Syllabus for B.Sc. (Biotechnology)
CBCS- 2018
Group I Core Courses
SEMESTER - I

BSCBTV 131: BIOCHEMISTRY AND BIOPHYSICS 48 hours

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Classify biomolecules based on structure and function and understand how biomolecules interact to form polymers

CO 2. Describe role and types of enzymes in biological systems, enzyme activity, factors affecting enzyme activity and application of enzymes in clinical applications

CO 3. Comprehend the importance of pH and buffers in cells, ATP as energy currency, Beer-Lambert's law and its applications, and biochemical techniques such as spectrophotometry, X-ray crystallography and NMR

CO 4. Understand the principles, types, instrumentation and applications of techniques such as microscopy, chromatography, electrophoresis and centrifugation

Unit I ` (12 hours)

Aims and scope of biochemistry and biophysics

General classification, structure and functions of biomolecules: carbohydrates, proteins, lipids and nucleic acids. Detailed structure and general properties of monosaccharides, glycosidic bond; structural polysaccharides - cellulose, chitin, peptidoglycans; storage polysaccharides - starch, glycogen. Classification of standard amino acids, peptide bonds, general properties of amino acids, titration curve. Protein structure - primary, secondary, tertiary and quaternary with examples.

Unit II (12 hours)

Enzymes: History, general properties, active site, Michelis Menton equation, allosteric enzymes; nomenclature and classification. Enzyme inhibition types- reversible, non-competitive and uncompetitive with examples. Multienzyme and isoenzyme with examples. Brief account of applications enzymes: enzymes in genetic engineering - restriction enzymes and polymerases; enzymes in clinical significance - LDH, SGOT, SGPT and diagnostic kits.

Unit III (12 hours)

Structure and function of water, pH impact on biomolecular reactions, Handerson and Hasselbach's equation with applications. Buffers- types and applications. Laws of thermodynamics, free energy, ATP as biological energy currency.

Lambert - Beer's law, absorption spectrum, absorption maxima. Chromophores; UV, Visible and Infrared spectrophotometry with applications. Fluorescence, phosphorescence and spectroflurometry with applications. Brief account of principles and applications to understand the structure of molecules: X-ray crystallography and NMR.

Unit IV (12 hours)

Microscopy: Magnification, Resolution power, Optical - Bright field, dark field, phase contrast and fluorescence; Electron microscopy - TEM and SEM. Partition coefficient, adsorption chromatography, paper and thin layer chromatography - principle, methodology, applications and significance of R_f value. Gel filtration chromatography, affinity chromatography, agarose and polyacrylamide electrophoresis - principle and applications. Centrifugation: differential, density gradient and ultra - principle, instrumentation and applications

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BSCBTP 132: BIOCHEMISTRY AND BIOPHYSICS PRACTICAL (12 × 3 hours)

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Practice good laboratory practices

CO 2. Perform qualitative test for the identification of biomolecules such as carbohydrates and proteins

CO 3. Apply Beer Lambert's law to quantitatively assays biomolecules such as carbohydrates and proteins

CO 4. Separate biomolecules in a mixture using chromatography, electrophoresis and use the centrifuge and microscope for experiments.

Qualitative tests for carbohydrates - monosaccharides, disaccharides and polysaccharides.
Qualitative tests for proteins.
Qualitative tests for lipids.
Assay of enzymes – salivary amylase and urease.
Estimation of reducing sugar by DNS and Nelson Somogyi method
Estimation of proteins by Lowry's and Biuret method
Lambert – Beer's law
Absorption maxima of a solution
Paper chromatography
Thin layer chromatography
Electrophoresis
Differential centrifugation to separate cell organelles
Microscopy

SEMESTER - II

BSCBTV 181: CELL BIOLOGY AND GENETICS 48 hours

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Describe the ultrastructure of cells, structure and function of organelles, cytosol and cytoskeleton

CO 2. Understand phases of cell cycle, cell division, reductional division in gametes, molecular mechanisms that regulate life and death of a cell including programmed cell death or apoptosis and differentiation in plants

CO 3. Comprehend organization and structure of chromosomes, banding techniques and Mendelian laws of inheritance, deviations and exceptions to these laws.

CO 4. Describe mutations at the molecular level, types of mutations, genetic or hereditary disorders and concepts in population genetics

Unit I (12 hours)

Cell theory, classification of cell types. Levels of organisation in cell biology: cell, tissue, organs and organism. Cell locomotion - amoeboid, flagellar and ciliary. Prokaryotic and eukaryotic cells: ultrastructure, cell membrane and cell wall. Golgi complex, endoplasmic reticulum, mitochondria, chloroplasts, lysosomes, peroxysomes, interphase nucleus (nuclear membrane, nucleoplasm and nucleolus) and ribosomes. Cytosol and cytoskeletal structures - microfilaments, intermediate filaments and microtubules.

Unit II (12 hours)

Cell division: mitosis and meiosis, cell cycle, cell synchrony and its importance. Cell to cell interactions and signal molecules. Cell senescence and programmed cell death (apoptosis). Cell differentiation in plants - *Arabidopsis thaliana* and animals - *Drosophila melanogaster.*

Unit III (12 hours)

Chromosomes: chemical composition, structural organisation of chromatids, centromeres, telomeres, chromatin, nucleosome organisation. Euchromatin and heterochromatin. Special chromosomes: polytene and lampbrush chromosomes. Banding patterns in human chromosomes-G, C, R and T banding.

Mendelian laws of inheritance, gene interactions- complementary, supplementary, epistasis and codominence with suitable examples. Sex determination in plants and animals, sex linkage, non-disjunction as a proof of chromosomal theory of inheritance and gene mapping. Extrachromosomal inheritance, mitochondria and chloroplast genetic systems.

Unit IV (12 hours)

Fine structure of gene - recon, muton and cistron.

Spontaneous and induced mutations, chemical and physical mutagens, induced mutations in plants and microbes and its applications.

Structural and numerical aberrations of chromosomes; evolutions of wheat, cotton and rice. Hereditary defects: Kleinefelter, Turner, Cri-du- Chat and Down syndromes. Analysis of mutations in Biochemical pathways, one gene - one enzyme hypothesis. Population genetics: Hardy- Weinberg equilibrium, gene, genotypes and gene frequencies.

References

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- De Robertis EDP and De Robertis EMF. 1995. *Cell and Molecular Biology*. 8th Edition, BI Waverly Pvt. Ltd., New Delhi.
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BSCBTP 182: CELL BIOLOGY AND GENETICS PRACTICAL (12 × 3 hours)

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Differentiate between stages of cell cycle and cell division, including reductional division
CO 2. Prepare permanent slides using microtomy and histological staining techniques
CO 3. Separate subcellular organelles using centrifugation and stain them; separate pigments by chromatography
CO 4. Carry out blood cell counting using hemocytometer and measurement using micrometry
CO 5. Use the model organism Drosophila for the study of wild type and mutants, sex comb mounting and salivary gland chromosomes
CO 6. Solve genetics-based problems and perform banding techniques and do karyotyping

Study of stages of mitosis: staining of onion root tips.
Study of meiosis: staining of grass hopper testis or onion/*Rhoea*/*Tradescantia* flower buds.
Microtomy: preparation of blocks for sectioning. Preparation of permanent slide and study of section.
Study of cell organelles: isolation and staining of mitochondria and chloroplast.
Separation of photosynthetic pigments by paper chromatography.
Separation of *Drosophila* eye pigments by circular paper chromatography.
Counting of RBC/WBC by Haemocytometer.
Micrometry.
Study of *Drosophila* (wild type and mutants), sex comb mounting.
Salivary gland chromosome isolation and staining.
Karyotyping.
Genetic problems

SEMESTER – III

BSCBTV 231: MICROBIOLOGY AND IMMUNOLOGY **48 hours**

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Describe the general classification of the microbial kingdom, concepts of sterilization and disinfection and classify antibiotics and their mode of action.
CO 2. Understand the comparative morphology, structure and reproduction in bacteria, cyanobacteria, yeast, fungi and viruses, structure and functions of microbial cell walls, lipopolysaccharide and flagella and isolation techniques of microorganisms and media.
CO 3. Comprehend the structure and functioning of the immune system, MHCs, antigens, antibodies, antigen-antibody reactions
CO 4. Explain immunological disorders such as autoimmune diseases and acquired immunodeficiency syndrome, vaccine types and immunization

Unit I **(12 hours)**

Aim, scope and historical perspectives of microbiology. Contributions of early microbiologists: Leeuvenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Concepts of sterilization and disinfection: dry heat, moist heat, radiation, chemical and filtration. Antibiotics: classification and mode of action. General classification of microbial kingdom - classical, nutritional and molecular approaches. Introductive concepts in virology- classification, structure and life cycle - lysogenic and lytic cycle.

Unit II **(12 hours)**

Selected representatives of archaebacteria (methanogens), eubacteria (*Escherichia coli*) and eukaryotic (*Saccharomyces*) microbes and their characteristics. Structure and functions of microbial cell wall, lipopolysaccharides, flagella, capsules, endospores, pili (fimbriae), cell membranes and cell inclusions.

Isolation techniques and media: Selective isolation of microorganisms (physical and chemical). Nutrition and growth kinetics. Microbes in extreme environments- thermophiles, psychrophiles, acidophiles, alkaliphiles, halophiles and barophiles. Microbial interactions – positive and negative interactions between microbes-microbes, interactions between microbes and plants, microbes and animals.

Unit III **(12 hours)**

Historical perspectives in immunology, origin and diversity of immune systems. Classification of immunity: innate and adaptive immunity. Immunity systems: organs, cells of immune system, major histocompatibility complexes (MHCs) - types, structure and their functions.

Unit IV **(12 hours)**

Bacterial conjugation, transduction and transformation. Structure, types and functions of antigens. Structure, types and functions of antibodies. Antigen-antibody reactions - precipitin test, agglutination test, complement fixation (or complement cascade) reaction and ELISA. Immunoblot - types, principle and applications. Immunological disorders -autoimmune diseases - Brief descriptions of two autoimmune diseases- Rheumatoid arthritis and myasthenia gravis. Acquired immunodeficiency syndrome: description of causative agent, and briefly description of mechanisms. Hypersensitivity and allergy. Vaccines-classical and modern, vaccination and immunization.

References

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BSCBTP 232: MICROBIOLOGY AND IMMUNOLOGY PRACTICAL (12X3 hours)

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Demonstrate hands-on of use of safety equipment and aseptic techniques in a microbiology laboratory

CO 2. Isolate, culture, stain and identify microorganisms from different sources and determine effects of pH and temperature on bacterial growth.

CO 3. Carry out Blood grouping and Rh factor determination and differentiate between leucocytes

CO 4. Separate macrophages and carry out immunodiffusion techniques

Instrumentation and microscopy with special reference to microbiology and immunology. Staining of microorganisms - Gram staining, capsule staining, spore staining, negative staining.

Preparation of media. Aseptic techniques.

Study of bacterial colony characteristics.

Biochemical activities of microorganisms - indole, methyl red, Voges Proskauer and catalase tests.

Antibiotic sensitivity of microorganisms. Isolation of microorganisms - air, water, human body and soil.

Isolation of bacteriophages from sewage.

Effect of pH and temperature on bacterial growth.

Blood grouping and Rh factor determination.

Study of different types of leucocytes.

Separation of macrophages.

Immunodiffusion studies

SEMESTER - IV

BSCBTV 281: MOLECULAR BIOLOGY AND RECOMBINANT TECHNOLOGY 48 hours

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Understand the processes involved in replication in both prokaryotic and eukaryotic systems and the significance of transposons.
CO 2. Comprehend the processes involved in transcription and translation in both prokaryotic and eukaryotic systems with suitable examples
CO 3. Describe aims, objectives and scope of gene cloning and recombinant DNA technologies
CO 4. Discuss construction of cDNA library, screening of recombinants, blotting techniques, PCR, DNA fingerprinting, hazards and biosafety practices for recombinant DNA research

Unit I **(12 hours)**

Discovery, structure and types of DNA. Experiments on DNA as genetic material. Replication of DNA in prokaryotes and eukaryotes. Structure of prokaryotic and eukaryotic genes. Mechanisms of DNA recombination in prokaryotes and eukaryotes. Discovery and types of transposons in prokaryotes and eukaryotes.

Unit II **(12 hours)**

Prokaryotic and eukaryotic transcription and translation. Prokaryotic gene expression - *lac* and *trip*. Eukaryotic gene expression - transcription factors, e.g. yeast.

Unit III **(12 hours)**

Aims, objectives and scope of gene cloning and recombinant DNA technology. Isolation and purification of DNA from bacterial, plant and animal cells. Tools of DNA modification: restriction enzymes- properties, classification, types with examples; ligation, DNA modifying enzymes. DNA vectors: plasmids, bacteriophages, phagemids, cosmids, plant and animal viruses.

Unit IV **(12 hours)**

Genomic and cDNA libraries: features, construction and application. Screening and selection of recombinants by selection media, insertional inactivation. PCR- principle, protocol and applications. Blotting techniques: Southern, Northern and Western- principle and applications. Probes - types, preparation and application. DNA finger printing- principle and applications. Hazards and biosafety measures for recombinant DNA technology and GMOs.

References

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BSCBTP 282: MOLECULAR BIOLOGY & RECOMBINANT TECHNOLOGY PRACTICAL **(12 × 3 hours)**

Course Outcomes:
After successful completion of this Course, students will be able to:
CO 1. Isolate and estimate DNA/RNA and proteins from plant and animal tissues
CO 2. Carry out electrophoresis techniques to separate DNA and proteins
CO 3. Develop skills and procedural acumen in recombinant DNA techniques, bacterial transformation and plasmid isolation
CO 4. Carry out western blotting techniques for product confirmation

Separation and study of cell organelles.
Isolation of DNA from bacteria, plant and animal tissues.
Isolation of RNA
Tests for DNA/RNA/proteins isolated from tissues
Estimation of total DNA/RNA/protein from animal cells and plant cells
Agarose gel electrophoresis to separate DNA
Acrylamide gel electrophoresis to separate proteins or SDS PAGE
DNA ligation
Restriction digestion
Preparation of competent cells
Bacterial transformation
Western blotting technique
Plasmid isolation

SEMESTER - V

BSCBTV 331: PLANT BIOTECHNOLOGY **40hours**

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Understand set up of plant tissue culture laboratory, equipment, sterilization and media for various types of clonal or micropropagation, haploid culture, embryo culture and embryo rescue

CO 2. Describe underlying principles, processes, protocols, methods and applications of callus induction, synthetic seeds, somaclonal variation, single cell suspension cultures, secondary metabolites, and cryopreservation.

CO 3. Demonstrate knowledge of protoplast isolation and culture, somatic hybridization, protoplast fusion methods and applications of protoplasts, hybrids and cybrids

CO 4. Comprehend mechanisms involved in genetic manipulation of plants for production of elite plants with insect resistance, understand common diseases found in plants and their control measures

Unit I **(10 hours)**

History of plant tissue culture, technical terms and definitions in tissue culture. Establishing sterile cultures - plant tissue culture lab set up, sterilization methods for instruments and explants. Tissue culture media, plant growth regulators. Principles, methodology and applications of clonal or micropropagation – axillary bud culture, shoot tip culture, meristem and mericlone culture. Haploid culture- principle, protocol and applications. Embryo culture – types, principle, protocol and applications. Embryo rescue.

Unit II **(10 hours)**

Callus induction, introduction to the process of embryogenesis- types and organogenesis. Synthetic seeds- principle, protocol and applications. Somaclonal variations- introduction, types, process, factors affecting process and applications. Single cell suspension cultures - types, methods, viability tests and applications. Secondary metabolites - introduction, classification, production *in vitro* methods and applications. Cryopreservation of plant tissues - introduction, principle, types, protocol and applications.

Unit III **(10 hours)**

Protoplast- introduction, principle; isolation methods- mechanical, enzymatic. CPW medium, source of enzymes. Isolation of protoplasts from intact tissue, callus, suspension cultures and haploid cells - protocols. Testing the viability of isolated protoplasts. Various steps and methods involved in the regeneration of protoplast. Markers used in the selection of hybrid cells. Somatic hybridization - introduction, principle, protocol; hybrids and cybrids. Protoplast fusion methods: chemical and electrical. Applications of protoplasts, hybrids and cybrids.

Unit IV **(10 hours)**

Genetic manipulations of plant cells- single cells, protoplasts protocols and applications. Structure of *Agrobacterium tumefaciens*, tumour formation in monocots and dicots, reporter genes used in genetic transformations. Root formation using *Agrobacterium rhizogenes* and applications. Genetic transformation – transgenic cotton, edible vaccines and transgenic brinjal: protocol and applications.

Disease development in plants caused by bacteria (bacterial blight or rice), fungi (late blight of potato), virus (tobacco mosaic disease) and viroid (potato spindle tuber) – classification, symptoms, disease cycle and control measures. Systemic acquired resistance (SAR) and development of disease resistant plants.

References

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BSCBTP 333: PLANT BIOTECHNOLOGY PRACTICAL (12x2hours)

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Set-up a plant tissue culture lab and establish callus, seed and embryo culture
CO 2. Demonstrate practical skills in plant tissue culture methods including sterilization
CO 3. Apply diverse media, hormones and methods in plant tissue culture
CO 4. Assess early development of plants, protoplast culture, somatic embryogeneis, organogenesis and callus culture etc.

Plant tissue culture laboratory set up
Different plant tissue culture media
Methods of sterilization of glassware, media and explants
Establishment of callus culture, seed, embryo culture
Anther and pollen culture
Clonal propagation - shoot tip and axillary bud culture
Establishment of suspension culture
Protoplast isolation and culture
Somatic embryogenesis and artificial seeds
Organogenesis from callus culture, and hardening of plantlets
Isolation of *Agrobacterium* from plants or soil and *in vitro* culture
Cocultivation of *Agrobacterium* with plant of interest
Cryopreservation method

BSCBTV 332: ANIMAL BIOTECHNOLOGY **40 hours**

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Understand the laboratory set-up, use of various instruments, substrates and media in animal cell culture.
CO 2. Discuss growth of cells in in-vitro condition, separation of cells, viability check.
CO 3. Comprehend the various techniques related to cell synchronization, gene transfer, production of monoclonal antibodies, DNA microarray,
CO 4. Describe various animal diseases and their management, gene therapy and use of various pharmaceutically important products obtained by genetic engineering.

Unit I **(10 hours)**

History of the development of cell culture. Contributions of R.G. Harrison, Alexis Carrel. Hanging drop technique, watch glass technique.
Equipments and materials for animal cell culture. Essential, beneficial and useful equipments. Substrates (glass, plastic, treated surface, feeder layer).
Animal cell culture media. Media for immediate survival of cells (BSS). Media for prolonged survival of cells (natural and artificial). Natural media - embryo extract, lymph serum; artificial (defined) media- media with serum (DMEM), RPMI 1640 and media without serum (HITES). Importance of serum in culture media.
Basic techniques of mammalian cell culture *in vitro*: primary explants culture - technique, advantages and disadvantages; primary cell culture - technique. Disaggregation of tissue: trypsinization - cold and warm, collagenase treatment, mechanical methods. Measurement of cells - cell count and cell viability. Cell counting - hemocytometer, electronic cell counter; cell viability - trypan blue, MTT assay.
Cell separation techniques - density gradient centrifugation, immunopanning, MACS, centrifugal elutriation, FACS.
Maintenance of cell culture: medium change-need, method; subculturing- factors affecting, methods - monolayer and suspension culture.

Unit II **(10 hours)**

Cell lines: types (finite and continuous), characteristics, examples for commonly used cell lines - BHK 21 - C13, HeLa, CHO-K1, WI-38, Vero, 3T3, mouse L. Routine maintenance – medium change, subculturing.
Growth kinetics of cells in culture: growth curve – lag, log, stationery and plateu phase; PDT, multiplication rate, generation number.
Measurement of cell proliferation- MTT assay, ^{3}[H]: thymidine incorporation. Cell synchronization: methods - chemical blockade (^{3}H: thymidine: double thymidine block, colcemid, vinblastin sulfate), low temperature procedure, starvation, centrifugation. Somatic cell fusion techniques: chemical/virus mediated, electrofusion, LASER induced. Production of MAbs by hybridoma technology: technique, applications of MAbs. Selection of hybrids: HAT selection; cell cloning- types: dilution and suspension (agar gel and methocis). Stem cell cultures: types- totipotent, pluripotent, multipotent, unipotent; embryonic and adult. Methods of culturing applications. Cryopreservation - technique (freezing and thawing) and applications.

Unit III **(10 hours)**

Animal cloning - reproductive cloning (Dolly- nuclear transplantation), therapeutic cloning (Xenotransplantation). Gene manipulation in animals- cloning vectors and expression vectors. Gene transfer methods (transfection): chemical methods-$CaPO_4$ coprecipitation,

DEAE dextran mediated, lipofaction; physical - microinjection, electroporation; biological method – retroviral infection. Reporter genes - GFP, antibiotic resistance markers (neomycin phosphotransferase). DNA microarray - method, applications. Gene therapy - somatic and germline. Somatic (SCID), gene therapy in cancer treatment (TNF gene, p53 gene replacement).
Study of animal diseases: Symptoms, disease diagnosis and treatment of AIDS, salmonellosis and Candidiasis and malaria.

Unit IV **(10 hours)**

Genetic engineering - Factor VIII, tissue plasmogen activator (tPA), hormones (growth hormone, insulin), hepatitis B vaccine. Silkworm as bioreactors: heterologus proteins (OFP, human growth hormone). Organ culture (3 dimensional cultures): methods- watch glass technique, raft method, agar gel method, grid method cyclic exposure to light and gas phase. Tissue engineering (artificial skin): methods-collagen method and mesh scaffolding method. Transgenic animals: transgenic cattle - tPA, AAT production; Animals as bioreactors (biopharming): mammary glands as bioreactors- production of regulatory proteins (alpha -1-antitrypsin [AAT], tPA), transgenic fish – GH induced fish, AFP (fish antifreeze protein) - method and production.

References

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BSCBTP 334: ANIMAL BIOTECHNOLOGY PRACTICAL **(12 × 2 hours)**

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Learn the set-up of a typical animal biotechnology laboratory
CO 2. Acquire procedural skills in sterilization, primary explant culture and lymphocyte culture techniques
CO 3. Develop skills in buffy coat separation and cell viability test procedures
CO 4. Describe cryopreservation techniques.

Lab set up and fumigation of the lab
Preparation and filtration of animal tissue culture media
Primary explants culture
Chick embryo culture (Spratt culture)
Isolation of bone marrow cells by flushing and primary culture
Culture of lymphocytes
Determination of viability of cells
Buffy coat preparation of WBC
Mammalian cell counting by Hemocytometer
Estimation of viability of cells by trypan blue dye exclusion
Staining for monolayer culture and suspension culture
Cryopreservation

SEMESTER - VI

BSCBTV 381: ENVIRONMENTAL BIOTECHNOLOGY 40 hours

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Comprehend the basic principles of environmental biotechnology and its relevance to environmental protection and pollution control through microbiological treatment of waste, composting, vermicomposting, bioremediation, degradation of xenobiotics.
CO 2. Understand conventional and non-conventional sources of energy, bioethanol production, solar energy, converters, use of wind and tidal energy, energy gardens or biomass energy
CO 3. Discuss the technology and applications of genetically modified organisms (GMOs), GMOs as food and ethical issues, biopesticides
CO 4. Describe various biocontrol agents and biofertilizers

Unit I (10 hours)

Basic principles of environmental biotechnology and its relevance to environmental protection: definition, its role in waste management, manufacturing process and pollution control.

Environmental pollution: definition, types- air, water and soil pollution – definition, causes, effects and control measures. Acid rain, photochemical smog, ozone depletion, greenhouse effect. BOD, eutrophification, Minamata disease, biomagnification. Biochemical cycles: definition, types – gaseous and sedimentary. Gaseous cycles- carbon and nitrogen. Sedimentary - phosphorous. Sulphur. Toxic element cycles- mercury, lead.

Unit II (10 hours)

Microbiological treatment solid wastes: composting, vermicomposting, land-farming. Biological treatment of liquid wastes (sewage): primary treatment, secondary treatment (activated sludge system, trickling filters), sludge digestion, septic tanks, oxidation ponds. Tertiary treatments.

Bioremediation: *In situ* and *ex situ* bioremediation. Phytoremediation, microbial bioremediation. Pollution control measures- control of air and water pollution. Indicator organisms. Permissible limits and indices for pollutants. Hazardous wastes and management: dyes and paints, distillery industry effluents, leather industry, radioactive wastes. Microbial mining, corrosion and remedies. Biomining (e.g. copper and gold). Microbiologically influenced corrosion (MIC) and remedies.

Unit III (10 hours)

Renewable and non-renewable resources. Conventional and non-conventional sources of energy. Biomass energy - firewood, plant and animal wastes, coal, gas and animal oils. Methanogenic bacteria and biogas, microbial H_2 production, bioethanol production, solar energy and solar energy converters, wind and tidal energy and its utilization. Energy gardens - *Pongamia* and *Jatropha.*

Unit IV (10 hours)

Microbial degradation of xenobiotics: pesticides, detergents, plastics. Degradation of organic compounds: cellulose, lignin, hydrocarbon. Degradation of economically valuable products: textiles, paper, leather, wood. Biocontrol agents: Bacterial, viral, fungal of plants as Biopesticides. Biofertilizers: utilization of Rhizobia, cyanobacteria, arbuscular mycorrhizae and ectomycorrhizae.

Coastal regulatory zone (CRZ), marine resources, environmental issues of freshwater and marine aquaculture. Genetically manipulated organisms (GMOs) - biopesticides e.g. *Bacillus thuringiensi*s. GM foods and ethical issues.

References

- Cassida, L.E. 1968. *Industrial Microbiology*. John Wiley & Sons.
- Jogdand SN. 2010. *Environmental Biotechnology*. Himalaya Publishing House, Bangalore, New Delhi.
- Odum EP. *Ecology* 1983. W.B. Saunders Co., Philadelphia and London.
- Odum EP. and Barrett GW. 2004. Fundamentals of Ecology W B. Saunders Co., Philadelphia and London.
- Subba Rao N.S. 1974. *Soil Microbiology*, 4th edition, Oxford & IBH Publishers, New Delhi
- Wang LK, Ivanov V, Tay JH and Hung YT. 2010. *Environmental Biotechnology*. Springer publisher

BSCBTP 383: BIOSTATISTICS AND BIOINFORMATICS 40 hours

Course Outcomes:
After successful completion of this Course, students will be able to:

CO 1. Understand the basics of sets, binomial theorem, differentiation and integration and applications thereof
CO 2. Comprehend use of statistical measures such as central tendencies, dispersion, probability, correlation, regression and applications thereof
CO 3. Use computers for biological applications, whether in fermentation or in bioinformatics
CO 4. Use various databases and tools in bioinformatics to elucidate sequence, structure of biomolecules and applications thereof in genomics, proteomics, pharmacogenomics, agriculture and aquaculture.

Unit I (10 hours)

The set theory: basic concepts of sets, methods of describing a set. Tabular form, rule form renndiagram. Types of sets, subsets, power set, universal set. The binomial theorem: statements, based on theorem problems
Logarithm: basic concepts
Differentiation and integration: basic

Unit II (10 hours)

Measures of central tendencies: definitions with examples- mean, median, Geometric mean, Harmonic mean
Measures of dispersion: definitions with examples - range, quartile deviation, mean deviation, standard deviation
Probability: definition, sample space, event, complement of an event, subevent, union of events. Introduction of events, equally likely events, mutually exclusive and exhaustive events with illustrations.
Correlation: definition, types of correlation, Karl Pearson's coefficient of correlation, Spearman's rank correlation.
Regression: definition, two regression equations, properties of regression equations with problems

Unit III **(10 hours)**

Introduction to computer and organisation of computers

Digital and analogue computers, computer algorithm, computers in monitoring and automation.

Application of computers in coordination of solute concentration, pH and temperature of fermenters.

Computers as computational tools for bioinformatics.

Unit IV **(10 hours)**

Introduction to bioinformatics. Biology and bioinformatics: relevance of bioinformatics to study biomolecules, structure of RNA and DNA, genetic code, genes, protein structure, folding and functions.

Biological data bases and data tools: types of databases, database softwares, tools for genomics and proteomics, genome data visualisation tools, annotation, genome comparison and analysis and data submission.

Application of bioinformatics in agriculture, pharmacogenomics and aquaculture.

References

Arnold E. 1979. *Introductory statistics for Biology* 2nd edition, London.

Attwood T and Parry-Smith D. 1999. *Introduction to Bioinformatics*. Prentice Hall Publications.

Lewis AE. 2010. *Biostatistics*. Prentice Hall. New Jersey.

Parker RE. 1979. *Introductory Statistics for Biology*. Hodder Arnold Publications

Zar J. H. 1974. *Biostatistical analysis*. Prentice Hall, New Jersey

BSCBTP 383: ENVIRONMENTAL BIOTECHNOLOGY, BIOSTATISTICS AND BIOINFORMATICS PRACTICAL **(12 × 2 hours)**

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Acquire skills and techniques used in environmental biotechnology

CO 2. Evaluate quality and quantity of organic constituents in water and soil samples

CO 3. Understand biogas and biofertilizer production, composting and vermicomposting

CO 4. Develop skills in statistical tools and use of bioinformatics tools

Estimation of alkalinity and salinity from water, soil or sewage

Water microbiology and sewage analysis

Determination of BOD and COD

Estimation of hardness of water

Estimation of total solids, dissolved and suspended solids

Estimation of inorganic phosphate and nitrogen in soil, sewage and water

Soil analysis- classification, water holding capacity and bulk density

Estimation of dissolves oxygen and carbon dioxide

Estimation of organic carbon.

Biogas production

Isolation of xenobiotic degrading microorganisms

Compost, vermicompost and biofertilizers

Studies on animals, plants and microbes in extreme habitats

Analysis of polluted water

Field trips to different biomes

Problems in biostatistics

Problems in bioinformatics

BSCBTP 384: Project **(12 × 2 hours)**

Project Work

Course Outcomes:
After successful completion of this Course, students will be able to:
CO 1. Carry out project work on topics in the field of biotechnology
CO 2. Work independently on a problem
CO 3. Gather background information and synthesise relevant information
CO 4. Create a hypothesis based on the lacunae and gaps
CO 5. Draft tangible objectives
CO 6. Develop technical skills in the lab/field
CO 7. Practice good laboratory practices
CO 8. Analyse data and interpret the same
CO 9. Develop scientific writing skills
CO 10. Learn to communicate scientific facts and present the same
CO 11. Use research methodologies for continued learning and research
CO 12. Work towards deadlines and carry out collaborative work in a team
CO 13. Create a product or identify a process with potential in biotechnology