

ಮಂಗಳೂರು  
MANGALORE



ವಿಶ್ವವಿದ್ಯಾನಿಲಯ  
UNIVERSITY

(Accredited by NAAC)

ಕ್ರಮಾಂಕ/ No. : MU/ACC/CR 39/2020-21/A2

ಕುಲಸಚಿವರ ಕಛೇರಿ

ಮಂಗಳಗಂಗೋತ್ರಿ - 574 199

Office of the Registrar

Mangalagangothri - 574 199

ದಿನಾಂಕ Date:13.12.2021

**NOTIFICATION**

Sub: Revised syllabus of M.Sc. Microbiology programme.

Ref: Academic Council approval vide agenda

No.: ಎಸಿಸಿ:ಶೈ.ಸಾ.ಸ.2:9 (2021-22) dtd 27.10.2021.

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The Revised syllabus of M.Sc. Microbiology programme which is approved by the Academic Council at its meeting held on 27.10.2021 is hereby notified for implementation with effect from the academic year 2020-21.

Copy of the Syllabus shall be downloaded from the University Website ([www.mangaloreuniversity.ac.in](http://www.mangaloreuniversity.ac.in))

  
REGISTRAR

To,

1. The Chairman, Dept. of Studies and Research in Microbiology, Post Graduate Centre, Jnana Kaveri Campus, Kodagu - 571 232.
2. The Chairman, Combined BOS in Microbiology, Dept. of Studies and Research in Microbiology, Post Graduate Centre, Jnana Kaveri Campus, Kodagu - 571 232.
3. The Registrar (Evaluation), Mangalore University.
4. The Superintendent (ACC), O/o the Registrar, Mangalore University.
5. The Asst. Registrar (ACC), O/o the Registrar, Mangalore University.
6. The Director, DUIMS, Mangalore University - with a request to publish in the website.
7. Guard File.

# **MANGALORE UNIVERSITY**

DEPARTMENT OF STUDIES AND RESEARCH IN MICROBIOLOGY POST GRADUIATE  
CENTRE, JNANA KAVERI CAMPUS, KODAGU-571232

## **Microbiology**

**M. Sc. Degree Course in  
Choice Based Credit System**

## **Syllabus**

**(Approved in the BOS held on 17<sup>th</sup> January, 2020)**

## **General Objectives of the Course**

1. To excel in various fields of Microbiology.
2. To gain higher education in the field of microbiology.
3. To gain knowledge regarding microbiological and analytical skills related to medical, food, pharmaceuticals, environmental and agricultural aspects.
4. To train the students practically eligible to pursue higher research work.
5. To make them competent to address various societal issues.

## **Programme Outcome: M. Sc Degree in Microbiology**

The M.Sc., Microbiology programme, intends to equip candidates with microbiological skills to render their service in various institutions and companies. The program prepares the students to gain knowledge in various specific areas/fields of Microbiology. The students are trained to get through competitive examinations at international, national and state level. The students are taught different aspects of microbiology and trained for creative self-employability.

### **Programme specific Outcomes**

- |       |                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------|
| PSO 1 | Employability skills capable to work in research institutes, Industries and Government departments. |
| PSO 2 | Research skills to pursue Ph. D and Research Assistants, Research Associates in reputed institutes. |
| PSO 3 | Establishment of own diagnostic centers and industries.                                             |
| PSO 4 | Teaching – Universities and Colleges.                                                               |
| PSO 5 | Work with FSL laboratories, Pollution control boards and Coffee board.                              |
| PSO 6 | Take up further research in abroad and outside the state.                                           |
| PSO 7 | Work with NGOs to create awareness of hygiene in rural and urban areas.                             |
| PSO 8 | Field work research through Project Works                                                           |

**Question Paper Pattern for University Examination  
Microbiology (CBCS-PG-CGPA)**

**Time: 3 Hours**

**Max Marks: 70**

- I. Write short notes on **any five** of the following 3X5 =15
- 1.
  - 2.
  - 3.
  - 4.
  - 5.
  - 6.
  - 7.
- II. Write notes on **any five** of the following 5 x 5 = 25
- 8.
  - 9.
  - 10.
  - 11.
  - 12.
  - 13.
  - 14.
- III. Answer **any three** of the following 10 X3= 30
- 15.
  - 16.
  - 17.
  - 18.
  - 19.

While setting question paper equal weightage should be given to all the units of the paper.

**Question Paper Pattern for Internal Assessment  
Microbiology (CBCS-PG-CGPA)**

**Time: 1.30 Hours**

**Max Marks: 30**

I. Answer **any two** of the following

6 x 2 = 12

- 1.
- 2.
- 3.

II. Write notes on **any three** of the following

4 x 3 = 12 .

- 4.
- 5.
- 6.
- 7.

III. Write short notes on **any three** of the following

2 x 3 = 6

- 8.
- 9.
- 10.
- 11.
- 12.

**Note: Two tests to be conducted for 30 marks each and the average of the two shall be awarded as IA marks**

# MANGALORE UNIVERSITY

## SYLLABUS & SCHEME

**CBCS-PG-CGPA: CHOICE BASED CREDIT SYSTEM-POST GRADUATE CUMULATIVE GRADE POINT AVERAGE**

| Sem                                                              | Course Code | Course title                             | Ins.Hrs /week | Credit | Exam Hrs | Marks |     | Total |
|------------------------------------------------------------------|-------------|------------------------------------------|---------------|--------|----------|-------|-----|-------|
| I                                                                | HARD CORE   |                                          |               |        |          | Int   | Ext |       |
|                                                                  | MBH -401    | Bioanalytical Techniques in Microbiology | 4             | 4      | 3        | 30    | 70  | 100   |
|                                                                  | MBH-402     | Bacteriology and Virology                | 4             | 4      | 3        | 30    | 70  | 100   |
|                                                                  | MBH-403     | Phycology and Mycology                   | 4             | 4      | 3        | 30    | 70  | 100   |
|                                                                  | MBH-404     | Microbial Genetics                       | 4             | 4      | 3        | 30    | 70  | 100   |
|                                                                  | MBP-405     | Microbial Techniques                     | 4             | 2      | 4        | 15    | 35  | 50    |
|                                                                  | MBP-406     | Microbial Physiology                     | 4             | 2      | 4        | 15    | 35  | 50    |
| SOFT CORE (Any two out of three soft core papers to be selected) |             |                                          |               |        |          |       |     |       |
|                                                                  | MBS-407     | Microbial Cell Biology                   | 3             | 6      | 3        | 30    | 70  | 200   |
|                                                                  | MBS-408     | Microbial Diversity                      | 3             |        | 3        | 30    | 70  |       |
|                                                                  | MBS-409     | Biomolecules                             | 3             |        | 3        | 30    | 70  |       |
|                                                                  |             | Total                                    | 33            | 26     |          |       |     | 700   |
|                                                                  |             |                                          |               |        |          |       |     |       |
| II                                                               |             | HARD CORE                                |               |        |          |       |     |       |
|                                                                  | MBH-451     | Genetic Engineering                      | 4             | 4      | 3        | 30    | 70  | 100   |
|                                                                  | MBH-452     | Food Microbiology                        | 4             | 4      | 3        | 30    | 70  | 100   |
|                                                                  | MBH-453     | Medical Microbiology & Immunology        | 4             | 4      | 3        | 30    | 70  | 100   |
|                                                                  | MBP-454     | Genetic Engineering & Food Microbiology  | 4             | 2      | 4        | 15    | 35  | 50    |
|                                                                  | MBP-455     | Immunology & Medical Microbiology        | 4             | 2      | 4        | 15    | 35  | 50    |
| SOFT CORE (Any two out of three soft core papers to be selected) |             |                                          |               |        |          |       |     |       |
|                                                                  | MBS-456     | Microbial Biotechnology                  | 3             | 6      | 3        | 30    | 70  | 200   |
|                                                                  | MBS-457     | Phytopathology                           | 3             |        | 3        | 30    | 70  |       |
|                                                                  | MBS-458     | Immunotechnology                         | 3             |        | 3        | 30    | 70  |       |
| OPEN ELECTIVE                                                    |             |                                          |               |        |          |       |     |       |
|                                                                  | MBE-459     | General Microbiology                     | 3             | 3      | 3        | 30    | 70  | 100   |
|                                                                  | MBE-460     | Bioinoculants                            |               |        |          |       |     |       |
|                                                                  |             | Total                                    | 32            | 25     |          |       |     | 700   |

| Code                                                                    |                                  |                                                              | weeks      |           | Hrs |     |     |             |
|-------------------------------------------------------------------------|----------------------------------|--------------------------------------------------------------|------------|-----------|-----|-----|-----|-------------|
| <b>III</b>                                                              |                                  | <b>HARD CORE</b>                                             |            |           |     | Int | Ext |             |
|                                                                         | MBH -501                         | Molecular Biology                                            | 4          | 4         | 3   | 30  | 70  | 100         |
|                                                                         | MBH -502                         | Environmental Microbiology                                   | 4          | 4         | 3   | 30  | 70  | 100         |
|                                                                         | MBH -503                         | Biostatistics and Bioinformatics                             | 4          | 4         | 3   | 30  | 70  | 100         |
|                                                                         | MBP-504                          | Molecular Biology                                            | 4          | 2         | 4   | 15  | 35  | 50          |
|                                                                         | MBP-505                          | Environmental Microbiology, Biostatistics and Bioinformatics | 4          | 2         | 4   | 15  | 35  | 50          |
| <b>SOFT CORE (Any two out of three soft core papers to be selected)</b> |                                  |                                                              |            |           |     |     |     |             |
|                                                                         | MBS-506                          | Metagenomics & Proteomics                                    | 3          | 6         | 3   | 30  | 70  | 200         |
|                                                                         | MBS-507                          | Marine Microbiology                                          | 3          |           | 3   | 30  | 70  |             |
|                                                                         | MBS-508                          | Cancer Biology                                               | 3          |           | 3   | 30  | 70  |             |
|                                                                         |                                  |                                                              |            |           |     |     |     |             |
| <b>OPEN ELECTIVE</b>                                                    |                                  |                                                              |            |           |     |     |     |             |
|                                                                         | MBE-509                          | Microbial Techniques                                         | 3          | 3         | 3   | 30  | 70  | 100         |
|                                                                         | MBE-510                          | Pharmacology and Pharmacognosy                               |            |           |     |     |     |             |
|                                                                         |                                  | <b>Total</b>                                                 | <b>32</b>  | <b>25</b> |     |     |     | <b>700</b>  |
| <b>IV</b>                                                               |                                  | <b>HARD CORE</b>                                             |            |           |     |     |     |             |
|                                                                         | MBH -551                         | Agricultural Microbiology                                    | 4          | 4         | 3   | 30  | 70  | 100         |
|                                                                         | MBH-552                          | Industrial Microbiology                                      | 4          | 4         | 3   | 30  | 70  | 100         |
|                                                                         | MBP-553                          | PROJECT WORK                                                 | 4          | 4         | 3   | 30  | 70  | 100         |
| <b>SOFT CORE (Any one out of two soft core papers to be selected)</b>   |                                  |                                                              |            |           |     |     |     |             |
|                                                                         | MBS-554                          | Bio-Nanotechnology                                           | 3          | 3         | 3   | 30  | 70  | 100         |
|                                                                         | MBS-555                          | Research Methodology                                         | 3          |           | 3   | 30  | 70  |             |
|                                                                         |                                  | <b>Total</b>                                                 | <b>18</b>  | <b>15</b> |     |     |     | <b>400</b>  |
|                                                                         | <b>Grand Total (I+II+III+IV)</b> |                                                              | <b>115</b> | <b>91</b> |     |     |     | <b>2500</b> |

Note: **Internal Assessment marks may be awarded as follows**

- Conduct of 02 internal assessment tests for 30 marks, average Converted to 10 marks
- Seminar presentation with submission of seminar manuscript for 10 marks
- Assignment /Field Report / Tour report/Summer project for 10 marks

#### **MBP- 553: Project work**

- Project work shall be decided by the Department Council before starting the III Semester
- The project work may be carried out either in the department or outside institutions (common to all students)
- Internal assessment marks for project work may be awarded through pre-final project presentation (1 or 2 times)
- The project report/dissertation shall be evaluated by an Internal and External Examiners or by the Board

## **I SEMESTER**

### **MBH 401: BIOANALYTICAL TECHNIQUES IN MICROBIOLOGY**

**52 HRS**

#### **UNIT-I**

**(13hr)**

Historical developments in Microbiology, Inventions/contributions of Louis Pasteur, Robert Koch, Edward Jenner, Antony van Luevenhoek....., Types of Microscopes and advantages, Components of microscopes, Compound microscope, Phase Contrast, Fluorescent Microscope, Confocal, Electron Microscopy – Principle, Techniques and applications of Transmission Electron microscope (TEM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM), Microtomy – Basic and Freezing microtome – specimen preparation.

#### **UNIT-II**

**(13 hr)**

Working of LAF, Biosafety cabinets, Incubator, Colony counters, Haemocytometer, Micrometry, Autoclaves, Colorimeter/Spectrophotometer, Inoculation loops, pH meter, Serial dilutions, Methods of Inoculations: Pour plate, Streak method, Spread plate, Stab inoculations, Physical and Chemical Sterilization methods; heat sterilization, moist, use of chemicals alcohols and disinfectants

#### **UNIT-III**

**(13 hr)**

Isolation of bacteria, Fungi, Actinomycetes, Cyanobacteria -Physical and Chemical requirements for growth; Culture Media and types; simple, complex and special media, Growth kinetics and growth curve, anaerobic culture techniques. Methods of Preservation of Cultures; subculturing, glycerol stock, Cryopreservation, Liquid Nitrogen, Bacterial Culture collection centre's, ATCC, MTCC., Staining Technique: Principle, procedure and Types-Simple, Differential, Negative, Flagellar, Endospore, Cell wall and Capsule.

#### **UNIT-IV**

**(13 hr)**

Principles and applications of Centrifugation, Sedimentation coefficient, Rotors and types, Analytical and preparative Ultra centrifugation, Electrophoresis, Principles of Agarose, SDS PAGE and applications, 2-D gel Electrophoresis, Iso electric focusing, Spectroscopy; mass spectroscopy, MALDI-tof Spectroscopy, NMR, Atomic spectroscopy, Chromatography; Gel filtration, Ion exchange, Affinity, HPLC, GCMS;

## **MBH 402: BACTERIOLOGY AND VIROLOGY**

**52 HRS**

### **UNIT- I**

**(13hr)**

Bacteria: Morphological types; cell wall – cell walls of Gram negative, Gram positive, Cell wall synthesis, cell membrane, capsule type's composition and function. Structure and function of flagella, fimbriae and pili, gas vesicles, Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes. Endospore and exospores. chlorosomes, and phycobilisomes. Reserve food materials -polyhydroxybutyrate, polyphosphates, cyanophycin, Nuclear material - bacterial chromosomes and bacterial plasmids

### **UNIT II**

**(13hr)**

Taxonomy of bacteria- morphological, biochemical and molecular methods for identification; 16srRNA analysis, phylogenetic analysis, DNA sequencing and comparison ; Bergy's Manual of Systematic Bacteriology; characteristics of major groups of bacteria. – general characteristics, classification ultra-structure, reproduction and economic importance; a) Actinomycetes b) Cyanobacteria c) Mycoplasma d) Archaeobacteria

### **UNIT III**

**(13 hr)**

Viruses, Discovery, nomenclature, classification and properties of viruses, Morphology and ultra structure - capsid and their arrangement, envelope - types and their composition, viral genome – types and structure, Sub viral agents- viroids, prions, virusoids and satellite viruses, Virus-Host interaction; Multiplication of viruses: attachment, uncoating, penetration, biosynthesis and release viral pathogenesis: transmission, tropism, virulence, host factors, host defense mechanism.

### **UNIT- IV**

**(13 hr)**

Plant viruses: General symptoms, economic importance, diseases in pulses: transmission and control. Special references - BCMV, PMV, SMV, ULCV, BYMV, Human viruses: importance epidemiology symptoms and control measures - HIV, H1N1 Ebola virus, SARS virus, Small pox virus, Rabies virus, Zika virus. Bacterial viruses: classification, Lytic and lysogenic cycle. Phage Mu, M13, T4, P1, Bacteriophage typing, Cultivation & Maintenance of virus; cell culture techniques and their types, Host plant inoculation test, Histopathological examination, ELISA, Dot assay, RIA, western blot, immunofluorescence

**UNIT-1****(13 hr)**

History and Recent developments in Mycology, General characters, Distribution and Nutrition in fungi, Ultra structure of fungal cell, cell wall, hyphal structure and growth, Reproduction in fungi-Vegetative, Asexual and Sexual. Fungal systematics- Chytridiomycota, Hypochytridiomycota, Oomycota, Zygomycota, Basidiomycota, Ascomycota, Deuteromycota, Fungal fruiting bodies, Types of spores-motile and non-motile cells, and spore dormancy.

**UNIT II****(13 hr)**

Follicolous and Endophytic fungi, Plant Fungal Diseases; Different types of mycosis- Cutaneous, subcutaneous and Systemic mycosis. Mycotoxins, Opportunistic fungal infections, lab diagnosis and treatment of fungal infections: Aspergillosis, Candidiasis, Dermatitis. Economic importance of fungi: fungi in Agriculture, Industry, Medicine, Fungi as biocontrol agent, Mycorrhiza- Ecto and Endomycorrhizae, Vesicular and ArbuscularMycorrhizae, Lichens and their importance. Macrofungi and their importance in food industries: cultivation of mushrooms and applications, Role of fungi in biodegradation.

**UNIT III****(13 hr)**

Distribution, Classification, Morphology &Ultrastucture of Cyanophycean cell, Microalgae and Macroalgae, Prokaryotic- blue green algae and eukaryotic algae- green, red, brown. Photosynthetic pigments, Significance of pigments (structure of chlorophyll a, b, c, and c2, xanthophyll, carotenoids and other pigments), Algal habitats: fresh water, marine water, soil algae,Cultivation and Reproduction in algae,measurement of algal growth

**UNIT IV****(13 hr)**

Uses of algae as SCP, *Spirulina* &*Chlorella*, Algal biofuel: Bio diesel, bio ethanol, mass culturing of alga, extraction and refinement, symbiotic algae, lichens, coral reefs and sea sponges, Algae as indicators of pollution, eutrophication, algal blooms, algal toxins, algae as raw food and feed, algae as biofertilizers Algae with special references to soil fertility, Industrially important algal products, commercial products, food and medicine, Role of algae in heavy metal removal, immobilized and labelled algae, strain selection and large scale cultivation, Role of algae in water purification.

**Unit I**

Structure and types of chromosomes, centromere, telomere, nucleosome, genome organization, split gene. Types of histones, histone modifications- methylation, acetylation, phosphorylation and their effects on structure and function of chromatin, DNA methylation, repetitive and non-repetitive DNA sequence. Law of DNA constancy, C value paradox and genome size, karyotype and ideogram. *E. coli* genome: coiled, supercoiled, folded fibre model.

**UNIT II**

Mendelian Laws, Contribution of Griffith, Avery, Hershy and Chase towards Genetics. Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications, genetic analysis of virus, bacteria and yeast genomes. Plasmids and Bacteriophages: Plasmids, F-factors - description and their uses in genetic analysis, R plasmids. Lysogeny and lytic cycle in bacteriophages.

**UNIT III**

Structure of gene, Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution. Nature, type and effects of mutations. Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms. Site directed mutagenesis and its applications.

**UNIT IV**

Genetic recombination in bacteriophages and *E. coli*, synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases, Genetic Mapping: Complementation analysis, deletion mapping, cis-trans test. Overlapping genes. Transposons. General mechanism of genetic engineering in eukaryotes and prokaryotes. Restriction Mapping, Genetic Engineering, Transfection of a cloned gene into a eukaryotic cell & its expression

### **MBP-405: Microbial Techniques**

1. Preparation of culture media & Inoculation methods
2. Colony characteristics of bacteria
3. Staining techniques (Simple, Negative, Gram's, Endospore, flagellar)
4. Bacterial Growth curve (Titrimetric and Turbidometric)
5. Enumeration of bacteria from different sources
6. Micrometry
7. Lactophenol cotton blue staining for fungal culture
8. Enumeration of fungi from soil, water and air
9. Study of endophytic fungi
10. Study of follicolous fungi
11. Isolation of VAM fungi
12. Identification of wood rotting fungi
13. Identification of Phytoplanktons in fresh water,& marine water
14. Isolation and culturing Cyanophycean members
15. Study of Lichens

### **MBP-406: Microbial Physiology**

1. Estimation of reducing sugar by DNS method
2. Estimation of Protein by Lowry's method
3. Estimation of Protein by Biuret method
4. Estimation of Saponification value of fats
5. Estimation of Peroxide Value
6. Gelatin Hydrolysis by microorganisms
7. Fermentation of Carbohydrates
8. Casein Hydrolysis
9. Determination of specific gravity of fats & oils
10. Triple sugar Iron test
11. Urease production test
12. Determination of catalase activity
13. Determination of  $V_{\max}$  and  $K_m$  value

14. Qualitative testing of carbohydrates (Glucose, Fructose, Lactose, Starch)

**MBS- 407: Microbial Cell Biology**

**40 HRS**

**Unit I**

**12h**

Introduction to microbial cell biology, Prokaryotic and eukaryotic cells and their intracellular organization, Nucleus, bacterial nucleoid architecture & chromosome organization, Bacterial genome, DNA of mitochondrial and chloroplast, Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Chromatin: molecular organization, nucleolus and rRNA processing.

**Unit II**

**14 h**

Bacterial cell cycle- regulation and coordination of replication, chromosome segregation and nucleoid exclusion, Binary fission- FtsZ and the Z-ring, structures and functions of bacterial cell envelopes- Gram-positive bacteria, Gram-negative bacteria, mycobacteria, Archaea. Peptidoglycan, penicillin-binding proteins and resistance, antibiotic resistance, alternative approaches for combatting infections.

**Unit II**

**14 h**

Central Dogma of Molecular Biology: transcription and translation in prokaryotes and eukaryotes. Post transcriptional modifications, Transcription and translation Inhibitors. Bacterial replication, Activators and inhibitors of replication, Molecular Biology of Cancer: Mechanism of transformation of cells, Physical and chemical carcinogens, role of carcinogens & oncogenes in cancer, Oncogene proteins, Tumor repressor genes, Viral oncogenes.

**MBS-408: MICROBIAL DIVERSITY****40 HRS****Unit-I****12 h**

Importance of microbial diversity in environment: Forest ecosystem, Aquatic ecosystem, Soil ecosystem, Marine ecosystem, Air microflora. Microbial interaction: Algae & Plants, Plants & fungi, Bacteria & Animals, Plants & Bacteria. Parasitism: Bacterial, Fungal and Viral diseases. Rhizosphere and Phyllosphere microflora. Microbial life in extreme environment.

**Unit-II****14 h**

Indicator organisms and Bioleaching, biodegradation, bioremediation and phytoremediation. Ecological and Evolutionary diversity (Genetic diversity) of microbes. Intestinal microflora, Biofilms, Rumen Microbiology. Conventional and molecular methods of studying microbial diversity.

**Unit-III****14 h**

Microorganisms in different soil horizons, Classification of microorganisms, Role of Microbes in Geochemical cycling of Carbon, Nitrogen, Sulfur and Phosphorus. Studies on extremophiles in different geological spheres, Microorganisms in aquatic ecosystem and their role. Role of microbes in weathering of rocks, Lichens, the events that led to the emergence of life, evolution of metabolic processes, and the diversification of the biosphere

**MBS: 409 BIOMOLECULES****40 HRS**

## Unit-1

12 h

Macromolecules in Biological system, General function and importance of biomolecules in cellular organization, Carbohydrates – classification & properties mono, di, oligo and polysaccharides. Identification and analysis of Mono, Di and Polysaccharides-qualitative and quantitative tests.

## Unit-II

14 h

Lipids: Properties, functions and classification of Fatty acids, types, Triglycerides- biosynthesis of cholesterol. Phospholipids, biomembrane lipids and functions, liposomes, role of lipid in membrane fluidity. Nucleic acid – Functions and properties of purines and pyrimidines - Structure of DNA and RNA.

## Unit-1

14 h

Proteins: classification properties and biological functions, Chemical and biological properties of Amino acids, peptides, Structural levels-primary, secondary, tertiary and quaternary and three dimensional structure of proteins, methods of isolation and purification of proteins functional groups in proteins and their chemical reactions, protein denaturation and renaturation, Vitamins as coenzymes-classification, properties and function. Micronutrients-source, requirements and biochemical role and deficiency symptoms.

## REFERENCES:

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- Advances in Fungal Biotechnology, Sohan Sharma, Random Publication New Delhi.
- Bacteria and Antibacterial agents, John Mann, M. James, C Corabbe, Spectrum
- Bacteria and Viruses, Misten, IVY Publishing House, Delhi
- Bacterial disease in plants, K M C handniwala, Anmol publications pvt Ltd. New Delhi
- Bacterial photogenesis, Abigail. A Salyer & Dirie D. Whitt, ASM Press Washington DC 2<sup>nd</sup> Edition
- Bacterial systematic, Niall A. Logan, Blackwell scientific publications London
- Bacterial, Phage and Molecular Genetics, U. Winkler, W. Ruger, W. Wackernagel, Narosa Publishing House, New Delhi
- Biodiversity of microbial life, James T Staley, Anna Louis, Reysenbach, Eville-Liss Publication
- Biofertilizers in agriculture and forestry, N. S Subha Rao, Oxford & IBH publishing Co pvt. Ltd. New Delhi
- Cases in medical microbiology and infectious diseases. Peter H. Gilligan, M. Lynne Smiley, David S. Shapiro, ASM Press Washington DC 3<sup>rd</sup> edition.
- Cell biology and Genetics, Cecie Starr, Ralph Taggart, Brooks Cole, Thomson Learning Australia, 9<sup>th</sup> edition
- Crop disease Identification & Management, L. V. Gangawane, V. C. Khilare, Daya Publishing House, Delhi
- Cyanobacteria, Purshotam Kaushik, Abhishek Chauhan, New India Publishing Agency, Pitampura, New Delhi
- Detection and isolation of soil fungi, Pirre Davet, Francis Rousset, Science Publishers Inc. UK.
- Dictionary of Microbiology and Molecular biology, Paul Singleton, Diana Sainsbury, John Wiley and Sons Ltd. New York, Singapore, 3<sup>d</sup> edition
- Dictionary of the fungi, D.L. Hawksworth P.M. Kirk. B. C Sutton, CAB International.
- Elementary Microbiology Dr. HA Modi, Akta Prakashan Nadiad, Gujarat, Volume-1 & 2
- Fundamentals of molecular biology, Dr Ashok Kumar Sharma.
- Fundamentals principles of Bacteriology, A. J. Salle, Tata M. C., Graw-Hill, Publishing Company, Ltd. New Delhi 7<sup>th</sup> edition.
- Fungal Diseases of plants, B M Dugger, Agro Botanica IVE 176 J N VYAS nagar Bikaner.
- Fungi biology, Vijay Kumar, Discovery publishing house, New Delhi.
- Fungi cides in plant diseases control, % L Nene, P N Thaplyal, Oxford and IBH publishing co. Pvt Ltd. New Delhi
- Fungi in Biotechnology, Anil Prakash, C B S Publishers and distributors, New Delhi.
- Fungi of India, A K Sarbhoj, J L Varshney, D K Agarwal, CBS Publishers and distributors 459611-A Daryag New Delhi.
- Fungal diseases of plants, Benjamin Minge, Duggar, Rishabh Publishers and distributors, Delhi.
- Gas Chromatography, Raibir Singh, Mittal Publications, New Delhi.
- Gas Chromatography, Raibir Singh, Mittal Publications, New Delhi.
- Gel Chromatography, Tibor Kremmer, Laszlo Bross, John Wiley & Sons Chichester New York.
- General Microbiology, Hans. G. Schlegel, Cambridge University Press, 7<sup>th</sup> edition.
- General Microbiology, Hans. G. Schlegel, Cambridge University Press, 7<sup>th</sup> edition.
- General Microbiology, S.B. Sullia, S. Shantharam, Oxford & IBH Publishing. Co. Pvt Ltd. New Delhi. Calcutta.
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- Genes in medicine molecular biology and human genetic disorders, Istvan Rasko, C Stephan Downes, Chapman and Hall London, New York.
- Genetic engineering of plants, Gyan Deep Singh, Anmol publications Pvt Ltd, New Delhi (India)

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- Genetic Engineering, Sandhya mitra, M CMILIAN INDIA LIMITED, Delhi, madras.
- Genetic recomina, David R F Leach, Black well science
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## **II SEMESTER**

### **MBH-451: GENETIC ENGINEERING**

**52 h**

#### **UNIT- I**

**(14 h)**

Genetic Engineering- Definition, concepts and scope of Genetic Engineering. Historical perspectives and milestones in Recombinant DNA Technology (rDNA technology). Importance of gene cloning and future perspectives. Tools in Genetic Engineering- Enzymes in genetic engineering. Cloning vectors and their properties- Ti Plasmid, pBR322, pUC, Lambda, M13 Phage vector, Cosmids- Phasmids, Phagemids, Shuttle vectors, YAC and BAC vectors, Mammalian expression vectors. Isolation and construction of vectors.

#### **UNIT- II**

**(14 h)**

rDNA Technology- the basic principles of gene cloning strategies: Preparation, Manipulation and Insertion of desired DNA into vector. Introduction of DNA into host cells-Transformation, Transduction, Transfection, Microinjection, Biolistics, Electroporation, Liposome fusion, Shotgun cloning. Genomic and c-DNA Libraries. Cloning and expression in bacteria, yeasts. Identification and selection of recombinants

#### **UNIT- III**

**(14 h)**

Analysis of products, Nucleic acids staining, Molecular markers in genome analysis: RFLP, RAPD, AFLP and ISSR. Blotting techniques- Southern, Northern and Western blotting techniques. PCR- Principles, types and applications. Synthetic genes of microbes. Microbial genome sequencing projects- DOE microbial genome programme, TIGR microbial database. Analysis of genome sequences, DNA chips: studying gene expression using DNA microarrays. Next Generation sequence.

#### **UNIT- IV**

**(10 h)**

Application of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Antisense technology. Restriction and regulation for the release of GMOs into Environment, Ethical, Legal, Social and Environmental Issues related to rDNA technology.

## **MBH-452: FOOD MICROBIOLOGY**

**52 hrs**

### **UNIT- I**

**(13 h)**

Food and its constituents: carbohydrates, proteins, fats & oils, vitamins, minerals, fiber and water-properties and significance. Food as substrate for microorganisms, Extrinsic and Intrinsic factors influencing microbial growth, Microbes important in food: molds, yeasts, bacteria. Detection of food spoilage, Food- borne Infection & Intoxication: Bacterial, Fungal, Nematodal, Protozoal. Spoilage of fruits, vegetables, cereals, meat, fish, sea foods, poultry and canned foods.

### **UNIT- II**

**(13 h)**

Milk handling & processing, microbial contamination of milk, Biochemical activities of milk: Souring, Lactosis, Proteolysis. Milk - borne infections, Probiotics and their importance. Fermented dairy products- buttermilk, sour cream, cheese, yoghurt, Pasteurization and its types, Fermented Foods- Bread, Cocoa, Vinegar, Sausage, Oriental foods- Shoyu, Tofu, Idli. Food preservation: Classification- physical, chemical and biological.

### **UNIT- III**

**(13 h)**

Principles of Food Packaging: Types of containers, Food packaging materials and forms, Package testing, Packages with special features, Safety of food packaging. Food Processing and Environment: Food Sanitation in manufacture and Retail trade, Properties and requirements of processing water, Waste water and waste solids disposal, up-gradation and treatment.

### **UNIT- IV**

**(13 h)**

Food Safety, Risks and Hazards: Microbiological consideration in Food Safety, Effects of processing and storage on Microbiological safety, Microbiological methodology, Food Laws and Regulations- HACCP, FSSAI, BIS, Federal Food, Drug and Cosmetic Act, International Food Standards and Codex Alimentarius.

**Unit-I****( 13 h)**

Microbes-Host interaction, cell organization, signal transduction. Infection: Definition, Types, portal of entry, role of enzymes, proteins and toxins during invasions, stages of infection. Bacterial toxins: Types, superantigens, pore-forming toxins, soluble toxins, toxins acting on signal transduction, membrane perturbation and permeabilization. Important human pathogens: *Mycobacterium tuberculosis*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Shigella dysenteriae*, *Vibrio cholerae*. Emerging and re-emerging pathogens. Rapid diagnostic principles, Nucleic acid probes, Real Time PCR, Methods in molecular typing, Microarray technology.

**Unit-II****( 13 h)**

Antibiotics, Mechanisms of antibiotic resistance, extended spectrum  $\beta$ -lactamases. Inhibitors of enzymes, novel antibiotics from natural resource, strategic mechanism and interference between host cell and pathogen interaction and control of pathogenesis. Mechanisms of antimicrobial therapeutic molecules. AMPS, Newer vaccines: Recombinant vaccines, subunit vaccines, DNA vaccines, BCG & HIV- vector based vaccines.

**Unit-III****( 13 h)**

Immunity, Innate(non-specific) and Adaptive(specific) immunity, primary and secondary lymphoid organs, Cells of the immune system- macrophages, B-cells, T-cells, NK Cells, Basophils, mast cells, hematopoiesis, Humoral or antibody mediated immune response and Cell mediated immune response, receptors of the B-cells, T-cells, monoclonal and polyclonal antibodies, Immunogenicity, antigenicity, factors that influence immunogenicity, primary and secondary immune response, Immunoglobulin classes, Immunoglobulin superfamily, secretion of immunoglobulins.

**Unit-IV****( 13 h)**

Hypersensitivity, types I, II, III DTH, Immunodeficiencies, Acquired immunodeficiency syndrome, SCID, X-linked gammaglobulinemia, Opportunistic infections Cancer induction, Tumors of the Immune System, Tumor Antigens, viral induced antigens, Immune Response to Tumors, Evasion of the Immune System, Immunosurveillance, Organ-Specific Autoimmune Diseases, Systemic Autoimmune Diseases, Hashimoto's thyroiditis, autoimmune anemia, Insulin-dependent diabetes mellitus, Goodpasture's syndrome, Graves' disease, myasthenia gravis, Systemic Lupus Erythematosus, Rheumatoid arthritis, multiple sclerosis.

## **MBP- 454: Genetic Engineering & Food Microbiology**

1. Genome analysis in *E coli*
2. Genome analysis in *Saccharomyces cerevisiae*
3. Isolation of Plasmids and purification from E coli
4. Restriction digestion analysis on agarose gel electrophoresis
5. DNA purification for PCR
6. DNA amplification by PCR
7. Transduction in *E coli*
8. DNA uptake by E coli cell by transformation
9. Enumeration of milk Micro flora by DMC
10. Production and evaluation of curd
11. Estimation of lactic acid
12. Milk spoilage microbes
13. Test for food adulteration
14. Effect of food preservatives
15. Isolation and identification of spoilage microbes from vegetables, fruits, pickles

## **MBP- 455: Immunology & Medical Microbiology**

1. Detection of allergens and pollen count by Sticky slide method
2. Blood group determination
3. Radial immunodiffusion assay
4. Ouchterlony double diffusion assay
5. DOT-ELISA
6. SDS-PAGE
7. Rocket Immuno Electrophoresis
8. RBC Count
9. Study on Immune cells
10. Isolation of Lymphocytes
11. VDRL
12. WIDAL test
13. Isolation of microflora from skin, mouth, wound
14. Snyder's test for dental decay

## **MBS-456: MICROBIAL BIOTECHNOLOGY (40 h)**

### **Unit-I (12 h)**

Over Expression of Recombinant Proteins in *E.coli* driven by lac, T7 and Tet regulatable Promoters, Expression in *B. subtilis*, Gene Expression in other Microorganisms, cDNA, *Saccharomyces cerevisiae* expression systems, Secretion of Heterologous Proteins, Baculovirus over expression system.

### **Unit-II (14 h)**

Screening of Microorganisms for Novel Products – protein pharmaceuticals, human interferons, optimizing gene expression, Vaccines, small biological molecules. Synthesis of L- Ascorbic acid, Amino Acids, Secondary Metabolites – Antibiotics Penicillin, Bacteriocins, Chloramphenicols, Streptomycin. Biopolymers – Polyhydroxy alkanoates, Polyhydroxy butyrates. Monoclonal Antibodies, Aromatic compounds, Single Cell Proteins, Functional Foods, Probiotics.

### **Unit-III (14 h)**

Patenting of Biotechnological Inventions, Copyrights, IPR, National and International Patent Laws, Patentability Requirements, Rights, Infringement, applying, obtaining, patent protection, Regulations in Biotechnological Research, NIH-RAC. Genetically Engineered food. Food ingredients, Deliberate release of GEOs, EPA, Public concern,

## **MBS-457: PHYTOPATHOLOGY**

**40 h**

### **Unit I**

**(10 h)**

History and Scope of Pathology, Nature and Concept of plant diseases, Parasitism, Disease symptoms, Plant pathogenic Organisms, Disease Triangle, and Plant disease Cycle, Phytopathological Methods.

### **Unit II**

**(10 h)**

General aspects of plant diseases by Viruses, Mycoplasmas, Bacteria, Fungi, Protozoa, Nematodes – symptoms, Etiology, Transmission and Life Cycle, Non Parasitic diseases, Management of Plant Disease by Physical, Chemical and Biological Methods, Cultural Practices, Plant Quarantine, Integrated Disease Management Concepts.

### **Unit III**

**(10 h)**

Host –Parasite Interactions, Mechanism of Penetrance and Infection, Pre penetration and Infection, Invasiveness – Bio trophic and Neotrophic Pathogens, Effect of Infection, Physiological Functions of Hosts, Translocation of Water and Mineral Nutrients, Organic Nutrients, Respiration and Permeability.

### **Unit IV**

**(10 h)**

Structural and Biochemical Host Defence Mechanisms. Genetics of Host – Parasite Interaction, Genes and Variability in Pathogens, Genetics of Virulence and Resistance, Gene to Gene concept, Horizontal and Vertical Resistance, Development of Epidemics, Disease Forecasting, Post-Harvest Diseases, Seed Borne diseases.

**Unit-I****(14 h)**

Concepts, general structure of Immunoglobulins, antibody classes, functions, antigenic determinants (epitopes) on Igs, monoclonal and polyclonal antibodies, hybridoma technology for monoclonal antibody productions and applications, humanized monoclonal antibodies, Immunological methods for the preparation of serum and plasma, preparation of antigens from pathogenic bacteria, flagellar antigens, capsular antigens,

**Unit-II****(14 h)**

Purification of Immunoglobulins, enzyme tagging to Igs, purification of antigens and antibodies by affinity chromatography Immunoprecipitation techniques-ring test, flocculation test, Immunodiffusion in gel-ouchterlony double diffusion, radial diffusion, Immuno electrophoresis-Laurell's rocket immuno electrophoresis, western blotting techniques, Immunofluorescence –direct and indirect ,cell staining for immunofluorescence,

**Unit-III****(12 h)**

Immunoassay techniques-ELISA, RIA, Isolation methods of lymphocytes-antibody coated magnetic beads, flow cytometry, isolation of dendritic cells, culture of macrophages, cell viability-trypan-blue method, Fluorescein method, Immunologic Basis of Graft Rejection\_ Clinical Manifestations of Graft Rejection, Immunosuppressive Therapy, Immune Tolerance to Allografts

## **OPEN ELECTIVE**

### **MBE- 459: General Microbiology**

**40h**

#### **UNIT I**

**12 h**

Isolation and Identification of Microbes, Culturing of Microbes- Culture media, Types of culture media. Media for bacteria, fungi, algae and viruses. Pure culture techniques: Different types of inoculation methods - Spread plate, Pour plate and Streak plate methods. Economic importance of Microorganism: Agriculture, Industry, Medicine, Environment.

#### **Unit II**

**14 h**

Classification and general properties of microbes: Virus, Bacteria, Fungi, Algae and protozoans. Distribution of microorganisms in soil, Role of microorganisms in soil fertility. Microbial Interactions- mutualism, commensalism, competition, amensalism, parasitism, predation. Interactions between microbes and plants, Microbes and animals, Microbes and Humans.

#### **Unit III**

**14 h**

Bacterial diseases: Cholera, Typhoid, Tuberculosis, Salmnellosis, Anthrax, Shigellosis. Fungal Disease: Candidiasis, Dermatitidis, Aspergillosis, Mycotoxicosis. Viral Diseases: AIDS, HIV, Rabies, Hepatitis, Poliomyelitis, Small pox, Chicken pox. Control of microbes- Sterilisation, disinfection, antiseptic, pasteurization, radiation, Chemical-phenol and phenolic compounds.

**UNIT I****12 h**

Bio inoculants-definition, history and scope. Types of bio inoculants. Microbial Inoculants- types in microbial inoculants-seed, soil, nursery. Methods of inoculant preparation in seed/seedling and soil inoculants. ISI standards and quality tests followed in bioinoculants

**UNIT II****14 h**

Biofertilizers- Definition & types, Biological Nitrogen fixers- symbiotic and non- symbiotic- *Gluconoacetobacter*, *Rhizobium*, *Frankia*, *Azotobacter*, *Azospirillum*, *Azolla*, Blue green algae .Phosphate solubilizers- mechanisms, examples. Phosphate Mobilizers- Mycorrhizae- Ecto and Endomycorrhizae and VAM

**UNIT III****14 h**

Biopesticides- Definitions, Importance in management of crop pests-, *Verticillium*, *Metarrhizium*, *Beauveria*. Biofungicides: *Trichoderma* and its importance in Biocontrol of plant diseases. Bacterial biopesticides- *Bacillus thuringiensis*, *Pseudomonas*. Production and formulation of *Rhizobium* biofertiliser

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### III SEMESTER

#### Hard core

#### MBH- 501: Molecular Biology

52 h

#### UNIT- I

(13 h)

Definition, concepts: genes, chromosome, genetic code, prokaryotic and eukaryotic genomic organization structure and types of nucleic acids. Central Dogma of Molecular Biology: transcription and translation in prokaryotes and eukaryotes. Genetic recombination: transformation, transduction & conjugation. Organelle DNA- mitochondrial, chloroplast, Bacterial genome.

#### UNIT- II

(13 h)

Replication enzymes, factors involved in prokaryotic and eukaryotic Initiation, Elongation and termination of replication, Transcription, DNA proof reading, Activators and inhibitors of replication. Enzymes: activators, transcription factors, prokaryotic and eukaryotic promoters. Post transcriptional modifications- splicing, adenylation, capping, polyribosomes, polycistronic and monocistronic mRNA, Transcriptional inhibitors, Translation and Post Translation modifications.

#### UNIT- III

(13 h)

DNA damage repair mechanisms: Photo reactivation, Excision, Recombinant, SOS & Mismatch repair. Gene regulation in prokaryotes and eukaryotes: operon concept, catabolic repression, control by attenuation. Constitutive and Induced Gene expression. Protein splicing, Inter and Intracellular Protein translocation.

#### UNIT- IV

(13 h)

Molecular Biology of Cancer: Mechanism of transformation of cells, Physical and chemical carcinogens, role of carcinogens & oncogenes in cancer, Oncogene proteins- Protein Kinases, growth factors, the *ras* proteins, Tumor repressor genes, Protein Kinases and transformation. Viral oncogenes: Structure & detection of integrated viral DNA.

## **MBH-502: Environmental Microbiology (52 h)**

### **UNIT- I (13 h)**

Interactions of microbes with their living and non-living environment, microbial habitats and functions, Roles and regulation of microbes in natural and man-made environments, from cellular to community level. Microbial ecology and environmental microbiology to explore the functional ubiquity and diversity of microorganisms

### **UNIT- II (13 h)**

Introduction to microbial ecology: overview, motivation, history, applications etc. Aut- and synecology of macro and microorganisms: definitions, terminology, concepts. Individuals and populations: productivity, growth, distribution, activity. Communities: colonization, succession, diversity, structure. Microbial functions in ecosystems and global cycles, Methods in microbial ecology, Habitat characterization

### **UNIT- I II (13 h)**

Interactions of microorganisms with their physical and chemical environment, Microbial guilds and biogeochemical cycles. Interactions with the biotic environment: symbiosis, competition, parasitism, predation. Interactions within microbial communities: quorum sensing, syntrophy, antibiotics. Interactions of microorganisms with algae and plants, Interactions of microorganisms with animals and humans. Ecology of natural and engineered microbial habitats

### **UNIT- IV (13 h)**

Marine ecosystems: ocean surface, tidal flats, deep-sea, methane seeps, estuaries, anoxic basins. Freshwater ecosystems: lakes, rivers, swamps, bogs, Terrestrial ecosystems: rocks and soil, prairie, forest, tundra, Extreme environments: deserts, hot springs, glaciers, deep subsurface, mine drainage, Landfills, wastewater treatment reactors, bioremediation Culture collections, food ecosystems, agricultural systems, aquaculture.

## **MBH-503: BIOSTATISTICS & BIOINFORMATICS**

**(52 h)**

### **Unit I**

**(13 h)**

Introduction to basic statistics, Types of data, primary and secondary Collection and Classification of Data, tabulation, Types of Numerical Data, Frequency Distribution, Population and Sampling, Representation of Data. Line chart, Bar diagramme, Pie chart, Histograms, Frequency Polygons.

### **Unit II**

**(13 h)**

Measures of Central Tendencies, mean, median, mode Measures of Dispersion, Standard Deviation, Coefficient of Variation, Probability, Tests of Significance, ANOVA. BINOMIAL, POISSON, NORMAL DISTRIBUTION. Tests of significance: normal, t, F tests, chi square test, goodness of fit, statistical packages.

### **Unit III**

**(13 h)**

Basics of Computer, Spread Sheet Application, Data Storing, Generating Charts / Graphs and other features, Molecular Modelling, Presentation tools, Basics of Internet, Search Engines, Citation Search, H Index, Literature Search Techniques, Statistical Data Analysis using Computer and Software, TOOLPAK, COSTAT, SPSS, Sequence Analysis, Homology, Analogy, BLAST, EMBL, GENE BANK, FASTA,

### **Unit IV**

**(13 h)**

INTRODUCTION TO BIOINFORMATICS: Search engines, molecular modelling, phylogeny, Genomics and Proteomics, Protein Structure Prediction, Molecular Modelling and Docking, Computer Aided Drug Designing.

## **MBP-504: MOLECULAR BIOLOGY**

1. Isolation of Genomic DNA from *E.coli* and Yeast
2. Isolation of RNA
3. Qualitative and Quantitative analysis of DNA and RNA
4. Agarose gel Electrophoresis
5. Southern Blotting
6. Northern Blotting
7. Western Blotting
8. *E.coli* gene expression (Lactose Metabolism)
9. *E.coli* cell transformation ( preparation of competent cells and foreign DNA uptake)
10. Gene expression in *S.cerevisiae*
11. Plasmid isolation from *E.coli*
12. Gel documentation studies
13. Polymerase chain reaction
14. *In - vitro* translation

## **MBP-505: ENVIRONMENTAL MICROBIOLOGY& BIOSTATISTICS**

1. Determination of TDS of water
2. Determination of BOD of water
3. Determination of COD of water
4. Microbial analysis of potable water – MPN method
5. Test for coliforms in water
6. Isolation of indicator algae from polluted water
7. Isolation of oil degrading microbes
8. Air sampling technique
9. Enumeration of lichens
10. Representation of Statistical data by
  - a) Histograms
  - b) c) Pie diagrams
12. Determination of Statistical averages/ central tendencies.
  - a) Arithmetic mean
  - b) Median
  - c) Mode
13. Determination of measures of Dispersion
  - a) Mean deviation
  - b) Standard deviation
  - and coefficient of variation
14. Tests of Significance-Application of following
  - a) Chi- Square test
  - b) t- test
  - c) Standard error

## **MBS-506: Metagenomics & Proteomics**

**40 h**

### **Unit I**

**13h**

Structure and organization of Genomes in Prokaryotes and Eukaryotes: gene structure, Open reading frames, Conceptual translation, Termination sequences and GC content. Genome Sequencing: High throughput sequencing, clone-by-clone approach, Whole genome shot gun approach, quality of genome sequence, human genome sequencing project.

### **Unit II**

**13h**

Comparative Genomics of prokaryotes and eukaryotes, Comparative genomics of organelles, Large scale mutagenesis and interference. Analysis of Transcriptomes: Introduction, DNA microarray technology, Functional genomics, Expressed Sequence Tags (ESTs) and Serial Analysis of Gene Expression (SAGE,) Allele mining and SNPs, Applications of genomics.

### **Unit III**

**14h**

Metagenomics: Introduction to sequence based and function based metagenomics. Analyses of community composition and change, Metabolic reconstruction analyses, metatranscriptome and metaproteome analyses Proteomics: Introduction to proteomics, Proteomics Technologies - Protein Arrays, Protein Chips and their applications, 2D Gel Electrophoresis and its application, Mass Spectrometry and Protein identification, Shotgun proteomics.

**MBS-507: MARINE MICROBIOLOGY****40h****Unit I****12h**

Ecology of Marine water; physical, chemical and biological components in marine water. Stratification of marine ecosystem based on pH, temperature, oxygen and nutrient availability. Extreme conditions prevailing in marine water. Estuaries; definition, physical and chemical properties.

**Unit II****14h**

Microbial diversity the marine water and estuaries- algae, fungi and bacteria and actinomycetes. Anoxic environment and its microbes. Methods to study microbial communities in marine water. Methanogens, Sponges, Coral reefs, protozoans and algae and their role in the construction of marine ecosystem

**Unit III****14h**

Metabolites of Marine Microbes- Bioactive compounds from actinomycetes and algae- their chemical nature, properties and commercial applications . Sampling methods to isolate marine microbes from sea water. Island Biodiversity. Pollution/contamination of marine water by oil spills, hydrocarbons and industrial waters and its management.

## **MBS-508: CANCER BIOLOGY**

**40h**

### **Unit I**

**12h**

Origin and Terminology, Cancer induction, cell transformation, genetic and environmental factors, causes and prevention, benign and malignant tumors, immortalization, metastasis, Characteristic traits, chemical carcinogenesis, Ames test, radiations, oncogenes: viruses & cellular oncogenes, tumor suppressor genes, accumulation of mutations, immune system Evasion.

### **Unit II**

**14h**

Introduction, Cell cycle progression, control points, Checkpoints, Protein phosphorylation and dephosphorylation, DNA damage, cdk subunits, Hematopoiesis, Apoptosis in normal cell and cancer cells, morphological and biochemical events, tumor suppressor p53, Fas receptor, Caspases, Angiogenesis, oxygen and nutrients supply, activators and inhibitors

### **Unit III**

**14h**

Chemotherapeutic agents, monoclonal antibodies, radioactive elements, toxic effects on cancerous and normal cells. Role of microorganisms in cancer therapy, Bioprospecting of anticancer molecules from microbial origin, antimicrobial peptides as anticancer agents, antiangiogenic compounds.

## **Open Elective**

### **MBE-509: Microbial Techniques**

**40h**

#### **Unit I**

**12h**

Isolation techniques of microorganisms: Isolation of pure cultures; dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics of cultures. Maintenance and preservation of pure cultures, culture collection center-national and international. Direct microscopic count, standard plate count, membrane filtration.

#### **Unit II**

**14h**

Microscopy- Principles and Applications of Bright field and Dark field Microscopy. Fluorescent Microscopy, Phase contrast Microscopy, Confocal Microscopy. Electron Microscope-Principles and Applications of Transmission Electron Microscope, Scanning Electron Microscope, Sample preparation for Electron Microscopy.

#### **Unit III**

**14h**

Centrifugation- Basic principles of sedimentation, Types of centrifugation and their Applications, Rotors, Ultracentrifugation. Principle and applications of spectrophotometer- UV/visible, fluorescence. Electrophoresis, SDS-PAGE, Isoelectric focusing, 2D gel Electrophoresis, PFGE. Principles and applications of Chromatography.

**Unit I****12h**

Medicinal and aromatic plants, A brief account on Phytochemical and Pharmacological aspects and uses of medicinal plants. Study of biosynthetic pathway of Atropine, Morphine Cardiac glycosides, Terpenes and Flavonoids. Definition of Functional foods and Nutraceuticals. Classification, Medicinal uses and health benefits of Nutraceuticals / Functional foods - Spirulina, Soya bean, Garlic, Turmeric, Tea and Coffee, Carotenoids,  $\alpha$  and  $\beta$  Carotene, Lycopene, Xanthophyll and Flavonoids. Vegetable Bitters: Definition; bitter principles, actions and therapeutics.

**Unit II****14h**

HERBAL EXTRACTS: Types of extracts; Extraction methods such as Maceration, Percolation, super critical fluid extraction, Distillation Methods; Methods for drying of extracts. Solvent extractions, Ointment bases, Suppository bases and Hardening agents: Lanolin, Beeswax, Cocoa Butter, Hard paraffin, Petroleum jelly. Flavours and Perfumers: Cardamom oil, Vanilla, Lemon oil, Orange oil, Sandal wood oil. Natural sweeteners: Definition of Nutritive and Non-nutritive sweeteners with examples, sweetness potency. Herbal drugs industry, International Scenario, Cultivation of medicinal and aromatic plants. Patent laws, proposed amendments as applicable to herbal/natural products and processes; drafting and filing a patent.

**Unit III****14h**

Herbal Cosmetics: General method of preparation and evaluation of Herbal Cosmetics such as Skin care products. A brief account of Herb extracts or Herbal products of cosmetic importance such as Aloe vera, Neem, Henna, Acacia concinna pods, Citrus aurantium peel, Liquorice, Sandal wood, Olive oil, Wheat germ oil, Almond oil. Herbal products intended for treatment of GIT, CVS, Respiratory systems, CNS Examples of Disorders of a) GIT – Diabetes, Liver, Constipation, Diarrhoea, Dysentery. B) CVS – Hypertension, Angina c) RS – Bronchitis, Asthma, Tussive d) CNS – Pain, Fever, Anxiety Convulsions e) Musculo – Skeletal – Rheumatism, Cramps, f) Skin – Leucoderma g) GUS-Oedema, Urinary calculus, Leucorrhoea Dysmenorrhoea. Industrial and Research aspects of Pharmacognosy A brief account of some of the technologies developed by different research institutes and companies of both national and international status like CIMAP, RRL, CDRI, NBRI, CSIR. National centre for development of natural products (NCDNP).

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## IV SEMESTER

### MBH-551: AGRICULTURAL MICROBIOLOGY

52 h

#### Unit-I

13 h

Microbial diversity in Soil, Qualitative and quantitative analysis of Soil microflora Rhizosphere and non-rhizosphere microorganisms and their importance. Soil- Types, Physical, chemical and Biological properties, Soil horizons and Microbial distribution. Microorganisms in nutrients recycling- Nitrogen, Sulphur, Phosphorus and Carbon cycles.

#### Unit-II

13 h

Nitrogen fixation- Symbiotic and Non-Symbiotic Nitrogen fixation, Biochemistry of nitrogen fixation. Phosphate solubilization, VAM- Endomycorrhizae and Ectomycorrhizae, PGPR and role in agriculture, Cyanobacteria. Biofertilizers- Microbial inoculants, *Rhizobium*, *Azospirillum*, *Azotobacter*.

#### Unit-III

13 h

Diseases of important crop plants-Bacterial, fungal and Viral diseases and its management, Biopesticides- *Bacillus thuringiensis*, *Bacillus papillae*, *Beauveria bassiana*, *Metarhizium anisopliae*. Bio control agent - *Trichoderma*. Genetic engineering technology for crop improvement, Harvesting, transportation and storage of Agricultural products. Global Environmental Problems Ozone depletion, UV-B, greenhouse effect, acid rain, their impact and biotechnological approaches for management. Global warming and climate change.

#### Unit-IV

13 h

Bioremediation of Contaminated Soils, ISI Standards and Quality tests, Nursery Inoculants, Impact of Heavy Metals on Soil Microbial communities. Biodeterioration: Definition and concept, biodeterioration of woods. Biomagnification: concept and consequences, Biomagnifications of chlorinated hydrocarbons and pesticides. Biotransformations: metals and metalloids, mercury transformations, biotransformation of pesticides such as hexachlorobenzene. Biodegradation of plastics. Concept of phytoremediation and applications.

## **MBH-552: INDUSTRIAL MICROBIOLOGY**

**52h**

### **Unit-I**

**13 h**

History and Development of Industrial Fermentation Technology, Industrial Microorganisms: Screening, selection, Isolation, Identification and characterization of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centres and their importance.

### **Unit-II**

**13 h**

Fermentation: aerobic and anaerobic fermentation and their application. Substrate and oxidative phosphorylation and their energy yield, Types of fermentation processes- Surface, submerged, solid-substrate Batch, Continuous, Dual, Fed batch fermentation and their applications. Fermentation economics and feasibilities.

### **Unit-III**

**13 h**

Media for Industrial Fermentations: Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents. Sterilization of bioreactor, media, air and exhaust air and filter sterilization. Downstream processing: Steps in recovery and purification of fermented products.

### **Unit-IV**

**13 h**

Primary and Secondary metabolites. Production of amino acids, Enzymes, Biopolymers- Xanthans, chitin and pullulan. Production of beer, wine, alcohol. Organic acids- Citric acid, Lactic acid, vinegar and gluconic acid. Biopesticides- Production and formulation, Production of Biofertilizers, Bioethanol production. Good Manufacturing Practices( GMP) and Good Laboratory Practices ( GLP) Quality control, quality assurance, ISO, WHO Certifications.

## **MBP-553: PROJECT WORK**

## **MBS-554: BIO-NANOTECHNOLOGY**

**40 h**

### **Unit-I**

**12 h**

Nanomaterials- Definition of nanomaterials, Nanoparticles and types of nanoparticles. Properties of nanoparticles and metallic nanoparticles. Properties and Characterizations: Optical (UV- Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zeta potential), Surface and Vibrational (FTIR and RAMAN), SERS Magnetic, Electrical and Electrochemical.

### **Unit-II**

**14 h**

Green Nanotechnology: Green Synthesis, need for green synthesis of nanoparticles Extracellular and intracellular nanoparticles. Biological synthesis of nanoparticles using bacteria, fungi, actinomycetes, yeast, virus and plants. Principles of nanoparticles synthesis, Biopolymeric nanoparticles. Nanomaterials and Toxicity Evaluation: Cytotoxicity, Genotoxicity, *in vivo* tests/assays etc. Toxicological Hazards of Nanoparticles: Current data on toxicology of engineered Nanoparticles.

### **Unit-III**

**14 h**

Applications of Nanoparticles- Antimicrobial activity, targeted drug delivery, combination chemotherapy (cancer therapy), Antioxidant and haemolytic properties, applications in water and waste water treatment and catalytic properties., in food preservation. Nano medicine and its developments.

## **MBS-555: RESEARCH METHODOLOGY**

**40 h**

### **UNIT- I**

**14h**

Scope, Formulation of Research Objectives, Hypothesis Testing, Components of research design, Good Laboratory practices, Bio-Safety level, Laboratory designing Literature Survey and Review: Report writing, Pre-writing considerations, Thesis writing, Formats of Report writing, Formats of Publications in Research Journals. Plagiarism: Tools and Software for detection

### **UNIT- II**

**14h**

Biostatistics –Descriptive and Inferential Statistics, Test of Significances: Student *t*-test, F-test, Chi-square test, Correlation and regression, ANOVA, Multiple-range test, Statistical Data Analysis using Computers and Software; TOOLPAK, COSTAT, SPSS.

### **UNIT- III**

**12h**

Intellectual Property Rights, Patent Laws, Patenting of Microorganisms, Bioethics, Institutional Ethics Committee, Model/Experimental Organisms: *E. coli*, *Drosophila melanogaster*, *Coenorhabditis elegans*, *Arabidopsis thaliana*, Mouse, Rat, Guinea pig, Rabbit. CPCSEA Guidelines- Maintenance, Handling, Treating and Collection of Biological Samples and Waste disposal

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