Course Curriculum, Scheme of Examination
for
B. Sc. Biotechnology
(Three Year Degree Course)

Department of Biotechnology
Vigyan Bhawan Block – B: New Campus
Mohanlal Sukhadia University
Udaipur

Course Curriculum and Scheme of Examination for B. Sc. Biotechnology (Three Year Degree Course)

Course Curriculum

There will be 6 Theory papers (of 75 marks each) both in Ist Year and IInd Year TDC while in IIIrd Year there will be five Theory papers and One Project work (All of 75 marks each).

In each year there will be Three Practical Examinations based on theory papers. The details of the scheme has been given as under:

B. Sc. Biotechnology Three Year Degree Course
Course Structure

Ist Year Biotechnology (2007-2008)

Paper Code	Nomenclature of the paper	Max. Marks	Teaching hours per week	Minimum Credit hours
I	Plant Biology and Diversity	75	3 hrs.	75
II	Animal Biology and Diversity	75	3 hrs.	75
III	Microbial Biology and Diversity	75	3 hrs.	75
IV	Cell Biology, Genetics and Evolution	75	3 hrs.	75
V	Fundamentals of Biochemistry	75	3 hrs.	75
VI	Metabolic Pathways	75	3 hrs.	75
VII	Practical I	75	4 hrs.	100
VIII	Practical II	75	4 hrs.	100
IX	Practical III	75	4 hrs.	100

In addition to above main papers a candidate will be required to offer either Hindi or English as a compulsory paper of 50 marks.

There will be an additional compulsory Credit course of 100 marks on Environmental Studies.

II[nd] Year Biotechnology (2008-2009)

Paper Code	Nomenclature of the paper	Max. Marks	Teaching hours per week	Minimum Credit hours
I	Principles of Plant Tissue Culture	75	3 hrs.	75
II	Principles of Animal Cell Culture	75	3 hrs.	75
III	Basics of Molecular Biology	75	3 hrs.	75
IV	Immunology and Enzymology	75	3 hrs.	75
V	Biophysics and Biostatistics	75	3 hrs.	75
VI	Plant and Animal Physiology	75	3 hrs.	75
VII	Practical I	75	4 hrs.	100
VIII	Practical II	75	4 hrs.	100
IX	Practical III	75	4 hrs.	100

The Candidate will be required to offer a compulsory paper on Introduction to Information Technology of 60 Marks (Theory) and 20 marks (Practicals).

III[rd] Year Biotechnology (2009-2010)

Paper Code	Nomenclature of the paper	Max. Marks	Teaching hours per week	Minimum Credit hours
I	Microbial Technology	75	3 hrs.	75
II	Principles of Recombinant DNA Technology	75	3 hrs.	75
III	Natural Resources and Environmental Biotechnology	75	3 hrs.	75
IV	Biotechnology in Human and Animal Health	75	3 hrs.	75
V	Plant Biotechnology and its Commercial applications	75	3 hrs.	75
VI	Project Work	75	3 hrs.	75
VII	Practical I	75	4 hrs.	100
VIII	Practical II	75	4 hrs.	100
IX	Practical III	75	4 hrs.	100

B.Sc. Biotechnology Part I (2007-08)

Paper I : Plant Biology and Diversity

Unit I

Introduction to plant world – Plant kingdom; History and principles of classification and units of classification. Binomial nomenclature.

General features, distribution, classification, thallus organization, mode of nutrition, reproduction, life cycle patterns and economic importance of algae, fungi, bryophytes and pteridophytes. Alternation of generation. Thallus structure, ecological significance and economic importance of lichens.

15 Credit hours

Unit II

General features, classification, evolution, distribution, external features, comparative anatomy, development, reproduction, life-cycle, affinities and economic importance of gymnosperms. Evolutionary parallelism between gymnosperms and angiosperms.

15 Credit hours

Unit III

Technical description of a plant, systematic study, affinities, distinguishing characters of the following families of angiosperms with special reference to Cruciferae, Malvaceae, Leguminoseae, Compositae, Solanaceae, Liliaceae.

15 Credit hours

Unit IV

Life history of a typical angiosperm, Male gametophyte – Structure of anthers, microsporogenesis, role of tapetum, pollen germination, pollen tube growth and guidance.

Female gametophyte – Megasporogenesis, organization of the embryo sac, types of embryo sacs, synergids and antipodal haustoria.

Pollination biology – Structural and functional aspects of pollen and pistil interaction, self and interspecific incompatibility, fertilization and control of fertilization, embryo and seed development.

Polyembryony : Types: genetic, somatic and pollen embryo apomixis and parthenocarpy.

15 Credit hours

Unit V

Introduction to economic botany, centre of origin, description and use of economically important plants from each category such as :

Cereals (Wheat, Rice, Maize)

Millets (Sorghum)

Pulses (Pigeonpea, Chickpea)

Vegetables (Potato, Onion)

Fruits (Mango, Banana)

Sugar producing plants (Sugar cane)

Oil crops (Groundnut, Mustard)

Spices and Condiments (Ginger, Turmeric)

Beverage Plants (Tea, Coffee)

Medicinally important Plants (*Cinchona*, Opium poppy, *Withania*)

Fibres (Cotton, Jute)

Wood (Sal, Teak, Shisham.)

15 Credit hours

Recommended Books

1. Alexopoulus, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. John Wiley and Sons, Inc.
2. Kumar, H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
3. Parihar, N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
4. Stewart, W.N. and Rathwell, G.W. 1993. Paleobotany and the evolution of plants. Cambridge University Press.
5. Vashishta, P.C. 1991. Vascular Cryptogam. S. Chand and Co. Ltd., N. Delhi.
6. Pandey, Mishra and Trivedi. 2001. A text book of Botany, Vol. 1 and II. Publishing House New Delhi.
7. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperm. New Age International Limited, New Delhi.
8. Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperm taxonomy. Oliver and Boyd, London.
9. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The embryology of Angiosperm, 4th Revised and Enlarged edition. Vikas Publishing House, New Delhi.
10. Sambamurthy, A.V.S.S. and Subramanyam, N.S. 1989. A Textbook of Economic Botany. Wiley Easter Ltd. New Delhi.

B.Sc. Biotechnology Part I (2007-08)

Paper II : Animal Biology and Diversity

Unit-I

Introduction to animal world, classification of animal kingdom, taxonomic hierchy of animals, organization of animal body-scheme of organization, levels of organization; body plan; symmetry of body plan; germ layers; body cavity.

15 Credit hours

Unit-II

General characteristics and classification of invertebrates. General characteristics of different phyla: Protozoa, Porifera, Coelenterata, Platyhelminthes, Archelminthes, Arthropoda, Annelida, Mollusca, Echinodermata. A general account of morphology, structure locomotion, excretion and reproduction in invertebrates.

15 Credit hours

Unit-III

General characteristics and classification of vertebrates. General characters of Protochordates, Pisces, Amphibia, Reptilia, Aves, Mammalia. A general account of nutrition, respiration, excretion and reproduction in vertebrates.

15 Credit hours

Unit-IV

Animal tissues – Organization of tissues, organs and organ systems, Epithelial tissue (Types of simple and stratified epithelium, glandular epithelium types of glands), Connective tissue (Connective tissue proper, supportive connective tissue, fluid connection tissue (blood and lymph), muscular tissue (striated muscle, smooth muscle, cardiac muscle), nerve tissue. Elementary idea of vermiculture, sericulture, apiculture and pearl industry.

15 Credit hours

Unit-V

Developmental biology – foetal membranes, placenta and its classification. Development of chick upto 4 somite stage, embryonic induction; brief account of primary organism, determination, differentiation, competence, organogenesis and growth, regeneration, concept of stem cells.

15 Credit hours

Recommended Books

1. Ganguli, B.B., Sinha, A.K. and Adhikari, S. 2001. Biology of Animals. (Vol. I and III). New Central Book Agency, Calcutta.
2. Kotpal, R.L. 1990. Modern Text Book of Zoology, Invertebrates, 8th Edition. Rastogi Publication, Meerut.
3. Jordan, E.L. and Verma, P.S. 2001. Invertebrate Zoology. S. Chand and Co., New Delhi.
4. Balinsky. Introduction to Embryology. Panima.
5. Subramaniam, T. Developmental Biology. Narosa.

B.Sc. Biotechnology Part I (2007-08)

Paper III : Microbial Biology and Diversity

Unit-I

Introduction to microbial world, definition, history and scope of microbiology, Modern systems of classification of bacteria. General features, distribution, cell size, shape and arrangement, structure of bacterial cell capsule, flagella, pilli, (structure outside the cell), cell wall – chemical composition and wall characteristics, plasma membrane, mesosomes, cytoplasm, nucleoids, plasmids, types of plasmid-fertility factor, R plasmid, Col plasmid virulence, metabolic, cryptic plasmid and cytoplasmic inclusions, mode of nutrition with growth sporulation and bacteria transformation, transduction, conjungation. Important diseases of plants (citrus canker, crown gall, blight of rice), humans (tuberculosis, pneumonia, enteric fever) and animals.

15 Credit hours

Unit-II

Cell structure of cyanobacteria – sheath, cell wall, plasma membrane, cytoplasm, cytoplasmic inclusions – cyanophycin, gas vacuoles, carboxysomes, phosphate bodies, phycobilisomes, specialized structures – hormogones and heterocysts, endospores, exospores, nonocysts, akinetes, heterocysts. Morphology and classification, distribution, organization, nutrition, mode of reproduction and economic importance.

Mycoplasma – history, ultrastructure, nutrition, classification, phylogeny, reproduction and methods of cultivation. Elementary account of most common human /animals diseases (Pulmonary pneumonia, urethritis) caused by mycoplasma. Brief account of phytoplasma and important diseases caused by them (Sesame phyllody, little leaf of brinjal, grassy shoot of sugarcane). L-Phase variants.

15 Credit hours

Unit-III

Viruses – theory, classification and phylogeny, general features-virus architecture and structure, replication in bacteriophages, plant and animal viruses, transmission of plant viruses, effect of viruses on plants (symptoms), virus animal interactions, virus epidemiology, some important diseases of plants (yellow vein mosaic of bhindi, leaf curl of tomato and bean mosaic), humans (Aids, Polio, Hepatitis) and animals (yellow fever, influenza, encephalitis) general features and classification of rickettsias, archebacteria, actinomycetes, viroids and prions.

15 Credit hours

Unit-IV

Methods in microbiology – microbial cultures, physical conditions for growth, requirement of gases, chemical selection, natural selection, methods for culturing aerobic and anaerobic bacteria. Sterilization and disinfection – sterilization by dry heat, moist heat, filtration, radiation, chemical agents – types of disinfectants, testing of disinfectants, incinerators, chemotherapy. Methods of isolation and maintenance of pure culture – streak plate, pour plate and spread plate methods, stab cultures. Culture media – selective and differential media nutrient agar, nutrient Broth, enrichment media and other media. Measurement of microbial growth, cell counting by use of counting chamber and spectrophotometer. Staining and smearing, negative staining, simple staining, differential staining and acid fast staining, special stains – negative stains for capsule, endospore-staining, flagella staining.

15 Credit hours

Unit-V

Plant-microbe interaction: bacterial (associative symbiont, PGPR, *Rhizobium*, fungal symbiosis-mycorrhiza), symbiotic association (bacteria and fungi, microbe-microbe interactions-symbiosis between algae and fungi : lichens) : Antagonistic interactions – amensalism, competition, parasitic and predation.

Soil Microbiology – Soil as a habitat, soil quality-Physico-Chemical properties of soil (organic matter, soil water and air) soil microbes – algae, bacteria, actinomycetes, bacteriophages, nematodes and fungi, microbial balance, rhizosphere and rhizoplane microorganisms.

15 Credit hours

Recommended Books

1. Pelczar and Krieg. Microbiology. McGraw Hill.
2. Prescot, H. and Klein. 2000. Microbiology. McGraw Hill.
3. Tortora. Microbiology : An Introduction. Pearson Education.
4. Stainer, R.Y., Ingrahm, J.L., Wheelis, M.L. and Painter, P.R. General Microbiology. The MacMillian Press Ltd.
5. Madigan, M.T., Martinko, J.M. and Parker, J. B. Biology of Microorganism. Prentice-Hall.

6. Cappuccino, J.G. and Sherman, N. Microbiology – a laboratory manual. Addison Wesley.
7. Alexander, M. Introduction to soil microbiology. John Wiley and Sons.
8. Colwd, D. Microbial Diversity. Academic Press.
9. Dubey, R.C. and Maheshwari, D.K. A Text Book of Microbiology. S. Chand and Company.
10. Dimmock, N. J. and Primrose, S.B. Introduction to Modern Virology, IV Edition. Blackwell Scientific Publications. Oxford.

B.Sc. Biotechnology Part I (2007-08)

Paper IV : Cell Biology, Genetics and Evolution

Unit-I

Discovery of cell, the cell theory, ultrastructure of a eukaryotic cell – plant and animal cell. Structure and functions of cell organelles – endoplasmic reticulum, golgi complex, mitochondria, chloroplast, ribosomes, lysosomes, peroxisomes, nucleus (nuclear envelope with nuclear pore complex, nucleolus, nucleoplasm, and chromatin). Vacuole, Cytoskeletal structures (microtubules, microfilaments and intermediate filaments).

15 Credit hours

Unit-II

Chromosome discovery, morphology and structural organization – centromere, secondary constriction, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype. Ultrastructure : Single-stranded hypotheses, folded-fibre and nucleosome models. Special types of chromosomes: Salivary gland and Lampbrush chromosomes. Cell cycle, mitosis and meiosis. Cell senescence and Programmed Cell Death (PCD). Amoeboid, ciliary and flagellar movement.

15 Credit hours

Unit-III

Mendel's work, laws of heredity, test cross, incomplete dominance and simple problems. Interaction of genes : supplementary factors-comb pattern in fowls, complementary genes- flower colour in sweet peas, multiple factors – skin colour in human beings, epistatis- plumage colour in poultry, multiple allelism-blood groups in human beings.

Sex determination in plants and animals : concepts of allosomes and autosomes, XX-XY, XX-XO ZW-ZZ, ZO-ZZ types, linkage and crossing over coupling and repulsion hypothesis, linkage in maize and *Drosophila*, mechanism of crossing over and its importance, chromosome mapping – linkage map in maize.

15 Credit hours

Unit-IV

Chromosomal variations : A general account of structural and numerical aberrations, chromosomal evolution of wheat and cotton.

Cytoplasmic Inheritance : Plastid inheritance in *Mirabilis*, petite-characters in yeast and kappa particles in *Paramecium*.

Mutations-types: Spontaneous and induced, mutagens : physical and chemical, mutation at molecular level. mutations in plants, animals and microbes for economic benefit of man. Human genetics – karyotype in man, inherited disorders – allosomal (Klinefelter syndrome and Turner's syndrome), autosomal (Down syndrome and Cri-Du-Chat Syndrome).

15 Credit hours

Unit-V

Evolution and origin of species – theories of evolution, lamarkism, darwinism, mutation theory neodarwinism. Succession and fossil records, genetic variation, phenotypic variation sources of genetic variation. Selection, mechanism of race differentiation, speciation, mechanism of reproductive isolation and origin of adaptations.

15 Credit hours

Recommended Books

1. Alberts, B., Bray, D. Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell. Garland Publishing Co. New York, USA.
2. Snustad, D.P. and Simmons, M.J. 2000. Principles of genetics. John Wiley and Sons.
3. Russel, P.J. 1998. Genetics. The Benjamin/Cumming Publishing Co.
4. Gasque, E. Manual of Laboratory experiments in cell Biology. W.C. Wilson Public.
5. Gardaner *et al.* Principles of genetics. John Wiley and Sons.
6. Robertis, E.D.P., Robertis, E.M.F. Cell and Molelcular Biology. Sauder College Publication.
7. Beeker, W.M. The world of the cell. Pearson Education.
8. Karp, G. Cell and Molecular Biology. John Willey and sons.
9. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.
10. Rastogi V.B. Organic evolution.

B.Sc. Biotechnology Part I (2007-08)

Paper V : Fundamentals of Biochemistry

Unit-I

Nature of biological material, Identifying characteristics of living matter, Molecular logic of life, Bioelements, General properties of biomolecules, Central role of carbon, Water : structure and unique properties, Acid, Base, Buffers, Polyprotic acids. Principles of oxidation- reduction, bonding and structure, type of bonds, bonding and reactivity in inorganic and organic molecules, covalent bonds. Potential and redox potential, high energy bonds and high energy compounds.

15 Credit hours

Unit II

Monosaccharides : Classification, configuration, conformation and derivatives, Common Disaccharides, Structure and occurrence of storage and structural polysaccharides, Glycosaminoglycans, Glycoprotein: structure and function.

15 Credit hours

Unit III

Fatty acids, Triacylglycerol, Glycerophospholipids, Sphingolipids: Sphingomyelins, cerebrosides and gangliosides, Cholesterol, Micelles, Bilayers, Liposomes, Lipoprotein structure and function. Glycogen synthesis and degradation, fatty acid biosynthesis.

15 Credit hours

Unit IV

Amino acids: Structure, nomenclature and general properties, Peptide bond, Primary structure of proteins: end group analysis, amino acid composition, specific peptide cleavage and sequence determination, Secondary structure: peptide group, Ramachandran diagram, Helical structures: alpha-helix and other polypeptide helices, Beta-pleated sheets, Protein stability: Electrostatic interactions, Hydrogen bond and Hydrophobic forces, Disulphide bond, General idea of tertiary and quaternary structure of proteins.

15 Credit hours

Unit V

Vitamins of B-group : their coenzyme forms, recommended dietary allowance (RDA), source and biochemical function. Fat soluble vitamins: RDA, sources and function. Enzymes: historical perspective, naming and classification, enzyme units, specificity and stereospecificity, Enzyme kinetics: Michaelis-Menten equation and its transformations. Mechanism of enzymes action and its regulation.

15 Credit hours

Recommended Books

1. Voet and Voet. 2000. Biochemistry. John Wiley.
2. Lehninger. 2000. Principles of Biochemistry. CBS Publishers.
3. Stryer, L. 2002. Biochemistry. W.H. Freeman.
4. Harper. 2003. Biochemistry. McGraw-Hill.
5. Zubay. 1995. Biochemistry. Brown Publishers.
6. Trehan, K. Biochemistry. Wiley Eastern Publications.
7. Jain, J.L. Fundamentals of Biochemistry. S. Chand and Company.
8. Deb, A.C. Fundamental of Biochemistry.
9. Methew, C.K. Biochemistry. Pearson Education.

B.Sc. Biotechnology Part I (2007-08)

Paper VI : Metabolic Pathways

Unit-I

Transportation across biomembrane, passive transport, active transport, facilitated transport, sodium, potassium and ATPase pump, role of calmodulin. Bioenergetics-general concepts of thermodynamics, energy, enthalpy, free energy, catalysis, activation energy. Metabolism- catabolism and anabolism. General concepts in metabolic pathways and their regulation.

15 Credit hours

Unit-II

Photosynthesis : significance, historical aspects, photosynthetic pigments, action spectra and enhancement effects, concept of two photosystems, Z-scheme, photophosphorylation, Calvin cycle, C_4 pathway, CAM plants, photorespiration. Transport of organic substances : mechanism of phloem transport, source-sink relationship, factors affecting translocation.

15 Credit hours

Unit-III

Respiration : ATP-the biological energy currency, aerobic and anaerobic respiration, Kreb's cycle, electron transport mechanism (chemi-osmotic theory), redox potentials, oxidative phosphorylation, pentose phosphate pathway, Gluconeogenesis.

15 Credit hours

Unit –IV

Nitrogen and lipid metabolism : biology of nitrogen fixation, importance of nitrate reductase and its regulation, ammonium assimilation, structure and function of lipids, fatty acid biosynthesis, β-oxidation saturated and unsaturated fatty acids, storage and mobilization of fatty acids.

15 Credit hours

Unit – V

Primary and secondary metabolism in plants. Structure, biosynthesis and functions of phenolics, lignins and lignans, alkaloids, terpenoids, flavonoids, suberins, coumarins and furanocoumarins, stilbins.

15 Credit hours

Recommended Books

1. Horton and Moran. Principles & Biochemistry. Prentice Hall.
2. Buchanan, G. and Jones. Biochemistry and Molecular Biology of Plant. American Society of Plant Physiology.
3. David, L., Nelson and Cox. Lehninger : Principles of Biochemistry. McMillon Worth Pub.
4. Stryer. Biochemistry. John Wiley & Sons.

B. Sc. Ist Year Practicals (2007-08)

Practical – I

(A) Plant Biology and Diversity

Study of thallus structure and reproduction in following organisms

Algae	: *Nostoc, Volvox, Ulothrix, Spirogyra*
Fungi	: *Albugo, Penicillium, Alternaria*
Bryophytes	: *Riccia, Marchantia*
Pteridophytes	: *Pteridium* (Stem and leaf only)
Gymnosperms	: *Cycas* (Rachis and leaf coralloid root)

Description in semi-technical terms the members of the following families

Crucifereae (Brassicaceae)	*Brassica, Iberis, Rhaphanus*
Malvaceae	*Hibiscus, Althea*
Papillionatae	*Crotolaria, Pisum*
Caesalpinoideae	*Caesalpinia, Cassia*
Comporitae (Asteraceae)	*Helianthus, Tridax*
Solanaceae	*Datura, Petunia*
Liliaceae	*Asphodelus, Allium*

Study of different types of placentation

Axile, Parietal, Basal, Marginal, Free central

Study of pollen viability and germination (*Calotropis*- pollinia)

Types of ovules in angiospermic plants

Embryo dissection – e.g. *Crotolaria*
Permanent slides – Megasporogenesis and Microsporogenesis

Economic Botany of the following:

Wheat, Maize, Sorghum, Pigeonpea, Chickpea, Potato, Onion, Mango, Banana, Sugarcane, Groundnut, Mustard, Ginger, Turmeric, Tea, Coffee, *Cinchona*, Opium poppy, *Withania*, Cotton, Jute.

B. Sc. Ist Year Practicals (2007-08)

Practical- II

(A) Microbial Biology and Diversity

1. General instructions for microbiology laboratory.
2. Study of construction, care and use of a compound microscope.
3. To study the principle and working of following microbilogical instruments:

   Hot air oven, Incubator, Spectrophotometer, Laminar Flow Clean Air Bench, Centrifuge, Autoclave, pH meter.
4. To demonstrate the importance of concept of asepsis and methods of sterilization. Isolation of bacteria from the soil sample in Nutrient broth medium under aseptic and non-aseptic conditions.
5. To study the following methods of sterilization-

   UV sterilization, Flame sterilization, Sterilization by dry and moist heat, Chemical methods of sterilization.
6. To become familiar with preparation of bacterial smears for the microscopic visualization of bacteria.
7. To perform the monochrome staining for the given bacterial samples (*E. coli, Bacillus cereus, Staphylococcus aureus*) to compare morphological shapes and arrangement of bacterial cells using crystal violet stain.
8. To perform the Gram staining procedure for the given bacterial samples (*E. coli*, *Lactobacillus* spp. *Rhizobium*) to differentiate two groups of bacteria gram-positive and gram-negative.
9. To perform the spore staining procedure for the given bacterial sample (*Bacillus cereus*) to differentiate between bacterial spore and vegetative cells.
10. Preparation of general purpose media (Nutrient agar and Nutrient broth) for cultivation of bacteria.
11. Isolation of bacteria from the given sample (soil, water or milk) by streak plate method.
12. To determine the cultural characteristics of bacteria as an aid for their identification.
13. To study the ubiquitous nature of bacteria.
14. To determine quantitatively the number of cells in a microbial culture (yeast cells) by direct microscopic count using Neubauer chamber.
15. To determine quantitatively the number of cells in a bacterial culture by pour plate technique.
16. To determine quantitatively the number of cells in a bacterial culture by spread plate technique.
17. To perform techniques for cultivating and enumerating bacteriophages.
18. Study of following plant diseases cause by bacteria:

    (a) Citrus canker (b) Crown gall (c) Blight of rice

19. Study of diseases caused by phytoplasma

    (a) Sesame phyllody (b) Little leaf of Brinjal (c) Grassy shoot of sugarcane.

20. Study of plant diseases caused by virus

    (a) Yellow vein mosaic of bhindi

    (b) Leaf curl of tomato

    (c) Bean mosaic

21. Microscopic measurement using stage and ocular micrometers.

22. Study of different types of Lichens

(B) Cell Biology, Genetics and Evolution

1. To study cell structure from onion leaf peels; demonstration of staining and mounting methods.
2. Examination of electron micrographs of eukaryotic cells with special reference to organelles.
3. Study of electron micrographs of viruses, bacteria, cyanobacteria and eukaryotic cells for comparative cellular organization.
4. Examination of various stages of mitosis and meiosis using appropriate material (*e.g.* onion roots tips, flower buds of onion, *Phlox* and *Tradescantia,* testis of grasshopper).
5. Preparation of metaphase chromosomes and karyotype from dividing cells in root tips of onion and pollen grains.
6. To draw idiogram from the prepared karyotype.
7. Isolation of chloroplasts from the plant cells.
8. Staining of mitochondria.
9. Demonstration of barr body in buccal smear.
10. Demonstration of salivary gland chromosomes from *Chironopous* larvae.
11. Separation of different organelles by sucrose density gradient.
12. Detection of enzyme activity(*e.g.* phosphatase and ADH) in cells/ tissue by cytochemical staining.
13. Demonstration of emasculation technique.
14. To perform the viability test and germination test for pollen grains.
15. Exercises based on genetics:
    (a) Working out the laws of inheritance using seed mixtures
    (b) Working out the mode of inheritance of linked genes from F2 data.
16. Permanent slides of cell organelles, stages of mitosis and meiosis.
17. Buccal smear preparation for demonstration of mitchondria and golgi using vital staining.

B. Sc. Ist Year Practicals (2007-08)

Practical - III

(A) Fundamentals of Biochemistry

1. Preparation of standard solutions *e.g.* normal solution, molar solution, per cent solution, ppm solution.

   Preparation of buffers-phosphate buffers, citrate buffer
2. Acid base titrations
3. To perform chemical test for the presence of following macromolecules in given sample/s:
   (a) Test for carbohydrates (Benedict's and Fehling's Tests)
   (b) Test for proteins (Biuret test, Million's test and anthoprotein test)
   (c) Test for lipids/ oils (Sudan III)
   (d) Test for polysaccharides (starch/ glycogen)
4. To extract and estimate total carbohydrates from the given plant sample by spectrophotometric method.
5. To extract and estimate total proteins (Bradford's Method) from the given plant sample by spectrophotometric method.
6. Determination of catalase activity by permanganate titration method.
7. Quantitative test for amylase activity in germinating seeds.
8. Isolation of casein from milk and determination of its isoionic precipitation point.
9. Estimation of amino acids using ninhydrin reagent.
10. Determination of iodine number of fat.
11. Determination of saponification value of fat.
12. Determination of acid value of fat.
13. Histochemical localization of biomolecules such as proteins, carbohydrates in plant tissues.
14. Use of dialysis to separate small molecules from larger molecules.

(B) Metabolic Pathways

1. To extract and separate the chlorophyll pigments by paper chromatography.
2. To separate the chlorophyll pigments by thin layer chromatography.
3. To separate chlorophyll pigments by chemical methods.
4. To prepare the absorption spectrum and determine λ max of various chloroplast pigments using spectrophotometer.
5. To find λ max for proteins.
6. Study of transport across membrane by potential measurement.
7. Phytochemical tests of the following secondary metabolites: tannins, anthocyanins, lignins
8. Demonstration of respiratory enzymes (peroxidase, catalase, dehydrogenase) in plant tissues.
9. To study permeability of plasma membrane using different concentrations of organic solvents

Ist Year TDC Biotechnology (2007-08)

Practical I

Incorporating Paper I and II

Paper I: Plant Biology and Diversity
Paper II: Animal Biology and Diversity

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper I	15
B. Major Exercise from Paper II	15
C. Minor Exercise from Paper I	10
D. Minor Exercise from Paper II	10
Spots 5 x 3	15
Viva-voce	05
Record	05

Ist Year TDC Biotechnology (2007-08)

Practical II

Incorporating Paper III and IV

Paper III: Microbial Biology and Diversity
Paper IV: Cell Biology, Genetics and Evolution

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper III	15
B. Major Exercise from Paper IV	15
C. Minor Exercise from Paper III	10
D. Minor Exercise from Paper IV	10
Spots 5 x 3	15
Viva-voce	05
Record	05

Ist Year TDC Biotechnology (2007-08)

Practical III

Incorporating Paper V and VI

Paper V: Fundamentals of Biochemistry
Paper VI: Metabilic Pathways

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper V	15
B. Major Exercise from Paper VI	15
C. Minor Exercise from Paper V	10
D. Minor Exercise from Paper VI	10
Spots 5 x 3	15
Viva-voce	05
Record	05

B.Sc. Biotechnology Part II (2008-09)

Paper I : Principles of Plant Tissue Culture

Unit-I

History, scope and applications of plant tissue culture – contribution of Indian Scientists. Concept of asepsis and methods of sterilization (physical and chemical methods). Nutrient media, their composition and methods of preparation. Role of plant growth regulators, vitamins and other adjuvants in tissue culture.

15 Credit hours

Unit-II

Concept of cell totipotency, polarity and *in vitro* differentiation. Callus and cell suspension culture, growth curve and methods of growth measurement. Callus organogenesis – dedifferentiation and redifferentiation. Somatic embryogenesis – induction of embryogeny *in vitro*, indirect and direct somatic embryogenesis, stages of embryogenesis, factors influencing embryogenesis.

15 Credit hours

Unit-III

Selection and preparation of explants for adventitious shoot bud induction and axillary bud proliferation. Steps of micropropagation-management of donor plants, culture establishment, shoot multiplication, rooting and hardening and acclimatization. Protoplast isolation, culture and differentiation. Somatic hybridization.

15 Credit hours

Unit-IV

Anther and pollen culture – production of haploids. *In vitro* fertilization, embryo, endosperm, ovary and ovule culture. Embryo rescue. Methods of cryopreservation for germplasm conservation. Somaclonal and gametoclonal variation. Meristem tip culture for elimination of viruses in plants.

15 Credit hours

Unit-V

Cell culture and *in vitro* production of secondary metabolites. Important alkaloids and factors affecting their production. Hairy root culture, elicitation and biotransformation, Bioreactors – their types, construction and use in secondary metabolite production.

15 Credit hours

Suggested Readings

1. Robert Smith. Plant tissue culture : Techniques and Experiments. South Asia Edition.
2. Gamborg and Phillip. Plant Cell, Tissue and Organ Culture. Narosa.
3. Dixon and Gonzales. Plant Cell Culture. Panima.
4. Narayanswamy. Plant Cell and Tissue Culture. McGraw Hill.
5. Bhojwani, S.S. and Rajdan, M.K. Plant Tissue Culture : Theory and Practices a revised Edition. Elsevier.
6. Razdan, M.K. Introduction to plant tissue culture. Oxford & IBH Publishers.
7. Chawla, H.S. Introduction to Plant Biotechnology. Oxford & IBH Publishers.
8. Dey, K.K. Plant Tissue Culture.

B.Sc. Biotechnology Part II (2008-09)

Paper II : Principles of Animal Cell Culture

Unit-I

History of development of animal cell culture and methods of animal cell culture : culture media composition and preparation. Balanced salt solutions and simple growth medium. Chemical, physical and metabolic functions of different constituents of culture medium – role of CO_2, serum and other supplements. Growth factors promoting proliferation of animal cell (EGF, PDGF, NGF, GAP43 etc.). Serum and protein-free defined media and their applications.

15 Credit hours

Unit-II

Animal cell lines – their culturing and maintenance. Characterization of cultured cells, test of viability, cytotoxicity and measurement of growth. Primary cultures, anchorage dependent growth, non-anchorage dependent cells. Secondary cultures, transformed animal cells – established/continuous cell lines. Commonly used animal cell lines – their origin and characteristics.

15 Credit hours

Unit-III

Stem cell cultures, embryonic stem cells and their applications, cell culture based vaccines, measurement of cell death, apoptosis, scaling-up of animal cell cultures and production of recombinant gene products.

15 Credit hours

Unit-IV

Organ culture, whole embryo culture, transfection of animal cells : selectable markers, HAT selection, antibiotic resistance etc. Somatic cell fusion, transplantation of cultured cells. Differentiation of cells, culture of animal mycoplasma.

15 Credit hours

Unit-V

Growth kinetics of cells in culture, applications of animal cell culture for studies on gene expression. Cloning of cell lines, three-dimensional culture and tissue engineering (artificial skin and artificial cartilage), *In vitro* fertilization in humans, super ovulation, embryo transfer in humans and livestock.

15 Credit hours

Suggested Readings

1. Masters, J. Animal Cell Culture. Panima.
2. Freshney, I. Culture of Animal Cell. John Wiley.
3. Martin, C. (Ed). Animal Cell Culture Techniques. Springer.
4. Mather and Barnes. (Ed). Methods in Cell Biology. Vol. 5-7, Animal Cell Culture Method. Academic Press.
5. Paul, J. Animal Tissue Culture.
6. Butler, M. and Dawson, M. Lab Fax : Cell Culture. Bios Scientific Publications.
7. Jenkins, N. Animal Cell Biotechnology. Panima Books Distributors.

B.Sc. Biotechnology Part II (2008-09)

Paper III: Basics of Molecular Biology

Unit-I

Introduction to molecular biology – historical background, nature of genetic material, experimental proof for DNA as genetic material, types of nucleic acids (DNA and RNA). Watson Crick model of DNA, other forms of DNA (A-form, B-form and Z-form), properties of DNA, DNA denaturation and renaturation, concept of central dogma, satellite DNA and tandem repeats.

15 Credit hours

Unit-II

DNA replication : mechanisms of prokaryotic DNA replication, semi-conservative model of replication, mechanism of DNA replication – discontinuous synthesis of DNA, RNA primer of DNA synthesis, DNA polymerases I, II, III and their role in DNA replication; eukaryotic DNA replication, Eukaryotic DNA polymerases, DNA ligases, mechanism of action and role in DNA replication; role of other proteins in DNA synthesis; DNA damage and repair.

15 Credit hours

Unit-III

Regulation of gene expression in prokaryotes : Transcriptional control; enzyme induction and repression, constitutive. Synthesis of enzymes, the operon hypothesis : genes involved in regulation – regulatory genes, promoter gene, operator gene, and structural gene, role of cAMP and cAMP receptor protein (CRD) in the expression of e.g. Lac operon, Arg operon, Tryptophan operon, His operon, catabolite repression. Brief account of eukaryotic gene regulation. Development and environmental regulation of gene expression.

15 Credit hours

Unit – IV

Transcription control by termination and anti-termination, mRNA splicing, genetic code, altered genetic code in ciliates and mitochondria, types of RNA, the assembly line for protein synthesis, wobble hypothesis, translation initiation and termination in prokaryotes, reading frame and open reading frame, translation initiation and termination in eukaryotes.

15 Credit hours

Unit – V

Post translational modification in prokaryotes and eukaryotes, protein sorting/ trafficking and protein localization and translocation: synthesis of secretory and membrane protein, import into nucleus, mitochondria, chloroplast and peroxisomes, receptors and signal transduction: channels and ion uptake.

15 Credit hours

Suggested Readings

1. Watson, J.D. Molecular Biology of Gene. Pearson Education.
2. Friefelder, D. Molecular Biology. Narosa Publishing House, New Delhi.
3. Weaver, R. Molecular Biology. McGraw Hill.
4. Lewin, B. Gene VIII. Pearson Education.
5. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.
6. Cooper, M. The Cell – A molecular approach. Sinauer.
7. Daniel. Molecular Cell Biology. Scientific American Books.
8. Smith. Molecular Biology. Faber and Faber Publications.
9. Dabre, P.D. Introduction to Practical Molecular Biology. John Wiley and Sons, Ltd.
10. Meyers, R.A. (Ed). Molecular Biology and Biotechnology : A comprehensive desk reference. VCH Publishers, New York.

B.Sc. Biotechnology Part II (2008-09)

Paper IV : Immunology and Enzymology

Unit-I

Immune system and immunity, history of immunology, structure, composition and functions of cells and organs involved in immune system. T cells, B-cells, macrophages, antigen-processing cells, eosinophils, neutrophils, mast cells and killer T-Cells; Microbial infections and immune responses, innate immunity, acquired immunity; clonal nature of immune response; immunohaemotology-blood groups, blood transfusion and Rh incompatibilities.

15 Credit hours

Unit-II

Antigens – structure and properties, types (iso and alloantigens), haptens, adjuvants; antigen specificity. Immunoglobulins – structure, heterogeneity, types and subtypes, properties (physico-chemical and biological). complement – structure, components, properties and functions of complement; complement pathways and biological consequences of complement activation. Effector mechanisms.

15 Credit hours

Unit-III

Antigen antibody reactions – agglutination, precipitation, complement fixation, immunofluorescence, immuneoelectrophoresis, ELISA and Radio-immunoassays. Applications of these methods in diagnosis of microbial infections. Major histocompatibility complex – structure and functions of MHC.

15 Credit hours

Unit-IV

History and introduction to enzymes, Classification of enzymes, IUPAC system of nomenclature, E.C. numbers, Enzyme kinetics (Michaelis-Menten laws), importance and determination of V_{max} and K_m values, catalytic mechanisms of enzymes, acid-base, covalent, metal ion and electrostatic catalysis, preferential binding of transition state proximity and orientation effects, Detail mechanism of action of chymotrypsin.

15 Credit hours

Unit-V

Regulation of enzyme activity, various controls : metabolic compartmentation, covalent modification, feedback regulation. Enzyme inhibition : competitive and non competitive. Introduction to cofactors and coenzymes. Multienzyme complexes, purification of enzymes : salt precipitation, gel filteration, ion exchange and affinity chromatography.

15 Credit hours

Suggested Readings

1. Coico R, Sunshine, Benjamin E. Immunology : A short course. John Wiley and Sons.
2. Roitt, Brostoff, Male and Mosby. Immunology.
3. Kuby *et al.* Immunology. W.H. Freeman and Company.
4. Rao, C.V. An Introduction to Immunology. Narosa Pub. House.
5. Coleman, R.M. Fundamental Immunology. McGraw Hill.
6. Paul, W.E. Fundamentals of Immunology. Raven Press New York.
7. Palmer, T. Understanding Enzymes.
8. Price and Stevenson. Fundamentals of Enzymology. Oxford University Press.
9. Dixon and Webb. The Enzymes. Academic Press, London.
10. Foster, F.L. The nature of Enzymology. John Wiley and Sons.

B.Sc. Biotechnology Part II (2008-09)

Paper V : Biophysics and Biostatistics

Unit-I

Radioactivity – radioactive nucleus, half life, physical and biological half life, handling and standardization of α emitting and β emitting isotopes, radioactive tracer technique, autoradiography, radio pharmaceuticals.

Spectroscopic principles, energy levels, excitation absorption, electronic, vibrational, rotational spectra. UV and visible spectroscopy. Raman spectra, application to biomolecules, UV-visible and IR spectroscopy fluorescence.

15 Credit hours

Unit-II

Elucidation of intact biological structures in living organisms. ultrasound, optical fibres X-ray, X-ray diffraction, CAT, Electrocardiography, Electro-encephalography and NMR imaging.

Colorimetry and spectrophotometry : fundamental laws of colorimetry-Lambart and Beer's law, types of colorimeter and Spectrophotometer.

15 Credit hours

Unit-III

Instrumentation – instruments used for thermoregulation, centrifuges analytical and different pH meter, G.M. counter, scintillation counter, Fluorescent, light and phase contrast microscope, scanning and transmission electron microscopes, electrophoresis apparatus.

15 Credit hours

Unit – IV

Tabulation and classification of data, frequency distribution and graphical distribution of data. Measures of central tendencies – mean, median, mode and their properties. Measures of dispersion – mean deviation, variance, standard deviation and coefficient of variation, correlation coefficient.

15 Credit hours

Unit – V

Concepts and problems on probability, random variable and its expectation, binomial, poisson, normal distribution and their applications. Different models of data presentations with special reference to biological samples. Random sampling, sampling distribution, standard error, concepts in hypothesis testing, large sample test for means and proportions (simple problems).

15 Credit hours

Suggested Readings

1. Daniel, M. 1999. Biostatistics (3rd Edition). Panima Publishing Corporation.
2. Pattabhai, V. and Gautham, N. Biophysics. Narosa pub.
3. Zar, J.H. Biostatical Analysis. Pearson Edu.
4. Gupta, S.C. and Kapoor, V.K. Fundamentals of applied statistics. S. Chand and Company.
5. Dutta, N.K. Funadamentals of Biostatistics. Kanika Pub. New Delhi.
6. Arora, P.N. and Malhan, P.K. Biostatistics. Himalya Publishers.
7. Swardlaw, A.C. Practical statistics for experimental Biology. John Wiley and Sons.
8. Campbell, R.C. Statistics for Biologist. Cambridge University Press.
9. Bliss, C.J.K. Statistics in Biology. McGraw Hill.
10. Narayan, P. Essentials of Biophysics. New Age International.
11. Roy, R.N. A Text Book of Biophysics. New Central Book Agency.
12. Daniel, M. Basic Biophysics. Agrobios.

B.Sc. Biotechnology Part II (2008-09)

Paper VI : Plant and Animal Physiology

Unit-I

Plant–water relations : Importance of water to plant life, physical properties of water, diffusion and osmosis, absorption, transport of water and transpiration, physiology of stomata. Mineral nutrition : essential macro and micro-elements and their role, mineral uptake, deficiency and toxicity symptoms.

15 Credit hours

Unit-II

Growth and development in plants. Definitions, phases of growth and development, kinetics of growth, seed dormancy, seed germination and factors of their regulation, plant movements, the concept of photoperiodism, physiology of flowering, florigen concept, biological clocks, physiology of senescence, fruit ripening, plant growth regulators– auxins, gibberellins, cytokinins, abscissic acid and ethylene, history of their discovery, biosynthesis and mechanism of action.

15 Credit hours

Unit-III

Photomorphogenesis, phytochrome and cryptochromes-discovery, physiological role and mechanism of action. Stress physiology – stress, plant responses to stress, water stress, temperature stress, salt and metal stress. Heat shock proteins. Reactive oxygen molecules.

General and cellular basis of animal physiology. Digestion and absorption of food-in stomach and small intestine; circulation of body fluid, blood vessels, blood flow and blood cells, ABO blood groups and Rh factor, mechanism of blood clotting.

15 Credit hours

Unit-IV

Respiration – mechanism of respiration; vital capacity of lungs; transport of gases; dissociation curve of oxyhaemoglobin and control of respiration. Excretion – Formation of ammonia, urea and uric acid; structure and functions of nephron; control of renal functions – role of kidney in the regulation of water and salt. Muscle and movement – ultrastructure and physiology of muscle contraction. Nerve physiology – ultrastructure of a neuron, synapse, propagation of nerve impulse.

15 Credit hours

Unit-V

Structure and functions of endocrine glands (pituitary, adrenal, thyroid and parathyroid). Neuro-endocrine regulation, secondary messenger concept. Reproductive physiology – reproductive mechanisms, functional morphology of reproductive organs, gametogenesis, reproductive cycle, hormonal control.

15 Credit hours

Suggested Readings

1. Guyton, A.C. and Hall, J.E. A Text Book of Medical Physiology (10th Edition). W.B. Saunders company.
2. Ganong, H. Review of Medical physiology. McGraw Hill.
3. Fluer, S. Physiology (a regular system approach). McMillan Pub. Co.
4. Shier, Jakie, Butler and Lewis. Human Anatomy and Physiology. WCB, USA.
5. Berry, A.K. Animal physiology.
6. Hopkins, W.G. Introduction to plant physiology. John Wiley and Sons.
7. Salisbury, F.B. and Ross, C.W. Plant physiology. Wadsworth Publishing Co. California, USA.
8. Mohr, H. and Schopfer, P. Plant physiology. Springer Verlag, Berlin, Germany.
9. Taiz, L. and Zeiger, E. Plant Physiology (2nd Edition) . Sinauer Associates, Inc., Publishers, Massachusetts, USA.

B. Sc. IInd Year Practicals (2008-09)

Practical – I

(A) Principles of Plant Tissue Culture

1. To study the principle and working of various instrument used in plant tissue culture.
2. To study the methodology and preparation of M S media containing various plant growth regulators of different concentration.
3. To study *in vitro* seed germination in *Feronia limonia*.
4. To study the preparation of various types of explant from the aseptically raised seedling.
5. To study methodology and preparation and sterilization of nodal explant for establishment of culture.
6. To study the characteristics of callus on the parameters of
    - (i) Colour and texture
    - (ii) Packed and volume
    - (iii) Fresh weight and dry weight
    - (iv) Cell viability test
7. Preparation of cell suspension culture and determination of cell count by Haemocytometer.
8. Test of cell viability in cell suspension culture.
9. Encapsulation of somatic embryos of the shoot bud.
10. To demonstrate the role of Gibberellic acid in *in vitro* shoot elongation.
11. To demonstrate the role of sucrose as carbon source in plant tissue culture.
12. To demonstrate the role of Nitrogen in Plant Tissue Culture.
13. To demonstrate the effect of Auxins in root induction.
14. To calculate the rate of in vitro shoot multiplication and growth performance.
15. To calculate stomatal characteristics for *in vitro* raised plantlets.
16. To calculate percent water loss from the leaves of micropropagated plants.

(B) Principles of Animal Cell Culture

1. To prepare media for animal cell culture (Undefined media: Chick embryo extract, chick plasma, chick serum).
2. Preparation of single cell suspension from spleen and thymus.
3. Fusion of cells by polyethylene glycol (PEG).
4. Culture of lymphocytes from blood samples.
5. Preparation of Hank's Balanced salt solution (BSS).
6. Culture of animal cells (embryo cells) on undefined media.

B. Sc. IInd Year Practicals (2008-09)

Practical – II

(A) Basics of Molecular Biology

1. Criteria for reliability of qualitative experiments.
2. Importance of clean handling, sterility and cleanliness.
3. Problems on gene, gene structure, chromosome, chromosome structure.
4. Isolation of total genomic DNA for plant sample.
5. Visualization of nucleic acids by agarose gel electrophoresis
6. Purification of plant genomic DNA by RNase treatment.
7. Quantification of plant genomic DNA and RNA by UV-spectrophotometer.
8. Demonstration of southern hybridization.
9. Amplification of DNA by PCR using RAPD and ISSR primers.
10. Preparation of protein samples for profiling on polyacrylamide gel.
11. Method of gel casting and sample loading for protein profiling through SDS-PAGE.
12. Running of gel, staining, destaining and analysis of protein profiles using standard protein markers.

(B) Immunology and Enzymology

1. To prepare blood film and observe various types of blood cells.
2. Formation of hemin crystals.
3. Determination of the clotting time of blood by capillary tube method.
4. Determination of the blood group.
5. Counting of the total RBC in the blood by haemocytometer.
6. Determination of kinetic properties (Km and V max values) of an enzyme.
7. Purification of enzymes by salt precipitation.
8. Immobilization of enzymes using different methods
9. Hapten conjugation and quantitation.
10. Demonstration of antigen-antibody reaction through clinical approach.
11. Immunodiagnostics (demonstration using kits)
12. ELISA
13. Double diffusion and Immuno-electrophoresis
14. Radial immunodiffusion
15. Purification of antigen, antibodies

B. Sc. IInd Year Practicals (2008-09)

Practical- III

(A) Biophysics and Biostatistics

1. To study the principle, construction and working of the following equipments:
   (a) Spectrophotometer (b) Centrifuge
   (c) pH meter (d) Electrophoresis apparatus
2. Demonstration of Lambert's and Beer's law.
3. To find out isoelectric point of amino acid
4. Study of Microscopes: Light microscope, Phase contrast microscope
5. Biostatistical exercised based on the following:
   (a) Mean (b) Mode
   (c) Median (d) Standard Error and standard Deviation
   (e) Probability (f) Coefficient of variation
6. Exercise based on frequency distribution and graphic representation.
7. Exercise based on hypothesis testing
8. To study different methods of chromatographic separation
   (a) Paper chromatography
   (b) Thin-layer chromatography
   (c) Column chromatography

B. Plant and Animal Physiology

1. To observe streaming movement of protoplasm in the cells of *Hydrilla*.
2. To demonstrate the phenomenon of plasmolysis in the cells of *Rhoeodiscolor*.
3. To demonstrate the phenomenon of osmosis by potato osmoscope.
4. To demonstrate opening and closing of stomata in leaf samples.
5. To demonstrate unequal transpiration in leaves using cobalt chloride paper.
6. To study the effect of various wavelengths of light on the process of photosynthesis.
7. To demonstrate that light, CO_2 and chlorophyll are necessary for photosynthesis.
8. To determine the value of Respiratory Quotient (RQ) of different substrates.
9. To demonstrate the continuity of vessels in higher plants.
10. Bioassay of auxin, cytokinin, GA_3, ABA and ethylene using appropriate plant material.
11. Identification of foodstuffs – Carbohudrates, proteins, lipids.
12. Demonstration of enzyme activity: Salivary action, Liver extract (glycogen).
13. Demonstration of oxygen uptake during respiration in cockroach.
14. Haematological estimates: RBC, WBC, Haemoglobin, PCV, ESR.
15. Demonstration of heart bead and effect of drugs on its using CAL tools.
16. Estimation of glucose and amino acids in urine.
17. Study of histological slides of mammalian endocrine glands.

IInd Year TDC Biotechnology (2008-09)

Practical I

Incorporating Paper I and II

Paper I: Principles of Plant Tissue Cultures
Paper II: Principles of Animal Cell Culture

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper I	15
B. Major Exercise from Paper II	15
C. Minor Exercise from Paper I	10
D. Minor Exercise from Paper II	10
Spots 5 x 3	15
Viva-voce	05
Record	05

IInd Year TDC Biotechnology (2008-09)

Practical II

Incorporating Paper III and IV

Paper III: Basics of Molecular Biology
Paper IV: Immunology and Enzymology

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper III	15
B. Major Exercise from Paper IV	15
C. Minor Exercise from Paper III	10
D. Minor Exercise from Paper IV	10
Spots 5 x 3	15
Viva-voce	05
Record	05

IInd Year TDC Biotechnology (2008-09)

Practical III

Incorporating Paper V and VI

Paper V: Biophysics and Biostatics
Paper VI: Plant and Animal Physiology

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper V	15
B. Major Exercise from Paper VI	15
C. Minor Exercise from Paper V	10
D. Minor Exercise from Paper VI	10
Spots 5 x 3	15
Viva-voce	05
Record	05

B.Sc. Biotechnology Part III (2009-2010)

Paper I : Microbial Technology

Unit-I

Introduction to industrial biotechnology, basic principles of fermentation technology, fermentation media – natural and synthetic media, fermenters and bioreactors – construction, design and operation. Process of aeration, agitation, temperature regulation and filtration method, Types of fermentation – solid state, submerged and continuous fermentation.

15 Credit hours

Unit-II

Process development – Shake flask fermentation, down stream processing, disintegration of cells, separation, extraction, concentration and purification of products, quality control, quality assurance, standard operating procedures and good manufacturing practices.

15 Credit hours

Unit-III

Production of microbial products, Brief account of the following products obtained by industrial microbiological fermentation – Alcohol, Alcoholic Beverage-Beer, Organic acid – Citric acid, Antibiotic – Penicillin, Amino acids – Glutamic acid, Vitamin-B12. Brief account of steroid biotransformation.

15 Credit hours

Unit-IV

Food processing; food spoilage – bacterial, fungal and yeast; food preservation – principles and general methods, elementary idea of canning and packing; sterilization and pasteurization of food products; technology of fermented foods – Yoghurt, Buttermilk, Idli, Dosa, Cheese, Tempeh, Olive, Sausages.

15 Credit hours

Unit-V

Microbial foods – Single Cell Proteins (SCP), Single Cell Oils (SCO); Hazard Analysis and Critical Control (HACCP) concept; Techniques of mass culture of Algae-spirulina; Microbial polysaccharides and polyesters; production of xanthaim gum and polyhydroxyalkaloides.

15 Credit hours

Suggested Reading

1. Waites, Morgan, Rockey. Industrial Microbiology. Blackwell Science.
2. Saha, B.D. Fermentation Biotechnology. American Chemical Society.
3. Demain and Davies . Industrial Microbiology and Biotechnology. A.S.M. Press Washington.
4. Glazer, A.N. and Nikaido, H. Microbial Biotechnology : Principle and application of applied microbiology. W.H. Freeman and com.
5. Stanbary, Whitaker and Hall. Principles of Fermentation Technology.
6. Shuler and Kargi. Bioprocess Engineering. Pearson.
7. Mukherji, K.G. Microbial Technology. APH. Pub. Corp.
8. Ray. Fundamental Food Microbiology. CBH Pub.
9. Bell, Neaves and Williams. Food Microbiology and Laboratory Practice. Panima.

B.Sc. Biotechnology Part III(2009-2010)

Paper II : Principles of Recombinant DNA Technology

Unit-I

Genetic Engineering – Introduction, definition, scope and importance, molecular tools for genetic engineering; restriction endonucleases- types, nomenclature, recognition sequences, cleavage pattern; DNA ligases-properties and functions, ligation techniques. Vectors – general characteristics of vectors, desirable characters such as size, ori site, selection/ markers gene, restriction sites and MCS, cloning and expression vectors. Plasmids- pBR-322, pUC vectors, Ti-plasmid, M13 derived pUC vectors.

15 Credit hours

Unit-II

Vectors for cloning large DNA fragments- bacteriophage, λ vectors, cosmids, YAC, BAC, creation of recombinant DNA- cloning and selection of individual gene, DNA amplification by PCR: RAPD, RFLP, AFLP. Transformation techniques: preparation of competent cells of bacteria: exogenously supplied chemical methods Calcium chloride heat shock method, methods of DNA transfer:, liposome mediated method and electroporation, *Agrobacterium* T-DNA mediated method, gene gun method; determination of transformation/ transfection efficiency.

15 Credit hours

Unit-III

Gene libraries – genomic library and cDNA library, reverse transcriptase, Colony hybridization, screening by DNA hybridization, immunological assay and protein activity, labelling of DNA, RNA and proteins: use of radioactive isotopes, non-radioactive labelling, relative advantages, *in vivo* labelling, nick translation, random primer labelling, autoradiography, blotting techniques southern and northern.

15 Credit hours

Unit-IV

In vitro translation, protein profiling and its significance, fusion proteins, polyacrylamide gel and 2D gel electrophoresis, Western blotting, gel retardation assay, T-DNA and transposon mediated gene tagging, chloroplast transformation and its utility, DNA microarrays to study gene expression etc., Basics of protein engineering and design.

15 Credit hours

Unit-V

Antisense and ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, biochemistry of ribozyme, hammerhead, hair pin and other ribozymes, strategies for designing ribozymes, application of antisense and ribozyme technologies.

15 Credit hours

Suggested Readings

1. Christopher, H. Gene cloning and Manipulation. Cambridge University, Press.
2. Nicholl, D.S.T. An introduction to genetic engineering. Cambridge University Press.
3. Sambrook, Russell and Maniatis. Molecular Cloning : A Laboratory Manual (Vol. I, II and III). Cold Spring Harber Laboratory.
4. Glover, D.M. and Hames, B.D. DNA Cloning : A practical approach. IRL Press. Oxford.
5. Brown, T.A. Gene cloning. Blackwell Publisher.
6. Kreuzar, H. and Massey, A. Recombinant DNA technology. A.S.M. Press, Washington.
7. Llibelli, Lanza and Campbell. Principles of Cloning. Academic Press.

B.Sc. Biotechnology Part III (2009-2010)

Paper III : Natural Resources and Environmental Biotechnology

Unit-I

Natural resources- Energy resources (renewable and non-renewable), conventional and non-conventional sources of energy, forest resources, fish resources, water resources. Conservation of natural resources- *ex situ* and *in situ* conservation strategies, wildlife management, afforestation, world conservation strategies (WCS) and National Conservation Strategies (NCS)

15 Credit hours

Unit – II

Waste water and its treatment, small scale and large scale sewage treatment, BOD and COD. Ground water remediation, water softening, water demineralization, desalination, ion-exchange and reverse osmosis, disinfection of water; ozonation and chemo-sterilization of water.

15 Credit hours

Unit – III

Solid waste and their treatment, organic compost and process of composting, vermi-culture technology. Microbial degradation of xenobiotics, microorganism in abatement of heavy metal pollution, aeromicrobiology: aeroallergens and aeroallergy.

15 Credit hours

Unit – IV

Environmental biotechnology- scope and applications, concepts of cleaner technology application of immunofiltration and immunoprecipitation, DNA probing methods for detection of microbial pathogens in aquatic environment. Biogas, biogas production- Solubilization, acetogenesis and methanogenesis , mechanism of methane formation.

15 Credit hours

Unit – V

Microbes and their genetic engineering for degradation of pollutants, application of microbes as biofertilizer, biopesticides, microbial leaching, biomining, biohydrometallurgy and biomineralization. Principles and applications of biosensors for detection of pollutants, Oil spills- Causes and recovery, use of super bugs for removal of oil spills.

15 Credit hours

Suggested Readings

1. Mooray Moo-Young. (Eds). Comprehensive Biotechnology (Vol. I, II, III) Pergamon Press, England.
2. Metcalf and Eddy. Waste water engineering treatment and uses. McGraw Hill.
3. Jogdand, S.N. Environmental Biotechnology. Himalaya Publication House.
4. De, A.K. Environmental Chemistry. Wiley Eastern Ltd.
5. Abbasi and Abbasi. Renewable Energy Sources and their environmental impact. Prentice Hall of India, Pvt. Ltd.
6. Chatterji, A.K. Introduction to Environmental Biotechnology. Prentice Hall of India.

B.Sc. Biotechnology Part III (2009-2010)

Paper IV : Biotechnology in Human and Animal Health

Unit-I

Transgenic animals – methods of obtaining transgenic animals using fertilized eggs and embryogenic blastocyte cells (examples). Importance of transgenic animals- increased productivity of domestic animals, improved desired characters of domestic animals, production of proteins for pharmaceutical use with special reference to insulin production.

15 Credit hours

Unit-II

Animal cloning and its importance. Methods of cloning in animal systems such as rat, sheep, pig and fish. Animal models for tackling human diseases : Gene knock out and mice models. Transgenic silkworms.

15 Credit hours

Unit-III

Gene therapy and cell mediated therapy. Genetic diseases targeted for gene therapy, Use of genetically modified and humanized antibodies against cell surface antigens in cancer treatment and organ transplantation, importance of Adenosine deaminase (ADA) gene in curing severe combined immuno deficiency (SCID)

15 Credit hours

Unit-IV

Diagnostics : application of immunological and molecular diagnostic methods (RIA, ELISA, PCR, DNA fingerprinting) in forensic medicine and disease diagnostics. Immune system and vaccine, development of vaccines for Hepatitis, Rabies, Herpes and Tuberculosis using recombinant DNA technology, peptide vaccines, vector vaccines, Edible vaccines.

15 Credit hours

Unit-V

An elementary account of genomics and proteomics, human genome project – its inception and outcome. Regulating the use of biotechnology for human and animal health. Intellectual Property Rights (IPR) and biosafety issues. Ethical and moral issues. Current legislation for use of genetically modified organisms. Patenting biotechnological inventions.

15 Credit hours

Suggested Readings

1. Primrose, S.B. Molecular Biotechnology. Panima.
2. Watson and Zoller. Recombinant DNA. Panima.
3. Winnacker. An introduction to Gene Technology – From genes to clones. VCH.
4. Boylan, M. Genetic engineering – science and ethics on new frontier. Pearson Edu.
5. Old and Primrose. Principles of Gene Manipulation.
6. Glick and Pasternak. Molecular Biotechnology. ASM Press Washington, USA.
7. Mickloss, D.V. and Freyer, G.A. DNA Science : A first course in recombinant technology. Cold Spring Harbor Laboratory Press, New York.

B.Sc. Biotechnology Part III (2009-2010)

Paper V : Plant Biotechnology and its Commercial Applications

Unit-I

Micropropagation – Definition, pathways of micropropagation and various stages of plantlet recovery. Role of micropropagation in silviculture, horticulture, agriculture, and conservation of biodiversity and threatened plant species. Somatic embryogenesis with special reference to production of synthetic seeds, encapsulation of shoot meristems and other plant parts for conservation and regrowth.

15 Credit hours

Unit-II

Applications of plant biotechnology in plant pathology with special reference to culture of obligate parasites and production of virus-free plants. Screening of germplasm and cell line selection. Application of somaclonal variation with special reference to development of disease resistant cell lines.

15 Credit hours

Unit-III

Applications of plant biotechnology in breeding and crop improvement with special reference to production of haploids and triploids. Application of protoplast culture in development of somatic hybrids and cybrids. Role of tissue culture in genetic engineering for crop improvement – *Agrobacterium* mediated gene transfer in plants and development of genetically modified organisms with special reference to drought and salinity, insect and virus resistance and improvement in plant nutritional contents.

15 Credit hours

Unit-IV

Bioreactors for production of secondary metabolites. Introduction types : stirred-tank type, air-lift type, membrane type bioreactor, packed bed reactor. Modes of culture applied in bioreactors – batch culture, fed-batch culture, semi-continuous culture, continuous culture. Optimization of conditions for growth of cells in bioreactors for production of secondary metabolites.

15 Credit hours

Unit-V

Secondary products in tissue cultures – production of alkaloids, phenols, steroids, lignins, coumarins, flavonoids, anthroquinones and naphthoquinones, isoprenoids, Plant cell immobilization, gel entrapment, applications of immobilization techniques. Secondary metabolite production using immobilized cells. Use of transgenic plants in production of secondary metabolites and therapeutic proteins. Plants as bioreactors.

15 Credit hours

Suggested Readings

1. Chrispeels, M.J. and Sadava, D.E. Plant, genes and agriculture. Jones and Barlett Pub., Boston, London.
2. Kyte, L. and Kleyn. Plant From test tube. Timber Press, Portland, Oregon.
3. Ravishanker, G.A. and Venkatraman, L.V. Biotechnology application of plant tissue and cell culture. Oxford and IBH Publishing Co. Pvt. Ltd.
4. Reinert, J. and Bajaj, Y.P.S. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa.
5. Chawla, H.S. Biotechnology in Crop Improvement. International Book Distributing Company.
6. Henery, R.J., Chapman and Hall. Practical application of plant molecular Biology.
7. Hammond, J. and McGarvey, P. Plant Biotechnology. Springer Verlag.

B. Sc. IIIrd Year Practicals (2009-2010)

Practical - I

(A) Microbial Technology

1. Isolation of industrially important microorganisms for microbial processes.
2. To test the production of enzymes: Amylase, proteinases, lipases and celluloses by microorganisms.
3. Demonstration of citric acid production by *Aspergillus niger, Penicillium citrianum.*
4. To study industrial production of beer/ wine.
5. Demonstration of production of antibiotics (penicillin) by microbes.
6. To study general methods of food preservation (e.g. Temperature, Salt, Moisture).
7. Testing of milk by MBRT.
8. Turbidity test for milk.
9. Test for pasteurization of milk.
10. Coliform test for milk.
11. Study of alcoholic fermentation- alcohol from different substracts- estimation of percentage of alcohol, total acidity and volatile acidity.
12. Study of food-spoilage microorganisms in fresh, canned, fermented food and meat.
13. Production and analysis of SCP: *Spirulina*, yeast, *Chlorella*, mushroom.
14. Bioassay methods for vitamins and amino acids.
15. Production of yoghurt using specific starter cultures.
16. Demonstration of fermenters.
17. Production of pectinase by *Aspergillus niger* using wheat bran coffee pulp using small scale fermenter and its assay.
18. Production of λ amylase using *Aspergillus oryzai*/ *Bacillus lichenforis* using bran in small scale solid state fermentation and its assay.
19. Production of microbial polysaccharides and yield estimation.

(B) Principles of Recombinant DNA Technology

1. Isolation and purification of plasmid from *Agrobacterium tumefaciens* LBA4404.
2. To perform restriction digestion of plant genomic DNA and its visualization.
3. To perform ligation of insert into the plasmid vector for construction of recombinant plasmid.
4. To check the presence of insert in the recombinant plasmid.
5. Preparation of competent cells of *E. coli* (strain DH5 α) using $CaCl_2$ treatment.
6. Transformation of *E. coli* (strain DH5 α) by mobilization of plasmid pBsKs into competent *E. coli* cells.
7. Demonstration of presence of GUS gene in plasmid of *Agrobacterium tumefaciens* strain LBA4404.
8. Preparation of protein samples for profiling on polyacrylamide gel.
9. Method of gel casting and sample loading for protein profiling through SDS-PAGE.
10. Running of gel, staining, destaining and analysis of protein profiles using standard protein markers.

B. Sc. III[rd] Year Practicals (2009-2010)

Practical – II

(A) Natural Resources and Environmental Biotechnology

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids in given water sample/s.
3. Determination of biological oxygen demand (BOD) of a sewage sample.
4. Determination of chemical oxygen demand (COD) of sewage sample.
5. Study on biogenic methane production in different habitats.
6. Test of heavy metals (Zn, Cu, Pb) tolerance in some identified bacteria.
7. Isolation of bacteria from various polluted sites (waste water, distillery waste) and their identification.
8. Isolation and identification of Mycorrhizal fungi from soil samples.
9. Isolation and identification of nitrogen fixing bacterium *Rhizobium* from root nodules.
10. Isolation of xenobiont degrading bacteria by selective enrichment technique.
11. Test for the degradation of aromatic hydrocarbons by bacteria.
12. Demonstration of methods for waste water treatment.
13. Test of herbicide tolerance and early seedling growth in some cereals, legumes and oil-seed crops.
14. Test of drought tolerance (induced by PEG) and early seedling growth in some cereals, legumes and oil-seed crops.
15. Determination of hardness in given water sample/s.
16. Determination of residual chlorine in given water sample.
17. Determination of composting (by verimculture)
18. To study the effect of Bt toxin on lepidopteran insects.
19. Baculovirus stock- preparation and titration using plaque colony.
20. Co-transfection of insects cells using linearized baculovirus stocks
21. Anaerobic digestion of organic fraction of municipal waste.
22. Bioinseclicidal effects of biopesticides obtained from microbial and plant sources.

(B) Biotechnology in human and animal health

1. Test of genetic fidelity of microclones by DNA fingerprinting using molecular markers.
2. Immunodiagnosis by Radioimmuno assay (RIA)
3. Immunodiagnosis by ELISA.

B. Sc. IIIrd Year Practicals (2009-2010)

Practical – III

Plant Biotechnology and its commercial application

1. Induction of adventitious shoots from appropriate explant (e.g. hypocotyl segments, leaf discs, internodes)
2. Induction of axillary shoots from appropriate explant (e.g. nodal segments)
3. Induction of somatic embryogenesis in carrot and study of various stages.
4. Induction of callus from the appropriate explants
5. *In vitro* organogenesis from callus cultures.
6. Rooting of in vitro shoots by different methods:

   (a) *In vitro* rooting (b) *Ex vitro* rooting
7. Hardening and acclimatization procedures for *in vitro* produced plantlets.
8. Study of growth of tissue culture plants under CO_2 enriched environment.
9. Meristem tip culture for elimination of virus from infected plants (Material- Bougainvillea)
10. Culture of anthers for production of androgenic haploids (Material- *Datura*)
11. Extraction of fats from the given sample using Soxhlet's method.
12. Use of Thin Layer Chromatography for separation of alkaloids (e.g. *Catharanthus, Orchrosia*).
13. Use of Thin Layer Chromatography for separation of food coloring agents and additive (e.g. Turmeric).
14. Alkaloid extraction using soxhlet apparatus.
15. Immobilization of plant cells by alginate gel entrapment.
16. Study of various types of bioreactors (demonstration only)

IIIrd Year TDC Biotechnology (2009-2010)

Practical I

Incorporating Paper I and II

Paper I: Microbial Technology
Paper II: Principles of Recombinant DNA Technology

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper I	15
B. Major Exercise from Paper II	15
C. Minor Exercise from Paper I	10
D. Minor Exercise from Paper II	10
Spots 5 x 3	15
Viva-voce	05
Record	05

IIIrd Year TDC Biotechnology (2009-2010)

Practical II

Incorporating Paper III and IV

Paper III: Natural Resources and Environmental Biotechnology
Paper IV: Biotechnology in Human and Animal Health

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper III	15
B. Major Exercise from Paper IV	15
C. Minor Exercise from Paper III	10
D. Minor Exercise from Paper IV	10
Spots 5 x 3	15
Viva-voce	05
Record	05

IIIrd Year TDC Biotechnology (2009-2010)

Practical III

Incorporating Paper V and VI

Paper V: Plant Biotechnology and its commercial applications
Paper VI: Project Work

Duration: 5 hours	Max Marks: 75
A. Major Exercise from Paper V	15
B. Minor Exercise from Paper V	10
Spots 5 x 3	15
Project Presentation/ Viva	25
Viva-voce	05
Record	05

Scheme of Examination

Each theory paper in the annual examination shall have three sections i.e. A, B and C. In section A, total 10 questions will be set in the paper, selecting at least two from each unit. These questions to be answered in a word or so. All questions are compulsory. Each question carries 1 mark, total 10 marks.

In section B, there shall be total 10 questions, selecting two questions from each unit, five questions to be answered by the student selecting at least one from each unit. Answer should be given in approximately 250 words. Each question carries 07 marks, total 35 marks.

In section C, 04 descriptive type questions will be set in the examination paper from five units of the syllabus of the paper, selecting not more than one question from a unit. Each question may have two sub divisions. Students are required to answer any two questions approximately in 500 words. Each question is of 15 marks, total 30 marks.