# UNIVERSITY OF CALICUT
# Ph.D. MICROBIOLOGY ENTRANCE EXAMINATION, 2023

## MODEL QUESTION PAPER

**Time: 2 Hrs.** **Marks: 100**

## Section A: (Answer all the questions)
**25x2=50 marks**

1. The theory of spontaneous generation was disproved by explaining maggots never develop from meat, if it is covered with fine gauze is by.....

   a. Francesco Redii
   b. Giralama Francastro
   c. Louis pasteur
   d. Lazzaro spalanzani

2. Enrichment culture

   i. Enhance population of desired microbe
   ii. It can be by modifying the nutrient content of the medium
   iii. Suitable to heterophic fungi alone

   a. (i) is correct
   b. (ii) is correct
   c. (i) and (ii) are correct
   d. (i), (ii) and (iii) are correct

3. The function of tannic acid in flagella staining is .....

   a. Primary stain
   b. Mordant and thickening of flagella
   c. Secondary stain
   d. Decolouriser

4. Unstained living microorganisms can be viewed through

   a. Light microscope
   b. Phase contrast microscope
   c. Flourescent microscope
   d. Confocal laser scanning microscope

5. Cluster of flagella at one end of the bacterium is referred as

   a. Lophotrichus
   b. Monotrichus

c. Amphitrichus
d. Peritrichus

6. ..... is an example of cell wall less archaea

a. Mycoplasma
b. Thermoplasma
c. Methanococcus
d. Halobacterium.

7. In taxonomic nomenclature the correct order to be followed is
   a. Domain –phylum – class-family- order- genus-species
   b. Domain –phylum – class-order -genus-species-family
   c. Phylum- Domain – class-family- order- genus-species
   d. Domain –phylum – class-- order-family- -genus-species
8. Semi rigid extension of cell wall and cell membrane is called
   a. Capsule
   b. Slime
   c. Prosthecae
   d. Flagella
9. In the growth equation: n= 3.3 (log10 N – log10 No ), n stands for_____
   a. Total population
   b. Initial population
   c. Number of generations
   d. Growth constant
10. The organisms which can use reduced inorganic compounds as electron donors are known as _____
    a. Chemotrophs
    b. Organotrophs
    c. Lithotrophs
    d. Phototrophs
11. The transfer of genetic material between bacteria in direct physical contact is called
    a. Conjugation
    b. transformation
    c. Transduction
    d. Recombination
12. During exponential phase, growth rate is _____
    a. Same as generation time
    b. reciprocal of generation time
    c. time required for population to double
    d. rate of doubling population
13. A microbe, which grows at temperatures above 95° C is most likely to be
    a. an archaean
    b. a fungus
    c. a protozoan
    d. none of these

14.Plasmids can best be described as

a. small, circular DNA molecules that can exist independently of chromosomes commonly found in bacteria
b. another name for a chloroplast
c. a complex membrane structure that covers the chromosome of bacteria
d. This type of plasmid carries genes encoding enzymes that degrade substances such as aromatic compounds, pesticides or sugar

15. The transport of naked fragment of DNA between bacteria is called

a. Conjugation
b. Transformation
c. Transduction
d. Recombination

16. Who proposed five kingdom concept

a. Whittaker
b. Carlolus linnaeus
c. Haeckel
d. Koch

17.The time to kill 90 % of organisms at a given temperature is known as

a. Decimal reduction time
b. Thermal death time
c. Thermal death point
d. Thermal death

18. Membrane invagination into the bacterial cytoplasm are known as

a. Ribosomes
b. Mesosomes
c. Vacuoles
d. Centrioles

19. Bacterial Cells are lined side by side like matchsticks at angles to one another

a. Streptobacilli
b. Palisades
c. Diplobacilli
d. Trichomes

20. Resolution increases under the oil immersion objective because refractive index of oil ----------

a. More than glass slide
b. Less than glass slide
c. Equal to glass slide
d. None of the above

21. Actinomycetes are

a. Gram negative, aerobic
c. Gram negative, anaerobic
b. Gram positive, anaerobic
d. Gram positive, aerobic

22.Entner–Doudoroff pathway yields ---------- ATP

a. 2
c. 1
b. 3
d. 12

23.---------- is the viral enzyme which breaks down the glycosidic bonds of host cell to enter and to rupture the host cell

a. Neuraminadase
c. Nucleic acid polymerase
b. Reverse transcriptase
d. Lysozyme

24. Creutzfeldt-Jakob disease is caused by

a. Bacteria
c. Yeast
b. Prions
d. Viroids

25.Topoisomerase I is an enzyme which ----------

a. Synthesize a new strand of DNA
b. Removes super coiling of DNA
c. Introduce super coiling of DNA
d. Breaks specific sequence of DNA

## Section B: Write essays on any Five of the Following: 5x10=50 marks

26.Write an essay on next generation sequencing

27.Draw the diagram of a CSTR and explain different parts in detail.

28.Write an essay on the applications of biosensors.

29.Discuss the citric acid cycle with illustrations.

30.Discuss various microbial interactions.

31. Describe with an illustration the structure of IgG

32. Write an essay on novel coronavirus disease.

UNIVERSITY OF CALICUT

# Syllabus of Ph.D Entrance Examination

## 2023 Admission onwards

# COURSES

## Semester I

1. MBG1C01. General Biochemistry and Microbial Metabolism
2. MBG1C02. Biophysics and Instrumentation
3. MBG1C03. Environmental and Sanitation Microbiology
4. MBG1C04. Agricultural Microbiology and Plant Pathology
5. MBG1L01. Practical I
6. MBG1L02. Practical II

## Semester II

7. MBG2C05. Principles of Genetics
8. MBG2C06. Food and Dairy Microbiology
9. MBG2C07. Industrial Microbiology
10. MBG2C08. Immunology
11. MBG2L03. Practical III

## Semester III

12. MBG3C09. Medical Microbiology
13. MBG3C10. Molecular biology
14. MBG3E01. Diagnostic microbiology
15. MBG3E02. Cell Biology
16. MBG3E03. Microbial Taxonomy
17. MBG3L04 Practical IV
18. MBG3L05. Practical V

## Semester IV

19. MBG4C11. Biostatistics and Bioinformatics
20. MBG4E04. Microbial Biotechnology
21. MBG4E05. Genetic engineering
22. MBG4E06. Biosafety, Bioethics and IPR
23. MBG4L06. Practical VI
24. MBG4Pr. Dissertation

# SEMESTER I

## MBG1C01. General Biochemistry and Microbial Metabolism

**Course objectives:**

- Explain the structure and functions of major biological macro and micro molecules.
- To provide an understanding of the synthesis of proteins, lipids, amino acids and carbohydrates and their role in metabolic pathways.
- To know about the regulation of metabolic pathways at the epigenetic, transcriptional, translational levels including RNA and protein folding, modification and degradation.

**Course Outcome:**

**CO1** Summarise the fundamental biochemical properties of biomolecules

**CO2** Describe the metabolism of Amino acids, Carbohydrates, Lipids and Nucleic acids

**CO3** Demonstrate the mechanism of ATP synthesis at various levels by biological process.

**CO4** Interpret the properties, classification and mechanism of action of Enzymes associated with the metabolism of biomolecules

Unit 1. Structure and functions of Biomolecules: - Structure, classifications and functions of carbohydrates- Monosaccharides; Disaccharides and polysaccharides.. Heteropolysaccharides, Glycosaminoglycans and Glycoproteins. Structure and functions of amino acids and proteins: - Chemical structures and classifications of amino acids. Chemical properties of amino acids; Lipids –structure, properties and classification. Fatty acid classification- Saturated, unsaturated and poly- unsaturated fatty acids (PUFA); Short chain, medium chain and long chain fatty acids. Phospholipids and Sphingolipids; prostaglandins, prostacyclins and leukotriens. Hormones and vitamins -structure and functions.

Unit 2. Carbohydrate metabolism: Respiration and fermentation. Respiration – aerobic and anaerobic respiration. Glycolysis- aerobic and anaerobic types; alcoholic fermentation; regulation of glycolysis. Pyruvate dehydrogenase complex; Krebs cycle; Glyoxylate cycle- significance, regulation; Phosphorylation – substrate level and oxidative phosphorylation. Electron transport chain- components and

mechanism of ATP formation; Chemi-osmotic coupling hypothesis. Gluconeogenesis. Glycogenesis and glycogenolysis. Peptidoglycan biosynthesis.

Unit 3. Amino acid metabolism- Transamination, deamination, transmethylation and decarboxylation. Glucogenic and ketogenic amino acids, Microbial metabolism of glycine, phenylalanine and lysine.

Unit 4. Lipid metabolism-Fatty acid oxidation; alpha, beta, and omega oxidations; Fatty acid synthesis; synthesis of unsaturated and long chain fatty acids.

Unit 5. Nucleic acid metabolism - Biosynthesis and degradation of purines and pyrimidines- de novo and salvage pathways.

Unit 6. Enzymology- Enzyme–IUB-Nomenclature; Classification; Enzyme active sites; coenzymes and co-factors; Factors affecting enzyme activity, Enzyme kinetics - Michaelis- Menton equation Multi-subunit enzymes; isozymes; allosteric enzymes; enzyme regulation; Enzyme inhibition; Mechanism of Enzyme action; Enzyme purification techniques. Enzyme immobilization.

## MBG 1C02: Biophysics and Instrumentation

**Course objectives:** The learner will develop in-depth understanding on the principles of scientific instrumentation and various analytical techniques used in biological research.

**Course Outcome:**

| | |
|---|---|
| **CO1** | Discuss the properties of interactions between atoms and molecules. |
| **CO2** | Demonstrate the interactions of DNA-protein, RNA-protein and DNA-drug. |
| **CO3** | Analyse the structure of protein through Ramachandran plot and advanced techniques |
| **CO4** | Compare different techniques in microscopy |
| **CO5** | Differentiate the working principle, instrumentation and applications of various bio-analytical instruments. |

Unit 1. Structure of atoms, molecule, Physico-chemical forces- ions, ionic bonds, covalent bonds, Hydrogen bonds, vander Walls forces, hydrophobic interactions, polar and non-polar molecules. Laws of thermodynamics, the concept of enthalpy, entropy and free energy, thermodynamic equilibrium, redox potential, high energy

molecules, examples of redox potential in biological system. DNA-Protein interaction-. Lambda repressor and cro binding to DNA. Interactions of transcription factors-HLH, bHLH, Leucine Zipper, Cys-His, Zinc fingers. Histone-DNA interaction, RNA protein interactions, DNA-drug Interaction.

Unit 2. Structural implication of peptide bond**,** Ramachandran plot, protein families, alpha domains, beta-domains, alpha- beta domains, Protein-drug interaction. peptide mass finger printing using MALDI-TOF, MASCOT database.

Unit 3. Principle, Instrument Design, methods and Applications of Microscopy: Light, Scanning and Transmission electron, phase contrast, polarization, confocal and interference microscopy, CCD camera, Introduction to Atomic force microscopy. Beer-Lamberts law, Principle, Instrument Design, methods and Applications of UV-Visible spectra, IR spectra, Raman Spectra, Fluorescence spectra, NMR and ESR spectra. Colorimetry, spectrophotometry, Flourimetry, Flame photometry and Spectroscopy. Xray diffraction technique-principle and application.

Unit 4. Principle, Instrument Design, methods and Applications of Chromatography, ion exchange, molecular sieve, affinity chromatography, paper, TLC, GC, HPLC, HPTLC, FPLC, GC-MS, LC-MS. Centrifugation and Ultracentrifugation, Centrifugation - Principle and application of various types of centrifugation. Electrophoresis- AGE, PAGE- SDS & Native PAGE, Capillary Electrophoresis, isoelectric focusing, 2D Electrophoresis.

Unit 5. pH meter- principle, types and applications. Dialysis-principle and applications. Principle, methods and Applications of Ultra filtration, Sonication, Lyophilization. Refractometry, Cytometry and Flow cytometry, Introduction to Radioactive isotopes, autoradiography, radiation dosimetry- GM counter, Liquid scintillation counting, safety aspects. Biosensors.

## MBG1C03. Environmental and Sanitation Microbiology

**Course objectives :** Attain knowledge about the various roles of microbes in the ecosystem and also understand the impact created by microorganisms in the field of agricultural development and also in various fields like bioremediation and waste treatment.

**Course Outcome:**

CO1 Discuss the basic concepts of ecological system, pollution and environment

CO2 Compare different types of interaction among microbial communities and

| | |
|---|---|
| | their significance |
| CO3 | Explain biogeochemical cycles and their importance in an ecosystem |
| CO4 | Elaborate the role of microbes in soil, water and air |
| CO5 | Summarise the methods of air quantitation, air sanitation, sewage treatment and water purification. |
| CO6 | Discuss the various aspects and the application of microbes in various fields of agriculture and environmental microbiology like bioremediation, biofertilizers and waste treatment methods. |

Unit 1. Microbial Ecology: Microbial Communities. Basic concept of ecosystem, Ecological niches, Microbial succession- Primary and secondary succession. Microbial interactions- Neutralism, commensalism, symbiosis, synergism, competition, parasitism, antagonism and predation. Bio-geochemical cycles- C,N, S, P and Fe.

Unit 2. Air microbiology: Air microflora- transient nature of air flora, droplet nuclei and aerosols. Methods of air sampling and types of air samplers – impaction on solids, impingement technique in liquid, sedimentation, centrifugation, precipitation and thermal precipitations. Air sanitation- methods and applications.

Unit 3. Water Microbiology: Fresh water and marine microbial populations; potable water and indicator microorganisms, Bacteriological analysis of drinking water and other quantitation techniques; drinking water purification. Waste water- Sources, types, composition and characteristics (DO, BOD, COD) . Microbiology of waste water. Sewage treatment.

Unit 4. Pollution and Environment: Biosensors and environmental applications. Pollution- Soil, Air, Water and Marine pollution. Solid waste management – land filling and composting. Biogas production. Treatment of petroleum waste and xenobiotic. Biodegradation of recalcitrant. Bioleaching – General mechanism, Bioleaching of Copper, Uranium, and Gold.

## MBG1C04. Agricultural Microbiology and Plant Pathology

**Course objectives**

- Understand various plant microbes interactions especially rhizosphere, phyllosphere and mycorrhizae and their applications especially the biofertilizers, biopesticides and their production techniques.
- The learner will be aware of the plant diseases caused by microorganisms and the defense strategies by the plants.

**Course outcome:**

| | |
|---|---|
| **CO1** | Describe the microbial interactions between microorganisms, plants and animals |
| **CO2** | Explain the various applications of microorganisms in agriculture to improve soil fertility as bio fertilizers and bio pesticides. |
| **CO3** | Contrast between bio fertilizer and chemical fertilizer. |
| **CO4** | Illustrate different plant diseases caused by different microorganisms with emphasis to pathology and epidemiology. |
| **CO5** | Discuss the defence mechanisms exerted by the plant in response to an infection |

Unit 1. Microbial interactions: Microbial flora of soil. Plant – Microbe interactions - Nitrogen fixation- Symbiotic and non-symbiotic, physiology and genetics of nitrogen fixation. Mycorrhizae, Rhizosphere and Phylloplane microorganisms. Animal-Microbe Interactions - Rumen microflora, Nematophagous fungi, Bioluminescent bacteria, Termite nutrition

Unit 2. Applications of microbes in agriculture: Biofertilizers. Symbiotic nitrogen fixation - (Rhizobium, Frankia). Symbiotic nutrient mobilizers - Endomycorrhizae and Ectomycorrizae. Non symbiotic microbes – Azotobacter. Associative Symbiosis – Azospirillum. Cyanobacteria (Nostoc, Gloeocapsa), Azolla-Anabaena System. Mass production of biofertilizers. Bio pesticides- bacterial, fungal and viral. Advantages and disadvantages of bio pesticides over the chemical counter parts. GM crops and its significance.

Unit 3. Plant pathology: Components of disease (disease pyramid). Symptoms, epidemiology and control of common plant diseases. Fungal diseases- Late blight of potato, Downy mildew of grapes, Powdery mildew of cucurbits, Early blight of potato, Rice blast, Red rot of sugarcane, Sheath blight of rice, Rusts of wheat. Bacterial diseases – Crown gall disease and Ti plasmid, BLB of rice, Red stripe of

sugarcane, Bacterial wilt of Banana (Moko disease), Soft rot of potato, Citrus canker, Ratoon stunting of sugarcane.

Unit 4. Mycoplasma – Coconut root wilt. Viral diseases – Tobacco mosaic, Yellow vein mosaic of Bhindi, Rice Tungro, Leaf curl of papaya, Bunchy top of banana, Potato spindle tuber, Coconut Cadang- Cadang. Nematode- Potato cyst nematode. Plant defense mechanisms- Structural, biochemical, SAR and ISR.

## MBG1L01. Practical I
## (General Biochemistry and Microbial Metabolism)

**Course objectives:** Will gain a proficiency in basic laboratory techniques in biochemistry and be able to apply the scientific method to the processes of experimentation and hypothesis testing

**Course Outcome:**

| | |
|---|---|
| CO1 | Apply the knowledge in the preparation of solutions and buffers according to the neediness using molar, percentage etc. |
| CO2 | Analyse the Qualitative and Quantitative aspects of different bio active components Proteins, carbohydrates, citric acids etc. |
| CO3 | Demonstrate Enzyme kinetics and its assay using spectrophotometer |
| CO4 | Perform isolation, Quantification, purification and separation of bioactive components using chromatographic techniques. |
| CO5 | Demonstrate various experiments which include basic methods of physical biochemistry, biochemical analysis and separation methods. |

1. Preparation of solutions – Percentage, Molar, Normal and dilution of stock solutions
2. Preparation of buffers.
3. Estimation of Glucose by ortho toluidine method
4. Estimation of fructose by Roe – Pappadapoulose Method
5. Estimation of reducing sugars by DNS method
6. Qualitative identification of carbohydrates in mixture containing mono, di and polysaccharides.- starch, dextrin, sucrose, maltose, lactose, glucose, fructose, xylose and glactose.
7. Estimation of amino acid, methionine by nitroprusside method.
8. Protein Estimation using Lowry's method.

9. Protein estimation by Bradford's method.
10. Estimation of ascorbic acid in plant matter
11. Estimation of citric acid
12. Estimation of cholesterol by Zak's method
13. Bacterial synthesis of PHB and its estimation
14. Demonstration of siderophore production by microbes
15. Spectrophotometric assay of enzyme activity.
16. Determination of Km and Vmax.
17. Effect of pH and temperature on enzyme activity - amylase SDS PAGE using protein Standards.
18. Gel filtration chromatography
19. Dialysis of proteins
20. Paper chromatography
21. TLC
22. Column separation of plant pigments
23. Fractionation of egg protein and its identification

## MBG1L02. Practical II

## (Biophysics and Instrumentation, Environmental and sanitation microbiology & Agricultural Microbiology and plant pathology)

**Course objectives:**

- Will Master in aseptic techniques and develop skills in enumerating and identifying the potential pathogens in the environment (Air, water, and soil)
- Will develop the skill and knowledge to design a fermentation process and translate the discoveries of life sciences to an economically valuable product.

**Course outcome**

| | |
|---|---|
| **CO1** | Isolate bacteria, fungi, actinomycetes and phages from various sources of concern |
| **CO2** | Demonstrate various growth patterns, culturing methods and different quantification techniques of microorganisms from air, soil and termite gut |
| **CO3** | Demonstrate the Anaerobic cultivation of bacteria |
| **CO4** | Evaluate the efficacy of autoclave and bacteria proof filters |
| **CO5** | Demonstration of special microorganisms with different unique applications in agriculture and environmental research. |
| **CO6** | Assess the quality of water by MPN, DO, BOD and COD. |
| **CO7** | Compare efficacy of different bio control agents. |
| **CO8** | Assessment of the synthesis of extracellular enzymes by microbes |
| **CO9** | Illustrate the role of microorganisms in bioremediation. |

1. Study of air microflora by plate exposure and liquid entrapment
2. Cultivation of fungi - Slide culture technique.
3. Water potability testing by Most Probable Number technique
4. Determination of DO, BOD and COD
5. Efficiency testing of bacteria proof filters and autoclave.
6. Anaerobic culturing by liquid paraffin overlay and pyrogallol.
7. Anaerobic enrichment of cellulose digesters
8. Winogradsky column.
9. Demonstration of Microbial Bioluminescence.
10. Phage cultivation

11. Microbial flora from different soil types and habitats – bacterial and fungal
12. Isolation of actinomycetes from soil.
13. Detection of R:S ratio by estimating rhizosphere population.
14. Assay of extracellular enzymes– cellulase, protease, lipase and phosphatase
15. Isolation of nitrogen fixing bacteria, Rhizobium.
16. Isolation of non symbiotic nitrogen fixing bacteria.
17. Isolation of Azospirillum
18. Isolation of phosphate solubilizing organisms.
19. Cultivation of Azolla
20. Isolation of biocontrol agents, Pseudomonas fluorescence and Trichoderma
21. Microflora of termite gut- isolation of cellulose degrading bacteria and direct microscopic examination of protozoa
22. Demonstration of microbial antagonism
23. Bioassay of Bti and Bt
24. Comparison of microflora in Bt-treated and chemical pesticide-treated soils
25. Microbial degradation of phenols
26. Phosphate, nitrogen and metal removal by microbes

## SEMESTER II

### MBG2C05. Principles of Genetics

**Course objectives:** The learner will get a general understanding on classical genetics, bacterial genetics with particular focus on linkage and crossing over, pedigree and chromosomal aberrations.

**Course Outcome:**

| | |
|---|---|
| CO1 | Recall the basic concepts of Classical genetics, History of Mandel experiments on pea plants and the laws and importance of Mendelian genetics. |
| CO2 | Explain the mechanism of sex linkage, crossing over and genetic mapping |
| CO3 | Summarize the importance and significance of Chromosomal aberrations. |
| CO4 | Analyse the importance of Pedigree analysis and its usage in genetic disease analysis. |
| CO5 | Discuss the basic concepts of bacterial genetics and mode of gene transfer mechanism in bacteria. |
| CO6 | Justify and correlate the importance of the molecular events in gene expression and in gene regulation. |

Unit 1. Introduction to Classical genetics: Pre- Mendelian genetic concepts: Preformation, Epigenesis, Inheritance of acquired characters and Mutation theory. Heredity and Environment: Concepts of Phenotype, Genotype, Heredity, variation, Pure lines and Inbred lines. Biography of Mendel and his experiments on pea plants. Law of Segregation: Monohybrid cross, Back cross and Test cross, Problems related. Law of Independent Assortment: Dihybrid cross in pea plant, Back cross and Test cross, Problems related. Multiple Alleles: Definition, ABO blood groups and Rh factor in Human, Genetic Problems related. Gene Interactions. Deviations from Mendelism: Incomplete inheritance and Codominance. Inter allelic: Complementary gene interaction (9:7) Ex: Lathyrus odoratus Supplementary gene interaction (9:3:4) Ex: Grain color in Maize. Epistasis - Dominant Ex.: Fruit color in Cucurbita pepo, Recessive - Ex.: Coat color in Mice. Non- Epistasis - Ex.: Comb pattern in Poultry.

Unit 2. Sex linkage in Genetics: Meiotic behavior of chromosome and non - disjunction. Theory of non-disjunction. Sex linked inheritance in man (Colour-blindness, Haemophilia). Attached X-chromosome. Chromosome theory of Sex determination: XX- XY, XX-XO, ZZ- ZW. Environment and sex determination. Hormonal control of Sex determination. Gynandromorphs Dosage compensation in Drosophila and Man (Lyon's hypothesis). Inheritance of Mitochondrial DNA and Chloroplast DNA

Unit 3. Linkage and Crossing over: Linkage: Definition of Linkage, Coupling and Repulsion hypothesis. Types of linkage-complete linkage and incomplete linkage. Factors affecting linkage- distance between genes, age, temperature, radiation, sex, chemicals and nutrition. Crossing over: Crossing over- definition and types of crossing over: Germinal and Somatic crossing over. Cytological basis of crossing over: Stern's experiments in Drosophila. Mechanism of crossing over: Chiasma type theory, Breakage first theory, Contact first theory, Strain or torsion theory. Molecular mechanism of crossing over - Holiday model, Crossing over in Drosophila. Interference and coincidence, Steps in Construction of genetic map.

Unit 4. Chromasomal aberrations: Numerical: Euploidy (Monoploidy, Haploidy and Polyploidy) Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomy, Nullisomy and Trisomy. Structural - Deletions (Terminal, Interstitial), Duplication (Tandem, Reverse tandem and Displaced), Translocation (Simple, Isochrome, Reciprocal, Displaced) and Inversions (Pericentric and Paracentric). Significance of chromosomal aberrations.

Unit 5. Pedigree: Symbols used in pedigree studies, Pedigree analysis and construction, Pedigree analysis for the inheritance pattern of genetic diseases, Genetic Counselling.

Unit 6. Bacterial genetics: Bacterial Genetics: Transformation, Transduction- Generalized and specialized; Conjugation: F factor mediated, Hfr and Sexduction. Transposable elements: Bacteria, Yeast, Maize and Drosophila.

## MBG2C06. Food and Dairy Microbiology

**Course objectives: S**tudents get sufficient knowledge in understanding the relationship between food and microbes. Develop the skills in techniques used in food processing, preservation and understanding the different control measures in food spoilage.

**Course Outcome**

| | |
|---|---|
| CO1 | Classify the type of Microorganisms present in food able to cause contamination and what are the factors influence growths of microbes in foods. |
| CO2 | Explain standards for assessing the quality of milk. |
| CO3 | Summarize spoilage of food, factors causing food spoilage and food preservation methods |
| CO4 | Elaborate different food borne infections |
| CO5 | Explain about food hygiene and regulatory practices |
| CO6 | Discuss the importance of microorganisms in food and factors affecting their growth in foods. |

Unit 1. Food as a substrate for microorganisms. Common microorganisms in food. Factors influencing microbial growth in food – intrinsic, extrinsic and implicit.

Unit 2. Fermented food products: Food fermentations- Principles and classification. Starter, non-starter cultures in food fermentation. Fermentation of wine and beer. Fermented vegetables- sauerkraut, pickle, olives. Fermented cereals- bread, idli, dosa, koji. Fermented meat– sausage. Fermented fish products. Other fermented foods- Vinegar, soy sauce. Whey fermentation. SCP fermentation

Unit 3. Dairy microbiology: Physical and chemical properties of milk. Microbiological analysis of milk- DMC, SPC, MBRT, Resazurin test, Alkaline phosphatase test. Fermented Dairy products- Yoghurt, kefir, Acidophilus milk, buttermilk and cheese. Probiotics (*Lactobacillus, Bifidobacterium*) and prebiotics.

Unit 4. Food spoilage and preservation: General principles underlying food spoilage. Spoilage of meat, fish, egg, milk, vegetables, fruits and stored grains. Spoilage at low temperature. Spoilage of canned food. Principles of food preservation. Food preservation by physical methods- high and low temperature, drying, freezing, irradiation and high pressure. Food preservation by chemical methods- characteristics of food preservatives. Class I and class II preservatives. Modern food

preservation techniques- high electronic field pulses, oscillating magnetic fields pulses, intense light pulses and ultra high hydrostatic pressure.

Unit 5. Food borne infections – Bacterial, Fungal and viral infections. Bacterial- *Salmonella, Staphylococcus, Listeria, Brucella, Bacillus, Clostridium*, *Escherichia.* Fungal – Aflatoxins and ergotism. Viral- Hepatitis, Bovine Spongiform encephalopathy.

Unit 6. hygiene, regulation and standards: Food sanitation. Food control agencies and their regulations. Codes for GMP. HACCP and FSO Systems for food safety.

## MBG2C07. Industrial Microbiology

**Course objectives:** Learner will be familiarised with the equipment's and various fermentation systems in the industry for product development. Will be able to understand the isolation, screening, strain development, fermentation and formulation of various industrially important products. Also acquire an understanding of process control, upstream and downstream processes.

**Course outcome:**

| | |
|---|---|
| CO1 | Describe the methods for screening, isolation, strain improvement, upstream processing and down stream processing in industrial process. |
| CO2 | Apply different isolation and development methods for industrially important microorganisms. |
| CO3 | Explain the mass transfer mechanism in fermentation. |
| CO4 | Compare different types of fermentations |
| CO5 | Explain the effects of different components in fermentation media. |
| CO6 | Discuss various techniques used for the recovery of fermentation products |

Unit 1. Isolation and screening of industrially important microbes. Strain selection and improvement. Bioprocesses- concepts and design. Continuous and batch fermentations. Types of bioreactors. Bioreactor design and control.

Unit 2. Kinetics of fermentation process. Transport phenomena in bioprocess such as mass transport coefficients for gases and liquids and oxygen transfer coefficients, heat transfer.

Unit 3. Principles of bioprocess media formulations. Sterilization systems. Concepts of inoculum development. Monitoring and control of variables such as temperature, agitation, pressure and pH.

Unit 4. Downstream processing – filtration, centrifugation, precipitation, salting out, crystallization and biphasic separation. Bioassays, Standardization, formulations and packaging. Shelf life consideration.

Unit 5. Manufacture of the following: penicillin, streptomycin, tetracycline, Vit. B -12. Citric acid by surface and submerged process. Ethanol fermentation from molasses. Industrial fermentation of wine and beer. Acetone - butanol fermentation. Bakers yeast. Lactic acid from whey, amylases by fungi, mono - sodium glutamate. Importance of fermentations in ayurvedic medicines. Importance and production of Single cell protein (SCP).

Unit 6. Industrial microbiological products as primary and secondary metabolites, regulation of overproduction of primary and secondary metabolites, bypassing of regulatory mechanisms for the over-production of primary and secondary metabolites.

## MBG2C08. Immunology

**Course objectives:**

- Promotes critical thinking on the cellular ontogeny and organ involvement in immunity and the mechanisms involved in immune responses.
- Will develop good understanding on how the immune system functions and also develop the skill to diagnose various diseases by immunological assays.
- Acquaint knowledge immune mediated conditions like hypersensitivity, autoimmunity and immune deficiency diseases.

**Course Outcome:**

| | |
|---|---|
| CO1 | Describe the cells, organs, molecules, mediators, receptors associated with immune responses. |
| CO2 | Illustrate the development of different immune responses in a host. |
| CO3 | Classify the immunoglobulins with a detailed understanding of their diversity generation |
| CO4 | Explain the mechanisms of Hybridoma technology, antigen antibody reactions and Complement system |
| CO5 | Categorize different immune associated disease conditions like hypersensitivity, autoimmunity, graft rejection and tumor development based on mechanism. |

Unit 1. Defense System: Immunity- Types and Detailed Mechanisms of Innate and Acquired Immunity. Vaccines. Antigens. Immunoglobulins- Structure, Classification and Biological Functions. Genetic Basis of Immunological Diversity. Monoclonal Antibodies and Hybridoma Technology.

Unit 2. Lymphoid System: Lymphoid Cells. Hematopoiesis. Structure, Function, Maturation, Development and Classification of T and B Lymphocytes. Lymphocyte Traffic. Toll Like Receptors (TLR), Lymphoid Organs – Primary and Secondary. Cytokines- Types and Biological functions.

Unit 3. Immune Response: Humoral and Cell Mediated Immune Response. Primary and Secondary Immune Response. Processing and Presentation of Intracellular and Extracellular antigens. Immunological Tolerance and Theories of Immune Response. Major Histocompatibility Complex

Unit 4. Antigen-Antibody Reactions and their applications in immunodiagnosis. Complement System- Activation and Biological Functions. Structure of Membrane Attack Complex, Complement Fixation Test. Hypersensitivity- Types and Mechanisms.

Unit 5. Autoimmune Diseases-Causes, pathogenesis, diagnosis and treatment of common autoimmune diseases. Immunodeficiency Diseases, Transplantation Immunology-Types of Grafts, Grafts Acceptance & Mechanism of Graft Rejections. Host Versus Graft (HVG) and Graft Versus Host (GVH) Reactions, Prevention of Graft Rejections. Immunohematology- ABO and Rh Blood Group Systems, Blood Transfusion, Hemolytic Diseases, Rh Incompatibility. Tumor Immunology

## MB2L03. Practical III

### (Food and Dairy microbiology & Industrial microbiology)

**Course objectives:**

- To acquire knowledge on various growth patterns, culturing methods and different quantification techniques of microorganisms.
- To study the microflora of air, water and soil
- Isolation, screening and strain improvement of industrially important organisms for product development.
- To demonstrate different fermentations and their product recovery processes.

**Course outcome:**

| | |
|---|---|
| CO1 | Enumerate the milk microflora and Apply the methods used in Testing the quality of milk. |
| CO2 | Demonstrate preservation of foods |
| CO3 | Enumerate microflora of food spoilage |
| CO4 | Isolation of enzyme producing microorganisms |
| CO5 | Demonstrate the Growth curve of bacteria |
| CO6 | Demonstrate the detection of industrially important microorganisms and its metabolite production |
| CO7 | Demonstrate the production of Mushroom production. |

1. Milk microbiology - direct microscopic count and standard plate count, presumptive test for coliforms
2. Testing the quality of milk - Methylene blue reductase test, Resazurin test and alkaline phosphatase test.
3. Isolation of microbes from yoghurt, idli batter – bacterial and fungal
4. Brine storage of foods.
5. Whey fermentation to alcohol
6. Microbial spoilage of refrigerated food
7. Microbial analysis of food products – detection of indicator organisms,faecal streptococci and *E.coli* by Most Probable Number method and direct plating.
8. Microbial analysis of food products – detection of pathogenic microorganisms, *S. aureus*, *Salmonella* and *Vibrio*.
9. Microbial analysis of food products – detection of anaerobic spore forming *Clostridia*

10. Microbial analysis of food products – detection of yeast and mould
11. Growth curve of bacteria using breeds count, CFU, turbidimetry and PCV
12. Demonstration of mutation in bacteria
13. Isolation of amylase producers.
14. Isolation of cellulase producers
15. Scale up of inoculum.
16. Cell disruption techniques
17. Downstream processing - Salting out
18. Immobilization of cell or enzyme
19. Bioassay of antibiotic.
20. Citric acid production by submerged fermentation.
21. Solid state fermentation
22. Production of wine.
23. Cultivation of mushroom.
24. Demonstration of IAA production

## SEMESTER III

### MBG3C09. Medical Microbiology

**Course objectives:**

- Get acquainted with the molecular basis of pathogenesis and virulence of different pathogens and would also be sensitized to the social impact of the most dreadful diseases.
- Will acquire knowledge on various antimicrobial drugs, drug resistance, biochemical characterization of medically important microorganisms etc.

**Course outcome:**

| | |
|---|---|
| **CO1** | Describe the morphology, pathogenicity, epidemiology, laboratory diagnosis and treatment of important human bacterial pathogens. |
| **CO2** | Explain the pathogenesis, laboratory diagnosis and prophylaxis of important viral pathogens. |
| **CO3** | Illustrate the characteristics of fungi with focus to superficial, sub cutaneous, deep and opportunistic infections. |
| **CO4** | Describe the general features and classification of protozoa. |
| **CO5** | Demonstrate the morphology, life cycle, pathogenesis and epidemiology of important protozoan diseases. |
| **CO6** | Describe the mechanism of action and activity spectrum of antibiotics. |
| **CO7** | Discuss the antifungal and antiviral drugs and determination of MIC. |

Unit 1. Bacteriology: Morphological characteristics, pathogenicity, epidemiology, laboratory diagnosis and treatment of following pathogenic bacteria. Morphological characteristics, pathogenicity, epidemiology, laboratory diagnosis and treatment of following pathogenic bacteria. Aerobic cocci- Staphylococcus, Streptococcus, Pneumococcus and Nesseria. Aerobic Gram positive bacilli- Cornybacterium diphtheriae and Bacillus anthracis. Anaerobic Gram positive bacilli – Clostridium botulinum. Gram negative bacilli – Enterobacteriaceae- Escherichia coli, Proteus, Klebsiella, Shigella and Salmonella. Vibrio cholerae. Spirochetes – Treponema and Leptospira. Mycoplasma. Mycobacteria – M.

tuberculosis and M. leprae Miscellaneous bacteria- Listeria, Campylobacter and Helicobacter

Unit 2. Virology: Quantification and classification of viruses. Pathogenesis, laboratory diagnosis and prophylaxis of following viral infections –Polio, Influenza, Mumps, Measles, Rabies, Japanese encephalitis, Viral haemorrhagic fever, Rubella, Hepatitis, HIV, Slow viru diseases, Emerging viral diseases- bird flu, swine flu and Nippah.

Unit 3. Mycology and parasitology: Fungi – General characteristics, classification based on morphology and reproduction. Fungal diseases – Superficial (Piedra and Pityriasis), Cutaneous (Dermatophytoses), Subcutaneous (Mycetoma), Deep (Histoplasmosis) and Opportunistic fungal infection (Candidiasis). Protozoa – general features and classification. Morphology, lifecycle, pathogenesis and epidemiology of protozoan parasites – Entamoeba hystolytica, Giardia lamblia, Trypanosoma, Leishmania and Plasmodium. Helminths – Schistosoma haematobium, Ancylostoma duodenale and Wuchereria brancofti.

Unit 4. Antibiotics- Classification of antibiotics based on the mode of action with one representative drug in each class- sulfonamides, quinolones, penicillins, cephalosporins, tetracyclines, aminoglycosides, macrolides. Brief outline of antifungal and antiviral drugs. Determination of MIC.

## MBG3C10- Molecular Biology

**Course Objectives:** The course aims to develop the concept of gene expression and the molecular events associated. The learner will be able to explain the mechanisms of gene expression regulation and their impact on the cellular development. An understanding of oncogenes and tumour suppressor genes also will be acquired by the learner.

**Course Outcome:**

| | |
|---|---|
| CO1 | Explain the mechanisms behind the information flow from DNA to proteins and the multiple levels at which gene expression can be regulated. |
| CO2 | Compare gene expression and regulation in prokaryotes and eukaryotes |
| CO3 | Discus the molecular mechanisms underlying mutations, DNA damage and repair |
| CO4 | Acquaint knowledge of DNA replication and other mechanisms of gene transfer mechanisms |
| CO5 | Discuss the concept of Oncogenes and tumour suppressor genes. |

Unit 1. DNA structure: Chemistry of DNA, Forces stabilizing DNA structure, Forms of DNA, Watson –Crick and Hoogsteen base pairing, Physical properties of ds DNA. Mechanisms of supercoiling in cells, Mechanism of action of Topoisomerase I and II, effect of supercoiling on structure of DNA and the role of supercoiling in gene expression. Organization of DNA into chromosomes: Eukaryotic chromosome organization and its molecular mechanism.

Unit 2. DNA replication- Prokaryotic and eukaryotic DNA replication, mechanism of replication. Enzymes and necessary proteins in DNA replication. Telomeres, telomerase and end replication. Role of telomerase in aging and cancer. DNA Repair- Mismatch, Base- excision, Nucleotide-excision and direct repair DNA recombination- Homologous, site- specific and DNA transposition

Unit 3. Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases general and specific transcription factors- regulatory elements- mechanism of transcription regulation- Transcription termination. Post transcriptional modification- 5’ cap formation-3’ end processing and polyadenylation- splicing editing- nuclear export of mRNA- mRNA stability.

Unit 4. Translation: Structure and role of t-RNA in protein synthesis, ribosome structure, basic features of genetic code and its deciphering, wobble hypothesis, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes) Post translation modification by cleavage, self-assembly, assisted self-assembly chaperones, acylation, phosphorylation, acetylation and glycosylation, Histone acetylation and deacetylases, chromosome remodelling complex. Intein splicing. Protein targeting, co-translational import, post translational import, Lysosome targeting.

Unit 5. Molecular mechanism of gene regulation in prokaryotes-Transcriptional regulation in prokaryotes; Inducible & repressible system, positive and negative regulation; Operon concept, structure of operon, Lac, Trp, Ara operon, Catabolic repression, Attenuation. Role of Hormones in gene regulation. Antisense RNA, SiRNA, MicroRNA, Riboswitches & their applications.

Unit 6. Oncogenes & tumour suppressor genes, viral & cellular oncogenes, tumour suppressor genes from humans, pRb &p53 tumour suppressor protein.

## MBG3E01. Diagnostic microbiology

**Course Objectives:** Will acquire the capability to use logical and systematic thinking to solve problems with diagnostic techniques and procedures and apply high level analytical skills to the chosen area of clinical laboratory specialization.

**Course outcome**

| | |
|---|---|
| **CO1** | Describe a wide range of diagnostic technologies and methodologies relevant to the fields of clinical biochemistry, haematology, histopathology, cytopathology, molecular biology and microbiology. |
| **CO2** | Differentiate between various Probe-Based Microbial Detection and Identification. |
| **CO3** | Compare various molecular diagnostic tools. |
| **CO4** | Explain the application of molecular tools in systematics. |

Unit 1. Automated Blood Cultures. Rapid Antigen Tests.- Advanced Antibody Detection.- Phenotypic Testing of Bacterial Antimicrobial Susceptibility.- Biochemical Profile-Based Microbial Identification Systems.

Unit 2. Probe-Based Microbial Detection and Identification.- Pulsed Field Gel Electrophoresis.- In Vitro Nucleic Acid Amplification: An Introduction.- PCR and It's Variations.- Non-Polymerase Chain Reaction Mediated Target Amplification Techniques.- Recent Advances in Probe Amplification Technologies.- Signal Amplification Techniques: bDNA, hybrid capture.

Unit 3. Detection and Characterization of Molecular Amplification Products: Agarose Gel Electrophoresis, Southern Blot Hybridization, Restriction Enzyme Digest Analysis and Enzyme-Linked Immunoassay.- Direct Nucleotide Sequencing for Amplification Product Identification.- Microarray-Based Microbial Identification and Characterization.- Diagnostic Microbiology Using Real-time PCR Based on FRET Technology.

Unit 4. Bacterial Identification Based on 16S Ribosomal RNA Gene Sequence Analysis. Advance in the Diagnosis of Mycobacterium tuberculosis and Detection of Drug Resistance. Molecular Strain Typing Using Repetitive Sequence –Based PCR.

## MBG3E02. Cell Biology

**Course Objectives:** The course is intended to provide basic level knowledge in cell biology. The learner will be able to understand the cellular organelle in detail along with an introduction to the signal transduction mechanism expanding through the apoptosis and cancer. The learner will have knowledge of the structure, function and interrelationships of various cell organelle in Eukaryotes.

**Course outcome:**

| | |
|---|---|
| CO1 | Explain the structure and functions of cell components in eukaryotic cells |
| CO2 | To distinguish the mechanism of protein sorting and transportation to various targets. |
| CO3 | Describe the mechanisms of cell signaling, cell death and cancer development. |
| CO4 | Correlate the cell communication mechanism with the cell cycle and its regulation. |
| CO5 | Conceptualize the theories and molecular mechanism of cancer development |

Unit 1. Introduction, Discovery of cell and Cell Theory. An overview of Cells – Composition of Cells Molecules of cell, cell membranes and cell Proteins. The Nucleus Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus.

Unit 2. Mitochondria, Chloroplasts and Peroxisomes Structural organization, Function, Marker enzymes, Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes'assembly

Unit 3. Cytoskeleton and Cell Movement Structure and organization of actin filaments; actin, myosin and cell movement; intermediate filaments; microtubules. Protein Sorting and Transport - The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes.

Unit 4. Signal transduction: electrical impulses and their transmission: Structure and electrical properties of neurons, resting potential, action potential, propagation of action potential, voltage gated and ligand gated channels, synaptic transmission

,chemical signals and receptors, second messengers: cAMP, Ca ions, Ras pathway, glycogen breakdown by epinephrine. Nucleus, structure of chromosomes, chromosome banding, mitosis and meiosis, chromosomal organization Cell cycle: G1, S,G2, M phases, model organisms, MPF, cyclins, checkpoints, Role of Rb & p53. Cell cycle inhibitors

Unit 5. Cell death and cancer: Apoptosis and necrosis, apoptotic pathways , theories on apoptosis, types of tumor, induction of cancer, properties of cancer cells, oncogenes and c-onco genes, tumor suppressors, Molecular pathways- PIP3 Akt, MAP kinase.

## MBG3E03. Microbial Taxonomy

**Course Objectives:**

- Recognize the extent of microbial diversity present in this world including prokaryotic and eukaryotic microbes and the importance of microbial diversity in different habitats including extreme environments.
- Understand conventional and molecular methods used for studying microbial diversity and problems and limitations in microbial diversity studies
- Describe the microbial classification schemes and methods used for taxonomy, distinguish and differentiate the use of various taxonomic tools apt for classification and identification of microorganisms.

**Course outcome:**

| | |
|---|---|
| **CO1** | Compare the classification systems with contributions of pioneers in taxonomy |
| **CO2** | Distinguish different criteria used in characterization and classification |
| **CO3** | Analyse the Molecular techniques used in classification |
| **CO4** | Discuss the Bergey's Mannual of Systematic Bacteriology with emphasis to different groups. |
| **CO5** | Demonstrate the knowledge of taxonomy of microorganisms and their importance in clinical microbiology, public health and to prevent growth and spread of microbes in the environment. |

Unit 1. Contributions of Pioneers in the field-Von Nageli, Chatton, Whittaker and Woese. Phylogenetic relationships. Brief outline of 5 kingdom classification. Three domain system- characteristics of the Domains: Bacteria, Archaea, Eukarya. Approaches in classification- Natural, Phenetic and Phylogenetic classification. Molecular or genetic approaches in classification. Numerical taxonomy.

Unit 2. Criteria used in classification-Morphological, cultural, biochemical, nutritional, ecological, serological characteristics. Principles and procedures of important tests (based on the characteristics) used in classification. Agglutination, Precipitation, ELISA, Western blotting, Phage typing, Fatty acid profile, Flow cytometry.

Unit 3. Molecular techniques: DNA base composition, DNA finger printing, Aminoacid sequencing, PCR, Nucleic acid hybridisation, Southern blotting, DNA chips, Nucleic acid sequencing, Ribotyping and rRNA sequencing. Flourescent In Situ Hybridisation (FISH).

Unit 4. Bergey's Mannual of Systematic Bacteriology: Brief outline. Distinguishing features of Prokaryotes-Archae and Bacteria. Characteristic features of the important groups under- Archae: Crenarchaeota (Hyperthermophile) and Euarchaeota (Methanobacteriales and Halobacteriales). Bacteria: Proteobacteria (Alpha, Beta, Gamma, Delta and Epsilon),

Unit 5. Nonproteobacteria (Deinococcus, Photosynthetic bacteria, Planctomycetes, Chlamydiae, Spirochetes and bacteroidetes), Gram positives -Low G+C gram positive bacteria (Firmicutes- Mycoplasma, Closrtidia and Bacilli) and High G+C gram positive bacteria (Actinomycetes-Corynebacterium, Mycobacterium, Streotomyces).

## MBG3L04 Practical IV

## (Immunology and Medical Microbiology)

**Course Objectives:**

The diagnostic methods in microbiology, haematology and immunology are practiced by the learner in this course. The course will also provide a hands-on expertise in identification of pathogenic bacteria from a clinical sample, sensitivity profiling of the isolate

**Course outcome:**

| | |
|---|---|
| CO1 | Perform the acid fast staining procedure |
| CO2 | Demonstrate skills in isolation and identification of various pathogenic microorganisms. |
| CO3 | Discuss the viral inoculation routes in embryonated eggs. |
| CO4 | Perform immunological tests for diagnosis of antigen/antibody |
| CO5 | Determine the MIC of an antimicrobial compound |

1. Acid fast staining
2. Preparation and microscopic examination of pathogenic microbes using permanent slides
3. Preparation of antibiotic discs
4. Determination of MIC
5. Demonstration of antifungal activity
6. Antibiograms of common bacterial pathogens by Kirby Bauer method
7. Detection of betalactamase production
8. Study of normal microbial flora of human beings
9. Identification of common bacterial pathogens from clinical specimen using morphological, cultural and biochemical characteristics.
10. Identification of common fungal pathogens from clinical specimen using morphological, cultural and biochemical characteristics.
11. Routes of viral inoculation in embryonated eggs
12. Blood group determination
13. Ouchterlony Double diffusion Test

14. Widal test: Slide and Tube tests
15. VDRL test
16. ELISA
17. Immunoelectrophoresis
18. Blood cell count - TC and DC
19. ESR determination
20. Complement fixation test

## MBG3L05. Practical V

## (Principles of Genetics & Molecular Biology)

**Course Objectives:**

This learner after the course will be able to isolate, purify and estimate DNA/Plasmids and RNA. The transformation and conjugation techniques will be demonstrated for the thorough understanding of the concept of gene transfer in bacteria. The course also aims at visualising the isolated nucleic acids by electrophoretic techniques. The demonstration on cloning and restriction mechanisms will enhance the practical capacity of the learner.

**Course Outcome**

| | |
|---|---|
| CO1 | Demonstrate the stages of mitosis and meiosis |
| CO2 | Isolate, purify and estimate DNA, RNA and plasmid from bacteria |
| CO3 | Demonstrate the visualization of the isolated nucleic acid by electrophoresis |
| CO4 | Demonstrate the concept of hyperchromism |
| CO5 | Evaluate the gene transfer process in bacteria by performing conjugation and transformation |
| CO6 | Assess the gene transfer by induction of beta gal gene in E coli<br>Demonstrate cloning and restriction digestion |

1. Study of mitotic stages using onion root tip
2. Meiosis
3. Agarose Gel Electrophoresis
4. DNA isolation, purification and visualization

5. Estimation of DNA
6. RNA isolation, purification and visualization
7. Estimation of RNA
8. Hyperchromic shift on DNA melting
9. Bacterial conjugation
10. Bacterial transformation
11. Isolation of plasmids
12. Induction of Beta galactosidase gene in E. coli
13. Cloning in E.coli
14. Restriction Enzyme digestion of DNA

## SEMESTER IV

### MBG4C11. Biostatistics and Bioinformatics

**Course Objectives:**

- To equip the students with the tools to summarize the experimental data in diagrammatic and graphical way, to obtain descriptive statistics and make possible appropriate interpretations.
- To understand the properties of the most important bioinformatics databases, perform text- and sequence-based searches, analyze the results in light of molecular biology.
- Attain knowledge and awareness on the basic principles and concepts of Biology, Computer Science and Mathematics.

**Course Outcome:**

| | |
|---|---|
| CO1 | Discuss the principles and practices of statistical methods in biological research. |
| CO2 | Explain various biological data bases for sequence retrieval, analysis, sequence alignments, phylogeny and other applications. |
| CO3 | Discuss the method of molecular docking and their application |
| CO4 | Discuss the concept behind drug designing with the application of bioinformatics tools. |

Unit 1. Biostatistics – Principles and practice of statistical methods in Biological Research; Basic statistics; Averages; statistics of Dispersion; Coefficient of variations; Standard error; Probability; Distributions; Tests of statistical significance; Students T-test; Basics of correlation and regression. Analysis of variance.

Unit 2. Introduction to Bioinformatics and Biological Databases:.Biological databases - nucleic acid, genome, protein sequence -Uniprot-KB: SWISS-PROT, TrEMBL,gene expression databases. Mode of data storage - File formats - FASTA, Genbank and Uniprot. Various file formats for biomolecular sequences: GenBank, FASTA. Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

Unit 3. Sequence Alignments, Phylogeny and Phylogenetic trees :Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction- UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood.

Unit 4. Molecular docking-types of docking-types of interaction-search algorithm, scoring function-key stages of docking-autodock -application-Drug designing. Structure prediction and protein modelling.

**MBG4E04. Microbial Biotechnology**

**Course Objectives:** Attain knowledge about the underlying principles of microbial fertilizers and their industrial applications. Understand the importance and environmental impact of genetic engineering. Understand the applications of Petroleum microbiology and microbial Insecticides.

**Course Outcome:**

CO1 Identify the issues related to plant nutrition, quality improvement, environment adaptation, transgenic crops and their use in agriculture.

CO2 Discuss the environmental impact of genetic engineering related to GM food crops and other agro, diary based products.

CO3 Explain the importance of microbes in oil recovery and degradation, leaching, bio-mining and also production of biopolymers, bio-surfactants, antibiotics enzymes etc.

CO4 Describe about genetic engineering for recombinant protein expression and production from various cell systems which has advanced knowledge about factorial experimental set up.

Unit 1. Production of microbial biofertilizers – cyanobacteria, *Rhizobium, Azotobacter*, *Azospirillum*, *Phosphobacteria* and VAM. Extremophiles and their possible uses - Thermophilic organisms. Yeasts and its uses - Brewer's and Baker's yeast - Food and fodder yeasts - yeast products and their uses. Microbes as a health food - Spirulina and its production methods.

Unit 2. Petroleum microbiology - Sedimental microbes in petroleum formation - Coal bioprocess to eliminate sulphur. Microbial enhanced oil recovery, oil spills degradation bymicroorganisms. Microbial production of fuels- H2 and ethanol. Microbial leaching of ores - oil extraction - metal leaching and biomining. Microbes and bioremediation - role of microbes in herbicides, pesticides and other xenobiotics degradation. Degradation of toxic chemicals by *Pseudomonas*. Biotransformation - useful products obtained in biotransformation. Microbial production of products like Biopolymers and biosurfactants.

Unit 3. Immobilization of cells and enzymes. Advantages and disadvantages of immobilized systems. Enzyme based electrodes. ATPase based cell quantitation and Lumac system. Hybridoma technology for monoclonal antibodies, recombinant vaccines, Animal cell culture. Novel bioreactor designs for animal cell culture – hollow fiber, microcarrier and spin bioreactors. Probiotics - use of *Lactobacilli* and *Bifidobacterium* - therapeutic and nutritional value.

Unit 4. Microbial Insecticides, Commercial Products by Recombinant Microbes, Plant and animal Transgenesis, Cloning, Gene Therapy. Vaccine farming. Environmental impact of genetic engineering – problems of GM foods and crops, Bti. Toxin resistance of insects - cotton bollworm, tobacco budworm, use of multiple alleles of Bti toxin genes. Environmental release and monitoring of genetically modified/engineered organisms. Milk flavor manipulation through rumen microflora, mitigating greenhouse gas emission from dairying using biotechnology.

## MBG4E05. Genetic engineering

**Course Objectives:** Will be capable of understanding and relating the conventional and molecular methods for gene manipulation in microbial and other systems, their problems and limitations.

**Course outcome:**

| | |
|---|---|
| CO1 | Discuss the fundamental molecular tools and their applications in DNA modification, manipulation and cloning. |
| CO2 | Compare genomic and cDNA Library |
| CO3 | Describe advanced molecular techniques in genetic engineering-PCR Methods, sequencing methods, RFLP, RAPD etc. |
| CO4 | Interpret the importance of molecular marker genes in cloning |
| CO5 | Explain the techniques for DNA introduction to the vectors and host cells. |

Unit 1. Restriction digestion of DNA, separation by isopycnic & agarose gel methods. Cloning vectors-plasmids, BACs, PACs & YACs, cutting &joining DNA molecules, linkers, adaptors & homopolymer tailing, DNA libraries-construction of DNA libraries, genomic & cDNA libraries,

Unit 2. PCR-different types like RT-PCR, long PCR, inverse PCR, quantitative PCR, differential display PCR, nested PCR, RACE etc., probes- radiolabel led DNA/RNA probes, synthetic oligonucleotide probes, cloning strategies-cloning in E.coli, yeast & gram +ve bacteria.

Unit 3. Expression strategies for heterologous genes, vector engineering & codon optimization, screening strategies, screening by hybridization, colony hybridization, plaque lift assay, Northern, southern & western blotting, FISH, reporter assays. (25 Marks)

Unit 4. DNA sequencing, nucleic acid microarrays, site directed mutagenesis & protein engineering, DNA introduction methods like calcium chloride facilitated uptake, microinjection, electroporation, particle bombardment, use of Ti plasmid in generating transgenic plants. Molecular markers in genome analysis: RFLP, RAPD, AFLP analysis. RNA interference. (15 Marks)

## MBG4E06. Biosafety, Bioethics & IPR

**Course Objectives:** Acquire basic understanding on the concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights. This will also enable us to understand balanced integration of scientific and social knowledge in sustainable development.

**Course Outcome:**

| | |
|---|---|
| CO1 | Discuss the significance of biosafety and bioethics related regulations. |
| CO2 | Appreciate the importance of Intellectual property rights and explain various types of IPR. |
| CO3 | Recognize importance of biosafety practices and guidelines in research |
| CO4 | Comprehend benefits of GM technology and related issues. |
| CO5 | Recognize importance of protection of new knowledge and innovations and its role in business |

Unit 1. Impacts of biotechnology – legal, socioeconomic, public elucidation of process of biotechnology in generating new forms of life. Biosafety in general, Food and feed products containing GMOs, Risk assessment/analysis, Risk management, Ethical aspects of GMOs, policy on the storage of GMOs, Gene technology act, Precautionary principle, Potential environmental risks & benefits, Potential socio-economical risks & benefits.

Unit 2. Bioethics**:** The Nature of Bioethics, Genetic modification/research on plants and animals, therapeutic cloning, human cloning, stem cell research. Federal Laws and the roles of: The Food and Drug Administration, The Centers for Disease Control and Prevention, The United States Department of Agriculture, The Environmental Protection Agency, State and Local Agencies

Unit 3. Patenting research tools and the law: Patents as a Strategy for Protection of Intellectual Property, Benefits and Costs of Patents, Requirements for Patent Protection, patentable subjects and protection in biotechnology, international convention for the protection of new varieties – Strasbourg convention, UPOV convention. Experimental Use Exemption. The patentability of microorganisms,

legal protection for plants and other higher organisms, new plant varieties by rights, tissue culture protocols, transfer of technology. Patentability of vectors.

Unit 4. Patents on Research Tools. Access to data and intellectual property: scientific exchange in genome research. Patented research tools - Recombinant DNA, PCR, Taq Polymerase, Protein and DNA Sequencing Instruments, Research Tools in Drug Discovery.

**MBG4L06. Practical VI**
**(Biostatistics and Bioinformatics)**

**Course Objectives:** Develop problem-solving skills, including the ability to develop new algorithms and analysis methods. Implement solutions to basic bioinformatics problems and use various bioinformatics tools to relate structure, sequence and function.

**Course Outcome:**

| | |
|---|---|
| CO1 | Demonstrate proficiency in bioinformatics methods including accessing the major public sequence databases, use of the different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages |
| CO2 | Retrieve data from Biological Databases |
| CO3 | Explain the features of National Centre for Biotechnology Information (NCBI) |
| CO4 | Preform sequence comparison using various alignment tools |
| CO5 | Create protein structures with modelling tools. |
| CO6 | Prediction of Gene structure, gene function and ORF position. |

1. Biological Databanks- Sequence Databases, Structure Databases, Specialized Databases
2. Introduction to National Center for Biotechnology Information (NCBI)
3. Data retrieval: Entrez, SRS and DBGet.
4. Analysis of gene sequence from nucleotide database.
5. Analysis of protein sequence from protein database.
6. Introduction to PDB and analysis of PDB file.
7. Molecular visualization
8. Gene structure and function prediction (using GenScan, GeneMark)

9. Sequence similarity searching using BLAST and interpretation of the results.
10. Multiple sequence alignment using Clustal and interpretation of the results.
11. Protein sequence analysis using ExPASy proteomics tools
12. Phylogenetic analysis using web tools
13. Phylogenetic analysis using PHYLIP
14. Sequence analysis using EMBOSS
15. Homology Modelling and structure refinement Swiss model
16. Model validation using What Check and Pro Check
17. Docking using HEX
18. Biostatistics problems
19. Statistical Analysis using EXCEL: graphical presentation
20. Regression Analysis using spreadsheet application

**MBG4P. Dissertation**

**Course Objectives:** Develop critical thinking and use of primary research publications to understand the scientific processes which will lead them to draw hypothesis. Will be able to systematically apply the scientific method of investigation and hypothesis testing, analysis and interpretation. Proficiency in scientific writing will also be achieved.

**Course outcome**

| | |
|---|---|
| CO1 | Perform data mining, literature search, systematic review, research gap finding and development of hypothesis. |
| CO2 | Design and execute experiment/ sampling methods |
| CO3 | Compilation and analysis of data and interpretation of results |
| CO4 | Analyse the results and validate the hypothesis to reach proper conclusions. |
| CO5 | Develop scientific writing skills |
| CO6 | Demonstrate skills in various advanced laboratory techniques |

A dissertation should be submitted by each student as a part of the curriculum, based on a topic related to the subject area at the end of the forth semester.

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4. Agricultural Microbiology – Rangaswami
5. Agricultural Microbiology – Subha rao
6. Bailey and Scott's Diagnostic microbiology – Baron et al
7. Basic food microbiology – Banwart GJ
8. Biochemistry – DM Vasudevan and S Sreekumari
9. Biochemistry – Strayer
10. Biochemistry – Voet and Voet
11. Biochemistry – West and Todd
12. Bioethics: An Introduction for the Biosciences - Ben Mepham,
13. Bioinformatics - sequence and genome analysis – Mount
14. Bioinformatics computing – Bergeron
15. Biological fundamentals – Biotechnology – Ed. H.J. Rehm and G. Reid
16. Biopesticides, use and delivery – Hall and Menn
17. Biostatistical analysis - Zar
18. Biotechnology – B.D. Singh
19. Biotechnology of Integrated pest management – Persley
20. Cell & Molecular Biology-Gerald Karp.
21. Comprehensive biotechnology – Murray and Moo Yung
22. Dairy Microbiology – Robinson RK
23. Diagnostic methods in Clinical Virology : N.R. Grist
24. Environmental Biotechnology – Principles and applications –Burce E et al.,
25. Environmental biotechnology and cleaner bioprocess
26. Essential Clinical immunology – Helen Chappell and Mansei Haemy
27. Essentials of Diagnostic Virology: G. Storch
28. Food microbiology – Adams MR and Moss MO
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32. Fundamental principles of bacteriology – A.J. Salle
33. Fundamentals of biotechnology – Ed. Paul Prave et al.,
34. Fundamentals of Immunology – Kuby
35. Fundamentals of microbiology – Frobischer
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