CENTRE FOR BIOTECHNOLOGY

EWING CHRISTIAN COLLEGE, ALLAHABAD
(An Autonomous Constituent College of University of Allahabad)

Curriculum for Semester System of Three-Year B.Sc. Program in BIOTECHNOLOGY

(w.e.f. AcademicSession 2020-21)

CURRICULUM STRUCTURE OF BIOTECHNOLOGY (W.E.F SESSION 2020-21)
THREE-YEAR UNDERGRADUATE DEGREE COURSE (06 SEMESTERS)

Academic Year	Semester No	Paper No.	Course Code	Title of the Paper	Mark Allotted	Credits
B.ScI	I	Core 1	1BIOT1	PRINCIPLES OF ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY -1 (BIOCHEMICAL)	75	02
		Core 2	1BIOT2	PRINCIPLES OF ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY -2 (BIOCHEMICAL)	75	02
		Core 3	1BIOTP	PRACTICALS BASED ON PAPER 1 AND 2	50	02
	II	Core 1	2BIOT1	HUMAN BIOLOGY	75	02
		Core 2	2BIOT2	CELL AND INHERITENCE BIOLOGY	75	02
		Core 3	2BIOTP	PRACTICALS BASED ON PAPER 1 AND 2	50	02
B.ScII	III	Core 1	3BIOT1	MICROBIOLOGY	75	02
		Core 2	3BIOT2	BIOMATHEMATICS AND BIOSTATISTICS	75	02
		Core 3	3BIOTP	PRACTICALS BASED ON PAPER 1 AND 2	50	02
	IV	Core 1	4BIOT1	MOLECULAR BIOLOGY	75	02
		Core 2	4BIOT2	BIOCHEMISTRY AND BIOENERGETICS	75	02
		Core 3	4BIOTP	PRACTICALS BASED ON PAPER 1 AND 2	50	02
B.Sc III	V	Core 1	5BIOT1	ANIMAL BIOTECHNOLOGY	75	02
		Core 2	5BIOT2	ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY	75	02
		Core 3	5BIOT3	IMMUNOLOGY AND MEDICAL BIOTECHNOLOGY	75	02
		Core 4	5BIOTP	PRACTICALS AND PROJECT WORK BASED ON PARER 1, 2, AND 3	75 (50+25)	03
	VI	Core 1	6BIOT1	PLANT BIOTECHNOLOGY	75	02
		Core 2	6BIOT2	RECOMBINANT DNA TECHNOLOGY AND GENETIC ENGINEERING	75	02
		Elective paper 3 (Select any one)	6BIOT3A	BIOINFORMATICS AND NANOBIOTECHNOLOGY	75	02
			6BIOT3B	DESSERTATION	75	02
		Core 4	6BIOTP	PRACTICALS AND PROJECT WORK BASED ON PAPER 1,2 AND 3	75 (50+25)	03
		SEC	6BIOTSE	SKILL ENHANCEMENT COURSE IN BIOTECHNOLOGY	GRADE	02

SEMESTER I

PAPER 1

TITLE: PRINCIPLES OF ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY – 1 (BIOCHEMICAL)

UNIT 1

Solutions: Definition of solution, solute, solvent, molarity, molality, normality, weight-percent, ppm/ppb, calculation of molecular weight, inter-conversion between percent, molar and normal solutions, methods of dilution and source of error.

Water: Water structure, Properties, interaction, water as solvent and reactant, water distillation, ion exchange and ion free water.

Colloidal solution: Types of Colloidal System, Properties of Colloidal Solution, Preparation of Colloidal Solution.DonnanEquilibrium,Gold number, Importance and application of Colloids.

UNIT 2

Chemical bonding: Concept of Ionic bonding, covalent bonding, Hydrogen bonding, and Vander-Waal forces of interaction.

Ionic Equilibrium in solution: Electrolytes (strong and weak) and Non-electrolytes, Ionizationof weak electrolytes (Ostwald dilution law), Concept of Acids and Bases (Arrhenius concept, Bronsted- Lowry concept. Lewis concept), Strength of Acids and Bases, Dissociation of Weak Acids, Bases and Water.

Indicators: Hydrogen ion indicator and their ranges. Theories of Indicator (Ostwald, Chromophore / Benzenoid Theory) with special reference to Phenolphthalein and Methyl Orange indicator, Limitation of indicators, Titration curves (Acid-base titration using indicators).

UNIT 3

pH and pH scale: pH value and determination of pH, pH scale, Common ion effect, Hydrogen ion selective electrode and pH meter, its operation and limitations.

Buffer solutions: Concept of Buffer, Types of buffer(acidic and basic standard buffers) and their buffer actions, Henderson Hasselbach equation for determination of pH of buffer solutions.

Biological buffers: Amino acid buffer(glycine),(Zwitterionic effect and determination of isoelectric pH), Phosphate buffer, Bicarbonate buffer, Hemoglobin buffer, TRIS buffer.

SUGGESTED READINGS

- Practical Biochemistry, Principles and Techniques: **Wilson and Walker**
- Bioinstrumentation:**Webster**
- Biophysical Chemistry (Principles and Techniques): **Upadhyay, Upadhyay and Nath**
- Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes: **J.F. Van Impe, Kluwer Academic.**
- Physical Chemistry:**Puri and Sharma.**
- Physical Chemistry:**R.C.Mukherjee.**
- Principles of Physical Biochemistry: **K.E. Van Holde, Prentice Hall.**
- Principles and Practice of Bioanalysis : **Richard F. Venn.**

PAPER 2

TITLE: PRINCIPLES OF ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY – 2 (BIOPHYSICAL)

UNIT 1

Thermometry: Law of thermodynamics, Enthalpy, free energy, heat dissipation and heat conservation, concept of temperature, Thermometers, Incubators, Oven, Water Bath. (Principle, working & precaution).

Photometry: Properties of light and sources of radiations. Basic principles of light absorption, Fluorescence and Phosphorescence, Raman effect. Beer lambert law.

Spectrophotometry: Basic principles of light absorption, Fluorescence and Phosphorescence, Raman effect. Beer lambert law, basic concepts and types of spectrophotometer (UV-Visible and Infrared Spectrophotometry), instrumentation and applications. Colorimeter.

UNIT 2

Microscopy: Microscope**,** principle, working and application of light and Electron microscopes.

Imaging Technique: MassSpectrometry, X-ray crystallography, Principle, working and applications of NMR and ESR. Circular Dichroism and its application in Biotechnology

Tracer techniques: Concept of Radioactivity, sources of radioisotopes, radioisotopes and their uses in biological science, techniques for detection of isotopes e.g.,Auto-Radiography, Geiger Counting Techniques, Liquid Scintillation, Gamma Counter. Isotope Dilution Technique. Safety in use of radiation.

UNIT 3

Centrifugation: Relative Centrifugal Force (RCF) and other factors effecting centrifugation, Sedimentation coefficient,Principles, instrumentation and application of centrifugation. Differential and Density Gradient Centrifuge, Ultracentrifugation.

Electrophoretic techniques: Electrophoresis, basic concept, principle, types(Gel Electrophoresis-Agarose gel, PAGE, SDS-PAGE)instrumentation techniques and application of electrophoresis.

Chromatographic techniques: Principle and types(Paper Chromatography, Thin-Layer Chromatography,Adsorption Chromatography, HPLC)

SUGGESTED READINGSs

- Modem Spectroscopy: J**.M. Hollas, John Wiley and Son Ltd.**
- NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry: **H. Gunther, John Wiley and Sons Ltd.**
- Microscopic Techniques in Biotechnology: **Michael Hoppert**
- Biochemistry :**J L. Jain**
- Practical Biochemistry, Principles and Techniques: **Wilson and Walker**
- Biophysical Chemistry (Principles and Techniques): **Upadhyay, Upadhyay and Nath**

PAPER 3

Practical based on theory Paper 1 and 2

SEMESTER II

PAPER 1

TITLE: HUMAN BIOLOGY

UNIT1

Classification of Animals: General classification of Animal kingdom. Salient feature of each phylum under Invertebrates and Vertebrates.

Human evolution: General characteristics and classification of Mammalia with special reference to *Homo sapiens*, Human evolution.

Human reproduction : Male and Female reproductive organ, Female reproductive cycle. The human sexual response, Fertilization and implantation of embryo. Embryonic Development.

UNIT2

Digestive System- different components, digestion and absorption of Carbohydrates, Lipids and Proteins.

Circulatory System: Structure and function of human heart and blood vessels,cellular and chemical composition of blood, Hemoglobin structure and role blood clotting, Blood Transfusion,

Respiratory system: Respiratory organ structure and function, breathing in human, transport and diffusion of oxygen and carbon dioxide,dissociation curve of oxyhemoglobin and its significance, Bohr's effect, Chloride Shift.

UNIT 3

Excretory system – Kidney - Its structure, organization and function. Structural and functional characteristics of tubules, ultra-filtration, selective reabsorption and secretion, role of aldosterone and antidiuretic hormones and mechanism of urine formation. Metabolic breakdown of amino acids, Transamination, Deamination, Urea Cycle.

Endocrine system - brief outline of various endocrine glands and their physiological roles, storage and secretion of hormones.

Nervous System- Nerve cells, nerve fibers, nerve impulse and neuro-transmission, chemical and electrical synapses, functional properties of nerve fibers, action potential, the reflex action and reflex.

SUGGESTED READINGSs

- Medical Physiology- **Bhanu Prakash**
- BIOS Instant Notes in Human Physiology- **Daniel McLaughlin, ,Jonathan Stamford David White**
- Medical Physiology – **Guyton and Hall**
- BRS Medical Physiology - **Linda Costanzo**
- Medical physiology- **Gillian Pocock, Christopher D. Richards, and David A. Richards**

PAPER 2

TITLE - CELL AND INHERITANCE BIOLOGY

UNIT 1

Cell organization: Structure and organization of prokaryotic and eukaryotic cells, Cell organelles- structure, function and integration, micro bodies.

Cell membrane structure and functions: Chemical composition and ultra-structure of cell membrane, Dynamic nature of plasma-membrane, Thermodynamics of transport through cell membrane, mechanism of transport passive transport (diffusion and facilitated diffusion,Ion gradient driven transport), ATP-driven active transport

Nucleus: Nuclear membrane and nuclear pore complex, nucleoplasm, nucleolus) chromatin and chromosome organization (Euchromatin and heterochromatin, Nucleosome organization, Centromere and telomere), banding patterns in human chromosome.

UNIT 2

Chromosomal Mutation: Structural and numerical changes in chromosomes, associated hereditary defects.

Cell Mechanics: Cell cycle and cell division (Mitosis and Meiosis), Karyotype and Idiogram, Feulgen staining technique. Chemicals used for arresting cell divisions.

Cancer: Characteristic of cancer cells. Cause of cancer, genetics of cancer cell senescence and programmed cell death.

UNIT 3

Principles of Inheritance: Mendel's law of inheritance, epistasis, Sex determination in animals, sex linked and sex influenced inheritance in human, Linkage and crossing over, recombination and gene mapping.

Gene Mutation: Concept, types, cause and mechanism ofgene mutation, mutagens typeand mutagenesis

Population genetics: Gene frequencies in population, Hardy-Weinberg law.

SUGGESTED READINGS

- Cell and Molecular Biology: Concepts and Experiments. **Karp**
- Cell and Molecular Biology. **De Robertis, and De Robertis**,
- The Cell: A Molecular Approach. **Cooper, G.M. and Hausman, R.E.**
- Molecular Biology of Cell- **Bruce Alberts**
- Molecular Cell Biology- **Lodhish**
- Genetics: **Gardner** and **Snustard**
- iGenetics- **PeterRussell**
- Principles of Genetics- **Tamarin**
- Concepts of Genetics- **RobertBrooker**
- Genetics: **Strickberger**
- Concepts of Genetics- **Klug** et al
- Genetics: **P. K. Gupta**
- Cell Biology, Genetics, molecular Biology, evolution and Ecology- **Verma and Agarwal**
- Cell Biology- **P.K.Gupta**

PAPER 3

Practicals based on Theory Paper 1 and 2

SEMESTER III

PAPER 1

TITLE - MICROBIOLOGY

UNIT 1

Introduction to Microbiology: History, scope and development of Microbiology; Applications of Microbiology in human welfare. Contribution of scientists in the field of microbiology: Antony von Leeuwenhoek. Alexander Fleming, Edward Jenner, Louis Pasteur, Robert Koch, Selman Waksman, Joseph Lister.

Diversity of Microbial World A: Classification, general characteristics and structure of Bacteria - (eubacteria & archaebacteria), Cyanobacteria, Actinomycetes, Mycoplasma ,Rickettsia, Chlamydia. Concept of Phyllosphere and rhizosphere.

Diversity of Microbial World B: Classification, general characteristics and structure of Viruses, Prions, Virusoids & Viroid. General features of virus reproduction. DNA & RNA Viruses with the example of TMV & Pox Virus.General characters and structure of bacteriophage (T_4 and Lambda phage).

UNIT 2

Culture techniques in microbiology: Pure culture techniques and contaminations, Physical and chemical methods of sterilization. Synchronous culture, continuous culture and batch culture.

Growth: Definition of growth, mathematical expression of growth. Growth curve, Growth yield, Effect of nutrient concentration on growth. Factors affecting growth: nutrients, temperature, oxygen, pH, osmotic pressure.

Growth measurement: Measurement of Bacterial, growth by measuring cell number, cell mass and cell activity. Cell count - direct and indirect method, turbidometric method, Plate count method, membrane filter count method, dry weight and wet weight method by measurement of cellular activity.

UNIT 3

Microbe identification: Identification of Microorganism commonly used in the laboratory based on Morphological and Biochemical parameters

Reproduction and genetic recombination in bacteria – Binary fission, conjugation, transformation, transduction and sexduction.

Antibiotics – types and origin of antibiotics, production, mode of the action. Antibiotic resistance.

SUGGESTED READINGSs

- General Microbiology by **C. B. Powar and H. F. Daginawala**,
- A Text book of Microbiology by **R. C. Dubey and D. K. Maheshwari**
- A Textbook of Fungi by **H.C. Dubey**
- Microbiology: **R. P. Singh**
- General Microbiology by **Davis and Harper**,
- General Microbiology Stanier, **R.Y, J.L. Ingraham, M. L. Wheetis and P.R. Painter**
- Microbial Biotechnology **byTrivedi**
- Microbiology **P.D. Sharma.**
- Microbiology by **M. J. Pelczar**
- Microbiology :**Prescott:**
- Textbook of Microbiology by **Ananthanarayan and Paniker**

- Microbiology**- Sullia and Shantharam**
- BIOS Instant Notes in Microbiology by **Baker**
- Brock Biology of Microorganisms**(** Pearson **)by Madigan Michael T. , Martinko John M. , et al.**
- Practical Microbiology **by Maheshwari D.K.**
- Experiments in Microbiology, Plant Pathology and Biotechnology **by K.R. Aneja**

PAPER 2

TITLE: BIOMATHEMATICS AND BIOSTATISTICS

UNIT 1

Set Theory: Set, subset, Set operations (union, intersection, difference, symmetric difference & complement), DeMorgan's Laws, Venn Diagrams and its simple applications.

Logarithm: logarithm and Anti-logarithm (definition & laws of logarithm, use of logarithm table)

Calculus: limits of a function (basic idea of limit of functions without analytic definition), derivative of a function, differentiation of standard functions, algebra of derivatives, integration of standard functions and integration of product of two functions.

UNIT 2

Matrix Theory: Matrices: definition and notation, types of matrices, Equality of matrices, Algebra of matrices (addition, scalar multiplication and multiplication), transpose of a matrix, Symmetric and skew-symmetric matrices, minors and cofactors of a square matrix, adjoint of a matrix and inverse of a matrix (upto order 3), solutions of homogenous and non-homogenous linear equations upto three variables by matrix method.

Permutations and combinations: Factorial Notation, simple permutation, permutation when all the objects are not distinct, combination,Binomial Theorem.

UNIT 3

Probability Theory: Classical & axiomatic definition of probability, theorems on simple probability.

Standard distribution with important properties, simple problems involving binomial, Poisson's and normal variables, distribution and standard error, confidence level, testing of hypothesis (t-test and f-test (ANOVA) method), measures of Central tendency (Mean, Median and Mode of an statistical data), measures of dispersion (measures of location and desperation).

SUGGESTED READINGS

- H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
- E. Batschelet: Introduction to Mathematics for Life Scientists, Springer Verlag. International Student Edition. Narosa Publishing House. New Delhi (1971,1975)
- Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.

PAPER 3

Practical based on theory Paper 1 and 2

SEMESTER IV

PAPER 1

TITLE: MOLECULAR BIOLOGY

UNIT 1

Molecular basis of life: Concept of Genetic material, Nucleic acid (DNA and RNA), Experimental evidences for nucleic acid as genetic material,Structure of DNA, Chargaff's rule and base composition, Types of DNA (A, B and Z),

DNA as hereditary material: Evidence for semiconservative replication, Enzymes and proteins involved in DNA replication in prokaryotes and its comparison with eukaryotes, DNA repair mechanism

Gene concept: Modern concept of gene,overlapping genes, pseudo genes.organization of mtDNAandcpDNA, Cryptic genes. Insertion elements, Transposons, retrotransposon, Transposable elements in Drosophila and maize.

UNIT 2

Transcription in prokaryotes: Concept of transcription, Enzyme and proteins involved in transcription in bacteria, Mechanism of transcription in bacteria, RNA types with special reference to the structure of t-RNA, m-RNA degradation

Transcription in Eukaryotes: Molecular mechanism of transcription in Eukaryotes, Enzymes involved in eukaryotic transcription, RNA splicing and RNA processing**,**transport and degradation of mRNA

Genetic code: Properties of genetic code, codon assignments, chain initiation and chain termination codons, wobble hypothesis, exception of universal genetic code

UNIT 3

Translation: Mechanism of translation and protein synthesis in Prokaryotes and its comparison with eukaryotes

Regulation of gene expression in prokaryotes: Operon model for regulation of gene expression in bacteria, *Lac* operon and trp operon (negative and positive regulation)

Eukaryotic gene regulation: Levels of control of gene expression in eukaryotes (mRNA degradation and protein degradation control brief idea), Gene battery model, Homeotic gene concept

SUGGESTED READINGS

- Molecular Biology by **David P. Clark BA**
- Molecular Biology of the Cell-by **Bruce Alberts, Alexander Johnson, et al.**
- Cell Biology by **Gerald Karp**
- The Cell: A Molecular Approach by **Geoffrey M. Cooper and Robert E. Hausman**
- Molecular Cell Biology by **Harvey Lodish, Arnold Berk, et al.**
- Cell and Molecular Biology - **De Robertis, E.D.P. and De Robertis. E.M.F.**
- Freifelders Essentials Of Molecular Biology by **George M Malacinski**
- Molecular Cell Biology by **James E. Darnell, etc., et al.**
- Molecular Biology of the Gene-**Watson**,
- Molecular Biology: **Robert Weaver**
- Molecular Biology - **David Clark**
- Essential Genes - **Benjamin Lewin**
- Principles of Molecular Biology by **Veer Bala Rastogi**

PAPER 2

TITLE:BIOCHEMISTRY AND BIOENERGETICS

UNIT 1

Concept of metabolic energy: Thermodynamics of energy transformation in biological system, Endergonic and exergonicmetabolic processes, ATP as universal currency of free energy in biological system and causes of energy richness of ATP

Glucose metabolism: Glycolytic pathway and its regulation, homo lactic fermentation, alcoholic fermentation, energetics of fermentation. glycogen breakdown and gluconeogenesis.

Metabolic energy generation pathway: Citric acid cycle and its regulation, Electron transport and oxidative phosphorylation, pentose phosphate pathway

UNIT 2

Carbohydrates: Classification of carbohydrates. Chemical structure and properties ofmonosaccharides ,disaccharides, oligosaccharides & polysaccharides, Starch, cellulose and glycogen.

Lipids: Classification, properties of lipid aggregates, biological significance. Fatty acid oxidation and glyoxalate pathway

Amino acids and Vitamins: General properties, peptide bond, essential and non-essential amino acids. Isoelectric points ; Vitamins**:**water- and fat-soluble vitamins, deficiency and diseases.

UNIT 3

Protein chemistry: Classification, different levels of protein structure, forces stabilizing protein structure. Protein folding (Chaperone Model)

Enzymescharacteristics: General characteristics of enzymes, mechanism of enzyme action,factor effecting enzyme action, Classification of enzymes, zymogens, co-enzymes and co-factors,Ribozymes, abzymes and isoenzymes.

Enzyme kinetics and inhibition: Kinetics of enzyme with special reference to Michaelis an Menton equation, Competitive and non-competitive inhibition of enzyme. Allosteric regulation of enzymes. Factors contributing to catalytic efficiency of enzymes.

SUGGESTED READINGS

- Analytical Biochemistry by **Holme, D. J. & Peek. H.**
- Basic Concepts in Biochemistry A Student's Survival Guide by **Gilbert. H. F.**
- Biochemistry by **Rawn J. D.**
- Biochemistry by **Todd, W. B, Mason, M. Bmggen. R. V. &Macmillan.**
- Biochemistry by **Voet&Voet**
- Biochemistry by **Mathews** 3rd Ed.
- Biochemistry The Chemical Reactions of Living Cellsby**Metzler.D.E**.
- Biochemistry**-Zubay, J**.
- **Lehningers** Biochemistry; **Nelson and Cox**
- Biochemistry: **Styrer**
- Biochemistry**: U satyanaran**
- **Harper's** Biochemistry
- Biochemistry- **J.L.Jain**

PAPER 3

Practical based on theory Paper 1 and 2

SEMESTER V

PAPER I

TITLE: ANIMAL BIOTECHNOLGY

UNIT 1

Principle of Animal cell tissue culture : Principle and basic techniques in animal cell culture, Types of Cell Culture, cell lines, isolation of cell line,Cell viability and cytotoxicity , Cell cloning, Application of cell culture

Animal Cell culture techniques: Culture media types, contaminations and their laboratory management, Differentiation,characterization and growth of cultured cells, bioreactors for large scale culture of cells, cell fusion, Biohazard, risk and safety in laboratory

Organ culture and Tissue Engineering:organotypic models**,** technique of organ and histotypic culture, advantages, applications and limitations. Tissue engineering, tissue modeling and Artificial skin,

UNIT 2

Stem cell biology: Concept and properties of stem cell, Types of stem cell and cell lines, source and importance of stem cell. Customization of stem cells and stem cell replacement therapy, Human embryonic stem cell research

Hybridoma technology: Principle and production of hybridoma cell, hybridoma technology,Productionand properties of Monoclonal antibodies (*Mabs*). Application of Monoclonal antibodies in disease diagnosis and as therapeutic agents with special reference to Immunotoxins and cancer therapy.

Assisted Reproductive technology: Artificial insemination, In-vitro fertilization, , Embryo transfer technique (Human), Manipulation of reproduction in human, Embryo cloning, test tube baby, Animal cloning through somatic nuclear transfer techniques(Dolly the first mammalian clone)

UNIT 3

Transgenic animals and Bioethics: Principle and importance of transgenic animals, different methods of production of transgenic animals(Cattles, goat,pigs, chickens and fish), Societal risk and bioethics

Gene Therapy: Introduction, types of gene therapy, vectors in gene therapy, major achievements, problems and prospects, Intellectual property rights and patenting

Pharmaceutical biotechnology: Human protein replacement (blood proteins, insulin, Human growth hormone, Clotting factors), Therapeutic agents for human disease (Erythropoietin, interferons, tissue plasminogen activator),Recombinant Vaccines

SUGGESTED READINGS

- Culture of Animal Cells, **R.IFreshney, Wiley-Leiss.**
- Animal Cell Culture Techniques, **M. Clynes, Springer Verlag**.
- Animal Biotechnology- **M.M Ranga**
- Animal Cell Culture and Technology by **Michael Butler**
- Textbook of Animal Biotechnology by **Carlos Wyatt**
- Recombinant DNA Vaccines: Rationale and Strategy by **Richard Isaacson**
- Textbook of Biotechnology by **H.K. Das**
- Biotechnology : **B. D. Singh**
- Biotechnology: **P. K. Gupta ;** Biotechnology : **U Satyanarayana**

PAPER 2

TITLE: ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY

UNIT 1

Environment and Pollution: Concept of environment, Components of environment, Environmental pollution-types, nature and sources.

Global environmental problems: Global warming and greenhouse effect, global ozone problem, Acid rain, Biotechnological approach of monitoring and management of pollution and Environmental sustainability

Biotechnology and energy production: Non-renewable and renewable energy resources. Conventional fuels and their major impacts, Concept of clean fuel technology: Biomass energy and biofuels, Bioassessment of Environmental Quality

UNIT 2

Biotechnology and Sewage treatment: Concept and composition of sewage and sludge, Treatment and disposal of municipal solid and liquid wastes,

Biodegradation: Concept of Xenobiotics**,** Biomagnification, Eutrophication, and Biodegradation**,** biodegradation of plastics. Pesticides, herbicides, oil spills, cellulose and hydrocarbons.

Bioremediation: Concept of bioremediation, Microbial consortium in bioremediation with special to *Pseudomonas,* Genetic engineering approach for efficient bioremediation with special reference to genetically engineered superbugs, Bioremediation of contaminated soil and wastelands

UNIT3

Microbes inAgriculture: Foods from microorganism (vinegar, dairy products, single cell proteins), vitamin B_{12}, Microbes in production of Bioinsecticides, Biopesticides, and Biofertilizers (*Rhizobium, Azotobacter* and *Anabaena azolla*),

Microbes in industry: Microbial production of citric acid, amylases, proteases, alcohol beer, wine, biogas, methane, hydrogen. Biodegradable plastics

Microbes in mining: Use of microbes in mining, (Copper and Uranium),BiomineralizationBiosorption, Bioleaching

SUGGESTED READINGS

- Environmental Science, **S.C. Santra**
- Environmental Biotechnology, **Pradipta Kumar Mohapatra**
- Environmental Biotechnology-Concepts and Applications, **Hans-Joachim Jordening and Jesef Winter**
- Waste Water Engineering. **Metcalfand Eddy, Tata McGraw hill**
- Agricultural Biotechnology, **S.S. Purohit**
- Environmental Microbiology: Methods and Protocols, **Alicia L. Ragout De Spencer, John FT Spencer**
- Introduction to Environmental Biotechnology, **Milton Wainwright**
- Principles of Environmental Engineering, **Gilbert Masters**
- Principles of fermentation Technology, **Salisbury. Whitaker and Hall**
- Industrial Microbiology –**Cassida**
- Wastewater Engineering **- Metcalf & Eddy.**

PAPER 3

TITLE: IMMUNOLOGY AND MEDICAL BIOTECHNOLOGY

UNIT 1

Human Immune system: Concept of Immunology and immune system, types of immunity (innate immunity and acquired immunity), Immune system and its organization (Primary and secondary lymphoid organs)

Cells ofthe immune system: Lymphoid immune cells(B-lymphocytes and T lymphocytes) and myeloid immune cells

Antigens and Antibodies: Structure and properties of antigens, antigenic determinant, epitope, paratope and haptens, structure and properties of immunoglobulins, classes of Immunoglobulins (IgG, IgA, IgM,IgD and IgE).

UNIT 2

Major Histocompatibility Complex: Concept of Major Histocompatibility complex (MHC) and their classes, Antigen Presentation and processing,

Immune response: Cell mediated (cellular immunity) and antibody mediated (humoral) immunity and complement system, inflammatory responses

Hypersensitivity: Hypersensitivity reactions, Graft rejection and organ transplantation

UNIT3

Autoimmunity and Autoimmune diseases: Self- tolerance and autoimmunity, Single organ autoimmune diseases(Hashimoto's*Thyroiditis, Pernicious and hemolyticAnemia, Diabetes I, Grave's disease and Myasthenia Gravis*), Systemic autoimmune diseases(*Rheumatoid Arthritis, Systemic Lupus,Multiple sclerosis*)

Immunodeficiency diseases and Vaccines: Primary and secondary immunodeficiency diseases, causes, origin and treatment with special reference to SCID, AIDS and COVID-19, Vaccine and its type, Development of vaccines

Immunological techniques: Role of Monoclonal antibodies in disease diagnosisand Radio-immunoassay, Immunoblotting techniques (Elisaand RIA technique principle and applications), Fluorescence activated cell sorting, Widal test, Immune hematology- R.A. factor test

SUGGESTED READINGS

- Essential immunology- **Roitt**
- Immunology - **Kuby**
- **Janeway's**Immunobiology.
- Basic and Clinical Immunology. **PeakmanM, and Vergani D**
- Immunology **Richard C and Geiffrey S.**
- Basic Immunology- **Abbas Litchman**
- Cellular and Molecular Immunology- **Abbas Litchman**
- Elements of Immunology- **Fahim Halim Khan**
- Immunology**- Tizard**

PAPER 4

A) Practical based on theory Paper 1,2 and 3

B) Project Report

SEMESTER VI

PAPER 1

TITLE: PLANT BIOTECHNOLOGY

UNIT 1

Plant Tissue Culture technique: Introduction/Concept, History, Scope and Applications of plant tissue culture, Basic technique of plant tissue culture, preparation and selection of plant tissue culture media.

Cellular totipotency and in-vitro differentiation: Concept of totipotency its genetic basis, mechanism and significance in plant tissue culture. Dedifferentiation and callus culture, redifferentiation and organogenesis, somaclonal variations

Plant cell culture techniques: Principle and methodology of cell suspension culture, Micropropagation of elite plants through cell suspension culture, Production of secondary metabolites and Molecular farming, Biotransformation, germplasm conservation

UNIT 2

Protoplast technique: Protoplast isolation, Protoplast culture,Somatic hybridization and protoplast fusion techniques (chemical and electro-fusion). selection of hybrids, Cybridization and production of cybrids, Applications of somatic hybrids andcybrids.

Haploid culture: Concept of androgenesis and gynogenesis**,** haploid production through anther and pollen culture, production of pure lines through haploid culture.

Micro- propagation techniques: axillary bud, shoot-tip and meristem culture, production of virus free plants. Embryo culture, embryo rescue, and its applications, Somatic embryogenesis and synthetic seed technology and its application

UNIT 3

Gene transfer in plants: Direct or vector-less gene transfer in plants (micro projectile bombardment, microinjection, liposome mediated gene transfer electroporation), Calcium phosphate mediated gene transfer), Vector mediated gene transfer through Binary and co-integrate vectors, Ti plasmid and Agro-infection, Agrobacteriummediated gene transfer in plants, virus mediated gene transfer, Gene targeting in plants

Transgenic Plants: Transgenic stability and expression, marker gene in plant transformation, Development of transgenic plants for resistance to biotic stresses (insect/pest resistance, bacterial and fungal disease resistance, virus resistance) and abiotic stresses (herbicide resistance).

Transgenic plant and human health:transgenic plants for nutritional enhancement in crop plants, transgenic plants for improved nitrogen fixation, transgenic plants as bioreactors, Terminator seed technology,

SUGGESTED READINGS

- Plant Biotechnology- **Hopkins**
- Plant Biotechnology by**Shain-dow Kung and Charles J. Arntzen**
- Introduction To Plant Biotechnology by **CHAWLA H S**
- Plant Biotechnology: The Genetic Manipulation of Plants by **Slater**
- An Introduction to Plant Tissue Culture. **M.K. Razdan**,
- Plant Biotechnology by **Singh B.D.**
- Plant Tissue and Organ Culture fundamental Methods" by **Gamburg OL and Philips GC**

- Plant Biotechnology" by **Krishna G K A Elangovan S Devika**
- Experiments in Plant Tissue Culture, **J.H. Dodds and L.K. Roberts**
- Plant Biotechnology and Transgenic Plants, **K.M.O. Caldenty. W.H. Barz and H.L. Wills. Marcel Dekker**
- Plant Biotechnology, **J. Hammond, P. McGarvy and V. Yusibov.**
- Plant Cell & Tissue Culture for the production of Food Ingredients, **T-J Fu, G Singh and W.R. Curtis**
- Plant Tissue Culture: Theory & Practice, **S.S. Bhojwani and M.K. Razdan**

PAPER 2

TITLE: RECOMBINANT DNA TECHNOLOGY AND GENETIC ENGINEERING

UNIT 1

Introduction: History, scope and application of Recombinant technology/genetic engineering.Principle of in-vivo gene cloning

Tools in Recombinant DNA technology

1. **Gene cloning enzymes:**Concept of restriction modification system and discovery of restriction enzymes,Restriction enzymes used in gene cloning and mode of their action, Ligases, polymerases, Alkaline phosphatases, Kinases. Transferases and other enzymes used in Genetic engineering
2. **Gene cloning vectors:** Concept, and nomenclature of gene cloning vectors. Properties of an ideal vector, Plasmid vector, Bacteriophage vector, cosmids, Phagemid, M13 vector, Vectors for cloning in eukaryotic cells YACs and BACs., Co-integrate and Binary vectors, Expression vector

UNIT 2

Methodology of in –vivo gene cloning: Construction of Recombinant DNA molecules, Isolation of DNA of interest,Modification of cut ends of DNA and role of linkers and adaptors, Integration of DNA inserts with cohesive and blunt ends into vector molecules

Methods of Gene transfer and gene cloning in animals: Gene transfer methods in animals, Cloning and expression of foreign genes in mammalian cells, integration of DNA into mammalian genome- different methods

In-vitro gene cloning: Gene Amplificationthrough Polymerase chain reaction (PCR) – principle, enzymes used, primer design, Types of PCR techniques, Genomic and c-DNA libraries preparation and uses

UNIT 3

DNA sequencing and synthesis: Maxam-Gilbert's and Sanger's method. Automated sequencing. DNA microarrays, Artificial DNA synthesis, Human genome sequencing project.

Genome Mapping: Concept and applications. Restriction enzyme digestion and restriction mapping. Molecular probes, molecular marker (RFLP, RAPD, AFLP, SNTP),

Analytical technique in Genetic Engineering: DNA separation through electrophoresis, Blotting techniques: Southern and Northern analysis, DNA finger printing and profiling PAGE, Western blotting, dot-blots and slot blots techniques

SUGGESTED READINGS

- Molecular Biotechnology: Principles and Applications of Recombinant DNA by **Bernard R. Glick and Jack J. Pasternak**

- DNA Technology: The Awesome Skill. **Alcamo IE.**
- Gene Cloning and DNA Analysis - **Brown TA.**
- Biotechnology-Applying the Genetic Revolution. **Clark DP and Pazdernik NJ.**
- Principles of Gene Manipulation and Genomics -**Primrose SB and Twyman RM.**
- Molecular Cloning -A Laboratory Manual Sambrook J, **Fritsch EF and Maniatis T**.
- Genetic Engineering (Oxford Higher Education) by **Smita Rastogi and Neelam Pathak**
- Recombinant Dna Technology and Genetic Engineering by **K Rajagopal**
- Molecular Biology and DNA Recombinant Technology by **R.N. Kumar**
- Introduction to Genetic Engineering **by N. Nicholl**
- Genetic Engineering: Principles and Methods by **Jane K. Setlow**

PAPER 3

TITLE: BIOINFORMATICSANDNANOBIOTECHNOLOGY

UNIT1

Bioinformatics: Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Biological Database and Database Retrieval system

Sequence Alignments: Introduction, Concept of Alignment, Pairwise and Multiple Sequence Alignment (MSA), FASTA, BLAST, MSA by CLUSTALW. Introduction of [Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM)].

Applications of Bioinformatics: Methods of Phylogeny, Software for Phylogenetic Analyses. Concept of Genomics, transcriptomics, Proteomics and Metabolomics Structural Bioinformatics in Drug Discovery.

UNIT 2

Introduction- Concept of Nanotechnology and Nanobiotechnology, History and importance of nanobiotechnology in modern science.

Nanomaterials: Concept of nanomaterials -Types and Synthesis of nanomaterials, protein based nano structures, DNA based nano structures,

Applications of nanobiotechnology in biosensors, drug delivery and gene therapy, disease diagnosis and therapy, risk potential of nanomaterials.

UNIT 3

Cell interaction: Introduction of Cell-to-cell interactions, Cell adhesion-integrins, selectins, cadherins. Cell Junction- Tight andgap junctions, Desmosomes.

Principles of cell signaling: Overview of receptor in cell signaling, Secondary messengers (cAMP), Calcium Calmodulin.

Signaling Pathways: GPCR mediated Cell Signaling.Receptor Protein Tyrosine Kinase and MAP Kinase Pathway of cell signaling.Nanoparticle mediated cell signaling

SUGGESTED READINGSs

- Introduction to Bioinformatics **Dhananjaya**.
- Essential Bioinformatics – **JinXiong**
- Bioinformatics- **Jhumur Das**
- Instant Notes on Bioinformatics-
- Bioinformatics **Higgins & Taylor** (2000).
- **Springer's** Bioinformatics
-
-
-
-

- Bioinformatics **Baxavanis**.
- Understanding Bioinformatics- **Marketa Zvelebil& Jeremy O. Baum**
- Nanobiotechnology: Concepts, Applications and Perspectives by **Christof M. Niemeyer and Chad A. Mirkin**
- Nanobiotechnology Handbook by **Tiffany Gardner**
- Nanobiotechnology: concepts, applications & perspectives **Niemeyer and Mirkin ed**.
- Nanobiotechnology in molecular diagnostics: current techniques and applications **Jain, KK.**
- "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education **T. Pradeep**
- "Bionanotechnology", John Wiley & Sons, **David S Goodsell,**

PAPER 4

A) Practical based on theory Paper 1,2 and 3

B) Project Report

Skill Enhancement Course in Biotechnology:

(Optional)

TITLE: BIOPROCESSING AND ITS APPLICATIONS

- History and design of fermenters. Basic function of fermenter
- Construction of fermenter: Control of temperature, aeration and agitation.
- Fermentation processes: Batch fermentation, Fed Batch Fermentation, Continuous Fermentation and Scale-up Fermentation.
- Fermenters: types and application of different types of fermenters and general outline of fermentation process.
- Downstream Processing: Extraction and purification of microbial metabolites.
- Fermentation and fermentable microbes.
- Fermentation products: Alcoholic and Non-alcoholic beverages.
- Immobilization of cells and enzymes: Methods, Techniques, stabilization, effect of immobilization on enzyme properties.
- Application of immobilized enzymes and cells.
- Basic ideas of Entrepreneurship

SUGGESTED READINGS

- Principles of fermentation Technology, **Salisbury. Whitaker and Hall**
- Biochemistry **– U. Satyanarayan**