ಮಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

**MANGALORE UNIVERSITY**

**(Accredited by NAAC Grade)**

ಕ್ರಮಾಂಕ/No. : MU/ACC/CR.8/2025-26/A2

ಕುಲಸಚಿವರಕಛೇರಿ
ಮಂಗಳಗಂಗೋತ್ರಿ – 574 199
Office of the Registrar
Mangalagangothri – 574 199
ದಿನಾಂಕ/Date:31.07.2025

## NOTIFICATION

Sub: Revised syllabus of M.Sc. in Microbiology Programme.

Ref: Academic Council approval vide agenda No.:ಎಸಿಸಿ:ಶೈ.ಮ.ಸಾ.ಸ.1:1 (2025-26) dtd 18.07.2025.

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The revised syllabus of M.Sc. in Microbiology programme which has been approved by the Academic Council at its meeting held on 18.07.2025 is hereby notified for implementation with effect from the academic year 2025-26 and onwards.

Copy of the Syllabus shall be downloaded from the University Website (www.mangaloreuniversity.ac.in)

**REGISTRAR**

4 1/8

To,

1. The Registrar (Evaluation), Mangalore University.
2. The Chairman, UG and PG Microbiology & PG Bio-Science Combined Board of Studies, Dept. of Bio Sciences, Mangalore University.
3. The Co-ordinator, Microbiology programme, Dept. of Biosciences, Mangalore University.
4. The Asst. Registrar (ACC), O/o the Registrar, Mangalore University.
5. The Director, DUIMS, Mangalore University – with a request to publish in the website.
6. Guard File.

# MANGALORE UNIVERSITY

# MSc Microbiology

# M. Sc. Degree Course

# Syllabus

**(Approved in the BOS held on 31st May, 2025)**

## 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

## MANGALORE UNIVERSITY SYLLABUS & SCHEME

| Sem | Course Code | Course title | Ins. Hrs/ week | Credit | Exam Hrs | Marks | | Total |
|---|---|---|---|---|---|---|---|---|
| **I** | **HARD CORE** | | | | | Int | Ext | |
| | MBH 410 | Microbial Techniques | 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 411 | Microbial Techniques Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| | MBP 412 | Microbial Biochemistry Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| **SOFT CORE** (Any **ONE** out of two soft core papers to be selected) | | | | | | | | |
| | MBS 413 | Pharmacognosy | 3 | 3 | 3 | 30 | 70 | 100 |
| | MBS 414 | Microbial Biochemistry | | | | | | |
| | | **Total** | | **23** | | | | **600** |
| **II** | **HARD CORE** | | | | | | | |
| | MBH 461 | Molecular Biology and Bioinformatics | 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 462 | Molecular Biology and Bioinformatics Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| | MBP 463 | Food Microbiology Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| | MBP-455 | Medical Microbiology & Immunology Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| **SOFT CORE** (Any **ONE** out of two soft core papers to be selected) | | | | | | | | |
| | MBS 464 | Microbial Technology | 3 | 3 | 3 | 30 | 70 | 100 |
| | MBS-457 | Phytopathology | | | | | | |
| **OPEN ELECTIVE** | | | | | | | | |
| | MBE-459 | General Microbiology | 3 | 3 | 3 | 30 | 70 | 100 |
| | MBE-460 | Bioinoculants | | | | | | |
| | | **Total** | **32** | **24** | | | | **650** |

| Sem | Course Code | Course title | Ins. Hrs/week | Credit | Exam Hrs | Marks | | Total |
|---|---|---|---|---|---|---|---|---|
| **III** | **HARD CORE** | | | | | Int | Ext | |
| | MBH 511 | Genetic Engineering | 4 | 4 | 3 | 30 | 70 | 100 |
| | MBH 512 | Marine Microbiology | 4 | 4 | 3 | 30 | 70 | 100 |
| | MBH 513 | Microbial Diversity | 4 | 4 | 3 | 30 | 70 | 100 |
| | MBP 514 | Marine Microbiology Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| | MBP 515 | Microbial Diversity Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| **SOFT CORE** (Any **ONE** out of two soft core courses to be selected) | | | | | | | | |
| | MBS-506 | Metagenomics & Proteomics | 3 | 3 | 3 | 30 | 70 | 100 |
| | MBS-508 | Cancer Biology | | | | | | |
| **OPEN ELECTIVE** | | | | | | | | |
| | MBE-509 | Microbial Techniques | 3 | 3 | 3 | 30 | 70 | 100 |
| | MBE 516 | Molecules of Life | | | | | | |
| | | **Total** | | **22** | | | | **600** |
| **IV** | **HARD CORE** | | | | | | | |
| | MBH-551 | Agricultural Microbiology | 4 | 4 | 3 | 30 | 70 | 100 |
| | MBH-552 | Industrial Microbiology | 4 | 4 | 3 | 30 | 70 | 100 |
| | MBP 557 | Agricultural Microbiology Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| | MBP 558 | Industrial Microbiology Lab | 4 | 2 | 3 | 15 | 35 | 50 |
| | MBP-553 | PROJECT WORK | 4 | 4 | 3 | 30 | 70 | 100 |
| **SOFT CORE** (Any **ONE** out of two soft core courses to be selected) | | | | | | | | |
| | MBS-554 | Bio-Nanotechnology | 3 | 3 | 3 | 30 | 70 | 100 |
| | MBS 556 | Research Methodology and Biostatistics | | | | | | |
| | | MOOC* | - | 2 | - | - | - | - |
| | | **Total** | | **19** | | | | **500** |
| | **Grand Total (I+II+III+IV)** | | | **82+6+2*** | | | | |

**Note:**

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

- Conduct of 02 internal assessment tests for 30 marks each and bring down to 10 marks
- Seminar presentation with submission of seminar manuscript for 10 marks
- Assignment /Field Report / Tour report/Summer project for 10 marks

**Practical Courses**

- Practical Question Paper shall be for 35 marks and shall have major question for 10 marks, 2 minor questions for 5 marks each, two spotters for 2.5 marks each, practical record for 5 marks and Viva voce for 5 marks.
- Similar pattern to be followed for Internal Assessment.

**Project Work**

- Project work shall be decided by the Department Council before stating the III Semester
- The project work may be carried out either in the department or outside institution (common all students)
- Internal assessment marks for project work may be awarded through pre-final project presentation (1 or 2 times) for 30 marks
- The project report/dissertation shall be evaluated by an internal and External or by the Board
- Project Work/Dissertation shall be evaluated based on Report submitted and Presentation/ Viva-voce for 70 marks

## I SEMESTER
## HARD CORE COURSES
## MICROBIAL TECHNIQUES 52 HRS

**Unit - I** **(13hr)**

Historical developments in Microbiology, Inventions/contributions of Louis Pasteur, Robert Koch, Edward, Jenner, Antony van Leeuwenhoek, 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, Staining Techniques: 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.

## 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. Nuclear Envelope-structure of nuclear pore complex, nuclear lamina. 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,

**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)Archaebacteria. Bacterial cell cycle-regulation and coordination of replication, chromosome segregation and nucleoid exclusion, Binary fission- FtsZ and the Z-ring.

**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 pathogeneses: 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: Covid-19; Small pox virus, Rabies virus, Zica 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.

## PHYCOLOGY AND MYCOLOGY 52 HRS

**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)**

Folicolous 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 Arbuscular Mycorrhizae, 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 & Ultrastructure 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.

## MICROBIAL GENETICS 52 HRS

**Unit I** **(13 hr)**

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** **(13 hr)**

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** **(13 hr)**

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** **(13 hr)**

Genetic recombination in bacteriophages and *E.coli,* synopsis of homologous duplexes, breakages and re- union role of RecA and other recombinases, Genetic Mapping: Complementaion 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

**MICROBIAL TECHNIQUES Lab**

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
16. Antibiotic Susceptibility Testing (Kirby-Bauer Method)
17. Determination of Minimum Inhibitory Concentration (MIC)
18. Biofilm Formation Assay (Tube Method).

**MICROBIAL BIOCHEMISTRY Lab**

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. Detection of Protease Activity on Skim Milk Agar
6. Estimation of Peroxide Value
7. Gelatin Hydrolysis by microorganisms
8. Fermentation of Carbohydrates
9. Casein Hydrolysis
10. Determination of specific gravity of fats & oils
11. Triple sugar Iron test
12. Urease production test
13. Determination of catalase activity
14. Determination of Vmax and Km value

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

## SOFT CORE COURSES

### PHARMACOGNOSY 40 h

**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, αand β 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, supercritical 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, Dysentry. B) CVS – Hypertension, Angina c) RS – Bronchitis, Asthama, Tussive d) CNS – Pain, Fever, Anxiety Convulsionse) Musculo – Skeletal – Rheumatism, Cramps, f) Skin – Leucoderma g) GUS-Oedema, Uninary 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).

## MICROBIAL BIOCHEMISTRY

**40 h**

**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-1II** **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.

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- Bacterial disease in plants, K M Chandniwala, Anmol publications pvt Ltd.New Delhi
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- Genetic Engineering, Sandhya mitra,M CMILIAN INDIA LIMITED,Delhi,madras.
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## II SEMESTER
## HARD CORE COURSES

### MOLECULAR BIOLOGY AND BIOINFORMATICS 52 h

**Unit - I ( 13 h)**

Organelle DNA- mitochondrial, chloroplast, Bacterial genome. 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 monocystronic mRNA, Transcriptional inhibitors, Translation and Post Translational modifications.

**Unit - II ( 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 - III ( 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.

**Unit- IV ( 13 h)**

Basics of bioinformatics: Databases EMBL, GENEBANK, file format, sequence retrieval and analysis, nucleotide structure prediction, Homology, Analogy, sequence alignment, BLAST, FASTA. Multiple sequence alignment, phylogeny, methods, softwares for editing and tree viewing. Protein structure prediction, molecular visualization software, molecular modelling, docking, Computer Aided Drug Designing, Genomics and Proteomics – genome@home; folding@home.

## FOOD MICROBIOLOGY 52 hr

**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.

## MEDICAL MICROBIOLOGY & IMMUNOLOGY 52 h

**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 perturbance and permeabilization. Important human pathogens: *Mycobacterium tuberculosis, Klebsiella pneumonia, Proteus vulgaris, Shigella dysenteriae, Vibrio cholera.* 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 - penicillin-binding proteins and resistance, alternative approaches for combatting infections, extended spectrum β- 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.

**MOLECULAR BIOLOGY and BIOINFORMATICS Lab**

1. Isolation of Genomic DNA from *E.coli* and Yeast
2. Isolation RNA

3. Qualitative and Quantitative analysis of DNA and RNA
4. Agarose gel Electrophoresis
5. Blotting techniques
6. Genome analysis in *Saccharomyces cerevisiae*
7. Isolation of Plasmids and purification from *E coli*
8. DNA amplification by PCR
9. Sequence retrieval
10. Molecular visualization software – RASMOL
11. Pair-wise alignment – BLAST
12. Multiple sequence alignment – CLUSTALW; MULTALIN
13. Primer designing – PRIMER BLAST; PRIMER 3PLUS

**FOOD MICROBIOLOGY Lab**

1. Enumeration of milk Micro flora by DMC
2. Production and evaluation of curd
3. Estimation of lactic acid
4. Milk spoilage microbes
5. Test for food adulteration
6. Effect of food preservatives
7. Isolation and identification of spoilage microbes from vegetables, fruits, pickles

**IMMUNOLOGY & MEDICAL MICROBIOLOGY Lab**

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. Synder's test for dental decay

## SOFT CORE COURSES

## MICROBIAL TECHNOLOGY (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, acteriocins, Chloramphinicols, 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, Patent Laws, Patenting of Microorganisms, 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,

## 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.

## OPEN ELECTIVES

## 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, Salmonellosis, 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, Chemicals-phenol and phenolic compounds.

**BIOINOCULANTS** **40 h**

**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, Azatobacter, 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, Beaveria. Biofungicides: Trichoderma and its importance in Biocontrol of plant diseases. Bacterial biopesticides- *Bacillus thuringensis*, Pseudomonas. Production and formulation of Rhizobium biofertiliser

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- Soil and the Environment, Alan Wild,Cambridge university,press.
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## III SEMESTER
## HARD CORE COURSES

## 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. Nest 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.

## MICROBIAL DIVERSITY 52 Hrs

**Unit I (13 Hrs)**

Microbial Diversity and Ecology Basics: Introduction to microbial ecology: concepts, and applications. Microbial habitats and their physical, chemical, and biological characteristics. Classification of microorganisms and ecological diversity (autecology and synecology). Individuals and populations: productivity, growth, distribution, and activity

**Unit II (13 Hrs)**

Microbial Interactions and Communities: Microbial interactions: algae & plants, plants & fungi, plants & bacteria, bacteria & animals (rumen microbiology). Microbial interactions with the abiotic environment and biotic communities: symbiosis, competition, predation. Interactions within microbial communities: quorum sensing, syntrophy, antibiotic production. Parasitism: bacterial, fungal, and viral diseases.

**Unit III (13 Hrs)**

Microbes in Biogeochemical Cycles and Environmental Applications: Role of microbes in biogeochemical cycle of carbon, nitrogen, sulfur, and phosphorus. Indicator organisms. Bioleaching, biodegradation, bioremediation, and phytoremediation. Biofilms and microbial succession in natural and engineered environments. Conventional and molecular methods in studying microbial diversity and microbial ecology.

**Unit IV (13 Hrs)**

Microbial Diversity in Ecosystems and Extreme Environments: Importance of microbial diversity in ecosystems: forest, soil, aquatic, marine, and air microflora. Terrestrial ecosystems: soil horizons, forest, prairie, tundra, rock microbiota. Extreme environments: hot springs, deserts, glaciers, deep subsurface, mine drainage. Engineered and anthropogenic systems: landfills, wastewater treatment.

## MARINE MICROBIOLOGY 40h

**Unit I 12h**

Ecology of Marine water; physical, chemical and biological components in marine water. Marine ecosystems: ocean surface, tidal flats, deep-sea, methane seeps, estuaries, anoxic basins. 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.

**MICROBIAL DIVERSITY Lab**

1. Test for coliforms in water
2. Isolation of indicator algae from polluted water
3. Isolation of oil degrading microbes
4. Microbial analysis potable water – MPN method
5. Air sampling technique
6. Enumeration of lichens
7. Determination of TDS of water
8. Determination of BOD of water
9. Determination of COD of water

**MARINE MICROBIOLOGY Lab**

1. Isolation and identification of microbes from mangroves, coastal waters and sediments
2. Assessment of salt requirement of marine isolates from different ecosystem
3. Analysis of physio-chemical parameters
4. Study of biofilm microorganisms
5. Isolation of Rhizobium from Root Nodules of coastal plants
6. Hydrolytic enzymes profiling of marine bacterial isolates
7. Nitrification and denitrification by marine bacterial isolates
8. Isolation and identification of microbes from marine life forms

## SOFT CORE COURSES

## 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, ESTs and 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.

## 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 canecr 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 ELECTIVES

### 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.

### MOLECULES FOR LIFE

**40 h**

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

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. Nucleic acid – Functions and properties of purines and pyrimidines - Structure of DNA and RNA.

**Unit-III** **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. Vitamins as coenzymes-classification, properties and function. Micronutrients-source, requirements and biochemical role and deficiency symptoms.

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## IV SEMESTER
## HARD CORE COURSES
## 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. Global Environmental Problems: Ozone depletion, UV-B, greenhouse effect, acid rain, their impact and biotechnological approaches for management.

**Unit-II** **13 h**

Nitrogen fixation- Symbiotic and Non-Symbiotic Nitrogen fixation, Biochemistry of nitrogen fixation. Phosphate solubilization, VAM - Endomycorrhiza and Ectomycorrhiza, 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 nisopliae*. Bio control agent - *Trichoderma.* Genetic engineering technology for crop improvement, Harvesting, transportation and storage of Agricultural products.

**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

## INDUSTRIAL MICROBIOLOGY 52h

**Unit-I** **13 h**

Industrial Microorganisms: Screening, selection, strain improvement. Preservation of industrially important microbes. Bacterial Culture collection centres - ATCC, MTCC, MCC, NFCCI, NCIM, NCDC and their importance. Bio-Safety levels and laboratory design. Good Manufacturing Practices ( GMP) and Good Laboratory Practices (GLP) Quality control,

quality assurance, ISO, WHO Certifications.

**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. Production and formulation of Biopesticides, Biofertilizers, Bioethanol production.

**AGRICULTURAL MICROBIOLOGY Lab**

1. Determination of soil moisture content
2. Determination of ammonification in soil
3. Determination of nutrification in soil
4. Isolation and identification of Rhizobium from root nodules
5. Isolation and identification of free nitrogen fixers
6. Isolation and identification of PS organisms
7. Isolation of Cellulose-Degrading Microbes from Compost
8. Mushroom Cultivation
9. Mass cultivation of Biofertilizers

**INDUSTRIAL MICROBIOLOGY Lab**

1. Isolation of Amylase Producing Microbes
2. Isolation and Production of Citric acid from microorganisms

3. Production of Wine
4. Fermentation of Fruit Juice Using Yeast
5. Production of Penicillin and Estimation of antimicrobial activity
6. Study of Pilot Scale Fermenters
7. Production and Estimation of Bacteriocin
8. Production of Biofuel from algae

## SOFT CORE COURSES
## 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.

## RESEARCH METHODOLOGY AND BIOSTATISTICS

**40 h**

**UNIT- I** **14h**

Scope of research methodology: Formulation of Research Objectives, Hypothesis Testing, Components of research design, Literature Survey and Review: Literature Search Techniques, search engines, Citation Search, H Index. Report writing, Formats of Report writing, Pre-writing considerations, Thesis writing, Formats of Publications in Research Journals.

Research ethics: ICMR guidelines for research on human samples – informed consent, incentives, information sheet, confidentiality, avoiding bias. Plagiarism: Ethical guidelines for conduct of research; data analysis and reporting. Tools and Software for detection. Bioethics.

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

Introduction to basic statistics. Descriptive and inferential statistics: Measures of central tendencies, mean, median, mode. Measures of dispersion, standard deviation, coefficient of variation. Types of data - primary and secondary; Types of numerical data, frequency distribution, population and sampling. Collection and classification of data and tabulation. Representation of Data - Line chart, Bar diagram, Pie chart, Histograms, Frequency Polygons.

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

Hypothesis testing – Null and alternate hypothesis, types of error. Normal distribution, binomial, Poisson. Parametric and non-parametric tests. Statistical Tests: Student's t test, ANOVA, F test, chi square test, goodness of fit, correlation and regression, Multiple-range test, Tests of significance, Probability. Statistical Data Analysis using software tools and statistical packages - TOOLPAK, COSTAT, SPSS.

## PROJECT WORK

**Course Outcomes:**

*After successful completion of the course, students will be able to*

CO1.Conduct a research-based study by selecting a problem, framing the objectives, carrying out literature review, conduct the work, and interpret the results.
CO2.Carry out field work for collection of samples
CO3.Apply research methodologies, techniques and tools to conduct lab-/field-based research
CO 4. Write the dissertation, present and interpret the research data
CO 5. Build capacity to carry out research work independently.

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**Question Paper Pattern for University Examination**
**MSc Microbiology**

**Time: 3 Hours** **Max Marks: 70**

I. Write short notes on **any FIVE** of the following 3 x 5 =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 X 3= 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**

**Time:1.30 Hours** **Max Marks:30**

I. Write short notes on **any TWO** of the following 3 x 2 = 6

1.
2.
3.

II. Write notes on **any THREE** of the following 5 x 3 = 15

4.
5.
6.
7.
8.

III. Answer **any ONE** of the following 9 x 1 = 09

9.
10.