

Department of Biotechnology
University College of Science
Mohanlal Sukhadia University
UDAIPUR 313001

Outline of Course Curriculum for B. Sc. Biotechnology
(Three Years Degree Course)

I Year TDC

Papers		Max. Marks	Pass Marks
Theory			
Paper I	Fundamentals of Chemistry	100	36
Paper II	Fundamentals of Physics	100	36
Paper III	Basic Biosciences	100	36
Paper IV	Mathematical and Statistical Methods For Biologists	100	36
Paper V	Fundamentals of Biological Chemistry	100	36
Paper VI	Biophysics and Instrumentation	100	36
Paper VII	Microbiology	100	36
Paper VIII	Microscopy and Use of Computers	100	36
Practicals			
Techniques in Chemistry and Biochemistry		50	17
Techniques in Physics, Biophysics and Instrumentation		50	17
Laboratory Exercises in Biosciences		50	17
Quantitative Methods in Biology		50	17
TOTAL		1000	

II Year TDC

Papers		Max. Marks	Pass Marks
Theory			
Paper I	Genetics and Immunology	100	36
Paper II	Cell Biology	100	36
Paper III	Metabolic Pathways	100	36
Paper IV	Fundamentals of Ecology and Environment	100	36
Paper V	Molecular Biology	100	36
Paper VI	Plant and Animal Tissue Culture	100	36
Paper VII	English	100	36
Practicals			
Exercises in Cell Biology and Genetics		50	17
Techniques in Molecular Biology		50	17
Tissue Culture Techniques		50	17
TOTAL		850	

III Year TDC

Papers		Max Marks	Pass Marks
Theory			
Paper I	Microbial Biotechnology	100	36
Paper II	Recombinant DNA Technology	100	36
Paper III	Biodiversity and Systematics	100	36
Paper IV	Large-Scale Manufacturing Processes	100	36
Paper V	Applications of Biotechnology in Agriculture and Health	100	36
Paper VI	Animal and Plant Development	100	36
Practicals			
Techniques in Genetic Engineering		50	17
Development Biology		50	17
Project		50	17
TOTAL		750	

Total Marks for all the Three Years	2600	
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**B. Sc. Biotechnology
First Year**

**PAPER – I
FUNDAMENTALS OF CHEMISTRY (THEORY)**

Unit-I

Gaseous State Kinetic theory of gases, and derivation of kinetic gas equation, Deduction of gas laws such as Boyle's Charles law, Graham's law of diffusion. Avogadro's principle, velocity of gas molecules, kinetic energy of translational motion. Dalton's law of partial pressure.

Colligative properties : Lowering of vapour pressure of solvent, elevation of boiling point, freezing point lowering of solutions, Osmosis and osmotic pressure, relation of osmotic and vapour pressure, Van't Hoff equation for osmotic pressure, Electrolytes, Arrhenius theory for dissociation of electrolytes, Debye-Huckel theory of inter-ionic attractions.

Unit-II

Phase Rule : Gibbs phase rule, one component/two component systems, determination of solid liquid equilibria, determination of nature of solid phases, classification of two component solid-liquid equilibria, simple eutectic diagram.

Ionic equilibria : Electrolytic conductance, Faraday's Laws of electrolysis, transference and transference numbers, variation of conductance with concentration, effect of infinite dilution and other factors on conductance, inter-ionic attraction theory of conductance, conductometric titrations, activity coefficients and their determination, Debye-Huckel theory of activity coefficients, ionization constants of weak acids and bases, pH, buffers, solubility product, salt effects and solubility.

Unit-III

Principles of electrochemistry : EMF and its measurement, single electrode potentials, calculation of single electrode potentials, thermodynamics of electrode potential, classification of electrodes, amalgam, gas, metal/insoluble salt and oxidation-reduction electrodes, electrochemical cells, the junction potentials, solubility product and EMF, potentiometric determination of pH, potentiometric titrations.

Unit-IV

Atomic chemistry-electromagnetism

Principles of oxidation-reduction

Bonding and structure

Attainment of stable configuration

Types of bonds, bonding in molecules-inorganic

Unit-V

Structure, bonding and reactivity in organic molecules, covalent bond

Organic chemistry : Structure Bonding and Reactivity in organic molecules, alcohols, aldehydes and ketones, acids, amines, phenols

Chemistry of biologically active molecules and classes of such molecules e.g., amino acids, sugars, fatty acids, purines, pyrimidines, vitamins, structure of proteins, carbohydrates, lipids and nucleic acids.

**B.Sc. (Biotechnology)
First Year**

**PAPER – II
FUNDAMENTALS OF PHYSICS**

M.M.: 100

Unit-I

Elasticity : Stress and strain in solids, Hook's law, Stress-strain curves, properties of Fluids : Viscosity, stream line and turbulent flow, Equation of continuity, Flow of liquids through capillaries, Poiseuille's equation, Reynold's number, Concept of pressure energy, Bernonlli's Theorem and its applications, Venturimeter, Pitot's tube, Viscosity estimates by Ostwald's viscometer, rotating cylinder, cone and plate.

Unit-II

Surface Tension : Surface tension and surface energy, capillary action, angle of contact, relation between surface tension, excess pressure and curvature, surface tension, soap bubble, Jaeger's method, Quincke's method, temperature dependence of surface tension.

Refrigeration : Introduction to refrigeration principle, coefficient of performance, simple structure of gas refrigerator.

Unit-III

The molecular organization of membranes and the role of lipids and carbohydrates. The importance of membranes in cellular metabolism.

Principles of modern instrumentation basic to physical, chemical and biological sciences, UV/VIS, atomic absorption, vibrational and nuclear magnetic resonance, mass spectrometry and chromatographic techniques, spectral identification, quantitative and qualitative analysis.

Conventional and non conventional energy sources, solar cells.

Unit-IV

Thermometry : Principles of Thermometry, Platinum resistance thermometer, thermocouple thermometers.

Atomic structure – Bohr H atom model, atomic nucleus.

Current electricity – DC circuits, concepts of AC circuits with resistor, Capacitor.

Unit-V

Optics : Diffraction, Polarisation and Interference, LASERS.

Semi Conductors : Semi Conductor Devices

Digital Electronics : Binary, BCD number system, Basic Logic Gates.

Fundamentals of measurements – Units

Recommended Books

1. Physics Vol I & II
NCERT Publication
2. College Physics Vol I and II
A.B. Gupta, Books and Allied (P) Ltd. Calcutta
3. Concepts of Physics Vol I & II
H.C. Verma (IIT. Kanpur)
Bharti Bhawan, New Delhi.

B.Sc. Biotechnology
PAPER – III
BASIC BIOSCIENCES

Unit-I

Introduction to plant world. Plant kingdom. The Classification up to the level of genus and species. Binomial nomenclature – Linnaeus theory. Algae (Uni and multicellular) fungi, bryophytes, pteridophytes, monocots, dicots, angiosperm and gymnosperms (with one example each).

Unit-II

Morphology : General organization of plant body such as aerial, underground parts. Differences in angiosperms and gymnosperms. Inflorescence – types of inflorescences, flower, function of each part of flower. Fruit – types of fruits, formation of fruit, parthenocarpy. Seed – formation of seed, seed germination and dormancy.

Unit-III

Anatomy : internal structure of stem, leaf and root of angiosperms and gymnosperms Differences in dicots and monocots, structure and function of different cells. Xylem and phloem. The concept of perennials. Annual ring and wood formation.

Unit-IV

Introduction to animal world, classification and taxonomy of animals. Animal classification – Importance, binomial nomenclature, five kingdom approach. Taxonomic hierarchy, concept of species. Study of animal types – Paramoecium. Hydra, Starfish, frog, earthworm – morphology, structure and classification special features, nutrition, respiration, reproduction, locomotion etc.

Unit-V

Environmental pollution : sources and types, air, water and harmful effect of pesticides, heavy metals, soil pollution, industrial waste. Vermiculture, apiculture, Agriculture pests and their control, sericulture, fisheries. Biodiversity – Concept and Evolution. Biodiversity and apomixis.

**B.Sc. (Biotechnology)
First Year**

**PAPER – IV
MATHEMATICAL AND STATISTICAL METHODS FOR
BIOLOGISTS (THEORY)**

Unit-I

Sets, Complex numbers, matrices, Linear algebra; linear systems of equations, row-reduction algorithms; linear dependence of vectors and subspace of Euclidean n-space; Eigen values and Eigen vectors; diagonalization of matrices.

Unit-II

Calculus : extension of systematic, indefinite integration beyond extension of differential equations including homogeneous and linear ODEs; Taylor's theorem; partial differentiation and local extreme of functions of two variables.

Unit – III

Convergence of series, Application to population growth models and mechanical system.

Principles of experimental design; analysis of variance models; planned and multiple comparison techniques; quality management; use of Statistical packages.

Unit – IV

Methods of Statistical data analysis, from the view point of the user, with an emphasis on planned experiments. Use of standard statistical packages. Topic covered include : multiple linear regression – analysis of residuals, choice of explanatory variables; models selection and validation; nonlinear relationships; introduction to logistic regression.

Unit – V

Descriptive statistics scatter plots, correlation, line of best fit. Elementary probability theory. Confidence intervals and hypothesis tests using normal, t and binomial distributions. Use of Minitab, ANOVA.

B.Sc. Biotechnology
First Year
PAPER – V
FUNDAMENTALS OF BIOLOGICAL CHEMISTRY

Unit – I

Introduction : Biological molecules. Molecular interactions as a basis for biological function. Chiral interactions, pH, pK, buffers. Mechanism of reactions – Nucleophilic substitution catalysis in chemical and biological reactions.

Unit – II

Esters; Acid and Base catalyzed hydrolysis; mechanism of action of serine hydrolysis; mechanism of action of serine hydrolases Lipids : structure of fatty acids Lipids, oils, fats, fatty acids-palmitic stearic, vitamins – water soluble.

Unit – III

Carbohydrates : definition, classification, structure, simple and complex carbohydrates. Polysaccharides : Structure and linkages in Di- and polysaccharides, energy reserve and structure polysaccharides, carbohydrates.

Unit – IV

Biomolecules : Nucleotides. Nucleosides, purines, pyrimidines, structure of nucleic acids, B, Z form of DNA. Structure and Properties of Amino acids, peptides peptide bonds. Protein structure : Nature of Amino Acids, the peptide bond, determination of primary sequence of secondary structure. The nature of tertiary and quaternary structure. Methods of determining protein structure.

Unit –V

Protein purification – Principles. Fractional precipitation with salts and organic solvents, chromatographic and electrophoretic methods. Enzymes and their role in metabolism-anabolism and catabolism. Enzymes and catalysts. Types of enzymes – classification.

B.Sc. (Biotechnology)

PAPER – VI
BIOPHYSICS AND INSTRUMENTATION (THEORY)

M.M.: 100

Unit – I

Thermodynamics as applied to biological system, First and second law of thermodynamics, Enthalpy, entropy, free energy, Gibbs's free energy, chemical potential, half cell potential, redox couple, Electron transfer mechanism, diffusion, Adsorption, Bioenergetics of mitochondria and chloroplast.

Unit – II

Spectroscopic principles, Energy levels, excitation, Absorption, electronic, Vibrational, rotational spectra, Application to Biomolecules, UV-Visible and IR spectroscopy fluorescence.

Radioactivity : Radioactive nucleus, half life, physical & Biological half life, Handling and standardization of α emitting and β emitting isotopes.

Unit –III

Choice of radio pharmaceuticals, its uptake, figure of merit and biological applications. Physical properties of membranes, cell and nuclear membranes, Passive and active transport, physical and kinetic model.

Unit – IV

Physico-Chemical properties of membrane, chemiosmotic hypothesis.

Electrical and mechanical properties of membranes, Conformational properties of membrane, Permeability of membrane and factors affecting it. Transport of substances across the membrane. Active and passive transport.

Unit-V

Instruments : Instruments used for thermoregulation, Centrifuges analytical and differential pH meter, G.M. Counter, scintillation counter, colorimeter, spectrophotometer, fluorometer, light and phase contrast microscopes. Scanning and transmission electron microscopes. Electrophoresis apparatus.

Recommended Books

1. Biophysics (A textbook for university students)
Dr. M.R. Rajeshwary (Rastogi Publications)
2. Biophysical Chemistry- Principles and Techniques
Avanish Upadhyay
Kakoli Upadhyay
Nirmanendu Nath
Himalaya Publishing House, New Delhi.
3. Text Book of Biochemistry
J.L. Jain, S. Chand
4. Cell Biology
C.B. Powar
Rastogi Pub.

B.Sc. Biotechnology
PAPER – VII
MICROBIOLOGY

Unit – I

Introduction to the microbial world; General properties and principles of classification for algae, actinomycetes, Fungi, Bacteria. Protozoa and Viruses (Outline classification included) Numerical Taxonomy. Systematics of bacteria.

Unit – II

Fungal ecology, fungal role in Biodeterioration, Plant diseases, brewing. Bacterial structure, nutrition, overview of metabolism, chemoautotrophic bacteria, phototrophic bacteria. Enteric bacteria; Gram positive fermenters, spore formers. Extremophiles. Marine microbiology. Antibiotics.

Unit – III

Virus diversity, Virus replication cycle, virus cell interactions, virus animal interactions. Virus epidemiology, Viruses of plants. Lytic bacteriophages, Teven and Todd. Lysogenic bacteriophage λ - life cycle.

Unit – IV

Concept of metabolism – unique pathways of microbes, Glycolysis, TCA, HMP, ED, fermentation, respiration, photosynthetic bacteria.

Unit – V

History of microbiology, population growth models, Methods of estimating microbial population, origin and evolution of life, fossil microorganisms, Archaeobacteria.

B.Sc. (Biotechnology)

First Year

PAPER – VIII

MICROSCOPY & USE OF COMPUTERS (THEORY)

M.M.: 100

Unit – I

Principles of microscopy, basic concepts, Optics, types of microscopes monocular, binocular, Kohlers illumination. Numerical aperture, Resolution power. Bright field, Dark field, phase contrast, fluorescence. Electron microscope-application and usage of microscope. Preparation and handling of specimens for microscopy.

Unit – II

Basics of computer hardware and software, machine languages, essentials of computer operation and application. Computer system – Basic structure, ALU memory, CPU,I/O devices. DOS-Fundamentals of DOS, Operating systems, input devices, memory – RAM, ROM etc., Storage device CD-ROM.

Unit – III

Data processing, flow chart, operating environment, Word Wordstar. Advance Spreadsheets, Algorithms- Definition & Properties. Flowchart- Principles, converting algorithm to flowcharting.

Unit – IV

Computer Networking, Modem, Components of LAN, WAN. Development and classification of computers.

Unit – V

Keyboards, storage devices, monitor interfacing, bus architecture and its effects on system performance. Use of basic programming in biology.

Recommendation of the Books

1. Computer fundamentals
Pradeep K. Sinha, Priti Sinha
BPB Publications
2. Computer Fundamentals, Architecture and Organization
B. Ram
New Age International
3. Biotechniques (Theory and Practice)
Prof. S.V.S. Rana
Rastogi Publications

B.Sc. Biotechnology
I YEAR TDC (PRACTICAL)

Techniques in Chemistry & Biochemistry

Determination of gas constant

Crystal models

Freezing point depression

Thermochemistry

Determination of an order of reaction

Acid-base titrations

Molarity, molality, normality

Unit volume & weight measurements

pH measurement

Optical activity of a chemical compound by polarimeter

Preparation of solutions, buffers – sensitivity, specificity accuracy

Spot test for carbohydrates

Estimation of reducing sugars by Benedict's Method

Spot tests for Amino Acids

Quantitative methods for Amino Acids

Protein estimation

Saponification of Fats

Estimation of Cholesterol

Enzyme assays

B.Sc. Biotechnology
I YEAR TDC (PRACTICAL)

Techniques in Physics, Biophysics & Instrumentation

Flat spiral spring : Y and n

Y of rectangular thin bar by bending

Viscosity measurement using Ostwalds viscometer.

Surface-tension measurement using Jaeger's method, soap bubble method

Temperature measurement : using thermocouple, RTD

Study of Lambert's and Beer's law

Absorption spectrum of protein

Fluorescence spectrum of protein

Counting statistics using G.M. counter

Study of DNA melting

Study of transport across membrane by potential measurement

To find out isoelectric point of amino acid

Instrumentation – Colorimeter

pH meter

Safety measure – time

Study of electronic components (resistance capacitance)

Microscopy – light

Viscosity

Instrumentation – Colorimeter

B.Sc. Biotechnology
I YEAR TDC (PRACTICAL)

Laboratory exercise in Bioscience

Study of example of each type i.e. bryophyte, pteridophyte, algae, fungi, Dicot, monocot and gymnosperm

Study of different parts of the plant – root, section, monocot/dicot.

Stem/section-dicot and monocot

Leaf, section dicot and monocot

Flower, inflorescence, seed, fruit types, morphology study

Microscopy

Introduction to Microbiology Laboratory

Aseptic Transfer Techniques

Observation of microorganisms

- a. Wet mount
- b. Monochrome staining
- c. Gram staining
- d. Spore staining
- e. Fungal staining

Isolation of bacteria by Streak Plate Technique

Enumeration techniques

- a. Pour Plate Method
- b. Spread Plate Method
- c. Neubauer Chamber
- d. Plaque Count

Study of Paramecium, *Hydra*

Study of *Drosophila* – Characters, sexual dimorphism – eye and wing mutations

Study of collection, preservation and presentation of insects

Study of different types of egg, larvae and pupae of insects

Use of microscope

**B.Sc. Biotechnology
II YEAR TDC**

**PAPER – I
GENETICS & IMMUNOLOGY**

Unit – I

Mendelian Inheritance patterns and laws of heredity

Co-dominance, linkage and linkage maps.

Unit – II

Mutations, variations and chromosomal alterations

Varieties of gene expressions – multiple alleles, lethal genes, pleiotropic genes, gene interactions etc.

Unit – III

DNA Transfer mechanism : Prokaryotes, Eukaryotes and viruses with examples.

Mobile genetic elements and transposons

Bacterial plasmids – structure and properties.

Unit – IV

Operon concept – with examples

Overview of immune system.

- a. History
- b. Adaptive immunity
- c. Innate immunity

Unit – V

Antigens; Antibodies – Structure and functions

Antigen – Antibody interactions, Principles and Applications

Introduction to vaccines : Active and Passive immunization, types of vaccines.

References

1. Strickberger “Genetics” (Macmillan)
2. Freifelder “Genetics”
3. Roitt “Essential Immunology”

B.Sc. Biotechnology
II YEAR TDC

PAPER – II
CELL BIOLOGY

Unit – I

Cell-shapes, morphology
Tissues : Types and functions
Cell theory

Unit – II

Cellular energy transactions – role of mitochondria and chloroplasts
Cytoskeleton

Unit – III

Intracellular compartments and protein trafficking.
Membrane transport

Unit – IV

Cell Signaling
Cell division cycle

Unit – V

The mechanism of cell division
Mathematical problems in cell biology

References

1. Lodish *et al.* “Molecular Cell Biology” (Scientific American Book)
2. De Robertis “Cell and Molecular Biology”
3. Eduard Gasque - “Manual of Laboratory Expts in Cell Biol.” (W.C. Wilson Public)

B.Sc. Biotechnology
II YEAR TDC

PAPER – III
METABOLIC PATHWAYS

Unit – I

Bioenergetics : General concepts of thermodynamics – energy, enthalpy, free energy, catalysis and activation energy, oxidation and reduction, potential, redox potential, high-energy bond and high energy compounds.

Unit – II

Metabolism – anabolism and catabolism – metabolic pathways and regulation-concpets

Enzymes-properties, purification, classification, kinetics allosteric regulation.

Unit – III

Carbohydrate metabolism EMP, HMP, ED, Phosphofructokinase pathways, details of individual steps, Glycolysis, Glycogenesis and gluconeogenesis, Citric acid cycle enzymes and pathways, Regulations of citric acid cycle, Regulation of carbohydrate metabolism.

Unit – IV

Respiration – aerobic and anaerobic respiration

Lipid and carbohydrate metabolism – Biosynthesis of fatty acids, degradation of fatty acids.

Unit – V

Nitrogen metabolism

Photosynthesis

Mathematical problems

References

1. Outlines of biochemistry : Conn and Stumpf
2. Principles of biochemistry : Voet and Voet
3. Principles of biochemistry : Jeffory Zubey
4. Clinical Biochemistry : A.C. Deb
5. Biochemistry : Stryer

B.Sc. Biotechnology
II YEAR TDC

PAPER – IV
FUNDAMENTALS OF ECOLOGY AND ENVIRONMENT

Unit – I

Basic Ecological Concepts and Principles
Our Environment : Geological Consideration
Atmosphere
Hydrosphere
Lithosphere
Scope of Ecology
Development and Evolution of Ecosystem

Unit – II

Principle and concepts of ecosystem
Structure of ecosystem
Strata of an ecosystem
Types of ecosystem
Cybernetics and Homeostasis
Biological control of chemical environment

Unit – III

Energy transfer in an ecosystem
Food chain, food web
Energy budget
Production and decomposition in a system
Ecological efficiencies
Trophic structure and energy pyramids
Ecological energetics

Unit – IV

Principles pertaining of limiting factors
Biogeochemical cycles (N.C.P. cycles)
Habitat Approach
Freshwater Ecology, Marine Ecology
Estuarine Ecosystem, Terrestrial
Radiation Ecology, Microbial Ecology
Space Ecology, Natural Resources
Pollution and Environmental Health

Unit – V

Pollution and Environmental Health
Soil
Water
Air
Food
Pesticides, Metals, Solvents, Radiation, Carcinogen, Poisons.
Detection of environmental pollution (Biochemical and Microbial detection)
Indicators and detection systems
Biotransformation
Plastics, Aromatics, Hazardous wastes
Environmental Cleanup : Case studies

References

1. E.P. Odum : Fundamentals of Ecology
2. Amann, R.I. Stromley, J. Stahl : Applied and Environmental Microbiology
3. Das : Concepts of Ecology
4. Chatterjee : Environmental Biotechnology
5. Verma and Agarwal : Environmental Biology
6. B.K. Sharma : Environmental Chemistry]
7. Peavy and Rowe : Environmental Pollution
8. Asthana and Asthana : Environmental Problems and Solutions
9. Manahan : Environmental Chemistry
10. Saigo, Canninham : Environmental Science

B.Sc. Biotechnology
II YEAR TDC

PAPER – V
MOLECULAR BIOLOGY

Unit – I

DNA as the genetic material

Nucleic acids –structure, properties and function : DNA : forms; RNA : tRNA, mRNA, rRNA

Unit – II

Genes and genetic code

Organization of Genomes – Viral, bacterial

Eukaryotic genomes : Chromosomal organization and structure (Nucleosome, heterochromatin), telomers, Organisation of chromatin – histone, nonhistone proteins.

Unit – III

Definition of gene – introns/exons, Regularly sequences, promoters

DNA replication – enzymes – general principle, semi – conservative mode of replication etc.

Unit – IV

DNA repair – mutations

Eukaryotic and prokaryote chromosomes, telomers, centromeres

Transcription – RNA polymerase, prokaryotic and eukaryotic RNA

Unit – V

Protein biosynthesis in prokaryotes, role of ribosomes, RNA mRNA, 2 Eukaryotic protein synthesis

Post translational modifications of proteins

References

1. Gene VII : Benjamin Lewin
2. Genome : T.A. Brown
3. Molecular biology of gene : Watson
4. Cell and molecular biology : Lodish

B.Sc. Biotechnology
II YEAR TDC

PAPER – VI
PLANT AND ANIMAL TISSUE CULTURE

Unit – I

Plant tissue culture

Introductory History – Concepts of Cell Theory and Cellular totipotency, Milestones in plant tissue culture.

Infrastructure and organization of plant tissue culture laboratory – General and aseptic laboratory, different work areas, equipments and instruments required, other requirements.

Aseptic techniques – Washing and preparation of glassware, packing and sterilization, media sterilization, surface sterilization, aseptic work station, precautions to maintain aseptic conditions.

Culture medium – Nutritional requirements of the explants, PGR's and their *in vitro* roles, media preparation.

Callus culture technique – Introduction, principle, protocol, factors affecting,

Morphology and internal structure, genetic variation, applications and limitations.

Unit – II

Suspension culture technique – Introduction, Principle, protocol, Types, growth and growth measurement, synchronization, applications and, limitations.

Organ culture technique – Introduction, principle, protocol, factors affecting applications and limitations with reference to Root tip culture, leaf culture, shoot tip and meristem culture, ovary and ovule culture.

Anther and pollen culture technique – Introduction, principle, protocol, factors affecting, applications and limitations.

Protoplast – Protoplast isolation, protoplast culture.

Unit – III

Micropropagation – Introduction, Stages of micropropagation, factors affecting different stages of micropropagation, problems and limitations, application.

Different pathway of micropropagation – a) axillary bud proliferation, b) somatic embryogenesis, c) organogenesis d) meristem culture

Production of secondary metabolites and biotransformations – Introduction, Principle, optimization of yield, commercial aspects, biotransformation applications and limitations.

Other applications of plant tissue culture –

Somatic hybridization – Protoplast fusion techniques, selection of hybrids, production of symmetric and asymmetric hybrids and cybrid production.

Somaclonal variation – Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, applications and limitations.

Germplasm preservation – Introduction, principle, long-term storage, factors affecting, short/medium term storage technique, applications and limitations.

Unit – IV

Genetic Transformations – DNA uptake by seeds, pollens, transformation of protoplasts, agrobacterium mediated transformations, direct DNA transfer methods – electroporation, microprojectile bombardment, microinjection, use of marker genes, Integration and expression of foreign DNA, applications in crop improvement.

Production of artificial seeds – techniques, factors affecting, application and limitations.

Commercial aspects of plant tissue culture –Location, design and requirements of commercial laboratory, selection of plants, reduction in production cost, production management.

Unit – V

Animal Tissue culture :

Animal tissue culture – Principles and practice cleanliness, precautions, care to be taken.

Nutrition and physiology media components – serum balanced salt solutions, washing, packing, sterilization practices instruments.

Primary cell culture, establishing maintenance lymphocyte culture

Cell lines – insects and animals cells subculture

Organ and tissue culture

Karyotyping, biochemical and genetic characterization of cell lines

Cell Repositories, their function

Application of animal cell cultures.

References

1. “Animal tissue culture” by Paul.
2. Introduction to Plant tissue culture : M.K. Razdan
3. Plant tissue culture : theory and practice : S.S. Bhojwani and M.K. Razdan
4. Micropropagation : Debergh and Zimmermann
5. Plant tissue culture : Kalyankumar Dey

B.Sc. Biotechnology
II YEAR TDC

PAPER – VII
ENGLISH

Unit – I

Programme of writing : Thinking and planning, information, ideas, topic outline, order of paragraph writing, revising.

Unit – II

Use of vocabulary : meaning of words, precise usages synonym, technical terms, nomenclature, context, superfluous words.

Use of Good English : Noun, Pronoun, verb, adverb, adjective, conjunction, article, tense, spelling etc.

Unit – III

Compilation of experimental records, writing progress reports.

Communication skill – Letters and memoranda communication as a part of science.

Unit – IV

Reading : How to read, making notes as you read, writing a book review.

Helping the reader – easy reading (how to begin, control, explain, sentence length, rhythm, style) capture and hold readers interest – effective communication.

Unit – V

The art of illustrations, figures

The art of thesis and report writing

Editing and correcting

References

1. “Written communication in English” Sarah Freeman
2. “English for students of science”, A. Roy, P.L. Sharma
3. McMillan Grammar : A Handbook of “Augustine and Joseph”, Orient Longman
4. A new guide to précis writing, R.W. Jepson (O.L.)

B.Sc. Biotechnology
II YEAR TDC (PRACTICALS)

Exercises in Cell Biology & Genetics

Cell structure – prokaryotes and eukaryotes

Separation of cells using sedimentation and velocity centrifugation

Study of subcellular organelles

Isolation and characterization of subcellular components – isolation of nuclei from rat liver

Isolation of mitochondria

Demonstration of phenolase/phosphatase in tissue section

Cell harvesting and cell lysis – methodology

Observation of *Drosophila* – Wild and mutant

Problem sets in Mendelian inheritance, single point two point crosses and gene mapping in bacteria

Isolation of mutants, isolation and enumeration of phages

UV survival curve

Immunoprecipitation

Demonstration of Antigen – Antibody reaction through clinical approach.

B.Sc. Biotechnology
II YEAR TDC (PRACTICALS)

Techniques in Molecular Biology

Criteria for reliability of qualitative experiments

Importance of clean handling, sterility, cleanliness

DNA isolation (a) Bacterial DNA, (b) Eukaryotic DNA

Agarose gel electrophoresis to separate DNA

Problems on gene, gene structure, chromosome, chromosome structure

Restriction enzyme digestion

Agarose gel electrophoresis

UV spectroscopy – DNA, RNA proteins

Protein estimation

SDS – PAGE separation of proteins

B.Sc. Biotechnology
II YEAR TDC (PRACTICALS)

Tissue Culture Techniques

Plant tissue culture

Introduction to PTC laboratory

Aseptic manipulation – washing, capping, packing and sterilization, laminar operation and general precautions.

Stock solutions and media preparation

Aseptic seed germination

Callus culture technique – Initiation of culture, callus morphology and internal structure.

Suspension culture technique – Initiation of culture, growth measurement

Micropropagation stage – I-Initiation of micropropagation-shoot tip and axillary bud culture technique

Micropropagation stage – II-Subculture and multiplication of culture

Micropropagation stage – III-Rooting – *in vitro* and *ex vitro*

Micropropagation stage – IV-acclimatization and hardening

Visit to a commercial plant tissue culture laboratory

Animal tissue culture :

Animal cell culture media preparation, sterilization, washing, packing

Observation of cells in culture – Principles and practice

Lymphocyte culture

Maintenance of cell lines

Visit to cell culture facilities/production set up

B.Sc. Biotechnology
III YEAR TDC

PAPER – I
MICROBIAL BIOTECHNOLOGY

Unit – I

Microbial Biotechnology – Historical perspectives

Microbial Growth Kinetics

Continuous culture, Batch fed culture, Cell constituents, Quantification of growth, Thermodynamics of growth, Y_{ATP} , $Y_{x/s}$, Y_{O_2} . Effect of different factors on growth.

Study of growth with respect to product formation.

Unit – II

Fermentation concept and types.

Basic nutrition and metabolism. Novel pathways of microorganisms.

Microbial strain improvement.

Bacterial genetics, Operon concept with examples (lac, tryptophan, arabinose).

Unit – III

Gene mapping – Transformation, conjugation, transduction.

Microbial and Viral diseases, Normal flora of the body, Infection of different systems, Chemotherapy – Use of antibiotics, antiviral agents.

Unit – IV

Food and Dairy Microbiology – Microbial flora, Microbial spoilage, Preservation, Microbes as single cell proteins.

Treatment schemes of Waste Water, Assessment of wastewater (water potability).

Unit – V

Sewage treatment plants, Aerobic and Anerobic treatment processes

Integration of genetic engineering and applied microbiology Uses of genetically engineered microbes in Agriculture, Industries, Medicine.

References

1. Microbiology, Pelczar
2. General Microbiology, Stainer
3. Food Microbiology, Frazier
4. Principles of Fermentation Technology, Whitaker, A., 2nd Edition.

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PAPER – II
RECOMBINANT DNA TECHNOLOGY

Unit – I

Scope of Genetic Engineering

Milestones of genetic engineering – Historical perspective, Recombinant DNA technology-Introduction.

Molecular tools and applications – restriction enzymes, ligases, polymerases, alkaline phosphates.

Unit – II

Gene cloning Vehicles – vector, properties of plasmids and phages, host-properties of host

Transformation – techniques of introducing DNA. Selection of transformants, insertional inactivation.

Unit – III

Nucleic acid purification, yield, yield, analysis, plasmid characterization, isolation strategies.

DNA sequencing techniques – Maxam-Gilbert, Dideoxy

Restriction enzymes digestion and restriction mapping southern and northern analysis.

Unit – IV

Genomic library – screening of recombinants

Restriction mapping of DNA, gene manipulations, PCR technology.

CDNA library, reverse transcription comparison between genomic and CDNA library.

Unit – V

Applications of genetic engineering-in plants, microbes and animals-Guidelines for release of engineered life forms.

Genomic and genome mapping. DNA fingerprinting.

References

1. Molecular Biology of the gene : Watson J.D.
2. Molecular Biotechnology : Glick
3. Milestones in Biotechnology – Classic papers in Genetic Engineering : J.A. Davis, W.S. Resnikoff
4. DNA Cloning – A Practical approach : D.M. Glover and B.D. Hames

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PAPER – III
BIODIVERSITY AND SYSTEMATICS

Unit – I

Principles and Concepts pertaining organization at community level
Ecological Dominance
Species diversity
Ecotones and Edge Effect
Paleoecology
Population dynamics
Population density and relative abundance
Population age distribution
Growth forms and carrying capacity
Population Structure : Isolation and Territoriality
Interactions

Unit – II

The species and individual in the ecosystem
Habitat and Niche
Ecological Equivalence
Biological Clock
Basic behavioral Patterns
Biodiversity and major biomes of world Biogeography : Specific flora and fauna

Unit – III

Conservation and preservation of Biodiversity
Importance
Conservation strategies – Wildlife conserves, forests, endangered flora and fauna, biosphere reserves, Sanctuaries, and national Parks
Ex-situ conservation strategies
Conservation laws, policies, organizations

Unit – IV

Bioprospecting
Taxonomic Principles:
History
Aims and Objectives
Hierarchy and Kingdoms
Nomenclature and classification

Unit – V

Tools and Techniques of taxonomy w.r.t. microorganisms, Plant and animals.

Morphological Keys and Taxonomy, Merits and Demerits

Chemotaxonomy

Cytotaxonomy

Numerical Taxonomy

Molecular Taxonomy

Analysis of Biodiversity

Evaluation of Biodiversity Indices

Biostatistics

Mathematical Modeling for analysis of Population, Variation

References

1. Begon and Harper Ecology
2. M. Kato : The Biology of Biodiversity
3. E.O. Wilson : Biodiversity
4. Stearns and Hoekstra : Evolution
5. Alcock : Animal Behaviour
6. Gilbert : Development Biology
7. Freeman and Herron : Ecological Analysis
8. E. Mayor : Elements of Taxonomy

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PAPER – IV
LARGE SCALE MANUFACTURING PROCESSES

Unit – I

Introduction to concepts of bioprocess engineering, Definition of bioprocess Engineering, Overview of Bioprocesses with their various compounds, Scales of operation and their global impact on Bioprocesses.

Introduction to Simple engineering Calculations, Mass and Energy Balances Fermenters, Bioreactors : Construction, Design and Operation, Materials of Construction, Welding, Surface treatment, Components of the fermenters and their specifications.

Unit – II

Air and Media Sterilization : Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth and Screen Filters, Sizing, Testing and validation of filters for air sterilization.

Principles of Media sterilization, Decimal reduction, Design of sterilization cycle using kinetics of thermal death of microbes. Equipments used in sterilization; Batch and Continuous.

Media for large-scale processes and their optimization : Constituents of media, their estimation and quantification. Design of media. Costing of media.

Unit – III

Type of Bioprocesses : Biotransformations (Enzyme, whole cell), Batch Fed-Batch, Cell recycle and Continuous fermentation process. Monod Model and constitutive equations used for expressing growth, substrate consumption and product formation, Solid State Fermentation.

Enzyme and cell immobilization (industrial aspects) Properties of enzymes to be immobilized. Adsorption, Covalent binding, Entrapment or encapsulation. Properties of immobilized enzymes (K_m , K_s , cycle time half time). Inactivation kinetics.

Unit – IV

Measurement and Control of Bioprocess Parameters. Cell Growth. pH temperature, Substrate consumption, product formation, Measurement of O_2/CO_2 uptake, evolution. Specific rates of consumption substrate and formation of product. Strategies for fermentation control. Computer controlled fermentations. Formation of heat, cooling requirements, Foam and its control. Oxygen uptake rate (OUR), K_{1a} , Viscosity and its control. Scale up in Bioprocess fermentations, Factors used in scale up.

Quality Control, Quality assurance, standard operating Procedures (SOP) Good Manufacturing Practices (GMP)

Unit – V

Product Recovery and Down Stream Processing in Fermentation and Bioprocess Technology. Solid-liquid separation (Flocculation, Filtration, centrifugation), Cell disruption (Solid and liquid shear), Extraction, Precipitation, distillation, Evaporation, Chromatographic separation, Adsorption, Concentration, Lyophilization, spray drying.

Industrial processes and applications; description of manufacture of enzymes (lipase, protease and nucleases), Antibiotics, amino acids, vitamins, ethanol, vaccines (FMD, DPT, New Castle disease), Single cell protein (Methanolic yeast, *Spirulina*).

Bioprocess Economics, Choice of process, process analysis, fixed and variable cost, Depreciation, Amortized costs, Selection of Pricing, Profitability, Scales of operation etc.

References

1. Principles of Fermentation Technology 'Whittaker & Stunburry, Pergamon Press.
2. Bioprocess Engineering Principles' Pauline Dcran, Academic Press, 1995.
3. Operational Modes of Bioreactors 'BIOTOL series, Butter worth Heinemann 1992.
4. Bioreactor design and Product Yield 'BIOTOL series, Butter worth Heinemann 1992.
5. Bioprocess Engineering : systems, equipments and facilities' Ed. B. Lydersen, N.A. 'Delia and K.M. Nelson John Wiley & Sons Inc., 1993.
6. Bioseparation and Bioprocessing 'Ed. G. Subramaniam Wiley-VCH, 1998.
7. Product Recovery in Bioprocess Technology 'BIOTOL series, Butter worth Heinemann 1992.
8. Bioseparation : Downstream Processing for Biotechnology 'Paul A. Belter, E.L. Cussler, Wei-Shou Hu, Academic Press.
9. Solvent Extraction in Biotechnology 'Larl Schuger Springer Verlag, 1994.

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**PAPER – V
APPLICATIONS OF BIOTECHNOLOGY IN AGRICULTURE
AND HEALTH**

Unit – I

Plant Tissue Culture – Plant transformation, Micropropagation, Clonal propagation technology.

Cryopreservation, slow growth and DNA banking of germplasms, hybrids and hybrids.

Unit – II

L and R₁ plasmids, gene manipulation CaMV, 35S promoter, shuttle vector, *Agrobacterium*

Methodology of gene transfer in plants, metabolic engineering, Application of plant transformation for selection of desirable phenotypes.

Unit – III

Genetically modified crops, GM food, ethical and social aspects, IRR and patenting Risk Assessment.

Molecular markers, RFLP, disease, QTL, AFLP, Greenhouse and green-home technology.

Unit – IV

Application of animal cell culture, organ culture, cell cloning and micromanipulation Growing cells in serum free media, scaling up, Hybridoma and microclonals tissue engineering

Vaccines- principles and practice

Unit – V

Diagnostic technology- PCR, RFLP, Molecular markers

Biosensors – Principles, applications

Recombinant products for human health

Epidemiology and Public health

References

1. Animal Cell Culture, Paul.
2. Plant Biotechnology, J. Hammond & P. McGravey, V. Yushibov, Springer Verlag.
3. Methods of Cell Biology, Vol. 57.
4. Culture of Animal Cells, R. Ian Freshney Wiley less

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PAPER – VI
ANIMAL AND PLANT DEVELOPMENT

Unit – I

Gametogenesis, Fermentation, Development

Types and Patterns of cleavage, blastulation

Gastrulation in frog and chick up to formation of three germ layers

Unit – II

Concepts of competence, determination and differentiation

Role of genes/s in patterning and development. Concept of stem cells progenitor cells, cell hirages

Unit – III

Ageing and Apoptosis, abnormal development. Cancer teretogenesis

Cloning in mammals, transgenic technology, concepts of stem cells

Unit – IV

Differentiation, dedifferentiation, redifferentiation, commitment, transdifferentiation, developmental plasticity

Plant embryogenesis-monocots and dicots Meristems, Plant hormones.

Unit – V

Organogenesis, somatic embryogenesis, regeneration of plant, protoplasts *Arabidopsis*-as a plant development model system, floral patterning, shoot and root patterning.

Cell fusion and somatic cell genetics, Immunoglobulin genes and antibody diversity.

References

1. An introduction to Embryology, Balinsky
2. Developmental Biology, Gilbert
3. Biology of Development system

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Techniques in Genetic Engineering

Isolation of plasmid DNA

Isolation and Quantitation of nucleic acids

Ligation theory and ligation of DNA

Development of competent cell system

Transformation of *E. coli* and selection of recombinants.

Restriction mapping of DNA

Reporter gene assay

Southern blotting techniques

PCR and PCR analysis

Concept of databases. Accessing databases

Searching for gene and protein sequences and accessing information from web

DNA sequencing

Information from genomes, BLAST, FASTA

Expression of genes in *E. coli*

Colony blotting techniques

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Developmental Biology

Study of different types of eggs.

Study of egg of hen and vital staining of embryo.

Study of frog development, observation of frog embryo different development stages.

Study of different types of sperms by smear preparation.

Frequency of genetic traits in human

Sex-linked inheritance

Multiple allelism

Study of plant development, collection and observation of type species

Growth curve study – Bacterial, fungal

Production of primary metabolite

Production of secondary metabolite

Biomass production (Baker's yeast, Bioinoculants)

Production of beverages (alcohol, wine)

Downstream processing of a fermentation product

Estimation of the fermentation products (Titration, Bioassay)