes - micrometry method.
4. Motility determination - Hanging drop method and stab method
5. Staining methods- Gram staining, Acid fast, Endospore, PHB, and Capsule staining.
6. Lactophenol cotton blue staining method

**MICROBIAL CELL PHYSIOLOGY**

7. Measurement of growth curve- Direct and indirect methods.
8. Effect of pH and Temperature on microbial growth.
9. Effect of high salt concentration on microbial growth.
10. Biochemical tests: IMVIC, Catalase, Oxidase, TSI test, Gelatin, casein, starch Hydrolysis, and Urease test.

**CHEMISTRY OF BIOMOLECULES**

11. Acid base Titration and PKa determination
12. Estimation of total sugar
13. Separation of amino acid by paper chromatography
14. Extraction and Estimation of Total protein – Lowery *et al* method

**Practical manuals**


1. K.R. Aneja, Experiments in Microbiology, Plant pathology and Biochemistry, 4th edition, New age International publishers, India, 2003.
2. Cappuccino and G. James, Microbiology a laboratory manual, 4th edition, Addison Wesley Publishing Company Inc. California, 1996.
3. K.Wilson and Walker, Practical Biochemistry, Principles and Techniques, Cambridge University Press, 1995.
4. J. Jayaraman, Laboratory Manual in Biochemistry, 2nd edition, Newage publication, 2011.

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | Title of the Paper | Hours | Credits |
|---|---|---|---|---|
| I | 20PMB1CC4P | GENERAL MICROBIOLOGY, MICROBIAL CELL PHYSIOLOGY AND CHEMISTRY OF BIOMOLECULES – PRACTICAL | 6 | 4 |

| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO2 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO3 | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| CO4 | ✓ | | ✓ | | ✓ | ✓ | | ✓ | | ✓ |
| CO5 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Number of Matches= 36, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.M.Mohamed Mahroop Raja

Checked by:
1. Dr.N.Reehana
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| I | 20PMB1DE1A | DSE – I | VIROLOGY | 6 | 4 | 100 | 25 | 75 |

**Course Outcomes:**

1. Explain the concepts studied in virus discovery, taxonomy, properties and structure, classification and replication strategies.
2. Introspect the knowledge on virus infecting plants and its economic importance.
3. Acquire knowledge on human and animal viruses.
4. Describe the structure and characteristics of various bacteriophages.
5. Demonstrate the different types of virus cultivation methods and biosafety.

**UNIT I** **18 hours**

**General Virology:** History of viruses, Virus taxonomy, nomenclature and classification. properties of viruses; morphology and ultrastructure; capsids and capsomers arrangements; types of envelops and their composition, #viral genome#, introduction to replication strategies. Virus related agents (viroids, virusoids and prions).

**UNIT II** **18hours**

**Plant viruses:** Characteristics- Tobamovirus group (TMV); Tymovirus group (Circular mosaic virus); #Tomato spotted wilt virus#, potato virus X, cauliflower mosaic virus, effects of these viruses on plants and various histological and physiological changes induced due to viral infection. Transmission of plant viruses with vectors insects, nematodes, fungi and without vectors (contact, seed and pollens).

**UNIT III** **18 hours**

**Human and animal viruses:** Characteristics- Adenovirus, Pox virus (DNS containing), Picornavirus, Rota virus, Retrovirus, Corona viruses (RNA containing). Mechanism of virus adsorption and entry into host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, #translation of viral proteins#, assembly, exit and maturation of progeny virions. Oncogenic viruses.

**UNIT IV** **18 hours**

**Bacteriophages:** Morphology, ultra structure and classification of phages. #one step growth curve and burst size#. life cycle pattern of bacteriophages: T- even phages; Structure of Cyanophages, Mycophages. General principles of phage- bacterium interaction and growth cycle studies of RNA and DNA phages, Phage genetics- Lambda phage.

**UNIT V** **18 hours**

**Cultivation of viruses:** Growth of viruses in embryonated egg, in experimental animals and in cell cultures-primary, secondary, Diploid and continuous cell culture. Susceptible cell lines. Assay of viruses: physical and chemical methods of assay, (protein, nucleic acid, radioactivity tracers, electron microscopy. Infectivity assay of animal virus (plaque method, pock counting, end point method) and #infectivity assay of plant viruses#. Biosafety and containment facility in virology lab.

#.....# **Self study portion**

**Text Books:**

**T.B-1** S. J. Flint, L. W. Enquest, V. R. Rancaniello and A. M. Skalka, Principles of Microbiology, 3rd edition, American Society for Microbiology, 2009.

**T.B-2** J. Michael, J. R. Pelczar, E. C. S. Chan and N. R. Kreig, Microbiology, 5th edition, McGraw Hill. Inc, New York, 1993.

**T.B-3** P. Saravanan, Virology, MJP Publishers, 2006.

**T.B-4** Apoorva Karanth, Plant virology, Dominant publishers and distributors, New Delhi, 2008.

| | | |
|---|---|---|
| **UNIT I** | Chapter I &IV | **T.B-1** |
| **UNIT II** | Chapter X, XIII & XIV | **T.B-4** |
| | Chapter III | **T.B-3** |
| **UNIT III** | Chapter IV | **T.B-3** |
| | Chapter V to VII, IX | **T.B-1** |
| **UNIT IV** | Chapter II | **T.B-3** |
| | Chapter XX | **T.B-2** |
| **UNIT V** | Chapter II | **T.B-1** |

**Books for Reference:**


1. S.J. Flint, L.W. Enquist, R. Krung, V.R. Racaniello and A.M. Skalka, Principles of Virology, ASM press,Washington, 2000.
2. Geeta Sumbali and R.S. Mehrotra, Principles of Microbiology, 1st edition, Tata McGraw Hill Pvt ltd, New Delhi, 2009.
3. H.F. Conrat, P.C. Kimball and J.A. Levy, Virology, 2nd edition, Prentice Hall, New Jersey,1988.
4. J.A. Cann, Principles of Molecular virology, 3rd edition, Academic press, California, 2001.


**Web Reference:**

1.https://courses.lumenlearning.com/boundless-biology/chapter/viral-evolution-morphology-and-classification/

2.https://www.khanacademy.org/science/biology/biology-of-viruses/virus-biology/a/bacteriophages

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | Hours | | Credits | |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 20PMB1DE1A | | | VIROLOGY | | | 6 | | 4 | |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | |
| CO2 | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ |
| CO3 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | |
| CO4 | ✓ | | | | ✓ | ✓ | | | | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| Number of Matches= 30, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.H.Vajiha Banu

Checked by:
1. Dr.N.Reehana
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| I | 20PMB1DE1B | DSE – I | MICROBIAL DIVERSITY | 6 | 4 | 100 | 25 | 75 |

**Course Outcomes:**

1. Describe the history and development of evolutionary relationships.
2. Report the evidence of biodiversity and its energy production.
3. Explore the different adaptations of microbes in stressful environment.
4. Acquire basic idea on marine diversity.
5. Analyze marine microbial association and its products applications.

**UNIT I** **18 hours**

**Origin and evolution of life** - Theories of evolution; evidences for evolution; sources of variations (mutation, recombination, genetic drift, migration, natural selection); concept of species; #Specification and isolation (geographical and reproductive)#; origin of species.

**UNIT II** **18 hours**

**Biodiversity:** Distribution, Abundance and Ecological niche. Biodiversity indices- alpha, beta and gamma diversity. Life detection methods: Evidence of metabolism (Gulliver), Evidence of photosynthesis (autotrophic and heterotrophic), ATP production, Phosphate uptake and Sulphur uptake.

**UNIT III** **18 hours**

**Extremophiles:** Definition, characteristics, classification and applications of Alkalophiles, Acidophiles, Halophiles, Barophiles, Extremophiles – adaptations & significance on bacteria- oxygen toxicity, pH, osmotic pressure and heat shock etc.

**UNIT IV** **18 hours**

**Marine Diversity:** Marine environment- properties of seawater, chemical and physical factors- Ecology of coastal, shallow and deep sea microorganism- significance of marine microflora. Diversity of microorganism in the mangroves and coral environments.

**UNIT V** **18 hours**

**Microbial endosymbionts**: Epiphytes- coral- microbial association, sponge- microbial association. Marine microbial products- Carrageenan, agar-agar, sea weed fertilizers, polysaccharide - biosurfactants - enzyme - antibiotics and antitumour agents.

**#.....# Self study portion**

**Text Books:**

**T.B-1** L.M. Prescott, P. John Harley and A. Donald Klein, Microbiology, 7th edition, Mc Grow Hill, USA, 2007.

**T.B-2** Manoj Tiwari, Kapil Khulbe and Archana Tiwari, Environmental studies, 1st edition, I.K. Internatonal, 2007.

**T.B-3** P.S.Bisen and Kavitha Verma, Hand book of Microbiology, CBS Publishing, 1994.

**T.B-4** David Freifelder, Molecular biology, Library of congress cataloging in publication data, 2007.

**T.B-5** D.M.Vasudevan, Biotechnology application, 1st edition, Jaypee Brothers Medical Publishers (p) Ltd, 2008.

| | | |
|---|---|---|
| **UNIT I** | Chapter VIII | **T.B-1** |
| **UNIT II** | Chapter IV | **T.B-2** |
| **UNIT III** | Chapter VII | **T.B-3** |
| **UNIT IV** | Chapter XXVI | **T.B-4** |
| **UNIT V** | Chapter VIII | **T.B-5** |

**Books for Reference:**

1. R.Y. Stainer, J.L. Ingraham, H.H.Wheolis andP.R. Painter, The Microbial world, 5thedition, Prentica Hall, 1986.

2. M.T. Madigan, J.M. Martinko and J.Parker, Brock Biology of microorganisms, 11th edition, Pearson Education international, USA, 2006.

3. P. M. Gault and H. J. Marler, Handbook on Cyanobacteria: Biochemistry, Biotechnology and Applications (Bacteriology Research Developments), Nova Science Publishers, 2009.

**Web Reference:**

1. https://www.khanacademy.org/science/biology/her/evolution-and-natural-selection/a/lines-of-evidence-for-evolution

2. https://www.khanacademy.org/science/biology/her/evolution-and-natural-selection/a/lines-of-evidence-for-evolution

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | | Hours | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 20PMB1DE1B | | | MICROBIAL DIVERSITY | | | | 6 | | 4 |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | ✓ | | | | ✓ | ✓ | | | |
| CO2 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| CO3 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| CO4 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO5 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| Number of Matches= 30, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.M.Mohamed Mahroop Raja

Checked by:
1. Dr.N.Reehana
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| II | 20PMB2CC5 | Core – V | MICROBIAL GENETICS AND MOLECULAR BIOLOGY | 6 | 5 | 100 | 25 | 75 |

**Course Outcomes:**

1. Describe the knowledge on nucleic acids.
2. Explain the system of DNA replication and DNA repair.
3. Analyze the principle of gene transfer mechanism and its regulations.
4. Acquire knowledge on mutation and its effect.
5. Demonstrate the molecular aspects of gene regulation.

**UNIT I** **18 hours**

**Nucleic Acids**: Genome organization of Prokaryotes and Eukaryotes. Structural aspects of Nucleic acid- the double helical model- various forms of DNA and RNA, hyperchromicity- Nucleic acid as a genetic material- Griffith, Blender jar experiment, Avery experiment, RNA as a genetic material, Beadle and Tatum experiment. Genetic code- general features, wobble hypothesis, #Code is triplet – Molecular evidence#.

**UNIT II** **18 hours**

**Maintenance of Genetic Information**: DNA replication- basic rules, Semi conservative model- Meselson and Stahl experiment, replication of circular DNA molecule, Discontinuous replication, Bi directional replication, Rolling circle mechanism. DNA damage and repair mechanism- Photo reactivation- Mismatch Repair- #Nucleotide Excision Repair#. Recombination repair- SOS repair.

**UNIT III** **18 hours**

**Gene transfer mechanisms:** Horizontal gene transfer. Transformation process and regulation. Transduction- general and specialized- Lederberg and Zinder experiment. Conjugation- $F^+$, F, Hfr and $F^{'}$, triparental mating, self transmissible and mobilizable plasmids and pili. Transposable elements and #reteroposons types and applications#.

**UNIT IV** **18 hours**

**Mutation**: Mutation and mutagenesis- Definition and types- Spontaneous mutation and induced mutation- substitution, Insertions, Deletions and frameshifts. Mutagenesis- physical and chemical- UV, alkylators, Base analogs, intercalating agents and mutator genes. Detection, isolation, characterization of mutant and their uses. #Ames test for mutagenicity#.

**UNIT V** **18 hours**

**Molecular aspect of gene expression:** Regulation of gene and gene expression in prokaryotes and eukaryotes- Transcription and translation. Gene rearrangement by RNA splicing. Catalytic RNA. Gene regulation in prokaryotes: Operon concept- Lac and Trp operon.

**#.....# Self study portion**

**Text Books:**

**T.B-1** W. H. Elliott and D. C. Elliott, Biochemistry and Molecular Biology, John Wiley & Sons Ltd, 1993.

**T.B-2** David Freifelder, Molecular Biology, 2nd edition, Narosa Publication, 1990.

**T.B-3** George M. Malacinski, Essentials of Molecular Biology, 4th edition, Jones and Bartlett publishers, 1992.

**T.B-4** P. J. Bottiono, The Science of Genetics, 6th edition, Macmillan publishing company, 1989.

| | | |
|---|---|---|
| **UNIT I** | Chapter VI | **T.B-3** |
| | Chapter IX | **T.B-4** |
| **UNIT II** | Chapter XXIII | **T.B-1** |
| | Chapter IX | **T.B-2** |
| **UNIT III** | Chapter VII,IX | **T.B-3** |
| | Chapter XXI | **T.B-2** |
| **UNIT IV** | Chapter X,XIII | **T.B-4** |
| **UNIT V** | Chapter XXIV | **T.B-1** |
| | Chapter X | **T.B-2** |

**Books for Reference:**

1. B. Lewin, Genes VII, Oxford University press, 2000.
2. J.D Watson, T.A. Baker, S.P. Bell and Alexander Gann. Molecular Biology of the Gene, 5th edition, Benjanun/cummmgs, Publishing Company Inc, New York, 2004.
3. P. Steller and D.E. Bianchi, Cell and molecular biology, 3rd edition, Wiley publication, India, 2009.
4. T.A. Brown, Essential Molecular Biology - A Practical approach, Oxford University Press, Oxford, 1991.

**Web reference:**

1.https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Free_For_All_(Ahern%2C_Rajagopal%2C_and_Tan)/2%3A_Structure_and_Function/2.6%3A_Structure_and_Function_-_Nucleic_Acids

2.https://www.khanacademy.org/science/biology/gene-regulation/gene-regulation-inbacteria/a/the-lac-operon

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | | Hours | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| II | 20PMB2CC5 | | | MICROBIAL GENETICS AND MOLECULAR BIOLOGY | | | | 6 | | 5 |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | |
| CO2 | ✓ | | | ✓ | | ✓ | | | ✓ | |
| CO3 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO4 | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| CO5 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| Number of Matches= 32, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.N.Reehana

Checked by:
1. Dr.M.Mohamed Mahroop Raja
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| II | 20PMB2CC6 | Core – VI | GENETIC ENGINEERING | 6 | 5 | 100 | 25 | 75 |

**Course Outcomes:**

1. Acquire knowledge on basic properties and classification of vector.
2. Examine the mode of action of various enzymes used in genetic engineering.
3. Explain the concept of cloning strategies and techniques.
4. Apply the rDNA by using advanced techniques.
5. Conclude the applications of rDNA technology and its safety guidelines.

**UNIT I** **18 hours**

**Vector Biology**: Vectors- properties and classification. Plasmid: types and properties. Structure and application of bacterial plasmids: ColE1, pBR322 and pUC19. Bacteriophages vectors - M13 vector and Lambda phage vector. Phagemids, Cosmids. Artificial chromosomes. Viral vectors used in gene therapy.

**UNIT II** **18 hours**

**Enzymes in genetic engineering:** Restriction enzymes (Type, classification, nomenclature and application). Role of Ligases, Alkaline phosphatase, Polynucleotide kinase, Terminal nucleotidyl transferase, DNA Polymerases, Taq DNA polymerases, RNAse, Reverse transcriptase in rDNA technology.

**UNIT III** **18 hours**

**Cloning strategies**: Gene Library construction- shotgun cloning and cDNA cloning. Cloning in *Saccharomyces cerevisiae* and other fungi. Screening of recombinants: Insertional inactivation, Blue white selection, positive selection, colony and plaque hybridization. Gene transfer in Bacteria- Electroporation, $CaPO_4$ mediated, DEAE, #liposomes# and DMSO.

**UNIT IV** **18 hours**

**PCR methods:** Molecular probes production, labeling and applications. Sequencing by chemical and enzymatic method. Next generation sequencing. Blotting techniques- Southern, Northern and Western blotting. Analyzing DNA- principle of PCR. Types of PCR: inverse PCR, RT PCR, Nested PCR and colony PCR. #DNA Microarray analysis#. DNA finger printing- RFLP and RAPD.

**UNIT V** **18 hours**

**rDNA Application:** Introduction to Gene therapy (*in vivo* & *ex vivo*), Antisense therapy. GMO's, BT cotton, production of Insulin, human growth hormone. New vaccine technology- Vaccine clinical trials- DNA vaccines- Recombinant Hepatitis vaccine, synthetic peptide vaccines and multivalent subunit vaccines. Safety guidelines of r-DNA research.

#.....# **Self study portion**

**Text Books:**

**T.B-1** Sandhya Mitra, Genetic Engineering, Rajiv Beri Macmillan India Ltd, 1996.

**T.B-2** Sathyanarayanan, Biochemistry, 3rd edition, Arunabha sen Pvt. Ltd, 2016.

| | | |
|---|---|---|
| **UNIT I** | Chapter VI | **T.B-1** |
| **UNIT II** | Chapter 2.7 | **T.B-1** |
| **UNIT III** | Chapter 2.1,2.7,2.8 | **T.B-1** |
| **UNIT IV** | Chapter VIII | **T.B-2** |
| **UNIT V** | Chapter 2.16, 2.18, 2.9 | **T.B-1** |

**Books for Reference:**


1. S.T. Desmond and Nicholl, An Introduction to genetic Engineering Cambridge University Press,1994.

2. S.C.H. Sussman, F.H. Coflms, Skimmer and D.E. Stewartful, The release of genetically engineered microorganisms, Academic Press, London, 1988.

3. J.D Watson, T.A. Baker, S.P. Bell, and Alexander Gann. Molecular Biology of the Gene, 5th edition, Benjanun/cummmgs Publishing Company Inc, New York, 2004.

4. C. Lenk, N. Hoppe and R. Andorno, Ethics and law of intellectual property: Current problems in politics, Science and technology, Ashgate publisher Pvt. Ltd. 2007.


**Web reference:**

1.https://www.abmgood.com/marketing/knowledge_base/next_generation_sequencing_introduction.php

2. https://courses.lumenlearning.com/boundless-biology/chapter/biotechnology/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | Hours | | Credits | |
|---|---|---|---|---|---|---|---|---|---|---|
| II | 20PMB2CC6 | | | GENETIC ENGINEERING | | | 6 | | 5 | |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO2 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | |
| CO3 | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| CO4 | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| CO5 | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Number of Matches= 38, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.N.Reehana

Checked by:
1. Dr.M.Mohamed Mahroop Raja
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| II | 20PMB2CC7 | Core – VII | ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY | 6 | 4 | 100 | 25 | 75 |

**Course Outcomes:**

1. Identify the role of microbes and nutrient cycles prevailing in environment.
2. Apply the acquired knowledge on recycling of solid and liquid waste.
3. Acquire the basic idea of biodegradation and its applications.
4. Describe the mechanism of nitrogen fixation and nif gene regulation.
5. Design the production and applications of bioinoculants and biopesticides.

**UNIT I** **18 hours**

**Soil Microbiology**: Soil profile and Soil Microbiology- Structure, Types, Physical and Chemical properties. Weathering and Humus formation, Soil pollution. Soil microbes- Types and Microbial interaction. Biogeochemical cycles and their sedimentary- Carbon, nitrogen, oxygen, hydrogen, phosphorous, #sulfur and iron#.

**UNIT II** **18 hours**

**Recycling of Liquid and Solid wastes:** Characterisation and types of liquid waste management and treatment- Primary, Secondary treatment and Tertiary treatment. Characterization and types of solid waste-solid waste management and treatment- Silage, Pyrolysis and saccharification. #Composting and Biogas process and production#. Bioconversion of solid waste and utilization as fertilizer.

**UNIT III** **18 hours**

**Environmental Applications**: Deterioration of paper, leather, woods, textiles and pharmaceutical products. Bioremediation, Biomagnification and Bioaccumulation. Bio degradation of complex polymers - cellulose, hemicelluloses, and lignin. Microbial leaching-copper and uranium. Xenobiotics degradation- Heavy metals, Radionuclides, Recalcitrants and Halogenated compounds. #Application of GIS and RS techniques in environmental monitoring#.

**UNIT IV** **18 hours**

**Diazotrophs**: Ecology of diazotrophs. Biological fixation of nitrogen, Nitrogen fixation sites, symbiotic and nonsymbiotic nitrogen fixation. Mechanism of biological nitrogen fixation. Nitrogenase enzyme complex - azoferredoxin and molybdo ferrodoxin. Physiological electron donors and mechanism of nitrogen reduction, #regulation of nitrogenase enzyme#. Nif genes and its regulation. Role of hydrogenase enzyme in nitrogen fixation.

**UNIT V** **18 hours**

**Bioinoculants:** Biofertilizers: Characteristics, Production and application of Rhizobium, Azotobacter, Azospirillum, Phosphate solublizing and mobilizing bacteria #Blue green algae#, Azolla and Mycorrhizae. Formulation of biofertilizer. Biopesticides- types, mechanism and application of Bacterial, Fungal and Viral insecticides.

**#.....# Self study portion**

**Text Books:**

**T.B-1** K.Vijaya Ramesh, Environmental Microbiology, MJP Publishers, 2004.

**T.B-2** P.Rajendran, Microbial Bioremediation, MJP Publishers, 2006.

| | | |
|---|---|---|
| **UNIT I** | Chapter V | **T.B-2** |
| **UNIT II** | Chapter V | **T.B-2** |
| **UNIT III** | Chapter VI | **T.B-1** |
| **UNIT IV** | Chapter III,V | **T.B-1** |
| **UNIT V** | Chapter VII | **T.B-2** |

**Books for Reference:**


1. C.F. Forster, Biotechnology and Wastewater Treatment, Cambridge University Press, Cambridge, 1985.
2. W.D. Grant and P.L. Long, Environmental Microbiology, Blackie Glasgow, London, 1981.
3. N.F.Gray, Biology of waste water Treatment, Oxford University Press Oxford, 1989.
4. M.K. Rai, Handbook of Microbial biofertilizers, Food Products Press, New York, 2005.
5. M. Gareth, Evans and J.C. Furlong, Environmental Biotechnology Theory and Application, John Wiley and sons Ltd, 2003.


**Web reference:**

1.http://www.futuredirections.org.au/publication/living-soils-role-microorganisms-soil-health/

2. https://courses.lumenlearning.com/trident-boundless-microbiology/chapter/microbial-bioremediation/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | Hours | | | Credits | |
|---|---|---|---|---|---|---|---|---|---|---|
| II | 20PMB2CC7 | | | ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY | | 6 | | | 4 | |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO2 | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| CO3 | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| CO4 | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | |
| CO5 | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Number of Matches= 38, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.H.Vajiha Banu

Checked by:
1. Dr.M.Mohamed Mahroop Raja
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| II | 20PMB2CC8P | Core – VIII | MICROBIAL GENETICS AND MOLECULAR BIOLOGY, GENETIC ENGINEERING, ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY PRACTICAL | 6 | 4 | 100 | 25 | 75 |

**Course Outcomes:**

1. Examine the isolation and characterization of plasmid and chromosomal DNA.
2. Demonstrate the principle and characterization of SDS PAGE.
3. Analyze the amplification of DNA by PCR.
4. Compare the estimation of BOD and COD in polluted water.
5. Identify the indicator organism and cellulase producing microorganism.

**MICROBIAL GENETICS AND MOLECULAR BIOLOGY, GENETIC ENGINEERING**

1. Scoring of mutants through physical agents.
2. Isolation and Characterization of chromosomal DNA.
3. Isolation and Characterization of plasmid DNA.
4. Restriction digestion of DNA
5. Principle and separation of protein gel electrophoresis (SDS PAGE).
6. Isolation of Protoplast and Spheroplast.
7. DNA amplification- PCR analysis.

**ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY**

1. Determination of BOD of polluted / pond water.
2. Determination of COD of polluted / pond water.
3. Assessment of water quality by MPN technique.
4. Isolation of cellulase producing microbes from soil.
5. Algae as indicators of water pollution.

**Practical manual**


1. T.A. Brown, Essential Molecular Biology - A Practical approach, Oxford University Press, Oxford, 1991.
2. K.R. Aneja, Experiments in Microbiology, Plant pathology and Biochemistry, 4th edition, New age International publishers, India, 2003.
3. Cappuccino and G. James, Microbiology a laboratory manual, 4th edition, Addison Wesley Publishing Company Inc. California, 1996.
4. J. Jayaraman, Laboratory Manual in Biochemistry, 2nd edition, Newage publication, 2011
5. R.M. Atlas and R. Bortha, Microbial Ecology Fundamentals and Application, 4th edition, LPE Pearson Education, Inc, 2005.

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | Title of the Paper | Hours | Credits |
|---|---|---|---|---|
| II | 20PMB2CC8 | MICROBIAL GENETICS AND MOLECULAR BIOLOGY, GENETIC ENGINEERING, ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY PRACTICAL | 6 | 4 |

| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| CO2 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO3 | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| CO4 | ✓ | | ✓ | | ✓ | ✓ | | ✓ | | ✓ |
| CO5 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Number of Matches= 36, Relationship : High | | | | | | | | | | |

Prepared by:
1. Dr.N.Reehana

Checked by:
1. Dr.M.Mohamed Mahroop Raja
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| II | 20PMB2DE2A | DSE – II | MICROBIAL ECOLOGY | 6 | 4 | 100 | 25 | 75 |

**Course Outcomes:**

1. Describe the distribution and association of microorganisms in microbial environment.
2. Acquire the knowledge of aerobic atmosphere, air sampling devices and airborne diseases.
3. Analyze the various techniques used to treat aquatic microbes.
4. Demonstrate the microbiological examination of water and indicator organism.
5. Acquire the knowledge of genetic population and genetic variation of microbial ecology.

**UNIT I** **18 hours**

**Microbial environment**: Distribution and communities of microbial environment- Factors influencing the microbial density in soil- zymogenous and autochthonous flora in soil- Microbial associations- symbiotic proto cooperation, Ammensalism, Commensalism, Syntropism, Parasitism and Predation with suitable examples. Methods of studying microbial ecosystem. #Biological equilibrium. # Meaning of succession: Tolerance and inhibition patterns of succession, theories of succession.

**UNIT II** **18 hours**

**Aero Microbiology**: Stratification of atmosphere. Microbial contamination of air- Sources of contamination-Biological indicators of air pollution. Droplet and Droplet Nuclei. Enumeration of bacteria from air, air sampling devices. Significance of air microflora, Outline of airborne diseases (Bacterial - Whooping cough, Diphtheria, Pneumonia; Fungal- Aspergillosis, Cryptococcosis; Viral- Chickenpox, Influenza, Measles). #Air sanitation#.

**UNIT III** **18 hours**

**Aquatic Microbiology:** Fresh and marine water zone. Microbial ecology of lakes, ponds, rivers, stream, ground water wetland, Factors affecting the microbial population. Techniques for the study of aquatic microbes. Eutrophication- #factors controlling eutrophication#. Water treatment: preliminary- aeration, sedimentation, coagulation and flocculation. Filtration- rapid and slow sand filters and Microfilters.

**UNIT IV** **18 hours**

**Microbiology of potable water**: Water quality measures: guideline, methods, identification and validation. Bacteriological techniques for the examination of water- MPN index. Indicators of faecal pollution. Waterborne disease: Enteric bacteria (indicators and pathogens) Opportunistic pathogens: *Legionella, Vibrio* and *Staphylococcus*. Viruses: *Polio, adenovirus*, and *Rotavirus*. Protozoa: *Giardia, Cryptosporidium* and #*Toxoplasma*#. Pathogens source tracking and disinfection.

**UNIT V** **18 hours**

**Ecology and Genetics**: Genetic structure of population:-Genotype frequency, allele frequencies. Hardy-Weinberg Law: Assumptions, predictions, derivation, extension and natural selection. Measuring genetic variation at protein level, measuring genetic variation at DNA level. #Factors effecting gene frequencies#: Mutation, Random genetic drift, migration, Hardy-Weinberg natural selection, Assortative mating and Inbreeding.

**#.....# Self study portion**

**Text Books:**

**T.B-1** N. S. Subrahmanyam and A. V. S. S. Sambamurthy, Ecology, Narosa Publishing House, 2000.

**T.B-2** H. D. Kumar, General Ecology, Vikas Publishing House, 1995.

**T.B-3** P. K. Gupta, Genetics, Rastogi publications, 2001.

**T.B-4** M. Ahamed, S. K. Basumatary, Applied Microbiology, MJP Publishers, 2006.

| | | |
|---|---|---|
| **UNIT I** | Chapter I, XVI | **T.B- 1** |
| **UNIT II** | Chapter XI | **T.B- 2** |
| **UNIT III** | Chapter XXIII | **T.B- 2** |
| **UNIT IV** | Chapter XIV, XXI - XXIII | **T.B- 3** |
| **UNIT V** | Chapter VII | **T.B- 4** |

**Books for Reference:**


1. G. Reiheimer, Aquatic Microbiology, 4th edition, John Wiley & Sons Inc. 1991.
2. W.D. Grant and P.L. Long, Environmental Microbiology, Blackie Glasgow, London, 1981.
3. R. Campbell, Microbial Ecology, 2nd edition, Blackwell publication, 1983.


**Web reference:**

1. https://www.onlinebiologynotes.com/microbial-ecology-and-role-of-microorganism-in-ecosystem/
2. https://www.studocu.com/en/document/university-of-nevada-reno/intro-to-microbiology/lecture-notes/study-ch-21-microbial-ecology/1063573/view
3. https://www.soinc.org/sites/default/files/uploaded_files/4 17_microbes_and_ecology.pdf

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | Hours | | Credits | |
|---|---|---|---|---|---|---|---|---|---|---|
| II | 20PMB2DE2A | | | MICROBIAL ECOLOGY | | | 6 | | 4 | |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| CO2 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO3 | | ✓ | | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| CO4 | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| CO5 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | |
| Number of Matches= 34, Relationship : Moderate | | | | | | | | | | |

Prepared by:
1. Dr.N.Reehana

Checked by:
1. Dr.M.Mohamed Mahroop Raja
2. Dr.A.Khaleel Ahamed

| Semester | Code | Course | Title of the Course | Hours | Credits | Max. Marks | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|---|
| II | 20PMB2DE2B | DSE – II | BIOREMEDIATION AND WASTE MANAGEMENT | 6 | 4 | 100 | 25 | 75 |

**Course Outcome:**

1. Analyse various wastes and associated risks on environment.
2. Apply the knowledge on recycling and disposal of wastes.
3. Examine the types of soil treatment and methods of aerobic bioremediation.
4. Identify the process of anaerobic bioremediation.
5. Assess the methods of radioactive and hazardous wastes.

**UNIT I** **18 hours**

**Waste Classification and Quantification:** Solid waste management and disposal: Sources and generation of solid waste- characterization, composition and classification. Hazardous waste management: Cyanides, Dioxins, Detergents, Plastics, Nylon and Paper. #Waste minimization approaches – Monitoring and management strategies#.

**UNIT II** **18 hours**

**Recycling of Wastes:** Types- sources- composition of waste- recycling of waste for Industrial, Agricultural and Domestic Purposes; Recycling of Metals, Reuse, recovery and reduction of paper and plastics; Recycling in Food Manufacturing, Beverages, Apparel, Leather, Paper, Pulp, Chemical and other industries; Fly Ash utilization. #Waste Disposal Methods- composting, incineration, pyrolysis, medical waste disposal strategies#.

**UNIT III** **18 hours**

**Aerobic Bioremediation**: Bioremediation of surface soils: Fate and transport of contaminants in the Vadose zone- #Biodegradation in soil ecosystems#- Types of soil treatment systems- Bioreactors. Subsurface Aerobic Bioremediation: Selection of bioremediation system- *in situ* Bioremediation- *in situ* Bioventing- *in situ* treatment of Harbour Sediments- *in situ* Lagoon treatment.

**UNIT IV** **18 hours**

**Anoxic/Anaerobic Bioremediation**: Anoxic/Anaerobic Environment - Potential anaerobic Bioremediation – Anoxic/Anaerobic Processes – Fermentation, Degradation of Polycyclic Aromatic Hydrocarbons (PAH), Heterocyclic Compounds and Cyanide Remediation. Factors affecting bioremediation – Bench Scale and Pilot Scale studies – *in situ* Bioreactor treatment of sediments – #*in situ* Bioremediation of contaminated lagoon sediment#.

**UNIT V** **18 hours**

**Radioactive Waste**: Sources, half life of radioactive elements, modes of decay. Effects on Plants, Animal and Man. Low and High-level Radioactive Waste Management – Waste Minimization and Treatment. Radiation standards. Legislation, Regulation and Policy - Current Regulations and programs of interest – #Hazardous Waste Management Act#.

**#.....# Self study portion**

**Text Books:**

T.B-1 K. Vijaya Ramesh, Environmental Microbiology, MJP Publishers, 2004.

T.B-2 P. Rajendran, Microbial Bioremediation, MJP Publishers, 2006.

| | | |
|---|---|---|
| **UNIT I** | Chapter VII | **T.B- 2** |
| **UNIT II** | Chapter V | **T.B- 2** |
| **UNIT III** | Chapter VI | **T.B- 2** |
| **UNIT IV** | Chapter III,V | **T.B- 1** |
| **UNIT V** | Chapter VII | **T.B- 1** |

**Books for Reference:**

1. M.D. LaGrega, P.L. Buckingham and J.C. Evans, Hazardous Waste Management, II$^{nd}$ edition, McGraw Hill, 2001.

2. T. Leisinger, A.M. Cook, R. Hutter and J. Nuesch , Microbial Degradation of Xenobiotics and Recalcitrant Compounds, Academic Press, London, 1981.

**Web reference:**

1. http://www.yourarticlelibrary.com/waste-management/solid-waste-management-types-sources-effects-and-methods-of-solid-waste-management/9949
2. http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/Radioactive-Waste-Management/

Relationship Matrix for Course Outcomes, Programme Outcomes and Programme Specific Outcomes:

| Semester | Code | | | Title of the Paper | | | | Hours | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| II | 20PMB2DE2B | | | BIOREMEDIATION AND WASTE MANAGEMENT | | | | 6 | | 4 |
| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | Programme Specific Outcomes (PSOs) | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| CO1 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO2 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO3 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| CO4 | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ |
| CO5 | | ✓ | | ✓ | | | ✓ | | ✓ | |
| Number of Matches= 34, Relationship : Moderate | | | | | | | | | | |

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