

**BACHELOR OF SCIENCE (B.Sc.)
BIOTECHNOLOGY**

**Semester-Wise Syllabus in CBCS Pattern
(WITH EFFECT FROM 2016-2017)**

Scheme For Choice Based Credit System

Code	Semester	Course category	Title of the Paper	No. of Credits	HPW	Max. Marks			Total Marks
						I.A	End Exam	Total	
FIRST YEAR									
BS104	I	DSC-1A (Theory)	Cell Biology & Genetics	4	4	20	80	100	125
		DSC-1A (Practical)		1	2	-	25	25	
BS204	II	DSC-1B (Theory)	Nucleic Acids- Biostatistics - Bioinformatics	4	4	20	80	100	125
		DSC-1B (Practical)		1	2	-	25	25	
SECOND YEAR									
BS304	III	DSC-1C (Theory)	Biological Chemistry	4	4	20	80	100	125
		DSC-1C (Practical)		1	2	-	25	25	
BS404	IV	DSC-1D (Theory)	Microbiology and Immunology	4	4	20	80	100	125
		DSC-1D (Practical)		1	2	-	25	25	
THRID YEAR									
BS503	V	DSC-1E (Theory)	Molecular Biology & rDNA Technology	3	3	15	60	75	100
		DSC-1E (Practical)		1	2	-	25	25	
BS506		DSC-1E (Theory)	Elective Paper A/B	3	3	15	60	75	100
		DSC-1E (Practical)		1	2	-	25	25	
BS603	VI	DSC-1F (Theory)	Microbial Biotechnology	3	3	15	60	75	100
		DSC-1F (Practical)		1	2	-	25	25	
BS606		DSC-1F (Theory)	Elective Paper A/B	3	3	15	60	75	100
		DSC-1F (Practical)		1	2	-	25	25	
Summary of Credits				36	-	-	-	-	900

B.Sc- I Year, Semester – I
PAPER - I
CELL BIOLOGY & GENETICS

UNIT- I : Cell Structure and Function

- 1.1 Discovery of Cell and Cell theory.
- 1.2 Cell as basic unit of life (Viral, bacterial, fungal, plant and animal cells)
- 1.3 Ultra structure of prokaryotic cell (Extra Chromosomal Material – Plasmid)
- 1.4 Ultra structure of eukaryotic cell (Cell wall, cell membrane, Golgi Complexes, Endoplasmic Reticulum, Peroxisome, Lysosomes etc).
- 1.5 Semi- autonomous Organelles (Mitochondria & Chloroplast : Endosymbiotic theory)

UNIT-II : Chromosome Organization and Cell Division

- 2.1 Chromosome organization in Prokaryotes and Eukaryotes
- 2.2 Structure of specialized chromosomes (Polytene and Lamp Brush)
- 2.3 Cell Division , Cell Cycle control
- 2.4 Significance of Mitosis and Meiosis
- 2.5 Programmed Cell Death

UNIT- III : Mendalism & Mendel's Laws

- 3.1 Mendel's experiments – Factors contributing to success of Mendel's experiments
- 3.2 Mendel's laws - Law of segregation – Monohybrid ratio, Law of Independent assortment – Dihybrids, Trihybrids
- 3.3 Deviation from Mendel's Laws - partial or incomplete dominance, co-dominance
- 3.4 Penetrance and expressivity, Pleiotropism
- 3.5 Gene interaction – Modified dihybrid ratios (12:3:1; 9:7; 15:1; 9:3:4:, 9:6:1; 13:3), Multiple Alleles : ABO blood groups & Rh factor

UNIT-IV : Sex Determination & Recombination

- 4.1 Genes and environment – phenocopies
- 4.2 Linkage and recombination – Discovery of linkage, cytological proof of crossing over, Recombination frequency and map distance. Interference and coincidence
Mitotic crossing over in *Drosophila*
- 4.3 Mechanism of sex determination-genic balance theory - *Drosophila*
Homogametic and Heterogametic theory (Human, Mammalian, Birds)
- 4.4 X – linked inheritance (eg. Haemophilia)
- 4.5 Non-Mendelian inheritance - Cytoplasmic inheritance (Shell coiling in snail)

Recommended Books:

1. Cell Biology and Genetics - By P.K. Gupta
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
6. Cell Biology, DE Robertis & De Roberis, Blaze publishers & Distributors Pvt. Ltd.,
6. Cell and Molecular Biology - By De Robertis
7. Cell and Molecular Biology - By Lodish
8. Theory and Problems in Genetics - By Stransfield
9. Genetics - By Gardner (Macmillan Press)

Practical Paper – I

1. Monohybrid and dihybrid ratio in *Drosophila*/maize
2. Preparation of different stages of Mitosis and Meiosis
3. Identification of plant, fungi, bacteria and animal cells.
4. Epistasis and codominance, 2 point test cross, gene mapping.
5. Preparation of polytene chromosomes from *Drosophila* salivary gland.
6. Identification, maintenance and culturing of *Drosophila* stock.

Spotters:

1. Prokaryotic cell (Bacteria)
2. Mitochondria
3. Chloroplast
4. Histone proteins
5. Polytene
6. Lampbrush
7. Test cross
8. Blood grouping
9. Webbed foot
10. Haemophilia
11. Crossing over
12. Phenocopies

B.Sc- I Year, Semester – II

PAPER-II

NUCLEIC ACIDS- BIOSTATISTICS – BIOINFORMATICS

UNIT- I : Structure of Nucleic Acids

- 1.1 DNA as the genetic material – Griffiths experiments, Avery, McLeod and McCarty's experiments. Hershey – Chase experiments.
- 1.2 RNA as genetic material – Tobacco Mosaic Virus
- 1.3 Structure and chemistry of DNA – Watson and Crick Model
- 1.4 Forms of DNA – A, B and Z forms of DNA, Super coiled and relaxed DNA – Role of DNA topoisomerases.
- 1.5 Structure of Cytoplasmic DNA – chloroplast DNA and Mitochondrial DNA.

UNIT- II : Functions & Mechanisms of Nucleic Acids

- 2.1 DNA Replication – Models of DNA replication (Semi-conservative, non-conservative models)
- 2.2 Mechanisms of DNA replication – Linear and circular – Rolling circle and theta mechanism of replication. Enzymes involved in DNA replication.
- 2.3 Mutation- spontaneous, induced- Physical and chemical (frame shift, transition, transversion)
- 2.4 DNA damage and Repair mechanisms
- 2.5 DNA Recombination

UNIT- III : Concepts of Biostatistics

- 3.1 Concept of probability, basic laws and its application to Mendelian segregation. Concept of Probability Distribution. Binomial and Poisson Distributions, Normal Distribution and their application in Biology
- 3.2 Concept of Sampling and Sampling Distribution. Measures of Central tendency (Mean, Median, Mode), Measures of deviation (Standard deviation, variance and coefficient of variation).
- 3.3 Concept of Test of Hypothesis. Applications of t-test statistics to biological problems/data: Chi-square, statistic applications in Biology
- 3.4 Simple Regression and Correlation.
- 3.5 Concept of analysis of variance (one-way classification)

UNIT- IV Concepts of Computers & Bioinformatics

- 4.1 Usage of MS DOS commands: Basic concept of Internal & External commands, directory & file commands, copying, erasing, renaming, and displaying files.
- 4.2 Microsoft word: Concept of toolbar, character, paragraph & document formatting, drawing tool bar, header, footer, document editing, page setup, short cut keys, text & graphics.
- 4.3 Microsoft power point: Slide presentation, slide layout & design, custom animation, image importing, slide transition.

4.4 Bioinformatics - Databases – (Nucleic acid and protein), Introduction to genomics and proteomics.

4.5. Data retrieval tools – (BLAST, PubMed)

Practical Paper - II

1. Estimation of DNA by diphenylamine method
2. Estimation of RNA by orcinol method
3. Finding statistical significance of a given data using chi – square test.
4. Graphical representation of data (Histograms, frequency polygon, Pie diagram)
5. Acquaintance with the Biological databases through Internet
6. Microsoft PowerPoint presentation.

Spotters :

1. TMV
2. B-DNA
3. Z-DNA
4. Replication fork
5. Okazaki fragment
6. SOS repair
7. Probability theorems
8. Test of hypothesis
9. F-test
10. Biological databases
11. NCBI
12. BLAST

Recommended Books

1. Molecular Biology - Freifelder
2. Cell & Molecular Biology – Schwann Series
3. Cell and Molecular Biology - By De Robertis
4. Cell and Molecular Biology - By Lodish
5. Basics in Computers – MS office
6. Biometry - By Sokal and Rohlf W.H. Freeman
7. Fundamentals of Biometry - By L.N. Balaram (George Allen and Unwin Ltd, London)
8. Biostatistics - By N.T.J. Bailey
9. Biostatistics- Manual of biostatistical methods for use in health, nutrition and Anthropology - By K. Visweshwar Rao (Jaypee Publications).
10. Bioinformatics and Bioprogramming in C - By L.N. Chavali
11. Introduction to Bioinformatics - By V. Kothekar
12. Introduction to Bioinformatics - By Arthur M. Lesk

B.Sc -II Year–Semester - III

PAPER-III

BIOLOGICAL CHEMISTRY

UNIT- I Carbohydrates

- 1.1. **Carbohydrates**-Importance, classification and physical and chemical properties of carbohydrates
- 1.2. Structure, configuration and biochemical importance of Monosaccharides (Glucose and Fructose)Oxidation, Reduction, Osazone formation, Aldose & Ketose, Glycosides (Streptomycin, Cardiac glycosides and Ouabain)
- 1.3. Structure, configuration and biochemical importance of Disachharides and glycosidic bond , Mutarotation, Haworth projection(Sucrose, Trehalose, Lactose, Maltose, Isomaltose, Cellobiose)
- 1.4. Homopolysaccharides (Starch, Glycogen, inulin, Cellulose and Chitin)
- 1.5. Hetero polysachharides (Hyaluroic acid, Chondroitin sulfata, heparin, peptidoglycan)

UNIT – II Proteins and Enzymes

- 2.1 Classification, structure and physical and chemical properties of aminoacids and synthesis of Peptide bond
- 2.2 Lipids,Fattyacids-importance, properties and classification, Simple lipids-TAG, Complex lipids, Derived lipids, sterols, Fatty acids: Saturated and Unsaturated fatty acids with examples. Biosynthesis of Fatty acids -palmitoyl-CoA, Cholesterol
- 2.3 Enzymes-classification and nomenclature. Michaelis Menton Equation-Factors influencing the enzyme reactions and Enzyme inhibition(Competitive and Non-competitive), role of co-enzymes and Enzyme Techonology.
- 2.4 Hormones, mode of action, (Thyroid gland)
- 2.5 Vitamins- classification, sources, functions and applications

UNIT – III Bioenergistics of biomolecules

- 3.1 Glycolysis
- 3.2 Gluconeogenesis and its significance
- 3.3 TCA Cycle, electron transport, Oxidative phosphorylation
- 3.4 β -oxidation of fatty acid
- 3.5 Transamination and Oxidative deamination reactions of amino acids. Amino acid catabolism (Phenyl ketonuria, albinism)

UNIT – 1V Bioanalytical techniques

- 4.1. Microscopy – light, inverted, fluorescent and electron microscopy
- 4.2. Colorimetry: Beer and Lambert's laws and UV- Vis spectrophotometry.
- 4.3. Separation techniques – Chromatography(Paper, thin layer, ion exchange and HPLC).
- 4.4 Electrophoresis (Native gels and SDS-PAGE, Agarose)
- 4.5 Basic principles of Centrifugation

Practical paper - III

1. Qualitative tests of Sugars, amino acids and lipids
2. Estimation of proteins by Biurate method
3. Estimation of total sugars by Anthron method
4. Reducing sugars DNS method
5. Separation of protein by SDS – PAGE.
6. Separation of amino acids by paper chromatography, TLC

Spotters

1. Cellulose
2. Peptidoglycan
3. Streptomycin
4. Cholesterol
5. Lock and Key model
6. Xerophthalmia
7. RUBISCO
8. Albinism
9. ATP synthase
10. Centrifuge
11. Microscope
12. Spectrophotometer

REFERENCE BOOKS

1. Lehninger Principles of Biochemistry By: David L. Nelson and Cox
2. Biochemistry By: Rex Montgomery
3. Harper's Biochemistry By: Robert K. Murray
4. Enzymes By: Trevor Palmer
5. Enzyme structure and mechanism By: Alan Fersht
6. Principles of Biochemistry By: Donald J. Voet, Judith G. Voet, Charlotte W. Pratt
7. Analytical Biochemistry By Cooper
8. Principles and techniques of Biochemistry and Molecular Biology Edited By Keith Wilson and John Walker
9. Experimental Biochemistry: A Student Companion by Sashidhar Beedu et al
10. Practical Biochemistry By Plummer

B.Sc- II Year, Semester – IV
PAPER-IV
MICROBIOLOGY AND IMMUNOLGY

UNIT – I Fundamentals of Microbiology

- 1.1 Outlines of classification of Microorganisms.
- 1.2. Sterilization techniques (Physical and Chemical).
- 1.3. Structure and general characteristics of Bacteria (Archaeobacteria, Cyano bacteria), Viruses (TMV, HIV), Micro algae (Clostridium, Chlamydomonas) and Fungi (Aspergillus, Penicillium)
- 1.4. Diseases caused by pathogenic fungi, bacteria, and viruses in humans
- 1.5. Isolation, identification and preservation of microorganisms (Bacteria).

UNIT – II Bacterial growth and nutrition

- 2.1 Bacterial nutrition , Nutritional types of bacteria, Essential macronutrients, micronutrients and growth factors.
- 2.2 Nutrient transport in bacteria -Simple diffusion, facilitated diffusion, passive and active transport.
- 2.3 Bacterial growth, Typical growth curve-batch and continuous cultures, synchronous cultures, Measurement of bacterial growth- measurement of cell number and cell mass
- 2.4 Factors effecting bacterial growth-Temperature, pH, water activity, oxygen concentration, salt concentration, pressure and radiation.
- 2.5 Measurement of cell mass by dry weight and metabolic activity.

UNIT – III Immunology – I

- 3.1. Introduction to immune system- organs and cells of immune system
- 3.2. Types of Immunity (Innate and Acquired)
- 3.3. Antigens, haptens physical chemical characteristics.
- 3.4. Structure of different immune globulins and their functions- primary and secondary antibody responses.
- 3.5. Antigen antibody interactions and antibody diversity. Types of MHC and role in organ transplantation.

UNIT – IV Immunology – II

- 4.1. Structure and functions of cytokines
- 4.2. T-cell maturation, activation and differentiation
- 4.3. B-cell activation, differentiation and proliferation.
- 4.4. Monoclonal antibodies, production and applications
- 4.5. Hypersensitivity- Coombs classification, types of hypersensitivity and Autoimmune diseases- mechanism of auto immunity.

Practical paper - IV

1. Preparation of microbiological media
2. Isolation of bacteria by streak, spread, and pour plate method
3. Staining and identification of bacteria-(Gram staining and simple straining)
4. ELISA test
5. Microagglutination using microtiter plates (eg. ABO and Rh Blood grouping)
6. RBC /WBC count

Spotters

1. HIV
2. Autoclave
3. Laminar Air Flow
4. Bacterial growth curve
5. Cyanobacteria
6. Hot air oven
7. Immunoglobulin
8. Monoclonal antibody
9. Vaccine
10. Haptens
11. Macrophage
12. Haemoglobin

, REFERENCE BOOKS

1. Brock, T.D. and Madigan, M.T. Biology of Microorganisms
2. Prescott, L.M., Harley, J.P. Klein, D.A. Microbiology
3. Pelczar, M.J, Chan, E.C.S., Ereig, N.R. Microbiology
4. Benson Microbiological applications
5. Freifelder, D Physical biochemistry: application to biochemistry and molecular biology
6. Wilson & Walker Practical biochemistry
7. Upadhyaya and Upadhyaya Physical biochemistry
8. Essential Immunology - By I. Roitt, Publ: Blackwell
9. Microbial Genetics - By S.R. Maloy, J.E. Cronan & D. Freifelder, Publ: Jones & Barlett
10. Immunology - By G. Reeve & I. Todd, Publ: Blackwell
11. From Genes to Clones - By E.L. Winnacker, Publ: Panima, New Delhi
12. Immuno diagnostics - By S.C. Rastogi, Publ: New Age

B.Sc- III Year, Semester – V
PAPER-V
Molecular biology and r-DNA technology

UNIT – I Gene expression

- 1.1 . Transcription in prokaryotes: Enzymatic Synthesis of RNA, Basic features of RNA synthesis, E.coli RNA polymerase, Classes of RNA molecules, Transcription mechanism in prokaryotes- Promoter, initiation, elongation, proof reading and Rho dependent and Rho independent termination.
- 1.2 . Transcription in Eukaryotes: Polymerases of eukaryotes, Promoters of eukaryotes,
- 1.3 . Synthesis of hn RNA, Splicing mechanisms-Self splicing, protein mediated splicing, alternative splicing, Capping and polyadenylation.
- 1.4 . The Genetic Code, properties of genetic code, Wobble hypothesis.
- 1.5 . Translation mechanism in prokaryotes and eukaryotes

UNIT – II Regulation of Gene expression

- 2.1. Regulation in Prokaryotes: General aspects of Regulation
- 2.2. Transcription level regulation-positive, negative, auto and coordinated regulation
- 2.3. Operon concept – lac, trp, operons.
- 2.4. Transcriptional Control through Transcription factors.
- 2.5 . Translation regulation in Eukaryotic and prokaryotic organism

UNIT – III r-DNA technology

- 3.1. Enzymes used in gene cloning: restriction endonucleases, ligases, phosphatases, methylases, kinases.
- 3.2. Cloning vehicles, plasmids, cosmids, phage vectors, Shuttle vectors Baculovirus vector system, expression vectors, expression cassettes.
- 3.3. Construction of genomic and cDNA libraries. Identification of cloned genes
- 3.4. Principles involved in blotting techniques- southern, northern and western.
- 3.5. Principles and application of PCR Technology and DNA fingerprinting technique and its application.

Practical Paper – V

1. Isolation of DNA from plant, animal/bacterial cells
2. Isolation of plasmid DNA
3. Analysis of DNA by agarose gel electrophoresis
4. Restriction digestion of DNA
5. PCR
6. Competent cell preparation, transformation and selection.

Spotters

1. Spliceosome
2. RNAP
3. t – RNA
4. Lac Operon
5. 5 – cap
6. PBR 322
7. Reverse transcriptase
8. Shine – Dalgarno sequence
9. Taq DNA polymerase

REFERENCE BOOKS

1. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)
2. Cell and Molecular Biology - By Robertis & Robertis, Publ: Waverly
3. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
4. Gene Structure & Expression - By J.D. Howkins, Publ: Cambridge
5. Genetic Engineering - By R. Williamson, Publ: Academic Press
6. Principles of Gene Manipulation - By R.W. Old & S.B. Primrose, Publ: Blackwell
7. Genes - By B. Lewin - Oxford Univ. Press
8. Molecular Biology & Biotechnol. - By H.D. Kumar, Publ: Vikas
9. Methods for General & Molecular Bacteriology - By P. Gerhardt et al., Publ: ASM
10. Molecular Biotechnology - By G.R. Click and J.J. Pasternak, Publ: Panima
11. Genes and Genomes – By Maxine Singer and Paul Berg
12. Principles of Gene Manipulation - By R.W. Old & S.B. Primrose, Publ: Blackwell
13. Genes - By B. Lewin - Oxford Univ. Press
14. Molecular Biology & Biotechnol. - By H.D. Kumar, Publ: Vikas
15. Molecular Biology - By D. Freifelder, Publ: Narosa

B.Sc- IIIYear, Semester – V
ELECTIVE PAPER-(A)
PLANT BIOTECHNOLOGY

UNIT – I Introduction

- 1.1. Historical perspectives of plant tissue culture, and Basic requirement for tissue culture laboratory
- 1.2 . Culture mediums for plant tissue culture- MS medium and B5 Medium. Sterilization of media-steam, dry and filter sterilization- Explants sterilization
- 1.3. Plant growth regulators and differentiation.
- 1.4. Method of tissue culture-formulation of medium explants collection, surface sterilization, inoculation, Callus induction, subculture and regeneration of plants
- 1,5. Suspension cultures- growth and subculture, types and synchronization of suspension cultures.

UNIT - II. Applications of plant tissue culture

- 2.1. Meristem culture and its uses in production of virus free plants
- 2.2. Clonal propagation, Micro propagation of plants – medicinal plants and endangered plants –method and advantages
- 2.3. Somatic embryogenesis- Principle, protocol and importance. Artificial seeds – production, applications and limitations.
- 2.4. Anther culture and production of androgenic haploids.
- 2.5. Somaclonal variations; - sources of somaclonal variations, selection of soma clones, progeny testing of soma clones, applications of somaclonal variations to crop improvement, Embryo rescue

UNIT - III : Applications of plant tissue culture

- 3.1. Protoplast – properties of protoplast ,Protoplast – Isolation (mechanical and enzymatic methods), Culturing and regeneration of protoplasts , Different methods of protoplast fusion (mechanical fusion, chemo fusion, electro fusion) and Selection of somatic hybrids and cybrids.
- 3.2. Cryopreservation of plant cultures and application of plant tissue culture .
- 3.3. Immobilization of cells and the effect of elicitors on the production of secondary metabolites of commercial value
- 3.4. Introduction to *Agrobacterium tumifaciens*, Features of Ti Plasmid, molecular mechanism of T-DNA transfer.
- 3.5. Physical gene transfer methods – Particle Bombardment, Electrophoration and Microinjection.

Practical paper VII

1. Preparation of medium for tissue culture. (MS or B5)
2. Sterilization methods of explants (seed leaf, inter node & root), medium
3. Establishment of callus cultures –from carrot.
4. Cell suspension cultures.
5. Protoplast isolation and culture.
6. Synthetic seed production.

Spotters

1. Callus
2. Somatic embryos
3. Rhizogenesis
4. Multiple shoots
5. Green house
6. Somatic hybrids
7. Synthetic seeds
8. GUS gene
9. Gene gun

REFERENCE BOOKS

1. Plant Tissue Culture and its Biotechnological Applications By W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture By Akio Fujiwara
3. Frontiers of Plant Tissue Culture By Trevor A. Thorpe
4. In vitro Haploid Production in Higher Plants by S. Mohan Jain, S.K. Sopory, R.E. Veilleux
5. Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan
6. Plant Cell, Tissue and Organ Culture, Applied and Fundamental Aspects By Y.P.S. Bajaj and A. Reinhard

SEMESTER V
ELECTIVE THEORY (B)
MEDICAL BIOTECHNOLOGY

Unit 1: Methods for diagnosis of human diseases

- 1.1 Karyotyping of human chromosomes
- 1.2 Chromosome banding– G banding and R-banding technique
- 1.3 Inheritance patterns in Man– Pedigree analysis
- 1.4 Diagnosis using monoclonal antibodies- ELISA
- 1.5 DNA/RNA based diagnosis– HBV, HIV

Unit 2: Inherited disorders

- 2.1 Chromosomal disorders caused due to structural chromosomal abnormalities (Deletions, duplications, Translocations)
- 2.2 Chromosomal disorders caused due to numerical chromosomal abnormalities (autosomal and allosomal)
- 2.3 Monogenic disorders (autosomal and X-linked diseases)
- 2.4 Mitochondrial diseases – LHON, MERRF
- 2.5 Cancer – types, molecular basis of colon cancer and breast cancer

Unit 3: Therapeutic approaches for human diseases

- 3.1 Gene therapy – exvivo and *invivo* gene therapy; somatic and germline gene therapy;
- 3.2 Strategies of gene therapy: gene augmentation – ADA deficiency; Prodrug therapy/ suicide gene – glioma
- 3.3 Stem cells – potency definitions; embryonic and adult stem cells; applications of stem cells – cell based therapies and regenerative medicine
- 3.4 Encapsulation technology and therapeutics-Diabetes
- 3.5 DNA based vaccines, subunit vaccines – Herpes Simplex Virus, Recombinant attenuated vaccines– Cholera

ELECTIVE (B): PRACTICALS

1. Karyotyping of normal and abnormal human chromosome sets
2. Human pedigree analysis
3. Estimation of C-reactive protein
4. Dot ELISA
5. Genotyping of candidate genes for diseases by RFLP
6. Encapsulation of mammalian cells

SPOTTERS

1. Pedigree
2. Monoclonal antibodies
3. ELISA
4. Oncogenes
5. Cri du Chat syndrome
6. Trisomy
7. Diabetes Mellitus
8. SCID
9. Stemcells

REFERENCE BOOKS

1. Medical Biotechnology-Pratibha Nallari, V.Venugopal Rao-Oxford Press
2. Introduction to Human Molecular Genetics – J.J Pasternak, John Wiley Publishers
3. Human Molecular Genetics –Tom Strachen and A P Read, Bios Scientific Publishers
4. Human Genetics Molecular Evolution, Mc Conkey
5. Recombinant DNA Technology, AEH Emery
6. Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery
7. Molecular Biotechnology, Glick and Pasternak

SEMESTER V
GENERIC ELECTIVE
AGRITECHNOLOGY

Unit I GM Crops:

1. Crop evolution and human civilization; Introduction to GM Crops
2. Applications of GM Crops, : (Bt- Cotton; and golden rice), Global area of biotech crops
3. Implications of GM-Crops in Agriculture, Public perception on GM crops and scientific solutions.
4. Bioethical issue on GM crops
5. Crop seasons and crop rotation, Sustainable agriculture; pheromones, traps etc

Unit II Organic farming and Conservation

1. Introduction to organic farming, green manure production, Soil fertility and management
2. Role of earthworms in soil structure, and productivity, Cost-benefit analysis of vermi-composting
3. *In vitro* propagation and Conservation of forest and medicinal plants
4. Conservation of germ plasm, Indigenous cultivars & wild plants
5. Commercial cultivation of medicinal and aromatic plants

REFERENCE BOOKS

1. Plant Tissue Culture By Akio Fujiwara
2. Frontiers of Plant Tissue Culture By Trevor A. Thorpe
3. Plant Cell, Tissue and Organ Culture, Applied and Fundamental Aspects By Y.P.S. Bajaj and A. Reinhard
4. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
5. Biotechnology -By H.J. Rehm and G. Reed. VIH Publications, Germany
6. Biogas Technology - By B.T. Nijaguna
7. Biotechnology - By K. Trehan
8. Food Microbiology - By M.R. Adams and M.O. Moss
9. Introduction to Biotechnology - By P.K. Gupta
10. Essentials of Biotechnology for Students - By Satya N. Das

B.Sc- III Year, Semester – VI
PAPER-VI
MICROBIAL TECHNOLOGY

Unit 1: Introduction to Microbial technology

- 1.1. Introduction to industrial biotechnology, scope and applications
- 1.2. Principles and exploitation of microorganisms and their products
- 1.3. Isolation and screening of microorganisms for industrial products
- 1.4. Strategies for Strain improvement (mutation, selection, recombination)
- 1.5. Preservation of industrial microorganisms

Unit 2: Microbial fermentation

- 2.1 Principles of Fermentation technology
- 2.2 Fermentation concept and Design
- 2.3 Types of Fermentations, Formulation and Design of fermentation Media
- 2.4 Substrates used as Carbon and Nitrogen Inoculum development.
- 2.5 Factors affecting fermentation process

Unit 3: Microbial technology products and applications

- 3.1 Microbial production of Organic acids (Lactic acid and citric acid)
- 3.2 Microbial production of Amino acids (Glutamic acid and Aspartic acid)
- 3.3 Fermentation by microbes for food additives: dairy products (Bread and SCP), beverages (Beer and Wine) and antibiotics (Penicillin and Streptomycin,)
- 3.4 Therapeutic drugs: Monoclonal antibodies and insulin,
- 3.5 Biofuel: Alcohol and Methane

CORE-VI: PRACTICALS

1. Screening of Microorganisms (primary selection, secondary selection)
2. Production of Citric acid
3. Screening of amylase producing microorganisms
5. Production of wine using common yeast
6. Production of hydrogen or biogas using cow/cattle dung

Spotters:

1. Fermented food
2. Bioreactor
3. SCP
4. Insulin
5. Biogas
6. Amylase

7. MAB
8. Penicillin
9. Down stream process

REFERENCE BOOKS

1. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
2. Biotechnology -By H.J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology - By b.T. Nijaguna
4. Biotechnology - By K. Trehan
5. Industrial Microbiology - By L.E. Casida
6. Food Microbiology - By M.R. Adams and M.O. Moss
7. Introduction to Biotechnology - By P.K. Gupta
8. Essentials of Biotechnology for Students - By Satya N. Das
9. Bioprocess Engineering - By Shuler (Pearson Education)
10. Essentials of Biotechnology - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)

B.Sc- IIIYear, Semester – VI
ELECTIVE PAPER-(A)
ANIMAL BIOTECHNOLOGY

UNIT-I Introduction to Animal Biotechnology

- 1.1. Animal tissue culture, history, requirements for animal cell culture
- 1.2. Substrate, liquids, culture mediums-Natural (Clots, Biological fluids, Tissue extracts), complex natural and chemically defined media
- 1.3. Explant-culture of explants, Cell culture technique- initiation, preparation and sterilization of media, isolation of explants, disaggregation of explants, culture, subculture
- 1.4. Cell lines, evolution of cell lines, maintenance of cell lines, Large scale culture of cell lines- monolayer, suspension and immobilized cell culture, Development of primary culture and cell lines, subculture
- 1.6. Stem cells: Characteristic features, maintenance, culture and Applications of Embryonic and adult stem cells, Animal cloning- Nuclear transfer and embryonic stem cell method

Unit-II Secondary Cultures

- 2.1. Cultured cells and evolution of continuous cell lines (established cell lines)
- 2.2. Commonly used cell lines - their origin and characteristics
- 2.3. Cell line preservation and characterization
- 2.4. High level expression of foreign gene in animal cells-expression vectors, enhancers, regulatory sequences. The need to express foreign genes in animal cells: advantage and disadvantages.
- 2.5. Molecular pharming: Transgenic animals and their applications, methods used for transgenesis with reference to transgenic mice ,cattle, sheep, goats, pigs, chicken and fish.

Unit-II Application of animal cell culture

- 3.1. Transfection methods of animal cells (Calcium phosphate, DEAE-dextran, Lipofection, Electroporation, Microinjection, Embryonic stem cell transfer)
- 3.2. Selection of recombinant cells with various marker genes (Thymidine Kinase, Dihydrofolate reductase, CAD protein, XGPRT, HAT, Neomycin phosphotransferase)
- 3.3. Production of transgenic animals (Mice, Cattle, Sheep, pigs, Fish and Birds)
- 3.4. Animal cells as a bioreactors for the production of commercially important products
- 3.5. Applications, advantages and disadvantages of animal tissue culture and Ethical issues related to transgenic animals.

PRACTICALS

1. Preparation of media
2. Isolation of cells from Chick embryo
3. Establishment and maintenance of primary cell cultures
4. Subculture of monolayer cells
5. Subculture of suspension cells
6. Determination of viable cells by trypan blue test

Spotters:

1. Trypsinization
2. Monolayer
3. Transgenic Mice
4. Lipofection
5. Microinjection
6. Cell lines
7. Marker genes
8. Bioreactor
9. HAT

REFERENCE BOOKS

1. Strategies in Transgenic Animal Sciences - By Glenn M.M. and James M. Robl ASM Press 2000.
2. Practical Biotechnology – Methods and Protocols - By S. Janarthanan and S. Vincent (Universities Press)
3. Animal Cells as Bioreactors - By Terence Gartwright, Cambridge Univ Press
4. Molecular Biotechnology - By Chinnarayappa (Universities Press)
5. Principles and Practice of Animal Tissue Culture - By Sudha Gangal (Universities Press)
6. Introduction to Veterinary Genetics - By F.W. Nicholas, Oxford University Press
7. Biotechnology – By U. Satyanarayana
8. Essentials of Biotechnology for Students - By Satya N. Das

SEMESTER-VI
ELECTIVE THEORY (B)
ENVIRONMENTAL BIOTECHNOLOGY

Unit 1: Environmental Pollution

- 1.1 Introduction to environment and pollution
- 1.2 Types of pollution- air, water and land pollutions
- 1.3 Types of pollutants– inorganic, organic and biotic sources
- 1.4 Sources of pollution – domestic waste, agricultural waste, industrial effluents and municipal waste
- 1.5 Climate change, greenhouse gases and global warming, Impact of pollution on environment and measurement methods

Unit 2: Bioenergy and Bio-fuels

- 2.1 Renewable and non- renewable energy resources
- 2.2 Fossil fuels as energy source and their impact on environment
- 2.3 Non-conventional source – biomass as source of bioenergy
- 2.4 Types of biomass – plant, animal and microbial biomass
- 2.5 Production of biofuels, bioethanol & biomethanol

Unit 3: Bioremediation and Restoration of Environment

- 3.1 Microbial treatment of waste water (sewage of industrial effluent)- aerobic and anaerobic methods
- 3.2 Solid waste and management; Bioremediation– concepts and types (in-situ and ex-situ); Bioremediation of toxic metal ions– biosorption and bioaccumulation
- 3.3 Microbial bioremediation of pesticides and Xenobiotic compounds
- 3.4 Phytoremediation- concepts and application
- 3.5 Conservation of biodiversity

ELECTIVE (B): PRACTICALS

1. Estimation of BOD in water samples
2. Estimation of COD in water samples
3. Estimation of total dissolved solid in water samples
4. Isolation of microorganisms from soil/industrial effluents
5. Production of biogas using cow/cattle dung
6. Bioremediation

Spotters:

1. Aerosols
2. Biomagnification
3. Tidal energy
4. Habitat destruction
5. Biodegradable plastic – Poly hydroxy butyrate
6. Elinino affect
7. Coral reefs
8. Xenobiotic compounds
9. Global warming

RECOMMENDED BOOKS

1. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
2. Biotechnology -By H.J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology - By B.T. Nijaguna
4. Biotechnology - By K. Trehan
5. Industrial Microbiology - By L.E. Casida
6. Food Microbiology - By M.R. Adams and M.O. Moss
7. Introduction to Biotechnology - By P.K. Gupta
8. Essentials of Biotechnology for Students - By Satya N. Das
9. Bioprocess Engineering - By Shuler (Pearson Education)
10. Essentials of Biotechnology - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)

**SEMESTER VI
GENERIC ELECTIVE
BIOTECHNOLOGY PERSPECTIVES**

Unit 1: Biotechnological applications in health care

- 1.1 Molecular diagnosis – monoclonal antibodies, DNA probes, Microarrays
- 1.2 DNA finger printing
- 1.3 Gene therapy
- 1.4 Recombinant therapeutic proteins – insulin, interferon, growth hormone
- 1.5 Stem cells and regenerative medicine
- 1.6 Transgenic animals – transgenic mice and transgenic fish

Unit 2: Biotechnological applications in agriculture and environment

- 2.1 Transgenic plants with insect resistance
- 2.2 Transgenic plants with drought stress tolerance
- 2.3 Bioremediation - Genetically engineered bacteria for bioremediation
- 2.4 Biofertilizers
- 2.5 Biopesticides
- 2.6 Biofuels

RECOMMENDED BOOKS

1. Human Molecular Genetics –Tom Strachen and A P Read, Bios Scxientific Publishers
2. Human Genetics Molecular Evolution, Mc Conkey
3. Recombinant DNA Technology, AEH Emery
4. Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery
5. Medical Biotechnology-Pratibha Nallari, V.Venugopal Rao-Oxford Press
6. Molecular Biotechnology-Glick
7. Biodegradation and bioremediation Academic press By:San Diego
8. Biotechnology in the sustainable environment,Plenumpress, NY
9. Biotechnology-U.Satyanarayana
10. Plant Tissue Culture By Akio Fujiwara
11. Frontiers of Plant Tissue Culture By Trevor A. Thorpe
12. Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan