**

**School of Sciences**

**Syllabi and Course Structure**

**M. Sc. (Microbiology)**

**(2017-2019)**

**Academic Programmes**

**JANUARY 2017**

The curriculum and syllabus for M.Sc. Program conforms to outcome based teaching learning process. In general, several outcomes have been identified and the curriculum and syllabus have been planned in such a way that each of the courses meets one or more of these outcomes. Student outcomes illustrate the students are expected to know and be able to do by the time of graduation. These relate to the skills, understanding, and behaviors that students acquire as they progress through the program. Further each course in the program brings out clear instructional objectives which are mapped to the student outcomes.

The student outcomes are:

1. An ability to apply profound understanding of science, zoology, botany and microbiology
2. An ability to design and perform experiments, as well as to analyze and interpret data
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. An ability to function on multidisciplinary teams
5. An ability to identify, formulate, and solve microbiological problems
6. An understanding of professional and ethical responsibility
7. An ability to communicate effectively
8. The broad education necessary to understand the impact of biological solutions in global, economic, environmental, and societal context
9. A recognition of the need for, and an ability to engage in life-long learning
10. A knowledge of contemporary issues
11. An ability to use the techniques, skills, and modern microbial tools necessary for microbiological practice.

**M.Sc. Microbiology Semester- I**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **Contact Hrs.** | **Credits** | **Type** |
| 1 | MMI 001A | **BACTERIOLOGY** | 4 | 0 | 0 | 4 | 4 |  |
| 2 | MMI 002A | **INSTRUMENTATION** | 4 | 0 | 0 | 4 | 4 |  |
| 3 | MMI 003A | **BIOCHEMISTRY & ENZYMOLOGY** | 4 | 0 | 0 | 4 | 4 |  |
| 4 | MMI 004A | **VIROLOGY, MYCOLOGY AND PHYCOLOGY** | 4 | 0 | 0 | 4 | 4 |  |
| 5 | MMI 005A | **Microbial Diversity & Instrumentation Lab** |  | 0 | 12 | 12 | 12 |  |
|  |  | **Total** | **16** | **0** | **6** | **28** | **28** |  |

**M.Sc. Microbiology Semester- II**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **Contact Hrs.** | **Credits** | **Type** |
| 1 | MMI 006A | FERMENTATION TECHNOLOGY | 4 | 0 | 0 | 4 | 4 |  |
| 2 | MMI 007A | MOLECULAR BIOLOGY AND MICROBIAL GENETICS | 4 | 0 | 0 | 4 | 4 |  |
| 3 | MMI 008A | IMMUNOLOGY | 4 | 0 | 0 | 4 | 4 |  |
| 4 | MMI 009A | BIOSTATISTICS AND COMPUTER APPLICATIONS | 4 | 0 | 0 | 4 | 4 |  |
| 5 | MMI 010A | **Fermentation, Molecular Biology, Immunology and Computer Lab** |  | 0 | 12 | 12 | 12 |  |
|  |  | **Total** | **16** | **0** | **6** | **28** | **28** |  |

**M.Sc. Microbiology Semester- III**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **Contact Hrs.** | **Credits** | **Type** |
| 1 | MMI 011A | **MEDICAL MICROBIOLOGY** | 4 | 0 | 0 | 4 | 4 |  |
| 2 | MMI 012A | **GENETIC ENGINEERING** | 4 | 0 | 0 | 4 | 4 |  |
| 3 | MMI 013A | **MICROBIAL TECHNOLOGY** | 4 | 0 | 0 | 4 | 4 |  |
| 4 | MMI 014A | **APPLIED ENVIRONMENTAL MICROBIOLOGY** | 4 | 0 | 0 | 4 | 4 |  |
| 5 | MMI 015A | **Medical, Environmental Microbiology and Genetic Engineering Lab** |  | 0 | 12 | 12 | 12 |  |
|  |  | **Total** | **16** | **0** | **6** | **28** | **28** |  |

**M.Sc. Microbiology Semester- IV**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **Contact Hrs.** | **Credits** | **Type** |
| 1 | MMI 016A | **Review Report** | 8 |  |  |  |  |  |
| 2 | MMI 017A | **Dissertation** | 18 |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |
| 4 | MMI 018A | Seminar | 2 |  |  |  |  |  |
|  |  | Total | 28 |  |  |  |  |  |
|  |  | **Total Credits of All Four Semesters** | **112** |  |  |  |  |  |

**M.Sc. (Microbiology) Program Educational Objective (PEO’s):**

A Post graduate of the Microbiology Program should:

**PEO- I**Students will develop themselves as effective professionals by solving real problems through the use of computer science knowledge and with attention to team work, effective communication, critical thinking and problem solving skills.

**PEO- II**Students will develop professional skills that prepare them for immediate employment and for life-long learning in advanced areas of computer science and related fields.

**PEO- III**Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies.

**PEO- IV**  
Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career.

**PROGRAM OUTCOME (PO’s)**

**A Post graduate of the Microbiology Program will demonstrate:**

PO1.**Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to whichthese assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2.**Effective Communication:** Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3. **Social Interaction:** Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4. **Effective Citizenship:** Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. **Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6. **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.

PO7. **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

**Program Specific Outcome**

PSO1. Perform procedures as per laboratory standards in areas of Microbes (Bacteria, Fungi, Algae,Viruses), Microbial technology, applied environmental microbiology, medical and food microbiology

PSO2 Understand the role, structure and importance of the bio molecules associated with microbiology.

PSO3 Analyse the basic skills and techniques related to microbiology.

PSO4 Understand the fundamental principles of microbiology, various developments in microbiology and potential applications.

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| **MMI 001A** | **BACTERIOLOGY** | **4-0-0 [4]** |

***Objective***

* + This course aims to impart an insight into the morphology, internal structure and reproduction of the most primitive to evolved group of algae, fungi, virus and bacteria.
  + Familiarize with the basic skills and techniques related to microbiology.
  + Understand DNA as the basis of heredity and variation in microbes.

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| **UNIT 1** | **Classification :** Classification of microorganisms- introduction, Haekel’s three kingdom concept, Whittaker’s five kingdom concept, five domain system of classification. Modern trends in classification (ribotyping, NA hybridization, RNA fingerprinting). Classification and salient features of bacteria according to Bergey’s manual of systematic bacteriology(a brief outline) Morphlogical types of bacteria . Nutritional classification of bacteria |
| **UNIT 2** | **Ultra structure of bacteria :** Cell wall structure and synthesis, cell membrane,. Flagella and motility, chemotaxis Pili, Cell inclusions like Glycogen granules, Volutin granules, Carboxysomes etc, Slime sheet and capsule. Endospore structure and formation stages of sporulation, activation germination and outgrowth of bacterial endospores. |
| **UNIT 3** | **Eubacteria and Archaebacteria:** General characters and structure of Spirochetes, cyanobacteria, purple and green bacteria, rickettsia, Chlamydia, budding bacteria and sheathed bacteria. Gram positive bacteria- endospore forming bacteria, actinomycetes, mycobacteria. Archaebacteria-methanotrophs, halophiles and sulphur bacteria. |
| **UNIT 4** | **Microbial Growth :** The definition of growth, growth curve, measurement of growth and growth yields, Synchronous growth, Continuous, Batch and Fed Batch Culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability oxygen and pH, activity of water and gaseous environment, maintenance and preservation of microorganisms |
| **UNIT 5** | **Microbial Physiology :** Photosynthesis: Oxygenic photosynthetic microbes and anoxygenic photosynthetic microbes. Brief account of photosynthetic and accessory pigments-chlorophyll and bacteriochlorophylls, rhodopsin, carotenoids, phycobiliproteins; oxygenic-anoxygenic photosynthesis. |

**Course outcome**

CO 1 Write down the classical and modern trends in classification with reference to Bergey’s manual of systematic bacteriology

CO 2 Describe the Ultra structure of bacteria, nutritional, bacterial endospores and sporulation.

CO 3 Give a general account of eubacteria (Gram + & -) and archaebacteria (methanotrophs, halophiles and sulphur bacteria).

CO 4 Describe the Cultivation of Bacteria: growth curve and environmental factors affecting growth.

CO 5 Give a detail account of oxygenic and anoxygenic photosynthesis and the different types pigments molecule involved in photosynthesis

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 | H | L |  | M | L |  |  |  | L |  |  |
| CO2 |  |  | L |  | M |  |  | H |  | H |  |
| CO3 |  | M |  |  |  |  |  |  |  |  | M |
| CO4 |  |  |  |  |  | H |  | H |  |  |  |
| CO5 | H |  |  |  |  | L |  |  |  | L |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Basic and Practical Microbiology, Ronald M Atlas, Mac Millan Company New

York, 1989

2. Biology of Microorganisms, T D Brock, M T Madigan, (10 edition), Pearson education, Inc., 2003

3. Microbiology , Prescott, Harley, Klein, (6 edition), Mc Graw Hill Companies,2005

4. Microbiology Fundamentals and Applications , R M Atlas, (2edition), Maxwell

Macmillan International edition, 1989th

5. Microbiology-a Laboratory Manual, J G Cappuccino and N Sherman,

(6 edition),Addison Wesley, Pearson education, Inc., 2006

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| **MMI 002A** | **INSTRUMENTATION** | **4-0-0 [4]** |

***Objectives***

* + Understand the role, structure and importance of the bio molecules associated with microbiology.
  + Familiarize with the various microbial diseases and measures adopted to control diseases.

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| **UNIT 1** | **Microscopy:**  construction of a microscope, Principle and applications of light microscopy (bright field, dark field, phase-contrast, interference, fluorescence, polarization microscopy). Electron microscopy- TEM, SEM, Scanned probe microscopic techniques (STEM, AFM). |
| **UNIT 2** | **Centrifugation:** Principle, sedimentation analysis & RCF, ultracentrifugation: Preparative (differential and density gradient) and analytical centrifuges. |
| **UNIT 3** | **Chromatography:** Principle, techniques of chromatography (Paper chromatography, TLC, Column chromatography), types of chromatography (GC, HPLC, Adsorption chromatography, Partition chromatography, Gel filtration, Ion-exchange chromatography and Affinity chromatography). |
| **UNIT 4** | **Electrophoresis:** Principle, factors affecting electrophoresis, types of electrophoresis - Agarose gel electrophoresis, PAGE, SDS-PAGE, 2-D electrophoresis, Pulsed field gel electrophoresis, isoelectric focussing, immuno electrophoresis. |
| **UNIT 5** | **Spectroscopy:** Beer-Lambert law, UV-Vis spectroscopy, fluorescence spectroscopy, IR spectroscopy, Raman spectroscopy, Atomic absorption spectroscopy, NMR, ESR, Flame emission photometry, flow cytometry.**Radioisotopic Techniques:** Principle and applications of radiation techniques (Radioisotopes; nature of radioactivity, types of radioactive decay, unit of radioactivity), detection and measurement of radioactivity (Geiger-Muller counter, Solid and liquid scintillation counter, autoradiography). |

**Course outcome**

CO 1 Explain the principal, working, application and classification of light microscopy and electron microscopy

CO 2 Write down the basic principle, working and applications of Centrifugation.

CO 3 Explain the basic principle, techniques and types of chromatograph.

CO 4 Describe the Principle, working, types, factors affecting and applications of electrophoresis

CO 5 Explain the basic principle, working and application of Spectroscopy and Radioisotopic Techniques.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 |  |  | H |  |  | L |  |  |  | L |  |
| CO2 |  |  | L |  |  | M |  |  |  | H |  |
| CO3 |  | M |  |  |  |  |  |  |  |  | M |
| CO4 |  |  |  | H |  |  | M |  |  |  |  |
| CO5 |  |  | H | L |  |  |  |  | M |  |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1 Principles and Techniques of Biochemistry and Molecular Biology ,(6 th edition),

K Wilson and J Walker (editor), Cambridge University Press, 2007

2 Bioinstrumentation, J G Webster, John Wiley & Sons Inc. 2004

3 Methods in Modern Biophysics, B Notting, Springer Verlag Berlin Heidelberg

New York, 2003

4 Protein Purification Principles and Practice, (3 rd edition), R K Scopes, Spring

International, 2004

5 Spectroscopy for the Biological Sciences, G G Hames, John Wiley & Sons Inc.

2005

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| **MMI 003A** | **BIOCHEMISTRY & ENZYMOLOGY** | **4-0-0 [4]** |

***Objectives***

* + Understand the importance of biochemisty in human welfare.
  + Familiarize with applied aspects of microbial metabolism in other fields like agriculture, environment and industry.

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| **UNIT 1** | **Chemical foundations of Biology:** pH, pK, acids, bases, buffers, weak bonds, chemical bonds, Bioenergetics: Principles of thermodynamics: free energy, important energy, rich molecules, standard free energy change, concept of redox reactions. Principles of self assembly, Hierarchy of molecular organization of living systems. |
| **UNIT 2** | **Amino acids and proteins:** Structure and chemistry of Amino acids, Classification, Chemical Reactions and Physical Properties, Proteins-purification and criteria for homogeneity, structural organization of proteins- primary, secondary, tertiary and quaternary structure. Ramachandran plot. Protein sequencing, glyco and lipo protein structure and function. |
| **UNIT 3** | **Carbohydrates:** Classification and reactions of aldehyde and ketone group, types, structural features(ring structure, tautomeric forms, mutarotation) of carbohydrates. Metabolism of carbohydrates, glycolysis, Krebs cycle, terminal oxidation/oxidative phosphorylation, reverse TCA cycle, gluconeogenesis, mechanism of ATP synthesis. |
| **UNIT 4** | **Lipids:** Classification, Structure and functions, Biosynthesis of saturated and unsaturated fatty acids, Metabolism of Lipid and fat bodies: Beta-oxidation and channeling of the products to ATP production: minor pathway of fatty acid oxidation, (alpha and omega oxidation), Biosynthesis of saturated and unsaturated fatty acids. Purines and pyrimidines, denovo and salvage pathways. |
| **UNIT 5** | **Enzymes & Enzyme Kintetics:** Rate of reactions, specific activity, molecular activity, Km, K, Michaelis Menten & Line weaver Burk plot and Bisubstrate Reaction, enzyme inhibition, mechanism of enzyme catalysis (acid-base electrostatic, metal ion, free radicals, transition state binding and covalent, proximity and orientation effects, Contribution of strain). Factors affecting enzyme activity, enzyme inhibition. |

**Course Outcomes**

CO 1 Describe the chemical foundations of biology with reference to pH, buffers, bioenergies and hierarchy of molecules.

CO 2 Describe a general account of types, structural and metabolic pathway of amino acids. CO3 Explain general account of types, structural and metabolic pathway of carbohydrates.

CO 4 Describe the Classification, Structure, functions, catabolism and anabolism of saturated and unsaturated fatty acids.

CO 5 Describe the Enzyme Kinetics and the mechanism of enzyme catalysis and Factors affecting enzyme activity as well as enzyme inhibition

CO 10 Explain

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 |  | L |  |  |  |  |  |  |  |  |  |
| CO2 |  |  | M |  |  |  |  |  |  |  |  |
| CO3 |  |  |  |  | H |  |  | L |  | H |  |
| CO4 |  | H |  |  |  | M |  |  |  | M |  |
| CO5 | L |  |  |  |  |  |  |  |  |  |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Biochemistry, D.Voet and J.G.Voet, John Wiley & Sons, (2 nd Edition), 1995.

2. Principles of Biochemistry, Lehninger ,Nelson and Cox, (3 rdEdition), 1999.

3. Principles and Techniques in Biochemistry and Molecular Biology, Edited by

Keith Wilson and John Walker, Cambridge University Press, (6 thEdition), 2007.

4. Biochemistry and Molecular Biology by W.H. Elliot and Daphne C. Elliot,

Oxford University Press, (3 rd Edition), 2005.

5. Biochemistry, J. David Rawn, Panima Publishing Corporation, 1 st Indian Reprint,2004.

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| **MMI 004A** | **VIROLOGY, MYCOLOGY AND PHYCOLOGY** | **4-0-0 [4]** |

***Objectives***

* + To understand the morphology, internal structure and reproduction of the most primitive to evolved group of algae, fungi and virus
  + Familiarize with the basic skills and techniques related to microbiology.

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| **UNIT 1** | **Brief outline on discovery of viruses:** nomenclature and classification of viruses[LHT system, classification as per VII report of the international committee on taxonomy of viruses], distinctive properties of viruses; morphology & ultra structure; capsids & their arrangements; types of envelops and their composition-viral genome, their types and structure, virus related agents (viroids, virusoids, prions) cultivation of viruses in embryonated eggs, experimental animals, cell cultures; Primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures, cell certains, cell lines and transgenic systems. |
| **UNIT 2** | **Plant viruses:** Classification and nomenclature, effect of viruses on plants, external appearance of plants; histology, physiology and cytology of plants; Viruses of cyanobacteria, algae and fungi. Transmission of plant virus with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens), Prevention of crop loss due to virus infection- virus free planting material; vector control. |
| **UNIT 3** | **Mycology:** An Introduction to fungi-History, general features of fungi, Classification of fungi, according to Ainsworth and Alexopolus and Mims with the general aspects of Major division of fungi. Nutrition of fungi, Homothallism, Heterothallism, Heterokaryosis,and the Parasexual cycle, Sex Hormones in Fungi. Fungi as insect symbiont. Mycotoxins and Mycotoxicoses. Attack on fungi by other microbes. Economic importance of fungi. |
| **UNIT 4** | **Phycology:** An introduction to Algae, General features and classification of algae. Occurrence, thallus organization and reproduction in Chlorophyceae, Euglenophyceae, Phaeophyceae, Rhodophyceae, Xanthophyceae, Pyrrophyceae and diatoms. Algal ecology & biotechnology. Economic importance of algae. |
| **UNIT 5** | **Lichens:** Lichen- ascolichen, basidiolichen, deuterolichen. Economic Importance of lichen. |

**Course outcome**

CO 1 Describe the Brief history, nomenclature, classification, morphology ultra structure, cultivation and composition-viral genome and virus related agents (viroids, virusoids, prions).

CO 2 Describe the Viruses of plants, cyanobacteria, algae and fungi and Prevention of crop loss due to virus infection also classify the transmission of plant virus with and without vectors.

CO 3 Describe the history, classification, nutrition and general features of fungi as well as economic importance of fungi.

CO 4 Describe the general feature and importance of families of algae eg. Cyanophyceae, Chlorophyceae, Xanthophyceae and Phaeophyceae

CO 5 Describe economic importance of algae and lichen as well as their ecology.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 |  |  | H |  | L |  |  |  |  | L |  |
| CO2 |  |  | L |  | M |  |  |  |  | H |  |
| CO3 |  | M |  |  |  |  |  |  |  |  | M |
| CO4 |  |  |  |  | H |  |  | H |  |  |  |
| CO5 |  |  | H |  | L |  |  |  |  | L |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Introduction to Modern Virology, IV. Dimmock Nj,Primrose SB Edition,Blackwell Scientific Publications,Oxford. 1994

2. Virology-3rd Edition, Conrat HF,Kimball PC and Lev y JA. Prentice Hall,Englewood cliff, New jersey1994.

3. An Introduction to Mycology (III edition) Alexopopulos CJ and Mims CW, Wiley Eastern Ltd., New Delhi, 1979

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| **MMI 006A** | **FERMENTATION TECHNOLOGY** | **4-0-0 [4]** |

***Objectives***

* + Use of microbial system to handle industrial implications.
  + Help the student to explore the potentialities of various underutilized microbes to project as the future food prospects.
  + Familiarize with the fundamental principles of microbiology, various developments in microbiology and potential applications.

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| **UNIT 1** | **Fermentor :** Main components and its uses, peripheral parts and accessories. Control systems and sensors. Fermentor preparation and use: disassembly and cleaning of vessel, autoclaving, inoculation of fermentor vessel, sampling from fermentor vessel and routine maintenance of a fermentor. Specialized bioreactors (pulsed, fluidized bed, airlift bioreactor). |
| **UNIT 2** | **Fermentation media and scale up of fermentation:** Fermentation media and scale up of fermentation: Medium formulation, energy source, carbon sources, nitrogen sources, minerals, growth factors, buffers, inhibitors and precursors, antifoaming agents. Air and medium sterilization. |
| **UNIT 3** | **Kinetics of microbial growth:** Inoculum preparation and scale up of fermentations. Batch, fed batch and continuous fermentations. Multiple fermentation and solid substrate fermentations. Microbial growth cycle, diauxic growth, growth yields. Kinetics of microbial growth and death. Framework for kinetic models- stoichiometry, reaction rates, yield coefficients and linear rate equation. |
| **UNIT 4** | **Isolation, preservation and improvement of industrially important Microorganism:** Isolation of industrially important microorganisms. Primary and secondary screening. Preservation of industrially important microorganisms. Strain improvement by genetic recombination approaches and directed screening for mutants with altered metabolism. |
| **UNIT 5** | **Downstream processing:** Downstrea: processing, detection and assay of fermentation products.Removal of microbial cells and solid matter, foam separation, cell disruption, precipitation, filtration, centrifugation, liquid-liquid extraction, chromatography, membrane process, drying and crystallization. Physical, chemical and biological assays for detection of fermentation products. |

**Course outcome**

CO 1 Give a details account of fermentor, its component, uses, sensor and control system and maintenance.

CO 2 Write down the Fermentation media and scale up of fermentation and Air & medium sterilization also Batch, fed batch and continuous fermentations.

CO 3 Describe the Kinetics of microbial growth.

CO 4 Describe the Isolation, preservation and improvement of industrially important Microorganism, screening and genetic recombination.

CO 5 Give a detail account of Downstream processing, detection and assay of fermentation products.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 | H |  |  |  | L |  |  |  | H |  |  |
| CO2 |  |  |  |  | M | L |  |  |  |  |  |
| CO3 |  | M |  | L |  |  |  |  |  |  | M |
| CO4 | L |  |  |  |  |  |  | H |  |  |  |
| CO5 |  |  | H |  |  |  |  |  |  | L |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1 Biochemcal Engineering Fundamentals, (2 nd edition). J.E. Bailey and D.F. Ollis

Mcgraw Hill International Editions 1986.

2 Process Biotehnology Fundamentals (2 nd edition by S.N. Mukhopadh yaya. Vivi

Books Pvt. Ltd.2004

3. Principles of Fermentation Technology by P.F. Stanbury,A. Whittaker & Hall

Pergaman. McNeul & Harvey Publications. 1990.

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| **MMI 007A** | **MOLECULAR BIOLOGY AND MICROBIAL GENETICS** | **4-0-0 [4]** |

***Objectives***

* + To understand the recent trends in the field of applied microbiology.
  + To validate molecular and microbial aspect in prokaryotes and eukaryotes.

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| **UNIT 1** | **Prokaryotic and Eukaryotic gene structure and function:** Structure and properties of nucleic acids, Central dogma of molecular biology,Prokaryotic gene structure and organization, Eukaryotic genome structure andchromosome organization Replication in Prokaryotes and Eukaryotes. Enzymes and accessory proteins involved in DNA Replication. |
| **UNIT 2** | **Prokaryotic & Eukaryotic transcription:** (Initiation, Elongation & Termination), general apparatus of transcription, RNA,Polymerase, General & Specific Transcription Factors, Regulatory elements & mechanism of transcription regulation, Post transcriptional gene silencing (PTGS), Modifications in RNA. |
| **UNIT 3** | **Prokaryotic and Eukaryotic Translation:** the translation machinery, Mechanism of initiation, elongation, termination, Regulation of translation, Co & post translational modification of proteins, Localization of proteins, synthesis of secretory & membrane proteins, mitochondria, chloroplast & peroxisomes. |
| **UNIT 4** | **Bacterial genetics:** Molecular mapping of genome, genetic and physical mapping, map based cloning. Gene transfer mechanisms-Transformation- molecular mechanism, mapping and other uses of transformation, Transduction- generalized transduction, cotransduction and linkage, mapping by cotransduction, specialized transduction, specialized transducing phage as a cloningvehicle. |
| **UNIT 5** | **Bacteriophages:** , Lytic phages-T7 and T4.Lysogenic phages Lambda phage, and P1, M13 and F, Ø X174 life cycles, Phage MU and their uses in microbial genetics. Role of microbial genetics in vaccine designing. Microbial genetics and design of vaccines. BCG and design of vaccine for TB and leprosy. DNA vaccines, design and advantages. |

**Course outcome**

CO 1 Give a general account of prokaryotic and eukaryotic gene structure and function.

CO 2 Describe the mechanism of prokaryotic & eukaryotic transcription.

CO 3 Describe the different tools and mechanisms of transcriptional regulation.

CO 4 Write a detail account on the Bacterial genetics in reference to molecular mapping, gene transfer mechanisms i.e. transformation, transduction.

CO 5 Write down the general account of Bacteriophages eg. Lytic phages, Lysogenic phages and their uses in microbial genetics.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 | H |  | L |  | M |  |  |  |  | H |  |
| CO2 | M |  |  |  |  |  |  |  |  |  | L |
| CO3 |  |  |  |  | H |  |  | L |  |  |  |
| CO4 |  |  | H |  | L |  |  |  |  | L |  |
| CO5 |  |  | L |  | M |  |  |  |  | H |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Microbial Genetics, Stanley R. Maloy, John E. Cronan, Jr., David Freifelder, 2 nd

edition, Jones and Barlett Publishers, 1994.

2. Molecular Genetics of Bacteria, Larry Snyd er and Wendy Champness, ASM

Press, Washington, D.C., 1997.

3. Essentials of Molecular Biology, George M. Malacinski, David Freifeld er,3 rd edition, Jones and Bartlett Publishers, 1998.

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| **MMI 008A** | **IMMUNOLOGY** | **4-0-0 [4]** |

***Objectives***

* + Familiarize with the various microbial diseases and measures adopted to control diseases.
  + Understand the importance of genetic engineering in human welfare.
  + Familiarize with applied aspects of microbial physiology in other fields like immunity

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| **UNIT 1** | **Introduction to immune system:** Phylogeny of immune system, Innate and acquired immunity, Clonal nature of immune response. Cells of the Immune system: Hematopoiesis and differentiation, Lymphocyte trafficking, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, NK and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast Cells. Organization and structure of lymphoid organs |
| **UNIT 2** | **Cellular and molecular aspects:** Nature and biology of antigens and super antigens. Immunoglobulin: structure, types and their function, Major histocompatibility complex, B-Cell Receptor and T-Cell Receptor, generation and diversity, Complement system. Immune response & its regulation Antigen processing and presentation, generation of Humoral and Cell mediated immune responses, B- and T- cell maturation, activation and differentiation, Cytokines and their role in immune regulation, T-cell regulation, MHC restriction |
| **UNIT 3** | **Antigen- antibody interactions:** Precipitation, Immunodiffusion, Immunoelectrophoresis, Agglutination, RIA, ELISA, Immunofluorescence. Advanced concepts in Immunology:Hypersensivity, Autoimmunity, Vaccine development and immunization programme,Transplantation, Immunity of infectious agents (intracellular parasites, helminthes and viruses), AIDS and other immunodeficiencies, Hybridoma Technology and Monoclonal antibodies. |
| **UNIT 4** | **Transplantation:** organ specific autoimmune disease, systemic autoimmune diseases, graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection |
| **UNIT 5** | **Autoimmunity:** immunosuppressive drugs, HLA and disease, mechanism of immunity to tumor antigen, Autoantibodies in human pathogenic mechanism, experimental models of autoimmune disease treatment of autoimmune disorders. |

**Course outcome**

CO 1 Describe the Overview of immune system comprising innate immunity & adaptive immunity also organization and structure of lymphoid organs.

CO 2 Describe the cellular and molecular aspect of immune system.

CO 3 Explain the antigen- antibody interactions and the advanced concepts in Immunology.

CO 4 Give a brief detail the organ and systemic specific autoimmune disease.

CO 5 Explain the Autoimmunity and different models of autoimmune disease treatment of autoimmune disorders.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 |  |  | H |  | L |  |  |  |  | L |  |
| CO2 |  |  | L |  | M |  |  |  |  | H |  |
| CO3 |  | M |  |  |  | L |  |  |  |  |  |
| CO4 |  |  |  | M |  |  |  | H |  |  |  |
| CO5 |  |  | H |  | L |  |  |  |  |  |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Kuby’s Immunology, (4Edition)-R.A. Goldsby, Thomas J. Kindr. Barbara, A.

Osbarne, (Freeman) & Co. New York.

2. Roitt’s Essential Immunology,(10edition), Ivan M .Roitt and Peter J. Delves,

Blackwell Science, 2001

3. Instant Notes on Immunology, (2edition), Lydyard, Wheran and Fanger, Viva

Books Pvt. Ltd., 2003

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| **MMI 009A** | **BIOSTATISTICS AND COMPUTER APPLICATIONS** | **4-0-0 [4]** |

***Objectives***

* + Acquaint the student with the significance of Environmental microbiology.
  + Use of computers to handle biological data base.

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| **UNIT 1** | **Classification and tabulation of data:** frequency distribution, individual, discrete, continuous data, exclusive and inclusive frequency table |
| **UNIT 2** | **Probability:** addition and multiplication theorem of probability. A brief idea of normal, Poisson and binomial distribution. |
| **UNIT 3** | **Measures of central tendency & dispersion Tests of significance:** Measures of central tendency and dispersion .Measure of central tendency- Mean, median and mode, Measures of dispersion - range, mean deviation ,standard deviation, coefficient of variation, Skewness and kurtosis. |
| **UNIT 4** | **Introduction to computers:** definition, a simple model of computer, fundamental, technical and commercial classification of computer. Characteristics of computer Systems. Data representation and application- input and output devices, Computer Memory, CPU, Types of Software - Application software, System Software, Operating Systems and types. Computer Languages, Windows and its applications. Elements of Desktop, Special Indicators. File Handling in Windows, Accessories. |
| **UNIT 5** | **MS Office and its application:** MS Office Fundamentals & Components - MS Word, MS Excel.MS Power Point, MS- Access. |

**Course outcome**

CO 1 Describe the classification and tabulation of data, measures of central tendency, different methods of dispersion.

CO 2 Give a brief detail of the Introduction, definition, types and theorems of probability.

CO 3 Explain the Tests of significance- Chi-square test, t-test, F-test, ANOVA-one way and two way classifications as well as simple correlation and simple regression.

CO 4 Write down the general account to computers including definition, a simple model of computer, fundamental, technical and commercial classification of computer

CO 5 Explain the MS Word, MS Excel, MS Power Point and MS- Access.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 |  |  | H |  | L |  |  |  | L |  |  |
| CO2 |  |  | L |  | M |  |  |  | H |  |  |
| CO3 | L | M |  |  |  |  |  |  |  |  |  |
| CO4 |  |  |  | H |  | M |  | H |  |  |  |
| CO5 |  |  | H | L |  |  |  |  |  |  |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Biostatistics: A Foundation for Analysis in Health Sciences, (6 th edition), W

W Daniel, John Wiley and Sons Inc., 1995.

4. Statistical Methods in Biology, N T J Bailey, Cambridge University Press, 1995.

5. Statistics for Biologist, R C Campbell, Cambridge University Press, 1989.

6. Fundamentals of Biostatistics, Khan, Publishing Corporation, 1999

7. Practical statistics for Experimental Biologists, A C Swardlaw, John Wiley

and sons Inc., 1985

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| **MMI 011A** | **MEDICAL MICROBIOLOGY** | **4-0-0 [4]** |

***Objectives***

* + Familiarize with the various microbial diseases and measures adopted to control diseases.
  + Understand the importance of genetic engineering in human welfare.

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| **UNIT 1** | **Normal micro flora and factors responsible for pathogenesis:** Classification of medically important micro organisms; Normal microbial flora of human body; role of the resident flora. Entry of pathogens into the host; colonization and mechanism of bacterial adhesion establishment, spreading, tissue damage and anti-phagocytic factors; factors predisposing to infections, types of toxins and their structure; mode of action. |
| **UNIT 2** | **Pathogenic bacteria I:** Diagnostic features of important diseases including their pathogenecity and control. Pyogenic cocci-*Staphylococci, Streptococci, Neisseria meningitides, N. gonococcus*  Gram positive cocci*-Clostridium tetani,* Mycobacteria*-M. tuberculosis, M. leprae* |
| **UNIT 3** | **Fungi and Protozoan:** Enteric Gram negative bacteria-  *Salmonella, Shigella, Vibrio cholera, E. coli Spirochaetes- Treponema palladium*  Chlamydiae- Trachoma, Rickettesial diseases, Diseases caused by Mycoplasma,  Pathogenic fungi-*Candida albicans* Protozoan diseases – Malaria, Amoebiasis |
| **UNIT 4** | **Animal viruses:** Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses- Picorna virus family- Poliomyelitis, influenza, Mumps, Measles, DNA viruses; Pox virus- Variola and Vaccina, Herpes virus- Varicella Zoster virus, Hepatitis viruses, Arthropod borne (arbo) Viral disease- Dengu, Swine flu. |
| **UNIT 5** | **Chemotherapy and Antimicrobial agents:** Mode of action of penicillin, Sulfa drugs, streptomycin, tetracycline and other broad spectrum antibiotics. Antifungal drugs, antiviral drugs. Brief account on available vaccines |

**Course outcome**

CO 1 Describe the Classification of medically important micro organisms and Normal microbial flora of human body with its pathogenesis

CO 2 Write down the Diagnostic features of important bacterial diseases including their pathogenecity and control with the reference to Pyogenic cocci, Gram positive cocci, Gram negative bacteria

CO 3 Pathogenic fungi-*Candida albicans* Protozoan diseases – Malaria, Amoebiasis

CO 4 Explain the general detail of Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses and DNA animal viruses.

CO 5 Brief account of available vaccines, Antifungal drugs, antiviral drugs and their mode of action.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 | H |  |  |  |  |  |  |  | M |  |  |
| CO2 | L |  |  |  |  |  | M |  |  |  |  |
| CO3 |  | M |  |  |  |  |  |  |  | L |  |
| CO4 |  |  | L |  |  |  |  | H |  |  |  |
| CO5 | H |  |  |  |  |  |  |  |  | L |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Bacterial Pathogenesis. A Molecular Approach, A A Salyers and D D Whitt, ASM Press, 1994
2. Instant Notes Medical Microbiology, Irving W, Boswell T, Ala Aldeen D, Taylor and Francis group, 2005
3. Medical virology- Morag C and Timbury M.C. X Edition. Churchill Livingstone, London. 1994
4. Microbiology A Human Perspective, Nester E. W., Roberts CE, Nester MT, Wm. C. Brown Publishers, 1995.

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| **MMI 012A** | **GENETIC ENGINEERING** | **4-0-0 [4]** |

***Objectives***

* + Understand DNA as the basis of heredity and variation in microbes.
  + Understand the role, structure and importance of the bio molecules associated with microbiology.

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| **UNIT 1** | **Tools of genetic engineering:** Scope and milestones in genetic engineering, Basic tools and techniques used in recombinant DNA technology: Restriction endonuclease, DNA modifying enzymes, cloning vectors: plasmids, bacteriophage, cosmid, phagemids, *in vitro* construction of vectors, expression vectors. |
| **UNIT 2** | **Principle and uses of nucleic acid hybridization:** Principle and applications of polymerase chain reaction. Patenting of cloned life forms. Site directed mutagenesis and protein engineering, *in vitro* DNA synthesis, *in vitro* transcription and translation. |
| **UNIT 3** | **Sequencing of genes DNA and genomic library:** : m- RNA enrichment, reverse transcription, Linkers, Adaptors,Screening of cDNA and genomic library, Sequencing and mapping: Sequencing vector,fluorescent tagging, Automated DNA sequencing, Pyrosequencing. Restriction mapping and map construction, Application of sequence information for identification of defective genes. |
| **UNIT 4** | **Molecular Mapping of Genome:** Genetic and physical mapping, Genome sequencing: genome size, organelle genome, YAC, BAC libraries, strategies of genome sequencing, Analysis of genetic variations: RAPD, RFLP, AFLP and other molecular marker techniques, application of RFLP in forensic studies, disease prognosis, genetic counselling, pedigree analysis etc. |
| **UNIT 5** | **Strategies of gene delivery:** Agrobacterium mediated transformation, electoporation, particle bombardment, microinjection, Gene therapy: Target gene replacement, gene knockout technique, computer aided drug designing. Gene expression DNA and protein microarray technology, RNase protection assay, Reporter gene assay, northern blotting and S1 nuclease assay, Heterologous gene expression in bacteria, yeasts, insects, mammals and plants. codon optimization. |

**Course outcome**

CO 1 Explain the scope of Scope and milestone in genetic engineering as well as Basic tools & techniques used in recombinant DNA technology as well as different vectors and their expression.

CO 2 Describe the Principle and uses of nucleic acid hybridization.

CO 3 Write down the sequencing gene DNA and genomic library.

CO 4 Describe the molecular mapping and physical mapping of genome as well as RAPD, RFLP, AFLP and other molecular marker techniques.

CO 5 Give a detail account of Strategies of gene delivery and classify the target gene replacement and the gene expression.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 |  | L |  |  | M |  |  |  |  | L |  |
| CO2 | M |  |  | L |  |  |  |  |  | H |  |
| CO3 |  |  |  |  |  |  | H |  | H |  | M |
| CO4 |  | H |  |  |  |  | L | H | L |  |  |
| CO5 |  | L |  |  |  |  |  |  | M | L |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Molecular Cloning: a Laboratory Manual, J. Sambrook. E.F. Fritsch and T.

Maniatis, Cold Spring Harbor Laborator y Press, New York, 2000.

2. DNA Cloning: a practical Approach, D. M. Glover and B.D. Hames, IRL Press

Oxford, 1955.

3. Molecular and Cellular Methods in Biology and Medicine, P. B. Kaufman, W.

Wu., D. Kim and L.J: Cseke, CRC Press.Florida,1995.

4. An Introduction to Genetic Engineering. Edited by Desmond S.T. Nicholl,

Cambridge University Press, Februar y 2002.

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| **MMI 013A** | **MICROBIAL TECHNOLOGY** | **4-0-0 [4]** |

***Objectives***

* + Help the student to explore the potentialities of various underutilized microbes to project as the future food prospects.
  + Familiarize with the fundamental principles of microbiology, various developments in microbiology and potential applications.

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| **UNIT 1** | **Industrial production of organic feed stocks:** ethanol, acetone/ butanol fermentations, organic acids- citric acid, acetic acid, amino acids- glutamic acid, lysine, vitamins- riboflavin. Microbial transformation of steroids. |
| **UNIT 2** | **Industrial application of microorganism:** Industrial uses of molds. Industrial production of antibiotics- penicillin, streptomycins, tetracyclines, polyketides and polyketide antibiotics. Enzymes as fermentation products- amylases, proteases. Techniques of enzyme immobilization. |
| **UNIT 3** | **Introduction to food fermentation technology:** Microbial cells as fermentation products- commercial production of bakers yeast, food and feed yeast, mushrooms and algae. Introduction to food fermentation technology. Microorganisms responsible for spoilage. |
| **UNIT 4** | **General Principle underlying spoilage:** Elementary idea of canning and packing, Sterilization and pasteurization of Food Products, Food preservation by Radiations, low and high Temperature.Chemical preservation and naturally occurring antimicrobials. Fermented foods (Soya sauce, bread, Sauerkraut, idly), fermented beverages (wine, Beer) Microbiological examination of food. |
| **UNIT 5** | **Industrial Dairy fermentations:** Classification of various groups of microorganisms associated with dairy industry. Starter cultures for fermented dairy products (*Streptococcus thermophillus, Lactobacillus bulgaricus*),Acid fermented milks (Yoghurt, Cultured butter milk, Kefir). Cheese production. Alcoholic beverages and alternative energy sources: Commercial production of beer, wines. |

**Course outcome**

CO 1 Describe the Industrial production of organic feed stocks

CO 2 Explain the application of microorganism and industrial production of antibiotics and techniques of enzyme immobilization.

CO 3 Give a account of Microbial cells as food fermentation products as well as responsible for spoilage.

CO 4 Write an account of canning and packing, Sterilization and pasteurization and various methods of food preservation as well as fermented food.

CO 5 Describe Classification of various groups of microorganisms associated with dairy industry and various dairy fermented products.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 |  |  | H |  | L |  |  |  |  | L |  |
| CO2 |  |  | L |  | M |  | H |  |  | H |  |
| CO3 |  | M |  |  |  |  | L |  |  |  | H |
| CO4 |  |  |  | L |  |  | M | H |  |  |  |
| CO5 |  |  | H | H |  |  |  |  |  | L |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1) Industrial Biotechnology, L.E.Casida Jr.New Age International Pvt Ltd. Publishers 2005.

2) Food Microbiology, W.C.Frazier and D.C.Westhoff . Tata McGraw Hill

Publishing Company Ltd, New Delhi 1998

3) Food Poisoning and Foo d Hygiene B.C.Hobbs and D. Roberts Edward Arnold (A division of Hodder and Stoughton London) 1993

4) Dairy Microbiology , R.K. Robinson Elsevier Applied Sciences, London.

5) Principles of Fermentation Technology b y P.F. Stanbury,A. Whittaker & Hall. Pergaman. McNeul & Harvey Publications. 1990.

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| **MMI 014A** | **APPLIED ENVIRONMENTAL MICROBIOLOGY** | **4-0-0 [4]** |

***Objectives***

* + To understand the fundamental principles of microbiology, various developments in microbiology and potential applications related to environment.
  + Familiarize with the recent trends in the field of applied microbiology.

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| **UNIT 1** | **Waste management:** Treatment of industrial effluents and municipal waste through micro-or ganisms. Aerobic Processes: Oxidation pools, Rotating Biological Discs, Rotating Drums |
| **UNIT 2** | **Anaerobic Processes:** Anaerobic digestion, Anaerobic filter, upflow an aerobic sludge blanket reactors. Indicator microorganisms. Solid wastes: Sources and management composting, vermiculture and Methane Production. |
| **UNIT 3** | **Biodegradation of natural compounds:** (cellulose, hemicelluloses, lignin, chitin,). Biodegradation of xenobiotics in environment – Organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, synthetic polymers, detergents and hydrocarbons Bioremediation- *ex situ* and *in situ*. bioaccumulation, biomagnifications. |
| **UNIT 4** | **Biodeterioration and Bioleaching:** Definition, biodetorioration of paper, wood, paint, textiles, leather, metals (corrosion).Control of biodetorioration. Microorganisms and metal pollutants- metal bioavalibility in environment, mechanism of microbial metal resistance and detoxification, metal- microbe interaction, Bioleaching of metals, Microbial enhanced oil recovery. |
| **UNIT 5** | **Biofertilizers:** Definition and types of biofertilizers, Mass cultivation and methods of inoculation of microbial inoculants – (Rhizobium, Azotobacter, &Asospirillium.) Cyanobacteria –Azolla– Anabaena association and its role in rice cultivationQuality control and ISI specifications for Rhizobium cultures. Mycorrhizal Relationship, Biopesticides and Bioplastics |

**Course outcome**

CO 1 Describe the aerobic treatment of industrial effluents and municipal waste through microorganisms

CO 2 Write down the Anaerobic Processes as well as composting, vermiculture and Methane Production

CO 3 Describe the Biodegradation of natural compounds as well as xenobiotics ex situ and in situ bioaccumulation and biomagnifications.

CO 4 Describe biodeterioration and bioleaching of paper, wood, paint and other metals.

CO 5 Write down the general characteristics, types, cultivation and methods of biofertilizers, Biopesticides and Bioplastics.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

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| ***Course Outcome*** | **Program Outcome** | | | | | | | **Program Specific Outcome** | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PO2 | PSO3 | PSO4 |
| CO1 | H |  |  |  | L |  | L |  |  |  |  |
| CO2 |  |  |  |  | M | H | H |  |  |  |  |
| CO3 |  | M |  |  |  | L |  |  |  |  | L |
| CO4 |  |  |  |  |  | M |  | H |  |  |  |
| CO5 | L |  | H |  |  |  |  |  |  | L |  |

H = Highly Related; M = Medium; L = Low

***Suggested Readings***

1. Environmental Biotechnology – Basic concepts and applications, Indu Shekhar Thakur, I K International publications. 2006

2. Environmental Microbiology R.M Maier, I.L. Pepper and C.P.Gerba , Academic Press. (2000)

3. Introduction of Environmental Microbiology, Michel. R. 1999

4. Microbial Ecology- Fundamentals & Applications, 4 th Edition, Ronald M. Atlas, Richard Bartha, Pearsrson Publication. 2005.

5. Microbials in Integrated Pest Management, (special Indian edition) edited by Ignacimuthu S, SEN A, Oxford and IBH Publishing Co. Pv. Ltd. 2001