B.Sc. Part – I
BIOTECHNOLOGY 2021

Theory

Course	Nomenclature	Number of Papers	Number of Periods per week	Maximum marks	Minimum marks
Paper I	Biochemistry and Biostatistics	1	2	50	54
Paper II	Cell Biology and Genetics	1	2	50	
Paper III	Microbiology and Computational Biology	1	2	50	
PRACTICAL COURSE			6	75	27

Duration of examination of each theory papers 3 hours
Duration of examination of practicals 5 hours

PAPER I: BIOCHEMISTRY AND BIOSTATISTICS

Max Marks: 50

Unit 1: Introduction: General Composition of living matter-A Brief account and function of biomolecules. Bioenergetics: Principles of bioenergetics. Energy Rich compounds. Biological oxidation-reduction reactions.
Water: Properties of water molecule, Hydrophilic and hydrophobic groups in biological molecules.
Carbohydrates: Classification and general structure and properties of monosaccharides.
Lipids: Classification and general structure, properties of fats and Oils.

Unit II: Amino Acids: Classification, general structure and properties
Proteins: Classification three–dimensional structure (helicity, bending, pleats, salt-bridges etc) and the basis for intermolecular interactions in enzyme– substrate and antigen-antibody recognition.
Nucleotides: Composition, General structure and properties.
Nucleic Acids: Types and general structure, Non-canonical DNA Structures (Bent DNA, cruciform triple stranded, G quartet, slipped DNA)

Unit III: Enzymes: Classification, Nature specificity & mechanism of catalysis, kinetics,inhibition, allosteric control.
Enzyme Technology: Enzyme Production, various sources of enzymes, extraction, purification & packaging.
Enzyme Applications: Therapeutic, Manipulative, Industrial and Analytical (ELISA & Biosensors)

Unit IV: Collection, classification, Tabulation and diagrammatic and graphical representation of statistical data: Histogram, pie chart, bar diagram, frequency polygon. Measurement of central tendency: Mean, Median, Mode.

Unit V: Measurement of dispersion : Mean Deviation, Standard Deviation, Standard Error, Variance, Coefficient of correlation, test for significance : t-test, (Single sample Mean and Two sample Mean), Chi-Square Test and F-Test.

PAPER II: CELL BIOLOGY AND GENETICS

Max Marks: 50

Unit I: Cell as a basic unit of living systems: The cell theory. Prokaryotic and Eukaryotic Cell, Eukaryotic Cell – Shape Size, Volume, and Number.
Broad classification of cell types: PPLOs, Bacteria, Plant and Animal cells. A detail classification of cell types within an organism. Cell, tissue, organ and organisms as different levels of organization.

Unit II: Structure and functions of cell organelles; ultra structure of cell membranes, Cytosol, Golgi bodies, Endoplasmic reticulum (rough and smooth), Ribosome, Cytoskeletal structure (actins, microtubule etc), Mitochondria, Chloroplasts, Lysosomes, Peroxisomes, and Nucleus (Nuclear membrane, nucleoplasm, nucleolus and chromatin).
Cell division, cell cycle and cell growth.

Unit III: Nature of genetic material, nucleic acids, DNA replication, Mendelian laws of inheritance, gene interaction.
Sex determination in plants and animals.Sex linkage, non-disjunction as a proof of chromosomal theory of inheritance. Linkage mapping of genes, interference, coincidence in Prokaryotes and Eukaryotes.

Unit IV: Chromosome: Chemical composition: Structural organization of chromatids, centromeres, chromatin, telomeres, nucleosomes, euchromatin and heterochromatin. Special types of chromosomes (e.g. polytene and lampbrush chromosomes); Mutations; spontaneous and induced; chemical and physical mutagens.

Unit V: Basic microbial genetics; conjugation, transduction and transformation. Isolation of auxotrophs, Replica plating techniques, analysis of mutations in biochemical pathways, one-gene-one-enzyme hypothesis. Extra chromosomal inheritance, genetic systems of mitochondria and chloroplast

PAPER III: MICROBIOLOGY AND COMPUTATIONAL BIOLOGY

Max Marks: 50

Unit I: Development of microscopy (Optical, TEM and SEM). The Concept of sterilization, Methods of sterilization (Dry heat, wet heat, radiation, chemicals and filtration etc.)

Unit II: Prokaryotic and eukaryotic microbial cells. The various forms of microorganisms-PPLO'S, Cocci, Bacilli and Spirilla. Nature of microbial cell

surfaces, gram (+) ve and gram (-) ve bacteria, Types of bacteria on the basis of flagella. Flagellar types in Gram (+) ve and Gram (-) ve bacteria.

Unit III: Nutritional classification of microorganisms-symbiosis and antibiosis among microbial populations.Microorganisms in extreme environments.Pathogenicity among microorganisms. Defence mechanism against microorganisms and Serotypes.

Unit IV: Microbial metabolism: Spontaneous and induced variation arising in microbial population.Recombination events in bacteria. Nitrogen-fixing microbes in Agriculture. Products from microorganisms-fermentation products, and antibiotics.

Unit V: Computers: General introduction to Computers, organization of computers, digital and analog computers, computer algorithms.

Computer in online monitoring and automation. Application of computers in co-ordination of solute concentration, pH and temperature etc. of a fermenter in operation.

Introduction to Bioinformatics. Molecular databases, application of data associates tools e.g. BLAST, FASTA, Storage, Retrieval and analysis of sequences. Application of bioinformatics.

Practical Exercises

1. Quantitative estimation of the following in biological samples:
   a. Sugar in given solution
   b. Sugar in biological sample
   c. Extraction and separation of lipids
   d. Estimation of proteins
   e. Estimation of DNA/RNA
   f. Isolation and purification of proteins
   g. Assays for enzyme activity
   h. Kinetic activities on enzymes
   i. Chromatographic methods of separation of macromolecules

2. Demonstration of computers and application.
3. Aseptic techniques:
   a. Preparation of media, cotton plugging and sterilization
   b. Personal hygiene-microbes from hands, teeth and other body parts.
   c. Isolation of microorganism from air, water and soil sample. Dilution and pour plating, colony purification
   d. Enumeration of micro organism from: Total v/s viable counts.
   e. Identification of isolated bacteria. Gram staining, other staining methods, metabolic characteristic.
   f. Growth curve of microorganisms.
   g. Antibiotic sensitivity of microbes- use of antibiotic discs.
4. Permanent slides of cell division (mitosis and meiosis)
5. Spots related to Microscopy

Suggested Readings

Cox, Nelson &Lehninger- Principles of Biochemistry, CBS Publishers & Distributors
L.Stryer- Biochemistry- W.H. Freeman & Co.
Geoffrey Zubay- Biochemistry- Mac-Millan Publishing Co.
J.L. Jain – Biochemistry – S. Chand & Co.

Conn, Stumpf & Blueumming- Outlines of Biochemistry- Wiley Eastern Ltd.
G.M. Malacinski& David Freifelder – Essentials of Molecular Biology- Jonnes&Barlet , Boston
Gardner, Simmons &Snustad- Principles of Genetics, John Wiley & Sons.
P.K. Gupta- a Text book of cell & molecular biology, Rastogi Publication Meerut.
Trevor Palmer- Enzymes- biochemistry, Biotechnology & Clinical Chemistry- Horwood Publishing House.
P D Sharma- Microbiology- Rastogi Publications
Pawar&Daginawala-General Microbiology Vol I & II – Himalaya Publishing House
A J Salle- Fundamental Principles of Bacteriology- Tata McGraw Hill
Pelczar, Chan &Kreib Microbiology – Tata McGraw Hill
Brock & Madigan- Biology of microganisms.Prentice Hall, Inc.
Higgins & Taylor – Bioinformatics, Oxford University Press.
Stephen P Hunt & Rick Liveey- Functional Genomics, Oxford University Press
Rashidi- Bioinformatics basic- Application to life Sciences & Medical Science ASM
B D Singh- Genetics, Kalyani Publishers, Kolkata

Practical Scheme

Time: 5.00 h — Max Mark: 75
Min Mark: 27

1.	Perform and explain the given biotechnology experiment. Show the result to the examiner	15
2.	Perform and explain the given microbiology experiment.	10
3.	Prepare a bacterial slide by Gram's staining method and report result	06
4.	Identify and comment upon the spots (1 to 6)	24
5.	Viva-Voce	10
6.	Practical Record	10

B.Sc. Part – II
BIOTECHNOLGOY 2022

Theory

Course	Nomenclature	Number of Papers	Number of Periods per week	Maximum marks	Minimum marks
Paper I	Molecular Biology	1	2	50	
Paper II	Biophysics	1	2	50	
Paper III	Immunology and Cell Culture	1	2	50	54
PRACTICAL COURSE			6	75	27

Duration of examination of each theory papers 3 hours
Duration of examination of practicals 5 hours

PAPER I: MOLECULAR BIOLOGY

Max Marks: 50

Unit 1: Molecular basis of life, Structure of DNA, DNA replication in prokaryotes andeukaryotes. Concepts of genomics and proteomics.

Unit 2: DNA recombination-molecular mechanism in prokaryotes and eukaryotes. Insertion elements and transposons. Structure of prokaryotic genes.

Unit 3: Prokaryotic transcription, prokaryotic translation, prokaryotic gene expression (*lac*, his, *trp*, catabolic repression).

Unit 4: Structure of eukaryotic genes- transcription, eukaryotic translation, eukaryotic gene expression and transcription factors.

Unit 5: Gene expression in yeast, post translation regulation of gene expression. Developmental and environmental regulation of gene expression.

PAPER II: BIOPHYSICS

Max Marks: 50

Unit I: Law of thermodynamics, Enthalpy, Free Energy, Heat dissipation and heat conservation. Primary events in Photosynthesis.

Unit II: Strategies of light reception in microbes, plants and animals. Electrical properties of biological components.

Unit III: Generation and reception of sonic vibrations. Hearing aids, Intra and intermolecular interactions in biological system.

Unit IV: Physical methods applied to find out molecular structure: X-ray crystallography and NMR. General Spectroscopy, Lambert-Beer Law, Spectrophotometry & Colorimetery, UV-VIS, Fluorescence, AAS, IR, Raman Spectra

Unit V: Physical methods of imaging intact structure: Ultra sound, Optical filters, X-ray, CAT scans, ECG, EEG, NMR imaging.

PAPER III: IMMUNOLOGY AND CELL CULTURE

Max. Marks: 50

Unit I: The immune system along with historical perspectives. Non-specific & specific immune mechanism, organs and cells of immunity and their function. Concept of Acquired and innate immunity and antigen.

Unit II: Structure and function of various classes of immuno-globulins
Humoral Immunity – Mechanism involved
Cell mediated immunity role of MHC, mechanism and cells involved.
Vaccines – Dead, live attenuated, recombinant, edible and chimeric vaccines.

Unit III: History of animal cell cultures. Biology of cultured Cells-the culture environment, Cell adhesion, Cell proliferation, energy metabolism.
Culture Vessels: The substrate, choice of culture vessels.
Laboratory requirements and sterilization techniques.
Simulating natural condition for growing animal cells- Importance of growth factor is serum.

Unit IV: Primary cultures: Isolation of tissue, primary explants cell line– Nomenclature, Subculture & Propagation, finite and continuous cell lines.
Commonly used cell lines: their origin and characteristics, growth kinetic and cell lines.

Unit V: Application of animal cell culture
Cell Separation, characterization and differentiation
Transformation–Characteristics and applications
Transfection of animal cell & selectable markers.

Practical Exercises

1. Separation of molecules in cellular extract in aqueous buffer
(a) Gel Filtration
(b) Ion exchange chromatography
(c) TLC of extracted material
(d) Isolation of chromosomal and plasmid DNA from bacteria
(e) Restriction digestion of DNA and assigning restriction sites (demonstrations)
2. Making competent cells of E-coli
3. Transfection cells of plasmid DNA and selection for transformants.
4. Purification of antigens and antibodies
(a) Raising polyclonal antibodies
(b) Enzyme Linked Immunoassay
5. Radio immunoassay
(a) Diagnosis of an infectious disease by an immunoassay
6. Spots related to Spectrophotometry and Spectroscopy

Book Recommended

Buchanan, Gruissem& Jones: Biochemistry and molecular biology of plants –American Society of Plant Physiologist, Maryland USA
Peter Paolella: Introduction to molecular biology. Tata McGraw Hill
Alberts, Bray, Lewis, Raff, Roberts & Watson: Molecular Biology of the cell. Garland Publishing Inc.
Darnell, Lodish& Baltimore: Molecular cell Biology –Scientific American Books
Roitt, Male &Brostoff: Immunology. Mobey, London
Roitt: Essential Immunology – Blackwell Scientific
Lewin: Gene VIII, Oxford University Press
Kuby J: Immunology –Understanding of immune system Wiley Liss NY
VolKenshtein: Biophysics, Russian Press
Deniel, M: Basic biophysics for biologists, Agrobios
Van HoIde: Principles of Physical biochemistry, Prentice Hall

Practical Scheme

Time: 5.00 Hrs — Max Mark: 75
Min Mark: 27

1.	Perform and explain the given Molecular Biology experiment. Show the result to the examiner	12
2.	Perform and explain the given Biophysics experiment.	12
3.	Perform and explain the given immunology and/or cell culture Experiment	12
4.	Identify and Comment upon the spots (1 to 7)	21
5.	Viva-Voce	10
6.	Practical Record	08

B.Sc. Part –III
BIOTECHNOLOGY 2023

Theory

Course	Nomenclature	Number of Papers	Number of Periods per week	Maximum marks	Minimum marks
Paper I	Recombinant DNA Technology	1	2	50	54
Paper II	Plant Biotechnology	1	2	50	
Paper III	Environmental and Animal Biotechnology	1	2	50	
PRACTICAL COURSE			6	75	27

Duration of examination of each theory papers 3 hours
Duration of examination of practicals 5 hours

Max Marks: 50

PAPER I: RECOMBINANT DNA TECHNOLOGY

Unit I: What is gene cloning and why do we need to clone gene? Tools and Techniques: Plasmid and other vehicle. Genomic-DNA, handling of DNA and RNA. Restriction enzymes and reagents. Laboratory techniques and other requirements.

Unit II: Safety measures and related regulations for recombinant DNA work, choice and selection of the tools and techniques. Vehicles: Plasmids and bacteriophages, available phagemids, cosmids and viruses.

Unit III: Purification of DNA from bacteria, plant and animal cells. Manipulation of purified DNA. Introduction of DNA into living cells. Cloning vectors for *E-coli*.

Unit IV: Cloning vectors for organism other than *E-coli,* yeast, fungi, plants- agro bacteria, plants viruses and animal viruses. Applications of cloning in gene analysis- how to obtain a clone of a specific gene, studying gene location and structure, studying gene expression.

Unit V: Gene cloning and expression of foreign genes in research and biotechnology. Production of protein from cloned genes. Gene cloning in medicine: Pharmaceutical compounds, artificial insulin gene, recombinant vaccine, and diagnostic reagents.

PAPER II: PLANT BIOTECHNOLOGY

Max Marks: 50

Unit I: Introduction to in–vitro methods. Terms and definitions. Use of growth regulators. Beginning of in-vitro cultures in India (Ovary and Ovule culture), in-vitro pollination and fertilization. Embryo culture, embryo rescue after wide hybridization and its application.

Unit II: Introduction to processes of embryogenesis and organogenesis and their practical applications. Clonal multiplication of elite species (micropropagation) through axillary bud, shoot tip and meristem culture Haploids and their applications. Soma clonal variation and their applications.

Unit III: Endosperm culture and production of triploids.
Single Cell suspension culture and their application in selection of variant mutants with or without mutagen treatment (of haploid cultures preferably).

Unit IV: Testing of viability of isolated protoplasts, various steps in the isolation and regeneration of protoplasts.
Somatic hybridization – Introduction, various methods of fusion of protoplasts (chemical and electrical), use of markers for selection of hybrid cells.

Unit V: Practical application of somatic hybridization (hybrids/cybrids). Use of plant cell, protoplasts and tissue culture for genetic manipulation of plants. Introduction to *Agrobacterium tumefaciens*: Tumor formation on plants using *A. tumefaciens* (monocots v/s dicots)
Hairy Root formation using using*Agrobacteriumrhizogenes*
Practical applications of genetic transformation.
Plant genomics (e.g. Rice, Arabidopsis)

PAPER III: ENVIRONMENTAL AND ANIMAL BIOTECHNOLOGY

Max Marks: 50

Unit I: General metabolism of animal cells. Special secondary metabolites/products (Insulin, growth hormone, Interferon, t- plasminogen activator, and factor VIII) Expressing cloned proteins in animal's cells. Over production and processing of chosen protein: The need to express in animal cells.

Unit II: Production of vaccines in animal cells. Production of monoclonal antibodies. Growth factors promoting proliferation of animal cells (EGF, FGF, PGDF, IL-1, IL-2, NGF, and Erythropoietin). Bioreactors for large-scale culture of cells. Transplanting cultured cells.

Unit III: Renewable and Non–Renewable resources. What is Renewable should be Bio-assimable/Biodegradable. Major consumable items: Food, Fuel and Fibers. Conventional Fuels and their Environmental impacts: Fire wood, Plant and Wastes, coal, gas, animal oils. Modern fuel and their environmental impacts: Methanogenic bacteria and biogas, microbial hydrogen production, conversion of sugars to ethanol

the gasohol experiment, Solar energy converters - hopes from the photosynthetic pigments, plant based petroleum industry, cellulose degradation for combustible fuel.

Unit IV: Biotechnological inputs in producing good quality and natural fibers- transgenic animals and transgenic plants. Microbial quality of food and water. Treatment of municipal waste and industrial effluents.
Degradation of Pesticides and other toxic chemicals by micro organisms. Thuringiensis toxin as a natural pesticide, Biological control of other insects swarming the agricultural fields. Enrichment of ores by microorganisms, Biofertilizers. Nitrogen fixing microorganisms enrich the soil with assailable nitrogen.

Unit V: Biodiversity and its conservation: Alpha- and Beta-biodiversity, steps to preserve biodiversity, in-situ and ex-situ conservation.
Intellectual property, IPR, and plant genetic resources, TRIPS and GATT
Patenting: Patenting of genetic material, obligations and complications, current issues: Ethics, Environmental safety.Risk assessment of GEOs (Genetically Engineered Organisms), Plant Breeder's right and farmer's rights.

Practical Exercises

1. Initiating Plant tissue culture: differentiation of explants.
2. Growth of plant cells into undifferentiated mass
3. Large-scale cultivation of plant cells in suspension
4. Induction of differentiation by modulating the hormonal balance
5. Culture of lymphocytes from blood samples
6. Preparation of media, filler sterilization, monitoring microbial contamination (bacteria, fungi & mycoplasma)
7. Cloning of animal cells by cell and colony purification
8. Fusion of cultured cells with myeloma cells.

Books Recommended

Old & Primrose: Principles of gene manipulation, Blackwell Scientific Publications
Sambrose& Russell: Molecular cloning CSH Press
Ausber: Current protocols in molecular biology CSH Press
Michel: Introduction to environmental microbiology
B.D. Singh Plant Breeding: Kalyani Publisher
Alexander, M: Microbial Ecology, John Wiley & sons
EC Eldowney, Hardman & Waite: Pollution Ecology biotreatment- Longman Scientific Technical
Baker &Herson - Bioremediation –Tata McGraw Hill
P.C.Debergh& R.H. Zimmerman: Micropropagation Technique & Applications. Kluwer Academic Publishers
K. Lindsey & M.G. K. Jones: Plant Biotechnology in Agriculture
R.A. Meyers: Molecules Biology & Biotechnology VCH Publishers N.Y.

B. D. Singh: Plant Biotechnology, Kalyani Publishers
Indra K Vasil &Trevar A Thorpe: Plant Cell & Tissue Culture, Kluwer Academic Publishers
S.S Bhojwani& M.K. Razdan: Plant Tissue Culture Theory & Practice, Elsevier

Practical Scheme

Time 5:00 hr
Max. Marks: 75
Min. Marks: 27

1.	Preparation of nutrient medium and its sterilization	13
2.	Preparation of explant (pretreatment), sterilization and inoculation for the given tissue culture technique	08
3.	Identification of microbial contamination in the given nutrient medium	07
4.	Identify & comment upon the Spots (1 to 6)	27
5.	Viva- Voce	10
6.	Practical Record	10