**M.Sc. MICROBIOLOGY (CBCS)**
**(Effective from the academic year 2014-2015)**
**SCHEME FOR INSTRUCTION AND EXAMINATION**
**SEMESTER SCHEME**

| Paper No. | Title of the paper | Type of paper | Periods/ Week | Duration of Exam (Hours) | IA | EA | Maximum Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| **I Semester Theory** | | | | | | | | |
| MBH-101 | Bacteriology & Virology | H Core | 4 | 3 | 30 | 70 | 100 | 4 |
| MBH-102 | Eukaryotic Microbiology | H Core | 4 | 3 | 30 | 70 | 100 | 4 |
| MBH-103 | Microbial Physiology and Biochemistry | H Core | 4 | 3 | 30 | 70 | 100 | 4 |
| MBH-104 | Microbial and Biochemical techniques | H Core | 4 | 3 | 30 | 70 | 100 | 4 |
| MBS-105 | Biostatistics | S Core | 2 | 2 | 15 | 35 | 50 | 2 |
| **Practical** | | | | | | | | |
| MBP-106 | Bacteriology, Virology and Eukaryotic Microbiology | Pract | 4 | 4 | 30 | 70 | 100 | 4 |
| MBP-107 | Microbial Physiology, Biochemistry, Microbial techniques | Pract | 4 | 4 | 30 | 70 | 100 | 4 |
| **Total Marks and Credits** | | | | | | | 650 | 26 |

**I SEMESTER (THEORY)**
**MBH- 101: BACTERIOLOGY AND VIROLOGY**
**Total Hours 52**

**Unit 1**

**Introduction and Classification:** Introduction to microbes and prokaryotes. Natural system of classification, binomial nomenclature, international code of nomenclature of prokaryotes. Taxon, species, strain. Criteria used for classification. Three domain classification, classification according to Bergey‟s manual of systematic bacteriology. Recent trends in Microbial Taxonomy: a) Chemotaxonomy: cell wall components, lipid composition, isoprenoid-quinones, cytochrome composition. b) Molecular method: DNA homology, DNA-RNA homology, G + C ratio, rRNA sequencing c) Numerical taxonomy d) Genetic methods in taxonomy e) Serological methods f) Taxonomy based on ecology. Bacterial phylogeny, Phylogenetic trees-evolutionary models, homology, methods for tree building, maximum likelihood, organizing data on a tree, evaluating phylogenies. Dichotomous key. **14hrs**

**Unit 2**

**Morphology and ultrastructure of bacteria**: Different cell morphology, flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly □ hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores. **Cyanobacteria:** Ultrastructure, reproduction and significance of *Microcystis, Gleocapsa, Spirulina, Nostoc, Anabaena* and *Scytonema.* **12hrs**

**Unit 3**

**Morphological characterstics of bacteria:** Spirochetes, Rickettsia, Chlamydiae**,** Mycoplasma, appendaged, sheathed, gliding and fruiting bacteria, Archaeobacteria, Actinomycetes. **8hrs**

**Unit 4**

**Nutrition and Cultivation:** Micro and macro nutrients, growth factors. Nutritional types of bacteria. Culture media**:** classification of media (Simple, complex and special media with example). Growth: Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Aerobic, anaerobic, batch, continuous and synchronous cultures. Mechanism of cell cycle and binary fission. **8hrs**

**Unit 5**

**Acellular entities- viruses, viriods and prions:** Brief outline on discovery of viruses, origin of viruses, Nomenclature and classification of viruses- ICTV system of classification, distinctive properties of viruses. Morphology and ultrastructure of viruses - capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA), structure and importance- Viroids, Prions. **6hrs**

**Unit 6**

**Cultivation and assay of viruses :** Cultivation of viruses in embryonated eggs, experimental animals and cell cultures (suspension cell cultures and monolayer cell cultures; cell lines and cell strains).

## MBH- 102: EUKARYOTIC MICROBIOLOGY
## Total Hours 52

**Unit 1**

**Protozoa:** Introduction, structure and significance: *Leishmania, Trichomonas, Entamoeba,Plasmodium,* cultivation of protozoa*.* **4hrs**

**Unit 2**

**Algae:** Distribution, morphology and classification (Smith ) of Algae; Isolation from soil and water; algal ecology, Media and methods used for culturing algae, measurement of algal growth, strain selection and large scale cultivation, Symbiotic algae: Lichens, Coral reef and sea sponges. Structure and reproduction of *Spirogyra, Euglena, Exuviaella, Diatoms, Sargassam and Porphyra.* **12hrs**

**Unit 3**

**Biological and economic importance of algae:** As primary producers and as commercial products [food, green energy (biofuel) and therapeutic uses], heavy metal removal, immobilized and labeled algae; algal blooms and toxins. **4hrs**

**Unit 4**

**Fungi:** Structure of Fungal cells and growth; Hyphae and non-motile unicells, motile cells, spores, dormancy, growth of population and colonies, Mechanism of growth in Fungi, Measurement and kinetics of growth, nutritional and environmental requirements; Prevention of fungal growth. Heterothallism, parasexuality, sex hormones in fungi; physiological specialization, phylogeny of fungi. **10hrs**

**Unit 5**

**Classification:** Evolutionary tendencies in fungi, Classification (Ainsworth) of fungi
**Salient features of Division and Subdivision of Fungal Kingdom:**
**Myxomycota:** Classes**:** Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes
**Eumycota**:
**Mastigomycotina:** Classes: Chytridiomycetes, Hyphochytridiomycetes, Oomycetes
**Zygomycotina:** Classes: Zygomycetes, Trichomycetes
**Ascomycotina:** Classes: Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, Laboulbeniomycetes, Loculoascomycetes
**Basidiomycotina:** Classes: Teliomycetes, Hymenomycetes, Gasteromycetes
**Deuteromycotina:** Classes: Hyphomycetes, Coelomycetes, Blastomycetes
**Structure and reproduction of**: *Dictyostelium, Allomyces, Pilobolus, Claviceps, Puccinia, Fusarium.* **16hrs**

**Unit 6**

**Fungi and ecosystem:** Substrate groups: saprophytic, parasitic, keratinophilic, coprophilous; substrate successions, parasitism, predation, mutualism and symbiosis with plants and animals. Diversity of aquatic fungi. Economic importance of fungi. **6hrs**

**MBH- 103: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY**
**Total Hours: 52**

**Unit 1**

**Metabolite transport:** Facilitated diffusion, mechanosensitive channels, ATP- binding cassette transporter family, chemiosmotic driven transport, ion ingredients, specific transport systems: ATP- linked ion motive pumps, histidine permease, iron, phospho transferase system.

**Microbial stress responses:** Osmotic stress, oxidative stress, thermal stress and heat shock response, nutrient stress and starvation stress response.

**Bioluminescence in microbes:** Mechanism and significance. **6hrs**

**Unit 2**

**Enzymes:** Definition, specificity, active sites, coenzymes, enzyme units, isozymes, enzymes kinetics; Michaelis-Menten equation. Sinificance of Km and Vmax, LB plot, Determination of kinetic parameters, multi substrate kinetics. Mechanism of enzyme action- lock and key and induced fit hypothesis, acid-base, covalent and metal ion catalysis. Regulation-Covalent, allosteric and feed back inhibition. Reversible (competitive, noncompetitive and uncompetitive) and irreversible inhibitions. Kinetics analysis of allosteric enzymes, Hills binding. Ribozymes and abzyme. **10hrs**

**Unit 3**

**Carbohydrates:** Structure and properties of mono, oligo and polysaccharides Metabolism and regulation- Glycolysis, TCA cycle, Glyoxylate cycle. Pentose phosphate pathway, Gluconeogenesis, Entner – Doudoroff pathway, Phosphoketolase pathway, Biosynthesis of peptidoglycan.

**Fermentation pathways:** Fermentation reactions**,** Fermentation balances, Homo and Heterolactic fermentation- lactic acid fermentation, acetic acid, butyric acid, mixed acid and propionic acid fermentation.

**Bioenergetics:** Laws of thermodynamics, High energy compounds.

**Energy production:** Substrate level phosphorylation; Oxidation- Reduction reactions. Redox potential**,** Electron transport chain, Oxidative phosphorylation. Generation of ATP in alkalophiles and chemolitotrophs. **15hrs**

**Unit 4**

**Lipids:** Classification, structure of saturated, unsaturated fatty acids, triacylglycerol, phospholipids**,** glycolipids and sterols; Oxidation of fatty acids (α, β, ω oxidation). Biosynthesis of fatty acids (saturated and unsaturated) and sterol (ergosterol). **9hrs**

**Unit 5**

**Nucleic acids:** Structure of bases, nucleosides and nucleotides; Biosynthesis: Purine and pyrimidine, *denovo* and salvage pathway. **4hrs**

**Unit 6**

**Amino acids & proteins:** Classification, structure and properties of amino acids. General aspects of aminoacid metabolism; amination, transamination, deamination. decarboxylation, urea cycle. Classification, properties and structural organization of proteins (primary, secondary, tertiary and quaternary). **8hrs**

**MBH- 104 MICROBIAL AND BIOCHEMICAL TECHNIQUES**
**Total Hours: 52**

**Unit 1**

**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.

**Microscopy:** Working principle of phase contrast microscopy, fluorescent microscopy, electron microscopy (TEM and SEM), confocal microscopy, fluorescent microscope scanning probe microscopy and their staining techniques: image processing methods in microscopy. Micrometry. **12hrs**

**Unit 2**

**Measurement of microbial growth:** Direct microscopic count, standard plate count, membrane filtration, MPN, Indirect method: turbidity, metabolic activity and dry weight. Automated microbial identification system.

**6hrs**

**Unit 3**

**Analysis of metagenomes:** Metagenomics, Culture independent analysis of microbes, phospholipids. Fatty acids analysis, Fluorescent *in situ* hybridization (FISH), Genomic *in situ* hybridization (GISH).

**Unit 4**
**Spectrophotometry:** Principle and applications of spectrophotometer- UV/visible, fluorescence.
**Spectroscopy:** Principle and applications of circular dichroism, NMR and ESR spectroscopy, X-ray diffraction. Mass spectroscopy **10hrs**

**Unit 5**
**Chromatography:** Principles and applications of Chromatography: Thin layer chromatography (TLC), Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Gas chromatography (GC) and High performance liquid chromatography[(HPLC).
**Electrophoresis:** Definition, principles and applications; different types of Electrophoresis- PAGE, SDS-PAGE, IEF, 2D-PAGE, Agarose gel electrophoresis, PFGE. **12hrs**

**Unit 6**
**Isotope techniques:** Stable and radioactive isotopes, radio isotopic labeling, autoradiography, scintillation counters, non-radioactive labeling, safety guidelines. **6hrs**

## MBS- 105 BIOSTATISTICS
## (Soft core)

Total Hours: 26

**Unit 1:**
Introduction to Bio-statistics, basic concepts, data types. Need for statistical techniques for biological applications, replicable data, Tabulation of data, construction of graph and graphical representations of data. Different models of data presentations.
Frequency distribution, Arithmetic mean, mode, median and percentiles. Measures of variability: Range, mean deviation. standard deviation and co-efficient of variation. Properties of the data- Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness and kurtosis and their various measures, percentiles Simple linear correlation and regression analysis. Analysis of variance. Population and sample: Random sample, use of table of random numbers, parameter and statistics, sampling distribution of sample means, Standard error; confidence intervals.

14 Hours

**Unit 2:**
Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions and a few simple problems. Statistical Inference- Estimation, standard error, confidence interval for means and proportion. Testing of hypothesis: basic concepts and definitions, types of errors. Tests based on Normal, student's t, chi-square and F distributions, interpretation of „p" value.
Statistical package- Features of statistical software, SPSS for various applications in Bio statistical programme. 12 Hours

## I SEMESTER (PRATICAL)
## MBP-106: BACTERIOLOGY, VIROLOGY AND EUKARYOTIC MICROBIOLOGY

**Total Units: 15**
1. **Isolation of microorganism:** Serial dilution, pure culture techniques
2. **Culturing and cultural characteristics of microorganisms**:
i. **Autotrophic** - Benecks broth, Chu"s medium
ii. **Heterotrophic** -Nutrient agar, glucose peptone media
iii. **Selective** - MRS, actinomycetes agar
iv. **Enriched** -Dorsetts egg growth medium, chocolate agar
v. **Differential** - Maconkey, Blood agar, EMB, DCA
3. **Staining techniques:** Simple, Differential: acid-fast, endospore, capsule, cell wall, cytoplasmic inculsion vital stains: flagella, spore and nuclear staining.
**4. Biochemical tests for identification of Bacteria:** Catalase, oxidase, IMViC, motility, gelatine test, urease, levan formed from glucose, H2S in TSIA and lead acetate paper, coagulase, optochin sensitivity, lecithinase, nitrate reduction, acid and gas from

glucose, arabinose, inosital, lactose, maltose, mannitol, rhamnose, salicin, trehalose, sucrose, xylose, fructose, ONPG acid, hippurate hydrolysis, chitin, starch, casein, Tween 80 hydrolysis, pectin, arginine dehydroysis, lysine decarboxylase, ornithine, esculin hydrolysis. Identification of bacteria by API system.
5. Bacterial growth measurement (cell count, turbidometry, plate count)
6. Isolation of bacteriophages from sewage and flies
7. Isolation of plant viruses from sap
**8. Isolation of fungi from soil:** Dilution plate method, Warcup method, stamping method.
**9. Isolation of fungi from plant material:** Epiphytic fungi, washing method, implant method, impression method, maceration method; endophytic fungi.
10. Growth measurement of fungi- linear and biomass
11. Effect of environmental (pH, temperature) and nutritional factors (carbon, nitrogen sources) on growth of fungi.
12. Isolation and identification of microscopic algae from soil and water
13. Isolation and identification of protozoa from soil and water
14. Screening for antibiotic producing microbes (antibacterial, antifungal)
15. Study of phototaxis in Dictyostelium.

**MBP- 107: MICROBIAL PHYSIOLOGY, BIOCHEMISTRY AND MICROBIAL TECHNIQUES**

**Total Units: 14**
1. Estimation of protein by Bradford method
2. Estimation of protein by Lowry‟s method
3. Estimation of protein by Bicinchoninic acid (BCA) method.
4. Estimation of reducing sugar.
5. Estimation of DNA
6. Estimation of RNA
7. Isolation of lipolytic microbes from soil-plate method and estimation of total lipid
8. Fractionation of total lipid (glycolipid, neutral lipid and phospholipid) by column chromatography
9. Extraction and estimation (by TLC) of ergosterol from fungi
10. Determination of protease activity
11. Determination of malate dehydrogenase and catalase activity
12. Study of enzyme kinetics, Km and Vmax of amylase
13. Analysis of optimum pH, temperature of amylase
14. SDS PAGE- Molecular weight determination

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**SEMESTER SCHEME**

| Paper No. | Title of the paper | Type of paper | Periods/ Week | Duration of Exam (Hours) | IA | EA | Maximum Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| **II Semester Theory** | | | | | | | | |
| MBH-201 | Microbial Genetics | H Core | 4 | 3 | 30 | 70 | 100 | 4 |
| MBH-202 | Molecular Biology | H Core | 4 | 3 | 30 | 70 | 100 | 4 |
| MBH-203 | Environmental Microbiology | H Core | 4 | 3 | 30 | 70 | 100 | 4 |
| MBH-204 | Food Microbiology | H Core | 4 | 3 | 30 | 70 | 100 | 4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MBS-205 | Bioinformatics | S Core | 2 | 2 | 15 | 35 | 50 | 2 |
| **Practical** | | | | | | | | |
| MBP-206 | Microbial Genetics, Molecular Biology | Pract | 4 | 4 | 30 | 70 | 100 | 4 |
| MBP-207 | Environmental Microbiology and Food Microbiology | Pract | 4 | 4 | 30 | 70 | 100 | 4 |
| **Total Marks and Credits** | | | | | | | 650 | 26 |

**II SEMESTER (THEORY)**
**MBH- 201: MICROBIAL GENETICS**
**Total Hours: 52**

**Unit 1**
**Prokaryotic Genome:** *E. coli* chromosome- coiled, supercoiled (plectonemic, solenoid), folded fiber model. *Mycoplasma genitalium* and *E. coli* genome. **4hrs**

**Unit 2**
**Eukaryotic Genome:** Structure of chromatin, chromosome, centromere, telomere, nucleosome, genome organization, split gene, overlapping genes and Cot curves, chromatin remodeling; 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 idiogram, chromosome banding pattern, types of chromosomes. Organelle genome. **12hrs**

**Unit 3**
**Gene and Mutation:** Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; mutagens, types of mutations, transposon mutagenesis, site directed mutagenesis; environmental mutagenesis; Ame‟s and other toxicity testing. **8hrs**

**Unit 4**
**Genetic recombination:** Genetic recombination in bacteriophages and *E. coli,* synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases, generalized & specialized transduction, transformation and conjugation, legitimate & illegitimate recombination, gene conversion, overview of bacterial genetic map. **10hrs**

**Unit 5**
**Gene transfer mechanisms**: Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications, genetic analysis of virus, bacteria and yeast genomes. Genetics of fungi-alteration of generation, induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants. **10hrs**

**Unit 6**
**Plasmids and Bacteriophages:** Plasmids, F-factors - description and their uses in genetic analysis, Colicins and Col Factors, R plasmids. Lysogeny and lytic cycle in bacteriophages, Life cycle and their uses in microbial genetics. Lytic phages-T7 and T4, Lysogenic phages Lamda, M13 and ΦX174.
**8hrs**



**MBH- 202: MOLECULAR BIOLOGY**
**Total Hours: 52**

**Unit 1**
**Concepts of molecular biology:** Introduction, flow of information, central dogma of molecular biology. Structure of DNA, DNA polymorphism (A, B, Z DNA). Structure and function of different types of RNA.
**DNA damage and repair**: Types of DNA damage – deamination, oxidative damage, alkylation, pyrimidine dimers; Repair pathways – photo-reactivation, excision repair, post replication repair, SOS repair, methyl directed mismatched repair, very short patch repair. **10hrs**

**Unit-2**

**DNA Replication:** DNA replication in prokaryotes and viruses (Rolling circle and M13 bacteriophages replication), asymmetric replication, looped rolling circle, semi conservative replication, primer or template, concotamy formation –P1. Origin of replication, replication fork- leading and lagging strands, enzymes involved at different steps of replication. Fidelity of replication. Extrachromsomal replicons. **6hrs**

**Unit 3**

**Transcription:** Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases. Initiation, elongation and termination. Heat shock response, stringent response. Inhibitors of RNA synthesis and their mechanism. Polycystronic and monocystronic mRNA. Control of elongation and termination. Alternate sigma factors. Post transcriptional modifications of mRNA- capping, editing, splicing, polyadenylation, modifications of tRNA and rRNA. **10hrs**

**Unit 4**

**Translation:** Genetic code- Features and character, wobble hypothesis**.** Ribosome assembly, initiation factors and their regulation, formation of initiation complex, Initiation, elongation and termination of polypeptide chain, elongation factors and releasing factors, translational proof-reading, inhibitors of translation and their mechanism, post-translational modification of proteins-glycosylation. Control of translation in eukaryotes. Differences between prokaryotic eukaryotic translation. **10hrs**

**Unit 5**

**Regulation of gene expression:** Transcriptional control. Operon concept, catabolite repression. Inducible and repressible systems. Negative gene regulation – *E. coli* lac operon; Positive regulation – *E. coli ara* operon; Regulation by attenuation – his and trp operons, anti-termination – N protein and nut sites, DNA binding protein, enhancer sequences, identification of protein binding site on DNA. Maturation and processing of RNA– methylation, cutting and modification of tRNA degradation system. **10hrs**

**Unit 6**

**Control of gene expression at transcription and translation level:** Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression.

**Gene silencing**: Transcriptional and post transcriptional gene silencing-RNAi pathway (siRNA and miRNA) .

**6hrs**

## MBH- 203: ENVIRONMENTAL MICROBIOLOGY

**Total Hours: 52**

**Unit 1**

**Aerobiology:** Air spora in different layers of atmosphere**,** bioaerosol, assessment of air quality using principles of sedimentation, impaction, impingement, suction and filtration. Brief account of transmission of airborne microbes; Microbiology of indoor and outdoor. Allergy: Causes and tests for detection of allergy. **10hrs**

**Unit 2**

**Aquatic Microbiology:** Fresh and marine ecosystem (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonation of water ecosystem; upwelling, eutrophication; food chain in aquatic ecosystems. Role of methanotrophs in ecosystem. Potability of water, microbial assessment of water, water purification. Ground water types and their contamination. Biofilm. Waste treatment: sewage and effluent treatment; primary, secondary and tertiary treatment, Solid waste treatment. Solid wastes as sources of energy and food. **12hrs**

**Unit 3**

**Soil Microbiology:** Biotic and abiotic interactions, concepts of habitat and niche. Microbial communities; nature, structure and attributes, levels of species diversity, succession and stability, r and K selection, genetic exchange between communities. Biodiversity management and conservation. Role of microbes in organic solid waste treatment matter in various soil types, subterranean microbes. Biogeochemical cycles of carbon, nitrogen, phosphorous and sulphur. **10hrs**

**Unit 4**

**Diversity in anoxic eco system:** Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury. **4hrs**

**Unit 5**

**Extremophiles:** The domain Archaea, acidophilic, alkalophilic, thermophlic, barophilic and osmophilic and radiodurant microbes- mechanisms and adaptation. Halophilic- membrane variation- electron transport-application of thermophiles and extremophiles. Extremozymes. **6hrs**

**Unit 6**

**Biodegradation:** Role of microbes in degradation, Biodegradation of Xenobioticshydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper; Biosorption/bioaccumulation of heavy metals. Bioremediation of soil, air and water: various methods, advantages and disadvantages. Bioleaching of iron, copper, gold and uranium. **10hrs**

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**MBH- 204: FOOD MICROBIOLOGY**
**Total Hours: 52**

**Unit 1**

**Introduction:** Development of food microbiology as a science, scope of food microbiology. Food as substrate for microorganisms, intrinsic and extrinsic factors affecting the growth of microbes, important microorganisms in food (molds, yeasts and bacteria) and their source (air, soil, water, plants and animals). **6hrs**

**Unit 2**

**Food contamination and spoilage:** Sources of food contamination. Principles of food spoilage; spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products, fish and sea foods, poultry; spoilage of canned foods; conventional and modern methods for detection of spoilage and characterization. **10hrs**

**Unit 3**

**Food-borne infections and intoxication:** Bacterial- *Brucella, Bacillus, Clostridium, Escherichia, Listeria;* Food intoxication- *Botulism, Staphylococcal.* Mycotoxins & their types – aflatoxins, ochratoxins, fuminosins, trichothecenes, zealenone, ergot alkaloids; food borne outbreaks and lab testing procedures. Preventive measures. Molds, Algae, Protozoa, Viruses. **10hrs**

**Unit 4**

**Food preservation:** Principles and methods of food preservation- Physical (temperature, irradiation, drying, canning, processing for heat treatment-D, Z and F values) Chemical (Organic acids, food additives. Class I and Class II preservatives), Biopreservation (Lactic acid bacteria).Food Packaging- Types of packaging materials, properties and benefits. **10hrs**

**Unit 5**

**Microbial and Fermented foods:** SCP- Nutritional & therapeutic importance, Quorn and SCO and their Industrial production. Fermented Vegetables (olives, cucumbers), Meat (sausages), Beverage (cocoa and coffee); Bread, Idli, Dairy foods (cheese, srikhand). production methods of Kefir, Yogurt, Acidophilus milk; Probiotics, Prebiotics and Synbiotics, Nutraceuticals (Cr/Se yeast), functional foods and their quality standards. Application of fungal pigments in food industry. **12hrs**

**Unit 6**

**Food and sanitation:** Good Hygiene Practices, Sanitation in manufacture and retail trade; food control agencies and their regulation, hazard analysis and critical control points (HACCP); GMP, plant sanitation – employees‟ health standard, waste treatment, disposal, quality control. Recent trends and development in food technologies in India. **4hrs**

**MBS- 205: BIOINFORMATICS**
**(Soft core)**
**Total Hours: 26**

Unit 1

**Introduction to Computer:** Binary, Octal and Hexadecimal number systems –Binary arithmetic, Binary code. Computer Architecture- internal and external Devices. Computer softwares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS). **5 Hours**

**Unit 2**

**Computer Network and Programming Languages:** Structure, architecture, Advantages, types (LAN, MAN & WAN), Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. C Programming and PERL- Algorithm and flowchart, Structure of C program, Header file, Global declaration, Main function, variable declarations, Control statement-conditional and unconditional - sub functions. Introduction to PERL, Application of Bioperl. **8** Hours

**Unit 2**

**Databases:** Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. **3** Hours

**Unit 3**

**Biological Databases:** Datamining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB). Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Sequence alignment - Global and Local alignment, scoring matrices.

Restriction mapping - NEB CUTTER, Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs. **10** Hours

**Unit 3**

**Protein Structure and Molecular Interaction:** Chemical bonding and non-bonding interactions, stability of electrovalent bond. Co-valent bond – partial ionic character of covalent bonds and Vander Waals forces. Introduction to protein structure - secondary structure prediction, tertiary structure prediction, protein modelling- principles of homology and comparative modelling. Threading, structure evaluation and validation and *ab intio* Modelling, Applications - Molecular docking - Autodoc . 10 Hours

**II SEMESTER (PRACTICAL)**

**MBP- 206: MICROBIAL GENETICS AND MOLECULAR BIOLOGY**

**Total Units: 16**

1. Isolation and electrophoretic analysis of genomic DNA(from bacteria, fungi and algae)
2. Isolation and electrophoretic analysis of plasmid DNA from bacteria
3. Mutagenesis: Identification and isolation of fungal mutants [physical (UV) and chemical(EMS)]
4. Study of replica plating techniques
5. Bacterial transformation by CaCl2 method)
6. Transduction and conjugation in *E. Coli*
7. Ampicillin selection for enrichment of auxotroph
8. Ame¨s test for detecting chemical carcinogens
9. Genetic mapping in Bacteria
10. Protoplast fusion
11. Generation and screening for mutants in *fur*
12. Induction and assay of β- galactosidase
13. Chromosome banding pattern
14. Western and southern blotting.
15. Induction of mutation in *Neurospora*
16. Identification of lytic and lysogenic cycles in bacteriophage

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**MBP- 207: ENVIRONMENTAL MICROBIOLOGY AND FOOD MICROBIOLOGY**

**Total Units: 18**

1. Quantification of microorganisms in air (outdoor and indoor occupational environment)-solid impaction and liquid impingement techniques
2. Sampling and quantification of air borne endotoxins by Limulus Amoebocyte assay
3. Isolation, cultivation and characterization of iron and manganese reducing bacteria
4. Isolation of methanogens from enrichments
*5.* Physical, chemical and microbial assessment of water and potability test for water-Microbiology-Heterotrophic plate count, MPN index, presumptive, confirmatory and completed tests, membrane filter technique for total coliform, faecal coliform, *Clostridia*, *Pseudomonads*
6. Study of microbial tolerance/resistance to heavy metals by agar dilution method, agar diffusion method
7. Chemical characterization of bacterial exopolymers produced in a biofilm
8. Screening of microorganisms for biodegradation of recalcitrant compounds
9. Study of Bacteriocin producing Lactic Acid Bacteria(LAB): Isolation, identification and partial purification
10. Study of antimicrobial activity of chemical preservatives
11. Isolation and identification of common food borne pathogens (Enterobacteriaceae, *Pseudomonas*, *Staphylococcus*, *Salmonella, Listeria, Vibrio*)
12. Detection of Aflatoxin from fungi-Qualitative and quantitative analysis
13. Study of fermented foods- Isolation and identification of microbes from yogurt, sauerkraut, idli batter, sausages.
14. Role of yeast in bread making
15. Production, antimicrobial effect and nutritional value of probiotics-
16. yoghurt, kefir and acidophilus milk
17. Quality testing for milk and milk products
18. Production and estimation of single cell protein from agricultural waste.

| III SEMESTER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Code No. of the Paper** | **Paper** | **Title** | **Theory (Hrs / Week)** | **Practical (Hrs/ Week)** | **Total No. of Hrs/Sem.** | **Duration of Exam (Hrs)** | **Maxi. Marks (Exam.)** | **Continuous Evaluation** | **Total Marks** |
| MBP 301 | I | Medical Microbiology | 4 | | 52 | 3 | 80 | 20 | 100 |
| MBP 302 | II | Recombinant DNA Technology | 4 | | 52 | 3 | 80 | 20 | 100 |
| MBP 303 | III | Immunology | 4 | | 52 | 3 | 80 | 20 | 100 |
| MBP 304 | IV | Food Microbiology | 4 | | 52 | 3 | 80 | 20 | 100 |
| MBP 305 | Practical I | Medical Microbiology And Recombinant DNA Technology | | 2 Practical 4 Hrs each | 52 | 3 | 40 | 10 | 50 |
| MBP 306 | Practical II | Immunology And Food Microbiology | | 2 Practical 4 Hrs each | 52 | 3 | 40 | 10 | 50 |
| | | | | | | | | **Total Marks** | **500** |

## III SEMESTER

## MBP 301 MEDICAL MICROBIOLOGY

**52hrs**

**Unit 1**

**Emerging and reemerging pathogens:** Viral, bacterial, protozoa and fungi. Normal microbial flora of human body and its significance, tissue tropism.

**Infection and transmission:** Entry of pathogen into human host – portals of entry. Virulence factors and their role in breaching host defense, mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts. G protein signaling-Establishment, spreading, tissue damage and anti-phagocytic factors; Evasion of host defense, non-specific host defense, toxigenesis-bacterial toxins and its types, Quorum sensing in *Staphylococcus pyogenes.* Modes of transmission and factors influencing. Communicable diseases; Nosocomial and community infections and their control.

**10hrs**

**Unit 2**

**Bacterial and Protozoan diseases:** Study of diseases caused by pathogenic bacteria: (pathogenicity, laboratory diagnosis, epidemiology and control) – *Streptococcus Staphylococcus, Shigellla, Salmonella,*

*Neisseria, Corynebacterium, Vibrio, Yersinia , Haemophilus, Mycobacterium*. Spirochetes-*Trepornema ,Chlamydiae, Mycoplasma*. Protozoan infections-malaria, leishmaiasis and filariasis. **10hrs**

**Unit 3**
**Fungal diseases**: Aetiology, clinical symptoms, laboratory diagnosis and treatment of superficial infections (dermatomycoses): Epidermophyton, Microsporum and Trichophyton; Madura foot; Subcutaneous mycoses: Sporotrichosis and Systemicmycosis: Blastomycosis, Coccodiodomysis, Candidiasis, Opportunistic mycoses. Aspergillosis, **10hrs**

**Unit 4**
**Viral diseases:** A etiology, clinical symptoms, laboratory diagnosis and treatment: Pox virus, Herpes virus (HSV I & II) Varicella-zoster, Adenovirus, Picorna virus, Orthomyxoviruses (influenza), Paramyxoviruses (Mumps and Measles), Rhabdoviruses, Hepatitis viruses (HAV, HBV HCV, HDV), H1N1, Oncogenic viruses (HPV, epstein-barr virus, CMV), HIV, Arboviruses (Dengue, Encephalitis, chikungunya, rubella). Prion infection- Mad Cow, CJD, Kuru. **10hrs**

**Unit 5**
**Antimicrobial agents:** Classification of antimicrobial agents, Mechanism of drug action – antibacterial (Bacteriostatic and bactericidal) antifungal and antiprotozoans. Methods of testing drug sensitivity (*in vitro* and *in vivo*), antibiotic assay in body fluids. Mechanism of drug resistance and dissemination of multi drug resistance. Probiotics as therapeutic agents. Brief account of vaccines (conventional and recombinant) and immunization schedules; Passive prophylactic measures; Interferons. **6hrs**

**Unit 6**
**Diagnostic Microbiology:** Principles and applications of immuno and molecular diagnostic methods: RID, RIE, Agg test; CFT, RIA, ELISA, PCR, DNA finger printing. **6hrs**

## MBP 302: RECOMBINANT DNA TECHNOLOGY

**52hrs**

**Unit 1**
**Tools of recombinant DNA technology:** Restriction endonucleases: types, nomenclature, recognition sequences, cleavage pattern. Ligases: mechanism of ligation, other DNA modifying enzymes- **(Polymerases, DNase, RNase, Polynucleotide kinases, Alkaline Phospahtases)**. Vectors:Cloning and expression vectors, plasmids (pBR 322, pUC, Ti), phages, cosmids, Phagemids, shuttle vectors, ARS, mini chromosomes, BACs, PACs and YACs. Promoter probe vectors, PET, BAC vectors, SV40, plant viruses as vectors. **14hrs**

**Unit 2**
**Cloning and Expression:** Cloning in Prokaryotes*(E.coli)* and Eukaryotes: (*Saccharomyces cerevisiae* and *Pichia pastoris);* construction of *cDNA* and genomic *DNA* library. Transformation into bacteria and yeast, transfection into plant and animal cells, selection of recombinant cells, expression of recombinant proteins. **10hrs**

**Unit 3**
**Molecular techniques:** Agrose gel electrophoresis; labelling of DNA and RNA; Blotting techniques- Southern, northern, western. Molecular markers, RFLP, RAPD, AFLP, DNase foot printing. PCR, DNA microarray. Human genome project: global patterns of gene expression. Analysis of single nucleotide polymorphisms (SNP) using DNA chips. **12hrs**

**Unit 4**
**DNA sequencing**: Dideoxy and chemical methods, sequence assembly, automated sequencing, genome sequencing, mapping of genes and fine structure analysis of genes. **5hrs**

**Unit 5**
**Chemical synthesis of genes:** Phosphodiester, phosphotriester, phosphate triester approaches: Enzymatic synthesis of DNA; application of synthetic oligonucleotides, synthesis of complete gene. **5hrs**

**Unit 6**

**Application of rDNA technology:** genetically modified organisms (Bt cotton). Overview of Transgenic plants, GM foods (golden rice, tomato, corn, brinjal), transgenic animals (cow, sheep, poultry, fish). Gene therapy. **6hrs**

## MBP 303: IMMUNOLOGY

**52hrs**

**Unit 1**

**Immune System and immunity:** History of immunology; innate and acquired immunity. Cells and organs involved in immune system – T-cells, B-cells, lymphoid organ, spleen and bone marrow. Antigenic properties, T and B cell epitopes, chimeric peptides, macrophages, antigen-processing cells, eosinophils, neutrophils, mast cells and natural killer cells; immune responses – cell mediated and humoral, clonal selection and nature of immune response. **10hrs**

**Unit 2**

**Antigen and antibodies:** Types, structure and properties of antigens, haptens; adjuvant -antigen specificity. Immunoglobulins – structure, types and subtypes, properties, primary and secondary responses, Antibody diversity. Complement system – Structure, components, properties and functions, complement fixation and complement pathways, biological consequences. Inflammation- effector mechanisms. **10hrs**

**Unit 3**

**Antigen-antibody reactions:** Agglutination, precipitation, immunoelectrophoresis, immuno-fluorescence, ELISA, RIA; Flow cytometry, Montaux test. Applications of these methods in diagnosis of microbial infections, autoimmunity mechanisms, altered antigens, systemic lupus erythematosus, Graves's diseases, rheumatoid arthritis, myasthenia gravis, multiple sclerosis.

Immunodeficiency-phagocytic, humoral, CMI, combined HLA association. **10hrs**

**Unit 4**

**Hypersensitivity reactions:** Allergy, Type I- Anaphylaxis; Type II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity. Symptoms and Immunological methods of diagnosis of hypersensitive reactions.

Lymphokines and cytokines – Assay methods. Immunological tolerance and modulation. **8hrs**

**Unit 5**

**Major histocompatibility complex(MHC):** Structure and functions of MHC and the HLA systems. Gene regulation and Ir-genes; HLA and tissue transplantation – Tissue typing methods for transplantations in humans; graft versus host reaction and rejection.

**Tumor immunology:** tumor specific antigens, Immune response to tumors, immunodiagnosis of tumors – detection of tumor markers – alphafoetal proteins, carcinoembryonic antigen, Cancer therapeutics. **10hrs**

**Unit 6**

**Immunization:** Common immunization practice, types of vaccines and its application. Edible vaccines. Production of Polyclonal and monoclonal antibodies; catalytic monoclonal antibodies; antibody engineering, plantibodies. **4hrs**

## MBP 304: FOOD MICROBIOLOGY

**52 hrs**

**Unit 1**

**Introduction:** Development of food microbiology as a science, scope of food microbiology.

Food as substrate for microorganisms: important microorganisms in food (molds, yeasts and bacteria) and their source (air, soil, water, plants and animals). **6hrs**

**Unit 2**

**Food contamination and spoilage:** Sources of food contamination. Principles of food spoilage; spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products, fish and sea foods, poultry; spoilage of canned foods; conventional and modern methods for detection of spoilage and characterization.

**10hrs**

**Unit 3**

**Food preservation:** Principles and methods of food preservation- Physical (temperature, irradiation, drying, canning, processing for heat treatment-D, Z and F values) Chemical
(Organic acids, food additives. Class I and Class II preservatives), Biopreservation (Lactic acid bacteria).
Food Packaging- Types of packaging materials, properties and benefits.

**Unit 4**

**Food-borne infections and intoxication:** Bacterial- *Brucella, Bacillus, Clostridium, Escherichia, Listeria;* Food intoxication- *Botulism, Staphylococcal.*
Mycotoxins & their types – aflatoxins, ochratoxins, fuminosins, trichothecenes, zealenone, ergot alkaloids; food borne outbreaks and lab testing procedures. Preventive measures.
Molds, Algae, Protozoa, Viruses. **10hrs**

**Unit 5**

**Microbial and Fermented foods:** SCP- Nutritional & therapeutic importance, Quorn and SCO and their Industrial production. Fermented Vegetables (olives, cucumbers), Meat (sausages), Beverage (cocoa and coffee); Bread, Idli, Dairy foods (cheese, srikhand). production methods of Kefir, Yogurt, Acidophilus milk; Probiotics, Prebiotics and Synbiotics, Neutraceuticals (Cr/Se yeast) and their quality standards.
Application of fungal pigments in food industry. **12hrs**

**Unit 6**

**Food and sanitation:** Good Hygiene Practices, Sanitation in manufacture and retail trade; food control agencies and their regulation, hazard analysis and critical control points (HACCP); GMP, plant sanitation – employees' health standard, waste treatment, disposal, quality control.
Recent trends and development in food technologies in India. **4hrs**

## MBP 305: MEDICAL MICROBIOLOGY AND RECOMBINANT DNA TECHNOLOGY

1. Isolation and identification of microbes from clinical specimens(throat swab, sputum, nasal swab, urine, blood, stool)
2. Isolation and identification of mycosis (Dermatomycosis)
3. Identification of pathogens on selective, differential and enrichment media
4. Different staining techniques
    a. Ziehl-Neelsen method of AFB
    b. Fluorochrome staining
    c. Leishman's staining
    d. Giemsa's staining
    e. Special staining methods to demonstrate granules, capsules and spores
5. Testing of drug susceptibility according to NCCLS
6. Determination of MIC by Kirby-Bauer method, T test, checker board method
7. Restriction digestion of DNA and molecular weight determination.
8. Ligation of Lac gene with plasmid.
9. Selection of recombinants by scorable and selectable markers.
10. Polymerase chain reaction (PCR).
11. Random Amplification of Polymorphic DNA (RAPD).
12. Western Blotting.
13. Southern Blotting.

## MBP 306: IMMUNOLOGY AND FOOD MICROBIOLOGY

1. Purification of antigens(bacterial, fungal)
2. Induction and purification of antibodies
3. Precipitation reaction

4. Agglutinations (slide)
5. Blood grouping and Rh typing
6. Determination of bactericidal activity of normal serum
7. ELISA
8. Tests for allergens
9. Study of Bacteriocin producing Lactic AcidBacteria(LAB): Isolation, identification and partial purification
10. Study of antimicrobial activity of chemical preservatives
11. Isolation and identification of food borne pathogens (Enterobacteriaceae, *Pseudomonas*, *Staphylococcus*, *Salmonella, Listeria, Vibrio*)
12. Detection of Aflatoxin from fungi-Qualitative and quantitative analysis
13. Study of fermented foods- Isolation and identification of microbes from yogurt, sauerkraut, idli batter, sausages.
14. Role of yeast in bread making
15. Production, antimicrobial effect and nutritional value of probiotics- yoghurt, kefir and acidophilus milk
16. Quality testing for milk and milk products
17. Production and estimation of single cell protein from agricultural waste.

| IV SEMESTER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Code No. of the Paper** | **Paper** | **Title** | **Theory (Hrs / Week)** | **Practical (Hrs/ Week)** | **Total No. of Hrs/Sem.** | **Duration of Exam (Hrs)** | **Maxi. Marks (Exam.)** | **Continuous Evaluation** | **Total Marks** |
| MBP 401 | I | Agricultural Microbiology | 4 | | 52 | 3 | 80 | 20 | 100 |
| MBP 402 | II | Fermentation Technology | 4 | | 52 | 3 | 80 | 20 | 100 |
| MBP 403 | III | Microbial Technology | 4 | | 52 | 3 | 80 | 20 | 100 |
| MBP 404 | Pract. I | Agricultural, Fermentation and Microbial Biotechnology | | 2 Pract 4 Hrs each | 52 | 3 | 40 | 10 | 50 |
| MBP 405 | Project | | | | 52 | | 100 | 50 (Project viva) | 150 |
| | | | | | | | | **Total Marks** | **500** |

## IV SEMESTER

## MBP 401: AGRICULTURAL MICROBIOLOGY

**52hrs**

**Unit 1**

**Microbes and soil fertility:** Role of microbes in soil fertility. Decomposition of organic matter by microorganisms - cellulose, hemicellulose, lignin, xylan and pectin. Soil fertility evaluation and improvement. Effect of pesticides on soil microflora. **4hrs**

**Unit 2**

**Biological nitrogen fixation(BNF):** Nitrification, denitrification; symbiotic nitrogen fixation (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation (*Azotobacter, Azospirillum*); Nitrogenase enzyme, *nif* genes and molecular mechanism of nitrogen fixation. Role of nodulin genes in nodule development and symbiosis. Genetic engineering of BNF **8hrs**

**Unit 3**

**Plant-microbe interactions:** Mutualism, commensalism, parasitism, amensalism, synergism. Rhizosphere microorganisms- phyllosphere, Mutualism, commensalism, parasitism, amensalism, synergism. Rhizosphere microorganisms- phyllosphere, **10hrs**

**Unit 4**

**Bioinoculants:** Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- *Azotobacter, Rhizobium, Azospirillum*, Cyanobacteria, phosphate solubilising microorganisms, *Azolla.* Carrier-based inoculants - production and applications.

Biopesticides – types and applications ( *Pseudomonas fluroscence, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viridae, Nuclear Polyhedrosis Virus*) **12hrs**

**Unit 5**

**Molecular plant pathology:** Recognition and entry of pathogens into host cells. Alteration of host cell behaviour by pathogens. Molecular mechanisms of disease establishment; enzymes, phytotoxins, growth regulators. involvement of elicitors; role of R and r genes in disease development. Molecular mechanisms of disease diagnosis. Resistance mechanisms in plants, resistance genes, phytoalexins, signalling mechanisms. Transgenic approaches for crop protection. **6hrs**

**Unit 6**

**Plant diseases: (Symptomatology, etiology & control)**

Diseases caused by

a) Fungi: Wilt diseases, Downy mildews, Powdery mildews, Rusts, Smuts)

b) Bacteria: (Bacterial wilt, Bacterial blight of rice, Angular leaf spot of cotton, Citrus canker)

c) Mycoplasmal diseases: (Sandal spike, Grassy shoot of sugar cane)

d) Viral diseases: (Cauliflower mosaic disease, Banana bunchy top, Cucumber mosaic, Cow pea mosaic, Tobacco mosaic)

e) Protozoa: (Hartrot of coconut, Phloem necrosis of coffee).

f)Viroids: (Potato spindle tuber viroid).

g)Parasitic plants: (Dodder, Mistletoes)

Post-harvest diseases and control measures. Integrated pest management. **16hrs**

## MBP 402: FERMENTATION TECHNOLOGY

**52hrs**

**Unit 1**

**Scope and selection:** Scope of Industrial Microbiology and fermentation technology. Study of industrially important micro-organisms and their preservation. Criteria for selection and strategies for strain improvement; maintenance and containment of recombinant organisms. **8hrs**

**Unit 2**

Fermentation process: Batch culture: growth kinetics; effect of environment: temperature, pH, nutrient concentration; monitoring microbial growth in culture: cell number, direct and indirect methods. Continuous culture: concepts of Newtonian and Non- Newtonian fluid, plastic fluids, apparent viscosities; anti-foam agents. **10 hrs**

**Unit 3**

**Fermentors:** basic features, design & components – Typical fermentor. Sterilization of fermentor, medium, air supply; aseptic inoculation and sampling methods; scale up of fermentation process (parameters used in scale up, problems associated). Merits & demerits. Fermentation media: Media formulation strategies, sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inhibitors and inducers. Specialized bioreactors (**Photobioreactors,** Membrane, Fluidised bed, Tubular and Packed bed bioreactor). **10 hrs**

**Unit 4**

**Solid state fermentation (SSF):** Estimation of growth in SSF, concept of sterility. Comparison of SSF with SmF. Factors influencing SSF, kinetics, design of fermentor in SSF(Koji fermentor). Production of commercially important products by SSF (cellulases, penicillin, gibberillic acid). **6 hrs**

**Unit 5**

**Downstream processing:** Objectives and criteria, foam separation, precipitation methods, filtration, centrifugation, cell disruption methods, liquid extraction, membrane filtration, chromatography, drying devices, crystallization. Solvent recovery. Effluent treatment. Quality control of fermented products, Process economics. **8hrs**

**Unit 6**

**Intellectual Property Rights (IPR):** Introduction to Intellectual Property & IPR, patent, copyrights, trademarks, trade secret, geographical indications, Industrial designs. Patent laws, Legislations covering IPR's in India, Patenting of living organisms, procedure involved in patenting, patent infringement, patent filing and international patent law, PCT, provisional and complete specification, patentable and non-

patentable materials, product planning and development, Trade related aspects (TRIPS), WTO, WIPO, international & regional

**Entrepreneurship:** Introduction, concept and theories of entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of entrepreneurs. Entrepreneurship in India, barriers in entrepreneurship, agreements, Valuation & business concerns. Government regulations for microbial products. **10 hrs**

## MBP 403 MICROBIAL BIOTECHNOLOGY

**52hrs**

**Unit 1**
Introduction: Principle, applications, economics and milestones in microbial technology.
**2hrs**

**Unit 2**
**Microbial products for commercial use:** Industrial production of organic acids (acetic acid, lactic acid). Amino acids (lysine, glutamic acid), Solvents (acetone, ethanol), Antibiotics (Cephalosporin, Streptomycin), Microbial polysaccharides (xanthan) and polyesters (PHB). Hormones (insulin), anticholesterol compound (Lovastatin). Vaccines (recombinant). Microbial insecticides. Secondary metabolites in bacteria and fungi (anti-cancer and anti-diabetic compounds). **14 hrs**

**Unit 3**
**Microbial enzymes**: Industrial production of lipase, protease & asparaginase. Enzymes in - starch processing, food, textile, detergent, leather, breweries, pharmaceuticals, therapeutics, and diagnostics. Recombinant enzymes.
**Immobilized enzymes and cells:** Techniques and types of immobilization, industrial applications of immobilization: merits and demerits. **8 hrs**

**Unit 4**
**Microbial transformation and organic synthesis:** Transformation of steroids and sterols, over production of glutathione by genetically engineered cells. Metabolic engineering for vitamin C production, synthesis of acrylamide by nitrile hydratase, synthesis of optically pure drugs. **10 hrs**

**Unit 5**
**Nanotechnology:** Introduction, Tools of nanosciences, Synthesis of Nanomaterials using microbes. Biopolymeric nanoparticles; nanosensors, biomedical applications, antimicrobial nanoparticles. **8hrs**

**Unit 6**
**Bioethics and biosafety**: Introduction, Human genome project and its ethical, legal and social implications. Biosafety guidelines and regulations for GMOs. GLP and GMP. Labelling of GM products. Ethics and safety of GM food. Testing of drugs on human volunteers. **6 hrs**

## MBP 405: AGRICULTURAL FERMENTATION AND MICROBIAL BIOTECHNOLOGY

1. Isolation of cellulose, hemicelluloses, lignin, xylan and pectin degrading microbes.
2. Isolation of symbiotic and nonsymbiotic nitrogen fixing microorganisms
3. Isolation of phosphate solubilising bacteria and fungi-plate method.
4. Isolation of bioinoculants: *Bacillus thuringiensis, Bauveria bassiana, Trichoderma , Pseudomonas.*
5. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement of root and shoot length).
6. Mushroom cultivation using locally available substrates and evaluation of total

7. protein content.
8. Extraction and estimation of phytoalexins and phenolics from diseased plants
9. Production of organic acids(lactic acid and citric acid) from microbes
10. Immobilization technique: whole cell or enzyme- sodium alginate gel method and demonstration of its significance.
11. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
12. Laboratory scale production of ethanol from industrial wastes and estimation of total and volatile acidity.
13. Laboratory scale production of wine/beer.
14. Detection and quantification of pigment from microbes: Melanin.
15. Detection and quantification siderophore produced by *Pseudomonas* spp.
16. Microbial assay of vitamins and amino acid (one in each)
17. Sterility tests for pharmaceutical products
18. Production of amylase by solid substrate fermentation (at least 4 substrates).
19. Demonstration of a fermentor.
20. Industrial visit and submission of report.