M.Sc. MICROBIOLOGY SYLLABUS

I SEMESTER

Core papers:
PS01CMIC01: Molecular Biology
PS01CMIC02: Bioinstrumentation
PS01CMIC03: Cell biology and Biochemistry

Elective Paper:
Any one from the list

PS01CMIC04: Practicals of PS01CMIC01 and PS01CMIC02
PS01CMIC05: Practicals of PS01CMIC03 and PS01EMICXX
PS01CMIC06: Viva voce

II SEMESTER

Core papers:
PS02CMIC01: Bioprocess and Biochemical Engineering
PS02CMIC02: Microbial Genetics
PS02CMIC03: Immunology

Elective Paper:
Any one from the list

PS01CMIC04: Practicals of PS02CMIC01 and PS02CMIC02
PS01CMIC05: Practicals of PS02CMIC03 and PS02EMICXX
PS01CMIC06: Viva voce

III SEMESTER

Core papers:
PS03CMIC01: Microbial Biotechnology
PS03CMIC02: Environmental Microbiology and Systematics
PS03CMIC03: Enzymology

Elective Paper:
Any one from the list

PS03CMIC04: Practicals of PS03CMIC01 and PS03CMIC02
PS03CMIC05: Practicals of PS03CMIC03 and PS03EMICXX
PS03CMIC06: Viva voce

IV SEMESTER
Core papers:
PS04CMIC01: r-DNA technology
PS04CMIC02: Environmental Biotechnology

Elective Papers:

Any two from the list

OR

PS04EMICXX: DISSERTATION

PS04CMIC03: Practicals of PS04CMIC01 and PS04CMIC02
PS04EMIC03: Practicals of PS04EMICXX and PS04EMICXX
PS04CMIC04: Viva voce

OR

PS04CMIC03: Practicals of PS04CMIC01 and PS04CMIC02
PS04EMICXX: Dissertation
PS04CMIC04: Viva voce

List of Elective Papers:

PS04EMIC01: Biostatistics
PS04EMIC02: Phytoresource utilization and conservation
PS04EMIC03: Microtechniques
PS04EMIC04: Plant Biotechnology
PS04EMIC05: Biopharmaceuticals
PS04EMIC06: Bioinformatics
PS04EMIC07: Human Physiology
PS04EMIC08: Microbial Physiology
PS04EMIC09: Virology
PS04EMIC10: Bioethics, Bio safety and IPR
PS04EMIC11: Food and Dairy Microbiology
PS04EMIC12: Toxicology
PS04EMIC13: Medical Microbiology
I SEMESTER

PS01CMIC01 : Molecular Biology

Unit-I
DNA structure: Chemistry of DNA, Forces stabilizing DNA structure, Helix parameters, Forms of DNA (A, B, C, D, T, and Z), Watson –Crick and Hoogsteen base pairing, Physical properties of ds DNA (UV-Absorption spectra, Denaturation and Renaturation, Cot curves, DNA hybridization), Chemicals that react with DNA.
DNA topology: DNA supercoiling, Supercoiled forms of DNA, Superhelical density, energetics of supercoiled DNA, Biology of supercoiled DNA (Topological domains of DNA, DNA topoisomerases, Mechanisms of supercoiling in cells, Mechanism of action of Topoisomerase I and II, effect of supercoiling on structure of DNA and role of supercoiling in gene expression and DNA replication)
DNA-protein Interactions: General features, Interaction of Helix-turn Helix motif, B-sheet, Zn-DNA binding domains, etc with DNA.

Unit-II
Organization of DNA into chromosomes: Packaging of DNA and organization of chromosome in bacterial cells; Packaging of DNA in eukaryotic nucleosome and chromatin condensation, assembly of nucleosomes upon replication, Chromatin modification and genome expression.

Unit-III
Transcription: RNA polymerases, features of prokaryotic and eukaryotic promoters, assembly of transcription initiation complex in prokaryotes and eukaryotes and its regulation; synthesis and processing of prokaryotic and eukaryotic transcripts. Transport of RNA within eukaryotic cell.
Translation: Structure and role of t-RNA in protein synthesis, ribosome structure, basic features of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes).

Unit-IV
processing of proteome Posttranslational processing of proteins (protein folding, processing by proteolytic cleavage, processing by chemical modification, Inteins), Protein degradation.
Regulation of gene expression in prokaryotes: Operon concept, positive and negative regulation. Examples of lac-, ara-, his- and trp- operon regulation; antitermination, global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

Reference books:
Genes IX: Lewin
Molecular Biology of the Gene: Watson et al.
Genomes 3: T. A. Brown
Molecular Genetics of Bacteria: Snyder & Champness
PS01CMIC02- Bioinstrumentation

Unit I
Electrochemistry: pH and buffers, potentiometric and conductometric titration.
Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal microscopy, cytophotometry and flow cytometry. Preparation of microbial, animal and plant samples for microscopy.

Unit II
Principle methodology and applications of gel – filtration, ion –exchange and affinity chromatography; Thin layer and gas chromatography; High performance liquid chromatography, FPLC.
Electrophoresis: Principle and applications of Native and SDS PAGE; Agarose and 2D gel electrophoresis.

Unit III
Spectroscopy: UV, Visible, IR, NMR and ESR spectroscopy. Atomic absorption and plasma emission spectroscopy; MS and MALDI-TOF.

Unit IV
Centrifugation: Basic principle and application; Differential, density and Ultracentrifugation. Principle of biophysical method and used for analysis of biopolymer structure; X ray diffraction, fluorescence,
Principle and applications of tracer technique in biology: Radioactive Isotopes and half life of isotopes; Effect of radiation on biological system; autoradiography; cerenkov radiation; radiation dosimetry; scintillation counting.
Biosensors: Principle and application

Reference Books:
Shrama BK, Instrumental method of chemical analysis
DA Skoog. Instrumental methods of analysis
Plummer, An introduction to practical Biochemistry
Chatwal and Anand, Instrumentation
Boyer, Modern experimental Biology
PS01CMIC03: Cell Biology and Biochemistry

Unit I:
Evolution of cell; Cell as a unit of living organism, evolution and structure of prokaryotic cell, evolution of eukaryotic cell
Structural and functional features of eukaryotic cell: cell organelles; endoplasmic reticulum, golgi complex, lysosomes, vacuoles, peroxisomes, mitochondria, chloroplast, cytoskeleton, microtubules, nucleus, extracellular matrix etc.

Unit II:
Chemical and physical foundations of biomolecules
Water, acid, base and buffers
Amino acids; classification, chemical reactions and physical properties; biosynthesis and catabolism; Principles of thermodynamics; Bioenergetics and energy metabolism in cells.

Unit III:
Nucleotides; biosynthesis and catabolism
Lipids: classification, structure and function; synthesis and oxidation of fatty acids
Vitamins; structure and function.
Carbohydrate and glycobiology; glycolysis and gluconeogenesis, citric acid cycle
Oxidative phosphorylation; light reaction of photosynthesis, Calvin cycle

Unit IV:
Biological membranes. Membrane structure and transport mechanisms; membrane channels and pumps
Cell signaling and signal transduction pathways; Molecular motors

Reference books:
Biochemistry: Lubert Stryer
Biochemistry: Lehninger
Microbial Physiology: Moat, Foster and Spector
Molecular biology of the cell: Bruce Alberts et al.
Cell and molecular biology: Gerald Karp.
Cell and molecular biology: DeRobertis and DeRobertis.
Molecular cell biology: By Lodish et al.
Topic related review articles

Elective Paper

Any one from list
II SEMESTER

PS02CMIC01: Bioprocess and Biochemical Engineering

Unit I
Introduction to bioprocess technology
Isolation, preservation and improvement of industrially important organisms.
Substrates for fermentation processes
Medium optimization

Unit II
Bioreactor design: Laboratory, pilot and large scale reactors. Plug flow reactors, enzyme reactors. Sterilization of media and air.
Scale up and Scale down
Mass transfer of oxygen: Agitation and aeration, Determination of $K_{La}$, factors affecting $K_{La}$, fluid rheology. Inoculum development, aseptic inoculation and sampling.

Unit III
Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems.
Control of process parameters: Instrumentation for monitoring bioreactor and fermentation processes, Sensors, Controllers, fermentation control systems and architecture, Incubation and sequence control, advanced control. Dynamic modeling of fermentation processes.

Unit IV
Downstream processing: Methods of Cell separation, Disruption and product purification.
Fermentation Economics

Reference Books
Principles of Fermentation Technology : Whitekar & Stanbury
Comprehensive Biotechnology : Murray Moo Young
Methods in Industrial Microbiology : Sikyta
Fermentation Microbiology and Biotechnology, El Mansi and Bryc

PS02CMIC02: Microbial Genetics

Unit-I
Mutation and DNA Repair: Mutation, Spontaneous mutations (Randam v/s adaptive nature of mutation, Luria and Delbruck experiment, Newcombe experiment, Lederberg’s experiment, Mutation rate and its determination, Origin of spontaneous mutations), DNA damages (Deamination of bases, alkylation, damage due to reactive oxygen, UV induced damage) and it repair pathways (Methyl-directed mismatch repair, Nucleotide excision repair, Base excision repair, recombinational repair, SOS inducible repair, specific repair for oxidative DNA damage, pyrimidine dimers and alkylation induced damage and adaptive response).
Plasmid Biology: Types, compatibility, replication, control of copy number and plasmid segregation.

Unit II
Recombination: Types of recombinations, Models for Homologous recombination, Molecular mechanism of homologous recombination, Homologous recombination in eukaryotes, Mating-type switching. Molecular mechanism for site-specific recombination, Biological roles of site-specific recombination.

Conjugation: Conjugation by E. coli F factor (Structure of F-factor, Regulation of F-factor fertility, establishment of cell contact, DNA mobilization and transfer and separation of mating pair, Hfr conjugation and chromosomal transfer, F-prime conjugation and merodiploids, Conjugation of fertility inhibited F-like plasmids, Nonconjugative, mobilizable plasmids, Broad Host Range self-transmissible plasmids, Chromosome mobilization by Non-F plasmids, Plasmid based conjugation in other bacteria (Salmonella, Pseudomonas, Streptomyces and Streptococcus. Interrupted mating and conjugational mapping.

Agrobacterium genetics: Ti-plasmid, Interkingdom gene transfer (Key early experiments, vir regulon, protein secretion apparatus, conjugation model of T-DNA transfer, Integration products).

Unit III
Transformation: Mechanism of Natural competence and transformation in Bacillus subtilis, Streptococcus pneumoniae and Haemophilus influenzae. Transformation by inducing artificial competence, Gene linkage and mapping by transformation.


Viral genetics: Bacteriophages (T-series, biology, Miniphages (M-13, X 174, Mu), Bacteriophage recombination (complementation, fine structure analysis).

Unit IV
Fungal genetics: Tetrad analysis and Mitotic recombination
Restriction-Modification systems: Role of Restriction-Modification systems, Types of RM systems, Modification, Restriction and Regulation.
Transposable elements: Types of transposable elements, Structure, genetic organization and mechanism of transposition of Tn5, Tn3 and related transposons, Bacteriophage Mu, Tn7 and IS911, Integrons, Retrotransposons, Conjugative and Mobilizable transposons. Assays of transposition.
Molecular biology of tumor: Control of cell proliferation, oncogene activation, role of tumor suppressor genes.

Apoptosis

Reference books:
Genes IX: Lewin
Modern Microbial Genetics: Uldis Streips and Ronald Yasbin.
Microbial genetics: Stanley Molay, John Cronan and David Freifelder.
Molecular Genetics of Bacteria: Snyder and Champness.
Molecular Genetics: Stent and Calendar
Principles of Genetics: Snustad and Simmons
Molecular Biology of the Cell: Alberts et al.

PS02CMIC03: Immunology
Unit I:
Adaptive immunity and innate immunity: inflammation, role of cells, receptors and proteins in innate immunity, ubiquity of the innate system.
Cells and organs of the immune system: Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs.
Antigens and antibodies: properties of immunogens, haptens, epitopes, structure and classes of immunoglobulins, biological activities and effector functions, monoclonal antibodies and abzymes. Antibody diversity: models, organization of Ig genes, mechanism of gene rearrangement, generation of diversity; expression, synthesis and class switching, antibody engineering.

Unit II:
Antigen-antibody interactions: principles and applications.
Complement: components of the system, activation, regulation, biological consequences and deficiency diseases.
Major histocompatibility complex and antigen presentation: MHC- organization, inheritance, genes, molecules and peptide binding, expression, disease susceptibility, immune responsiveness, self MHC restriction, cytosolic and endocytic pathway for antigen processing.

Unit III:
T-cell receptor, T-cell maturation, activation and differentiation: TCR- genetic organization and rearrangement of genes, TCR-complex, peptide binding, thymic selection, activation and differentiation of T cells.
Generation, activation and differentiation of B cells: B cell maturation, activation and proliferation, germinal centres, regulation of the responses.
Cytokines: properties, receptors, associated diseases, therapeutic applications.
Leukocyte activation and migration: CAM, chemokines, recirculation and extravasation, inflammation and anti-inflammatory agents.
Cell mediated cytotoxicity: effector T cells, cytotoxic T cells, NK cells, ADCC.

Unit IV:
Hypersensitivity reactions: classification and types of hypersensitivity reactions.
Immune tolerance and autoimmunity: establishment and failure of tolerance, autoimmune diseases, mechanisms for the induction, animal models, treatment.
Transplantation immunology: basis and manifestation of graft rejection, immunosuppressive therapy, immune tolerance. Cancer and immune system. Immunodeficiency.

Reference books:
Kuby-Immunology: T. J. Kindt, R. A. Goldsby and B. A. Osborne; W. H. Freeman
Janeway’s Immunology: K. Murphy, P. Travers and M. Walport; Garland Sciences
Immunology: Ivan Roitt, J. Brostoff and D. Male; Mosby
Essential immunology: Ivan Roitt; Oxford: Blackwell
Topic related review articles.

Elective paper : Any one from the list
III SEMESTER
PS03CMIC01: Microbial Biotechnology

Unit 1
General concept of Microbial biotechnology and Fermentation economics
Microbial production of
Antibiotics: penicillin, streptomycin
Enzymes: proteases, amylases
Organic acids: Citric acid, acetic acid

Unit 2
Microbial production of .......
Amino acids: Glutamic acid, Lysine
Industrial Alcohol,
Beer and wine
Vitamins: Vit B12, B2
Ergot alkaloids

Unit 3
Biotransformations of steroids
Production of single cell protein from bacteria, fungi and algae: Nutritional value and safety.
Edible Mushrooms: Cultivation of edible and medicinal mushrooms.
Bioplastics
Single cell oil

Unit 4
Microbial Exopolysaccharides: Xanthan, Alginate
Microbial Flavours: Diacetyl, Methyl ketones, Terpenes, Vanillin
Fermented food and dairy products: Starter cultures, science and technology of bread, cheese and yogurt manufacture.

Reference Books:
Biotechnology: Rehm and Reid.
Comprehensive biotechnology: Murray Moo Young.
Microbial Technology: Pepler
Topic related review papers

PS03CMIC02: Environmental Microbiology and Systematics

Unit 1
Global environmental problems: Global warming, Ozone depletion, Acid rain
Water pollution: Sources and types, Physical, chemical and biological pollution of water, Eutrophication and its control.
Biodeterioration of wood and metals: Role of micro-organisms, mechanisms and control.

Unit 2
Biogeochemical cycles: Role of microorganisms in nitrogen, sulfur and phosphorous cycling.
Detrimental effects of diverted biogeochemical cycles.
Biological Nitrogen Fixation in detail: Asymbiotic, symbiotic and associative nitrogen fixation.
Structure, function and genetic regulation of nitrogenases.

**Unit 3**
Microbes in extreme environments: Habitat, biodiversity, adaptive strategies and biotechnological potential of thermophiles and hyperthermophiles, psychrophiles and psychrotrophs, halophiles, acidophiles and alkalophiles.
Microbial communities and ecosystems: Microbial community dynamics, structure of microbial communities, ecosystems, structure and function of some microbial communities in nature.

**Unit 4**
The origin of life (chemical and cellular evolution), ribosomal RNA analyses for tracing microbial evolution, genetic basis of evolution, evolution of physiological diversity.
Taxonomy, binomial nomenclature, types of bacterial classification systems, new approaches to bacterial taxonomy (numerical taxonomy, ribotyping, rRNA sequencing, fatty acid profile) Bergey’s manual of systematic bacteriology.
Microbial diversity- molecular chronometers, phylogenetic trees and three domain universal phylogenetic tree.
Methods of studying microbial diversity (Conventional and molecular tools).

**Reference Books:**
Comprehensive Biotechnology Vol-4, Murray Moo Young.
Biotechnology- Rehm and Reid.
Environmental science, B. J. Nebel and R. T. Wright.
The prokaryotes- 3 rd edition, volume 2
Brock Biology of micro organisms by Madigan, Martinko, Dunlap, and Clark

**PS03CMIC03: Enzymology**

**Unit I**
Introduction to enzymology and historical developments in enzymology
Protein Structure: Primary, secondary, tertiary and quaternary structure, techniques used in enzyme characterization
Enzyme classification: IUB enzyme classification.
Enzyme Activity: Principle and techniques of enzymatic analysis, factors affecting enzyme Activity, Extraction and Purification of enzyme: Objectives and strategy, separation techniques, test of purity.

**Unit II**
Enzyme Kinetics: Bioenergetics and Catalysis
Single substrate kinetics: Equilibrium and Steady state kinetics, significance of Km, Vmax & Kcat. Pre-steady state and Relaxation kinetics.
Multisubstrate kinetics: General rate equation, compulsory order, random order and ping-pong mechanisms and their primary and secondary plots.
Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive, mixed, partial, substrate and allosteric inhibition.
Thermal kinetics: Effect of temperature on reaction rate, enzyme stability, Arrhenius equation and activation energy.

Unit III
Mechanism of Enzyme Action:
Enzyme activators, co-enzymes and co-factors in enzyme catalysis, Enzyme and substrate specificity
Investigation of active Centre, Factors affecting catalytic efficiency, Experimental approaches to determine enzyme mechanisms.
Enzyme mechanisms: Lysozyme, Chymotrypsin, Carboxypeptidase, Restriction endonuclease, Aspartate transcarbomylase. Allosteric enzymes and sigmoidal kinetics: Protein ligand binding, Co-operativity, MWC & KNF models,
Regulation of enzyme activity. Control of metabolic pathways.

Unit IV
Isoenzymes and its physiological significance, Ribozymes and Abzymes
Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents.
Enzyme Immobilization
Enzymes in non conventional media, Enzymes sensors, Enzymes as analytical reagents.

Reference Books:
Enzyme Structure and mechanism: Alan Fersht, Reading, USA.
Understanding Enzymes: Trevor Palmer
Proteins: Thomas Creighton
Biochemistry: Lubert Stryer.

Elective paper:
Any one from the list

IV SEMESTER

PS04CMIC01: r-DNA Technology

Unit-I
Scope of Genetic Engineering, Concept and importance of Genetic Engineering; General strategies and Steps involved in gene cloning; Extraction and purification of DNA from bacteria, plant and animal cells; Restriction enzymes, DNA ligase and other enzymes involved in gene cloning; mRNA and cDNA preparation.

Unit II
Chemical synthesis of gene/DNA
Cloning and expression vectors- Plasmids, \( \lambda \)-bacteriophages, M-13 based vectors, Phagemids, Cosmids, YAC, BAC, HAC/MAC, etc.
Expression of cloned gene in heterologous host
Introduction of DNA into different host systems

**Unit III**
Recombinant selection and screening
Southern blotting & hybridization, Northern analysis, Western blot analysis,
Agarose gel electrophoresis, Pulse Field Gel Electrophoresis, Rotating Gel Electrophoresis (RGE), PAGE, SDS-PAGE, Isoelectric Focusing, Two Dimensional Electrophoresis, Capillary Electrophoresis, Capillary Gel Electrophoresis, Mapping Regulatory Sequences by *in vivo* expression assay
Mapping of Protein Binding Site by DNase I Protection, Mobility Gel Shift Assay
Protein Activity Assay – Yeast-one hybrid, Yeast-two hybrid and Yeast-three hybrid system
Phage display, Subtractive hybridization and cloning, HRT/HART, Chromosomal Walk.
Characterization of Cloned genes
Restriction map, S1 mapping, Denaturation mapping, Heterologous mapping
DNA sequencing, Nucleic Acid Microarray

**Unit IV**
Polymerase chain reaction
Molecular markers
Linkage mapping using meiotic recombination frequencies
Genomic mapping using radiation induced Chromosome rearrangement
Genomic mapping using DNA sequence polymorphism as genetic marker
Invitro Mutagenesis
Metagenomics
Metabolic engineering
Gene therapy
Recombinant products- recombinant hormones, recombinant DNA vaccines
Transgenic plants
Transgenic animals
Genetic Engineering Guidelines
Levels of Physical containment
Levels of Biological containment
The Indian Guidelines

**Reference Books**
Genome 3rd Edition -- Brown
Molecular Biotechnology – Glick
Principles of Genetic Manipulation – Old & Primrose
Applied Molecular Genetics – Roger Miesfeld
Biotechnology – H. K. Das

**PS04CMIC02: Environmental Biotechnology**
Unit 1
Issues and scopes of environmental biotechnology.

Unit 2
Toxicity testing in waste water treatment plants using microorganisms.
Composting: Objectives, fundamentals, microbiology, factors influencing composting and composting systems. Compost quality and uses. Vermicomposting.

Unit 3

Unit 4
Microbial Insecticides : Bacterial, fungal and viral insecticides in pest management.
Biofertilizers: Nitrogen fixing and phosphate solubilizing biofertilizers.

Reference Books:
Comprehensive Biotechnology Vol-4, Murray Moo Young.
Biotechnology-Rehm and Reid.
Waste water microbiology by G. Bitton
Biodegradation and bioremediation by M.Alexander
Waste water treatment for pollution control, 2nd edition. Arceivala
Environmental Biotechnology by H. Jordening and Josef Winter
Topic related review articles

Elective papers:
Any two from the list

ELECTIVE PAPERS
PSICOEMIC01: Biostatistics

Unit I:
Data Collection and Presentation
Types of Biological Data: Qualitative Data - Nominal, Ordinal, Ranked; Quantitative Data: Discrete and Continuous.
Understanding of Population and sample
Methods of Collection of Data: (i) Experimental Data and (ii) Survey Data - Simple random sample (with and without replacement), stratified sampling and cluster sampling.
Tables: Frequency Distributions, Relative Frequencies.
Graphical Presentation: Bar charts, Histograms, Frequency Polygons, One way scatter plots, Box plots, two-way scatter plots, line graphs.
Practicals Using MS-Excel.

Unit II:
Descriptive Statistics
Measures of Central Tendency: Mean, Median and Mode, quartiles, deciles and percentiles (both for raw data and grouped data)
Measures of Skewness and Kurtosis.
Practicals Using MS-Excel.

Unit III:
Probability and Probability Distributions:
Random Experiment: Elementary outcomes, events, and Sample Space.
Random Variables: Discrete and Continuous. Some examples from biological sciences.
Probability Distributions: Binomial Distribution, Standard Normal Distribution, General Normal Distribution; Sampling Distributions - t, chi-square and F distributions.

Unit IV:
Testing of hypotheses:
Statistical Tests: Acceptance region and Rejection Region. Types of errors and power of the test.
Goodness of fit tests.
Significance Tests for Normal Distribution: One sample tests for mean – z test and t-test.
Two sample tests for normal distributions: Tests for means (i) when variances are known (ii) when variances are unknown. Tests for equality of variances.
Paired t-test for equality of means.
Confidence Intervals
Bivariate and Multivariate Data
Some examples on bivariate and multivariate data. Correlation: Simple, partial and multiple correlation Coefficients.
Regression: Simple and multiple linear regressions. Logistic Regression
Analysis of Variance: Completely Randomized Design, Randomized Block Design

PSCOEMIC02: Phytoresource utilization and conservation

Plant Biodiversity : Concept, status in India, utilization and concerns.
Origin, evolution, botany, cultivation and uses of (i) Food, forage and fodder crops, (ii) fibre crops (iii) medicinal and aromatic plants, and (iv) vegetable oil – yielding crops
Ethnomedicobotany: Basic approaches to study traditional knowledge on herbal medicine; Scope and potential applications.
Collection methods of ethnomedicobotanical data: Field methods and scrutiny of Herbarium specimens and folklore; verification of data; collection of materials for voucher specimen and for phytochemical screening; application of ethnomedicobotany.
Creating indigenous knowledge base of traditional medicines of plant origin.

Forest products :
Important timber yielding planting.
Timber types, identification diagnostic features, structure & quality
Important fire wood plants
Non Timber forest products bamboos, rattans, fibers pulp; gums, resins, tanins, loteX, fruits & tubers.
Innovations for meeting world food demands.
Plants used as avenue trees for shade, pollution control and aesthetics.
Principles of conservation; extincitons; environmental status of plants based on International Union for Conservation of Nature.

Strategies for conservation – in situ conservation : International efforts and Indian initiatives; protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity.
ex situ conservation : Principles and practices; botanical gardens, fields gene banks, seed banks, in vitro repositories, cryobanks; general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific & Industrial Research (CSIR), and the Department of Biotechnology (DBT) for conservation, non-formal conservation efforts.

Reference Books :
Arora, R. K. and Nayar, E. R. Wild Relatives of Crop Plants in India. NBPGR Science Monograph.


Plant Wealth of India. Special Issue of Proceedings India National Science Academy B – 63


S.K. Jain: Glimpses of Indian Ethnobotany

S.K.Jain, B.K. Sinha and R.C.Gupta: Notable plants in Ethnomedicine of India

J.K. Maheswari: Dictionary of Indian Folk medicine and Ethnobotany

S.K. Jain: Useful plants of India

Wiley Chichester, CIBA Foundation Symposium 185: Ethnobotany and the search for new drugs

**PSCOEMIC03: Microtechniques**

**Light microscopy:** Optical corrections, Properties and types of objectives. Oculars, Illumination.

Types of light microscopes: Bright field, dark field, fluorescence, phase contrast, polarizing, differential interference contrast. Micrometry.

**Electron microscopy:** Basic components of electron microscopes. Thermionic and field emission electron guns.

Types of electron microscopes: TEM, SEM, STEM, ESEM and HVEM


**Histochemistry:** Histo chemical localization of metabolites: Starch, proteins, lipids, total carbohydrates, lignin, polyphenols, nucleic acid, histones, cutin, suberin and waxes. Localization of enzymes: Peroxidase, acid phosphatase and succinic dehydrogenase.
Ultra structural cytochemistry:- Localization of tannin, protein, cell wall polysaccharide, lignin and membrane.
Enzymes: Peroxidase, acid phosphatase.
Immunocytochemistry

**PSCEOMIC04: Plant Biotechnology**

- Cell & tissue culture in plants; callus cultures; *in-vitro* morphogenesis-organogenesis and embryogenesis; Artificial Seeds, Micropropagation (Clonal propagation); Haploidy; anther and ovule cultures, Embryo cultures; Protoplast isolation, culture and protoplast fusion and somatic hybridization, Cybrids,
- Somaclonal Variation; *in-vitro* mutation methods; Virus elimination, pathogen indexing; Cryopreservation
- Production of secondary metabolites; Sources of plant secondary metabolites; criteria for cell selection, factors affecting the culture of cells; different bioreactors and their use in secondary metabolite production; biochemical pathways for the production of different secondary metabolites; and biotransformation;
- Principles and methods of genetic engineering, and its applications in Agriculture. Methods for genetic transformation and transgenic plants production through *Agrobacterium tumefaciens* and *A. rhizogenes*; Gene transfer methods in plants; PEG-mediated, microinjection, particle bombardment, electroporation, Molecular markers and their importance in plant breeding, Marker Assisted Selection (MAS).
- Molecular plant pathology: Mechanisms of disease resistance in plants against pathogens; Signalling pathways and molecular events during pathogen – plant interaction. Biotechnology and intellectual property rights (IPR); Plant genetic resources GATT & TRIPS; Patent for higher plant genes and DNA sequence

**Reference Books:**

- Plant cell and tissue culture for production of food ingredients – T J Fu, G Singh, *et. al.*
- Biotechnology in crop improvement – H S Chawla.
- Practical application of plant molecular biology – R J Henry, Chapman & Hall.
- Elements of biotechnology – P K Gupta.
- An introduction to plant tissue culture – M K Razdan.
- Plant propagation by tissue culture : The technology (Vols. 1 & 2) – Edwin George.
- Handbook of plant cell culture (Vols. 1 to 4) – Evans *et. al.*, Macmillan.
- Plant tissue and cell culture – H E Street, Blackwell Scientific.
- Cell culture and somatic cell genetics of plants (Vols. 1 to 3) – A K Vasil, A. Press.
- Plant cell culture technology – M M Yeoman.
- Advances in biochemical engineering / Biotechnology – Anderson, *et. al.*
- Applied and fundamental aspects of plant cell tissue and organ culture edited by Reinert & Bajaj Y P S, Springer Verlag.
- Plant cell and tissue culture – S Narayanswamy, Tata Mc Graw Hill Co.
PSCOEMIC05: Biopharmaceuticals

Drug discovery and development
Introduction to drug discovery and development, sources of drugs, approaches to new drug discovery, role of molecular recognition in drug design, enzymes and receptors as drug targets, prodrug design and applications, computer aided drug design, preclinical and clinical trials

Biopharmaceuticals
Concepts of pharmaceuticals, biologics and biopharmaceuticals, sources of biopharmaceuticals, biopharmaceuticals in production and research, cytokines, hematopoietic growth factors, hormones, blood products, therapeutic enzymes (Asparaginase, Streptokinase, beta lactamases), bacterial and viral vaccines, New vaccine production (DNA vaccines, synthetic, peptide vaccines, multivalent subunit vaccines, edible vaccines and their trials), Case studies.

Spoilage of pharmaceutical products, regulatory practices and policies in pharmaceutical industries
Microbial production contamination and spoilage of pharmaceuticals products (sterile injectables, ophthalmic preparations and implements) and their sterilization, FDA, govt. Regulatory practices and polices, concept of R & D, quality control and market planning.
Significance of IP, BP and USP.
Reimbursement of drugs, biological and legislative aspects, patenting of drugs and biological products.

Quality Assurance and Validation.


REFERENCES
8. Quinolinone antimicrobial agents- Edited by David C. Hooper, John S. Wolfson.
ASM Washington DC.
Republic of Germany.
11. Good manufacturing practices for Pharmaceuticals. By Sydney H. Willing,
New York.
12. Advances in Applied Biotechnology series Vol.10, Biopharmaceutical in
transition., Industrial Biotechnology Association by Paine Webber,. Gulf
Publishing Company Houston.
13. Drug carriers in biology & medicine Edited by Gregory Gregoriadis. Acedemic
Press New York.
14. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS
publishers & distributors, New Delhi.
15. An introduction to drug design by S.N. Pandya, new age international publishers
17. Biopharmaceuticals by Gray Walsh.

PSCOEMIC06: Bioinformatics

Unit -I
Introduction to Bioinformatics:
Overview, Internet and bioinformatics, Applications
Databases: Databases in Bioinformatics, various biological databases, Protein and Nucleotide
sequence Data bases. Protein sequence, structure and Classification databases
Sequence analysis: Pairwise alignment, local and global alignment, Scoring matrices, multiple
sequence alignment, tools for sequence alignment, programming algorithms

Unit-II
Gene prediction: Gene structure in Prokaryotes and Eukaryotes, Gene prediction methods:
Neural Networks, Pattern Discrimination methods, Signal sites Predictions, Evaluation of Gene
Prediction methods.
Transcriptomics: Complete transcript cataloguing and gene discovery- sequencing based
approach, Microarray based technologies and computation based technologies.
RNA secondary structure prediction

Unit III
Protein Computational Biology: Structural classification of proteins, Protein structure analysis,
structure alignment and comparison, Secondary and tertiary structure prediction and evaluation,
prediction of specialized structures, Active site prediction, Protein folding, Protein modeling and
drug design
Tools in Bioinfomatics: Protparam, Translate, Bioedit, findmod, Coils, TMHMM, Rasmol,
Deepview.
Unit IV
Genomics: Comparative Genomics

Proteomics: Types of proteomics, tools for proteomics- separation and isolation of proteins, acquisition of protein structure information, databases and applications
Phylogenetic analysis: molecular basis of evolution, Phylogenetic trees & different methods for phylogenetic inference

Reference Books:
Bioinformatics: A Beginners Guide, Clavarie and Notredame
Bioinformatics: David Mount
Bioinformatics: Rastogi
Introduction to Bioinformatics: Arthur M. Lesk
Bioinformatics: Principles and applications, Ghosh and Mallick
Bioinformatics: Genes, Proteins and Computer, C A Orengo
Protein Structure Prediction: Methods and Protocols, Webster, David (Southern Cross Molecular Ltd., Bath, UK)

PSCOEMIC07: Human Physiology

Unit I

Unit II
Digestive system – Composition, functions and regulation of saliva, gastric, pancreatic intestinal and bile secretions – digestion and absorption of carbohydrates, lipids, proteins nucleic acids, minerals and vitamins.

Unit III
Excretory system – structure of nephron formulation of urine, glomerular filtration, GFR, tubular reabsorption of glucose. The Muscular System – Types of muscles and their functions

Unit IV
Nervous System- Structure of neuron, function and organization of nervous system, Nerve impulse transmission.

Reference Books:
Molecular Biology of the cells : Alberts et. al., Garland Publications Inc. NY
Cell and Molecular Biology by E D P de Robertis and E M F de Robertis.
Text book of Medical Physiology by Garong.
PSCOEMIC08: Microbial Physiology

Unit-I
Microbial cell surfaces
Bacterial flagella and chemotaxis
Bioluminescence
Microbial toxins

Unit-II
Bacterial differentiation: endospore formation, physiological and genetic aspects of sporulation and spore germination
Bacterial cell division
Yeast cell division
Microbial stress responses

Unit-III
Mechanism of action of antibiotics and mechanisms of drug resistance
Microbial reserve compounds
Siderophores; structure, function and significance
Bacterial biofilms

Unit-IV
Quorum sensing
Bacteriocins
Microbial fuel cells
Host Parasite interactions

References:
Bacterial signalling, Kramar and Jung
Microbial Physiology, Moat, Foster and Spector
The Physiology and Biochemistry of prokaryotes, David White
Bacterial physiology: A molecular approach, W. E. Sharoud
Topic related review articles

PSCOEMIC09: Virology

Unit I
History of virology (latest Scientific investigations),
Viral taxonomy (ICTV classification).
Virus structure and morphology.
Cultivation of plant and animal viruses. Purification and maintenance of viruses.
Quantitation of viruses (viral assays)

Unit II

General idea about cyanophages, actinophages and mycophages and viruses of insects.
Baculovirus System for insect cell lines
Subviral particles- Prions, virusoids, satellite viruses.
Overview of plant diseases caused by viruses. Structure and Replication strategies of TMV, CaMV. CaMV 35S promoter and its application in genetically modified crops.

Unit –III

Human Viral infections: Epidemiology, Pathogenesis and Pathology;
Induction of interferon. Antiviral agents (chemical and biological) and their mode of actions
Structure and Replication strategies of Adenoviruses, Orthomyxovirus.

Unit –IV

Detailed account Human Immunodeficiency Virus and Hepatitis Viruses.
Detailed Study of Tumor virus (RNA and DNA).

Books Recommended

1. General Virology by Luria and Darnel
2. Virology and Immunology by Jokli
3. Text book of Virology by Rhodes and Van Royen
4. Plant Virology by Smith
5. A text book of Microbiology by P. Chakraborty
6. Genetics of bacteria and their viruses by W. Hayes
7. Molecular Biology of the gene by Watson, Roberts, Staitz and Weiner
8. A laboratory guide in virology by Chjarles H. Lunningham
9. Basic lab procedures in diagnostic virology by Marty Cristensen
10. Review of medical microbiology by Jawitz et al
11. Medical laboratory manual for tropical countries Vol I & II by Monica Cheesbrough
12. Text Book of Microbiology by Ananthanarayanan and Jayaram Paniker
13. Viral and Rickettsial infections of Man by Horsfall and Jam
15. Virological Procedures by Mitchal hasking
16. Virology by Wilson and Topley
Unit I

Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding, biotechnology in international relations, globalization and development divide.

Unit II

Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns.
Biosafety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety.
Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context).

Unit III

Introduction to IPR: IPR, forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property.
WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.

Unit IV

Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents.
Patentability, Patent application, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing.

Books Recommended:

6. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical
    Academic press.

**PSCEOMIC11: Food and Dairy Microbiology**

**Unit I:**
1) Scope of food microbiology
2) Food as a substrate
   a) Microorganisms important in food microbiology – Bacteria, yeasts and moulds.
   b) Factors influencing microbial growth in food.

**Unit II:**
3) Food Spoilage
   a) General principles underlying food spoilage and contamination.
   b) Spoilage of canned food, sugar products, vegetables, fruits, meat and meat products, milk
      and milk products fish, seafood and poultry.
4) Food poisoning
   a) Indicator food borne pathogens
   b) Bacterial food borne infections and intoxications-Brucella, Campylobacter, Clostridium,
      Escherichia (ETEC/EHEC/EPEC/EAEC), Salmonella, Shigella, Listeria, Vibrio, and
      Yersinia.
   c) Non-bacterial food borne infections and intoxications- Nematodes, protozoa, algae,
      fungi, and viruses.
   d) Culture and non-culture based detection of food pathogens and viruses
   e) General methods for diagnosis of infections, intoxications and preventive measures.

**Unit III:**
5) Food preservation
   a) Principles of food preservation – Asepsis, removal of microorganisms, anaerobic
      conditions, high and low temperatures, drying, irradiation.
   b) Chemical and bio preservatives and food additives.
   c) Food packaging & labeling.
6) Food fermentations
   a) Starter cultures their biochemical activities, production and preservation of the following
      fermented foods.
      i) Oriental fermented foods
      ii) Dairy fermented foods (Cheese, yogurt and Indigenous dairy products India)
      iii) Fermented vegetables – Sauerkraut
Production and application of Bakers Yeast
Application of microbial enzymes in food industry

Unit IV:
7) Genetically modified foods. Biosensors in food
8) Food research organizations/institutes in India
9) Recent foodborne outbreaks
10) Food sanitation – Microbiology of food plant sanitation, water and milk testing
11) Food laws and quality control – HACCP, Codex alimentarius, PFA, FPO, MFPO, BIS, AGMARK.

1. Books recommended, Frazier and Westhoff
2. Food microbiology, Adam and Moss

PSCOEMIC13: Medical Microbiology

Unit-I

Unit-II

Unit-III
Bacteriology - Characteristics, classification, pathogenesis, pathology, diagnosis, treatment, prevention and control of diseases caused by Staphylococci, Streptococci, Bacillus, Clostridium, Corynebacterium, Escherichia, Salmonella, Shigella, Klebsiella, Proteus, Vibrio, Pseudomonas, Mycobacteria, Spirochaetes, Rickettsia.

Unit-IV
Virology - Structure, multiplication, classification and medical importance of DNA viruses - Pox, Herpes, Hepatitis, Adeno; RNA viruses - Picorna, Orthomyxo, Paramyxo, Rabdo and HIV virus. Viral vaccines and antiviral agents.
Parasitology - Medical importance of Entamoeba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria. Laboratory techniques in parasitology.

Reference Books