

Choice Based Credit System  
(w.e.f 2016-2017)

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

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

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**STRUCTURE AND CREDITS**

Semester	Paper	Level	Subject	Credits		
				Theory	Practical	Theory + Practical's
I	I	CORE	Cell Biology and Genetics	4	--	6
			Practical	--	2	
II	II	CORE	Basics of Nucleic Acids– Biostatistics - Computers	4	--	6
			Practical	--	2	
III	III	CORE	Biological Chemistry	4	--	6
			Practical	--	2	
IV	IV	CORE	Microbiology and Biophysical Techniques	4	--	6
			Practical	--	2	
V	V	CORE	Molecular Biology	3	--	5
			Practical	--	2	
	VI - Advanced	ELECTIVE – A/B	Plant Biotechnology Or Animal Biotechnology	3	--	5
			Practical	--	2	
VI	VII	CORE	Genetic Engineering and Immunology	3	--	5
			Practical	--	2	
	VII- Applied	ELECTIVE – A/B	Industrial Biotechnology, IPR & Biosafety Or Environmental Biotechnology, Bioremediation and Restoration Biology	3	--	5
			Practical	--	2	
		INTER DISCIPLINARY ELECTIVE ( IDE)	Biotechnology for Human Welfare	3		
				<b>28+3</b>	<b>16</b>	<b>47</b>

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**Scheme of Instruction**

Semester	Paper	Subject	Hours/Week		Total Hours
			Theory	Practical	
I	I	CORE- Cell Biology and Genetics	4	---	60
		Practical	---	3	45
II	II	CORE- Basics of Nucleic Acids– Biostatistics - Computers	4	---	60
		Practical	---	3	45
III	III	CORE- Biological Chemistry	4	---	60
		Practical	---	3	45
IV	IV	CORE- Microbiology and Biophysical Techniques	4	---	60
		Practical	---	3	45
V	V	CORE- Molecular Biology	3	---	45
		Practical	---	3	45
	VI	ELECTIVE - Plant Biotechnology Or Animal Biotechnology	3	---	45
		Practical	---	3	45
VI	VII	CORE- Genetic Engineering and Immunology	3	---	45
		Practical	---	3	45
	VIII	ELECTIVE - Industrial Biotechnology, IPR & Biosafety Or Environmental Biotechnology, Bioremediation and Restoration Biology	3	---	45
		Practical	---	3	45
		IDE- Biotechnology for Human Welfare	3		45

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**Scheme of Examination**

Semester	Paper	Subject	Marks		Total Marks	Duration of Exam (hrs.)
			IE	UE		
I	I	CORE- Cell Biology and Genetics	10	40	50	3
		Practical	--	25	25	3
II	II	CORE- Basics of Nucleic Acids– Biostatistics - Computers	10	40	50	3
		Practical	--	25	25	3
III	III	CORE- Biological Chemistry	10	40	50	3
		Practical	--	25	25	3
IV	IV	CORE- Microbiology and Biophysical Techniques	10	40	50	3
		Practical	--	25	25	3
V	V	CORE- Molecular Biology	10	40	50	3
		Practical	--	25	25	3
	VI	ELECTIVE - Plant Biotechnology Or Animal Biotechnology	10	40	50	3
		Practical	--	25	25	3
VII	VII	Genetic Engineering and Immunology	10	40	50	3
		Practical	--	25	25	3
VIII	VIII	ELECTIVE - Industrial Biotechnology, IPR & Biosafety Or Environmental Biotechnology, Bioremediation and Restoration Biology	10	40	50	3
		Practical	--	25	25	3
	INTER DISCIPLINARY ELECTIVE (IDE)	Biotechnology for Human Welfare	<b>10</b>	<b>40</b>		3
		<b>Total Marks:</b>	<b>80</b>	<b>520</b>	<b>600</b>	<b>---</b>

**B.Sc- I Year- Semester -I**  
**CELL BIOLOGY AND GENTICS**

**PAPER-I**

**Total: 60 hrs (4hrs/week)**

**Each Module: 15hrs (1hr/week)**

**MODULE-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 - Compartmentalization (Cell wall, cell membrane, Golgi Complexes, Endoplasmic Reticulum, Peroxisome, Lysosomes etc).
- 1.5 Semi- autonomous Organelles (Mitochondria & Chloroplast : Endosymbiotic theory)

**MODULE-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 & Programmed Cell Death ( Cell death & Necrosis)
- 2.4 Significance of Mitosis and Meiosis
- 2.5 Stem cell and its origin & their applications

**MODULE- III: Mendelism & Mendel's Laws**

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

**MODULE-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, Mamalian, Birds)
- 4.4 X – linked inheritance (eg. Haemophilia)

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**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. Snustad, D.P., Simmons. M.J ( 2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
6. Cell Biology, DE Robertis & De Roberis, Blaze publishers & Distributors Pvt. Ltd., New Delhi, 2001.
7. Cell and Molecular Biology - By De Robertis
8. Cell and Molecular Biology - By Lodish
9. Theory and Problems in Genetics - By Stransfield
10. Genetics - By Gardner (Macmillan Press)

**Practicals:**

1. Monohybrid and dihybrid ratio in *Drosophila*/maize
2. Preparation of different stages of Mitosis and Meiosis
3. Types of chromosomes
4. Ames test for mutagenic agents
5. Preparation of Nuclear, Mitochondrial & Cytoplasmic fractions.
6. Pedigree charts of some common characters like blood group & color blindness

**Spotters:** Nucleus structure & functions; Eu & Prokaryotic Ribosomal components; Nucleosomes; Cyclin Dependent Kinases; Synaptonemal Complex; Dihybrid test cross; Chemical components of biological membranes; Cytological proof of Crossing over; Genic balance theory; Haemophilia; Tumor suppressor genes; lethal genes.

**B.Sc- I Year- Semester -II**  
**BASICS OF NUCLEIC ACIDS - BIOSTATISTICS – COMPUTERS**  
**PAPER-II**

**Total: 60 hrs (4hrs/week)**  
Each Module: 15hrs (1hr/week)

**MODULE- I: Structure of Nucleic Acids**

- 1.1 DNA as the genetic material – Griffiths experiments on transformation in *Streptococcus pneumoniae*. Avery, McLeod and McCarty's experiments. Hershey – Chase experiments with radio-labelled T<sub>2</sub> bacteriophage
- 1.2 RNA as genetic material – Tobacco Mosaic Virus
- 1.3 Structure 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/Gyrases

**MODULE- II: Functions & Mechanisms of Nucleic Acids**

- 2.1 DNA Replication – Models of DNA replication (Semi-conservative, non-conservative models) Mechanisms of DNA replication – Linear and circular – Rolling circle and theta mechanism of replication
- 2.2 Unique aspects of Eukaryotic Chromosome replication – Telomerase
- 2.3 DNA damage and Repair mechanisms
- 2.4 DNA Recombination
- 2.5 Central Dogma of Biology: Reverse Transcription

**MODULE- III: Concepts of Biostatistics**

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

**MODULE- IV: Concepts of Computers & Bioinformatics**

- 4.1 Usage of MS DOS commands: Basic concept of Internal & External commands, directory & file commands, copying, erasing, renaming, displaying files.

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4.2 Windows operation: Customizing the interface, windows explorer, computer upkeep & utilities Office operation

4.3 Microsoft word: Concept of toolbar, character, paragraph & document formatting, drawing tool bar, header, footer, document editing, page setup, short cut keys, text & graphics.

4.4 Microsoft excel- concept of spread sheets, creating worksheet ,well formatted documents, concept of row, column, cell & formula bar, using function, using shortcuts, chart, conditional formatting, goal seek, validation rule.

4.4 MS Power point- Power point basics, Views, Slide control, Apply design, Page setup, Templates, Background, Control, Color Screens, Transitions and animations, working with texts and working with graphics.

4.5 Internet- Biological Databases

**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. Fundamentals of Computers by P.K. Sinha
6. Biometry - By Sokal and Rohlf W.H. Freeman
7. Working in Microsoft Office By Ron Mansfield
8. Fundamentals of Biometry - By L.N. Balaram (George Allen and Unwin Ltd, London (1972)
9. Biostatistics - By N.T.J. Bailey
10. Le CT (2003) Introductory biostatistics. 1<sup>st</sup> edition, Jhon Wiley, USA
11. Biostatistics- Manual of biostatistical methods for use in health, nutrition and Anthropology - By K. Visweshwar Rao (Jaypee Publications).
12. Bioinformatics and Bioprogramming in C - By L.N. Chavali
13. Introduction to Bioinformatics - By V. Kothekar
14. Introduction to Bioinformatics - By Arthur M. Lesk

**Practical:**

1. Estimation of DNA by diphenylamine method
2. Estimation of RNA by orcinol method
3. Finding statistical significance of a given data using 't' test
4. Graphical representation of data (Histograms, frequency polygen, Pie diagram)
5. Fitting of binomial and Poisson distributions
6. Acquaintance with the Biological databases through Internet
7. Micro soft Power point presentation.

**Spotters** : Hershey-Chase experiments ; Fidelity of replication ; Meselson & Stalh experiments; Telomerase; Thymidine dimers; SOS repair; t-test; Chi-square test; Short cut keys; MS DOS commands; Protein databases.



**B.Sc -II Year–Semester - III**  
**PAPER-III**  
**BIOLOGICAL CHEMISTRY**

**Total: 60 hrs (4hrs/week)**

Each Module: 15hrs (1hr/week)

**MODULE – 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 sulfated, Heparin, Peptidoglycan)

**MODULE – II: Proteins and Enzymes**

- 2.1 Classification, structure and physical and chemical properties of aminoacids & protiens
- 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

**MODULE – III: Bioenergistics of biomolecules**

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

**MODULE – IV: Intermediary Metabolism**

- 4.1 Urea cyle and regulation
- 4.2 Biosynthesis and regulation of purine and pyrimidine nucleotides, de novo and salvage pathways

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4.3 Photosynthesis – Light reaction and photophosphorylation,

4.4 Photosynthesis – Carbon Assimilation

**Practical paper - III**

1. Preparation of normal, molar and molal solutions
2. Preparation of buffers ( acids, basic and neutral)
3. Qualitative tests of Sugars, amino acids and lipids
4. Estimation of proteins by Biurate method
5. Estimation of total sugars by Anthron method
6. Reducing sugars DNS method
7. Separation of protein by SDS – PAGE.
8. Separation of amino acids by paper chromatography, TLC

**Spotters:** Osazone; Cellulose; globular protein; Lock and Key model; Competitive inhibition; Xerophthalmia; RUBISCO; Albinism; ATP synthase; Cytochrome; Albinism; Gout.

**Recommended Books:**

1. Lehninger Principles of Biochemistry By: David L. Nelson and Cox
2. Biochemistry By: Rex Montgomery
3. Harper's Biochemistry By: Robert K. Myrray
4. Enzymes By: Trevor Palmer
5. Enzyme structure and mechanism By: AlanFersht
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 Rao and Despande et al
10. Practical Biochemistry By Plummer
11. Text book of Biochemistry By U. Sathayanarayana

**B.Sc- II Year, Semester – IV**  
**PAPER-IV**  
**MICROBIOLOGY AND BIOPHYSICAL TECHNIQUES**

**Total: 60 hrs (4hrs/week)**

Each Module: 15hrs (1hr/week)

**MODULE – 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, Pencillium)
- 1.4 Diseases caused by pathogenic fungi, bacteria, and viruses in humans
- 1.5 Isolation, identification and preservation of microorganisms (Bacteria).

**MODULE – II: Bacterial Growth and Nutrition**

- 2.1 Bacterial nutrition , Nutritional types of bacteria, Essential macronutrients, micronutrients and growth factors.
- 2.2 Bacterial growth, Typical growth curve-batch and continuous cultures, synchronous cultures, Measurement of bacterial growth- measurement of cell number and cell mass
- 2.3 Factors effecting bacterial growth-Temperature, pH, water activity, oxygen concentration, salt concentration, pressure and radiation.
- 2.4 Culturing of anaerobic bacteria & Viruses
- 2.5 Pure cultures and cultural charecterisitcs

**MODULE – III: Principles and Applications of Biophysical Techniques I**

- 3.1 Microscopy – Light, Inverted, Fluorescent and Electron microscopy- TEM & SEM
- 3.2 Colorimetry – Beer – Lambert’s Law
- 3.3 UV-VIS Spectrophotometry
- 3.4 Chromatography  
(a)Paper (b) Thin Layer (c) Ion-exchange (d) Gel-filtration (e) Affinity (f) HPLC
- 3.5 Introduction to Biosensors and Nanotechnology and their applications

**MODULE- IV: Principles and Applications of Biophysical Techniques II**

- 4.1 Electrophoresis – Native gels and SDS-PAGE, Agarose
- 4.2 Centrifugation and filtration – Basic Principles
- 4.3 Dialysis and lyophilization
- 4.4 Radio isotopes and their use in Biology
- 4.5 Principle and applications of X- ray crystallography & NMR

**Practicals**

1. Separation of amino acids by paper chromatography
2. Electrophoretic separation of proteins (SDS-PAGE)
3. Technique of Micrometry (Stage and ocular)
4. Preparation of routine microbiological media
5. Isolation of common non-pathogenic bacteria
6. Staining and identification of bacteria – *E.coli*, *Pseudomonas*, *Bacillus* and *Staphylococcus*.

**Spotters:** HIV; Autoclave; Laminar Air Flow; Pencillium; Tyndalization; Bacterial growth curve; Inoculation loop; Cyanobacteria; Hot air oven; Agarose gel electrophoresis; Serial dilution technique; Numerical aperture.

**Recommended Books**

1. Text Book of Microbiology - By Ananthanarayan and Paniker
2. Microbiology - By Cappuccino (Pearson Education)
3. Microbiology - By Tortora (Pearson Education)
4. Microbiology - B.J. Pelczar, E.S.N. Cfan and N.R. Kreig, McGraw Hill Publ.
5. General Microbiology – By Stanier, R.Y, J.L. Ingrahm, M.L. Wheel is & P.R. Painter
6. General Microbiology – By Powar (Vol. I and Vol. II).
7. Practical Microbiology - By Aneja.
8. Cell and Molecular Biology : Concepts and Experiments. Karp, G. 2010. 6<sup>th</sup> edition John Wiley & Sons . Inc.

**B.Sc- III Year, Semester – V**  
**PAPER-V - CORE**  
**MOLECULAR BIOLOGY**

**Total: 45 hrs (3hrs/week)**  
Each Module: 15hrs (1hr/week)

**MODULE –I: Gene, Organellar and Genome Organization**

- 1.1 Organization of Prokaryotic genes
- 1.2 Organization of eukaryotic genes - Exons, introns, promoters and terminators
- 1.3 Organization of nuclear genome – Genes and gene numbers – essential, non essential genes & Satellite DNA
- 1.4 Chloroplast genome organization in plants & Mitochondrial genome organization (eg: Human)
- 1.5 Gene families and clusters – eg. Globin gene, histones and ribosomal genes.

**MODULE –II: Gene expression in Prokaryotes and Eukaryotes**

- 2.1 Prokaryotic Transcription mechanism: *E.coli* RNA polymerase, Classes of RNA molecules, Promoters, initiation, elongation and Rho dependent and Rho independent termination.
- 2.2 Eukaryotic Transcription mechanism: Kinds of RNA polymerases, Promoters
- 2.3 Translation: Synthesis of polypeptides - initiation, elongation and termination in prokaryotes and eukaryotes
- 2.4 Genetic code and its features.
- 2.5 Wobble Hypothesis & Single letter code of amino acids

**MODULE- III: Gene Regulation in Prokaryotes and Eukaryotes**

- 3.1 Regulation of Gene expression in prokaryotes : Polyribosomes, Coupled transcription & translation
- 3.2 Regulation of Gene expression in eukaryotes : Post-transcriptional events (Capping, polyadenylation, splicing and alternate splicing)
- 3.3 Transcriptional control by *Cis* (enhancers, silencers) and *Trans* (transcriptional factors) regulatory elements .
- 3.4 Post-translational events
- 3.5 Operon concept in Bacteria : Inducible-lac & repressible - trp operon.

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**Practicals**

1. Isolation of DNA from plant/animal/bacterial cells
2. Analysis of DNA by agarose gel electrophoresis
3. Restriction digestion of DNA
4. Preparation of competent cells of Bacteria
5. Bacterial transformation and selection of transformants under pressure (antibiotic).

**Spotters:** Eukaryotic promoter; Spliceosome; Transcriptional bubble; 7 MG 5' – cap; Post - translational events; Polycistronic m-RNA; Attenuator; Inhibitors of translation; Charging of t-RNA.

**Recommended Books:**

1. Concepts in Biotechnology - By D. Balasubramanian, C.F.A. Bryce, K. Dharmalingam, J. Green and Kunthala Jayaraman
2. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner
3. (Pearson Education)
4. Cell and Molecular Biology - By Robertis & Robertis, Publ: Waverly
5. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
6. Gene Structure & Expression - By J.D. Howkins, Publ: Cambridge
7. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner  
(Pearson Education)
8. Cell and Molecular Biology - By Robertis & Robertis, Publ: Waverly
9. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
10. Gene Structure & Expression - By J.D. Howkins, Publ: Cambridge
11. Molecular Biology - By D. Freifelder, Publ: Narosa
12. Genes and Genomes - By Maxine Singer and Paul Berg
13. Cell and Molecular Biology - By S.C. Rastogi
14. From Genes to Clones - By E.L. Winnacker, Publ: Panima, New Delhi
15. Genes - By B. Lewin - Oxford Univ. Press
16. Molecular Biology & Biotechnology - By H.D. Kumar, Publ: Vikas
17. Gene Biotechnology - By Jogdand
18. Genome - T.A. Brown
19. Gene Cloning - T.A. Brown

**B.Sc- IIIYear, Semester – V**  
**ELECTIVE - A**  
**PLANT BIOTECHNOLOGY**

**Total: 45 hrs (3hrs/week)**  
Each Module: 15hrs (1hr/week)

**MODULE- I: Introduction to Plant Biotechnology**

- 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, B5 Medium, WPM medium and plant growth regulators and differentiation.
- 1.3 Sterilization of media-steam, dry and filter sterilization- Explants sterilization
- 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.

**MODULE – II: Applications of Plant Tissue Culture -I**

- 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. Culture of plant cells for the extraction of secondary metabolites- alkaloid, flavones, pharmaceutical products
- 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

**MODULE- III: Applications of Plant Tissue Culture -II**

- 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).
- 3.2 Selection of somatic hybrids and cybrids – definition and application.
- 3.3 Somatic embryogenesis- Principle, protocol and importance. Artificial seeds – production, applications and limitations.
- 3.4 Cryopreservation of plant cultures and application of plant tissue culture.

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3.5 Immobilization of cells and the effect of elicitors on the production of secondary metabolites of commercial value

**ELECTIVE (A): PRACTICALS**

**(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/ virtual labs etc.)**

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:** Callus; Somatic embryos; Protoplast; Cybrid; Rhizogenesis; Suspension culture; Agar – agar; Green house; Synthetic seeds

**Recommended Books:**

1. Plant Tissue Culture and its Biotechnological Applications By W. Barz, E. Reinhard, M.H. Zenk
2. Plant Biotechnology – H S Chawla
3. Plant Tissue Culture By Akio Fujiwara
4. Frontiers of Plant Tissue Culture By Trevor A. Thorpe
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



**B.Sc- IIIYear, Semester – V**  
**ELECTIVE - B**  
**ANIMAL BIOTECHNOLOGY**

**Total: 45 hrs (3hrs/week)**  
Each Module: 15hrs (1hr/week)

**MODULE- I: Animal diversity and Cataloguing of germplasm**

- 1.1 Conventional methods of Animal Breeding: Selective and Cross breeding
- 1.2 Embryo Biotechniques for augmentation of replication efficiency and faster Multiplication of superior germplasm
- 1.3 Cryopreservation of germplasm
- 1.4 Artificial insemination: Super ovulation, Oestrus synchronization, embryo collection and transfer
- 1.5 In vitro maturation of Oocytes, In vitro fertilization, embryo culture, preservation
- 1.6 Economically important livestock, Conservation of genetic resources

**MODULE –I: Animal Improvement for desired traits by biotechnology Interventions**

- 2.1 Scope for biotechnological interventions (Buffalo as multipurpose livestock)
- 2.2 Model organisms and their significance (Cattle, Rodents and Fish)
- 2.3 DNA Micromanipulation
- 2.4 Somatic cell nuclear transfer
- 2.5 Embryo sexing
- 2.6 Gene mapping and Identification of genes of economic importance in farm Animals

**MODULE – III: Developments in molecular markers in Livestock and Transgenic Animals**

- 3.1 Developments in livestock genomics (estimated breeding value, ebv)
- 3.2 Molecular markers and applications
- 3.3 Development of transgenic animals
- 3.4 Applications of transgenic animals in milk production, meat production and aquaculture
- 3.5 Transgenic technology for development of animals as bioreactors
- 3.6 Ethical considerations for transgenic animals

### **ELECTIVE (B): PRACTICALS**

**(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/ virtual labs etc.)**

1. Preparation of media
2. Isolation of cells from Chicken Liver
3. Isolation of cells from Chick Embryo
4. Preparation of somatic metaphase chromosomes
5. Karyotyping- banding procedures for comparing the chromosomal complement
6. Screening of chromosomal abnormalities

**Spotters :** Cell lines; Root-Knot Nematode; Super ovulation; Microinjection; Transgenic sheep; Transgenic mosquito; Molecular farming; Somatic cell fusion ; Cryopreservation; Artificial insemination.

### **RECOMMENDED BOOKS**

1. Lasley JF. Genetics of Livestock Improvement
2. Text book of Animal Biotechnology by B Singh. The Energy and Resources Institute (teri)
3. Ross CV. Sheep Production and Management. Prentice Hall
4. Schmidt GM & Van Vleck LD. Principles of Dairy Science. WH Freeman
5. Turner HN & Young SSY. Quantitative Genetics in Sheep Breeding. MacMillan
6. Van Vleck LD, Pollak EJ & Bltenacu EAB. Genetics for Animal Sciences. WH Freeman
7. Crawford RD. Poultry Breeding and Genetics. Elsevier
8. Singh RP & Kumar J. Biometrical Methods in Poultry Breeding. Kalyani

**B.Sc- III Year, Semester – VI**  
**PAPER-VI - CORE**  
**GENETIC ENGINEERING AND IMMUNOLOGY**

**Total: 45 hrs (3hrs/week)**  
Each Module: 15hrs (1hrs/week)

**MODULE-I: Genetic Engineering**

- 1.1 Enzymes used in gene cloning : Restriction endonucleases, Ligases, Phosphatases, Methylases, Kinases
- 1.2 Cloning vehicles – Plasmids, Cosmids, Phage vectors, Shuttle vectors , Baculovirus vector system, Expression vectors - expression cassettes
- 1.3 Construction of genomic and cDNA libraries
- 1.4 Identification of cloned genes
- 1.5 Principles involved in Blotting Techniques – Southern, Northern and Western
- 1.6 Principles and Applications of PCR Technology & DNA Finger printing technique

**MODULE-II: Immunology- I**

- 2.1 Introduction to immune system – Organs and cells of the immune system
- 2.2 Types of Immunity (Innate and Acquired)
- 2.3 Antigens, Haptens – physico-chemical characteristics
- 2.4 Structure of different immunoglobulins and their functions – Primary and secondary antibody response
- 2.5 Antigen - Antibody Reaction

**MODULE-III: Immunology- II**

- 3.1 The Major Histocompatibility gene complex and its role in organ transplantation, Generation of antibody diversity
- 3.2 Hypersensitivity – Coombs classification, Types of hypersensitivity
- 3.3 Autoimmune diseases – mechanisms of auto immunity
- 3.4 Production of polyclonal antibodies.

**Practicals:**

1. Immuno-diffusion test
2. ELISA Test
3. Micro agglutination using micro titer plates (eg. ABO and Rh Blood grouping)
4. Viability tests of cells/bacteria (Evans blue test or Trypan blue test)
5. Coombs' test
6. Demonstration of PCR
7. Production and applications of transgenic mice

**Choice Based Credit System**  
(w.e.f 2016-2017)

**Spotters :** pBR 322; pUC; Probe; c DNA; Haptens; Macrophage; Taq DNA Polymerase; VNTR; Rhuaematoid arthritis; primer design.

**Recommended Books;**

1. Concepts in Biotechnology - By D. Balasubramanian, C.F.A. Bryce, K. Dharmalingam, J. Green and Kunthala Jayaraman
2. Essential Immunology - By I. Roitt, Publ: Blackwell
3. Genetic Engineering - By R. Williamson, Publ: Academic Press
4. Test Book of Molecular Biology - By K.S. Sastry, G. Padmanabhan & C. Subramanyan, Publ: Macmillan India
5. Glick. B. R., Pasternak, J. J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA, ASM Press, Washington
6. Principles of Gene Manipulation - By R.W. Old & S.B. Primrose, Publ: Blackwell
7. Immunology - By G. Reeve & I. Todd, Publ: Blackwell
8. Molecular Biotechnology - By G.R. Click and J.J. Pasternak, Publ: Panima
9. Recombinant DNA - By J.D. Watson et al., Publ: Scikentific American Books
  
10. Genetic Engineering and Biotechnology - By V. Kumar Gera
11. Essentials of Biotechnology - By P.K. Gupta
12. Introduction to Applied Biology and Biotechnology - By K. Vaidyanath, K. Pratap Reddy and K. Satya Prasad
13. Laboratory Experiments in Microbiology - By M. Gopal Reddy, M.N. Reddy, D.V.R. Sai Gopal and K.V. Mallaiiah
14. Immunology - By Kubey
15. Introduction to Biotechnology - By W.J. Thieman and M.A. Palladino (Pearson Education)
16. Genetic Engineering - By Boylan (Pearson Education)
17. Basic Concepts of Biotechnology - By Irfan Ali Khan and Atiya Khanum (Ukaaz Publications)
18. Genetic Engineering - By Sandhya Mitra.

**B.Sc- IIIYear, Semester – VI**

**ELECTIVE - A**

**INDUSTRIAL BIOTECHNOLOGY, IPR & BIOSAFTEY**

**Total: 45 hrs (3hrs/week)**

Each Module: 15hrs (1hrs/week)

**MODULE-I: Industrial Biotechnology – I**

- 1.1 Introduction to industrial biotechnology – scope and applications
- 1.2 Primary and secondary metabolic products of microorganisms
- 1.3 Isolation, screening and preservation of industrial microorganisms
- 1.4 Strategies for strain improvement (mutation, selection, recombination)

**MODULE-II: Industrial Biotechnology – II**

- 2.1 Principles of Fermentation technology & Types of Fermentations
- 2.2 Formulation and design of fermentation media (carbon & nitrogen sources)
- 2.3 Fermentative production of microbial enzymes (amylases, proteases), and antibiotics (Pencillin, Streptomycin)
- 2.4 Fermentative production of foods and dairy products – Cheese, Yogurt, Bread, SCP
- 2.5 Commercial production of Biofuels (hydrogen, alcohol, methane) and chemicals ( Lactic acid, Citric acid)by microbial fermentations

**MODULE-III: IPR and Biosafety**

- 3.1 Intellectual Property Rights – Introduction to Indian Patent law. World Trade Organization and its related intellectual property provisions. Patenting in Biotechnology, economic, ethical and depository considerations
- 3.2 Biosafety – Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

**Practicals:**

- 1.Production of wine using common yeast
- 2.Production of alcohol by fermentation and Estimation of alcohol by colorimetry
- 3.Growth curves of bacteria, Measurement of growth in liquid cultures
- 4.Production of Citric acid
- 5.Screening of amylase producing microorganisms
- 6.Production of hydrogen or biogas using cow/cattle dung
- 7.Production of Penicillin/Ampicillin

**Spotters :** Fementer; Anti viral proteins; Batch culture; Fed batch culture; Replica plating; Beverage – Beer ; HAT medium; Proteases; biosafety policies.

**Choice Based Credit System**  
(w.e.f 2016-2017)

**Recommended Books**

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

Choice Based Credit System  
(w.e.f 2016-2017)

**B.Sc- IIIYear, Semester – VI**

**ELECTIVE THEORY (B)**

**ENVIRONMENTAL BIOTECHNOLOGY, BIOREMEDIATION AND RESTORATION  
BIOLOGY**

**Total: 45 hrs (3hrs/week)**

Each Module: 15hrs (1hrs/week)

**Module -I 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
- 1.6 Impact of pollution on environment and measurement methods

**MODULE –II 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, biomethane, biohydrogen
- 2.6 Microbial ore leaching

**MODULE – III 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 Composting of organic wastes
- 3.4 Microbial bioremediation of pesticides and Xenobiotic compounds
- 3.5 Phytoremediation- concepts and application
- 3.6 Conservation of biodiversity

**Choice Based Credit System**  
(w.e.f 2016-2017)

**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. Organic wastes for Compost production & vermiculture

**Spotters** : Aerosols; Biomagnification; Tidal energy; Habitat destruction; Biodegradable plastic – Poly hydroxy butyrate ; Elinino affect; Coral reefs; Xenobiotic compounds; Global warming; Acid rains

**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. Bioethics – Readings and Cases - By B.A. Brody and H. T. Engelhardt. Jr. (Pearson Education)
10. Biotechnology, IPRs and Biodiversity - By M.B. Rao and Manjula Guru (Pearson Education)
11. Bioprocess Engineering - By Shuler (Pearson Education)
12. Essentials of Biotechnology - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)



**B.Sc- IIIYear, Semester – VI**  
**INTERDISCIPLINARY ELECTIVE**

**BIOTECHNOLOGY FOR HUMAN WELFARE**

**Total: 45 hrs (3hrs/week)**  
Each Module: 15hrs (1hr/week)

**MODULE –I 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

**MODULE –II Biotechnological applications in agriculture**

- 2.1 Plant tissue culture : Totipotency
- 2.2 Transgenic plants with insect resistance
- 2.3 Transgenic plants with bacterial, fungal stress tolerance
- 2.4 Transgenic plants with drought, salt stress tolerance
- 2.5 Transgenic plants- Flavour tomato, Golden rice

**MODULE –III Biotechnological applications in environment**

- 2.1 Bioremediation - Genetically engineered bacteria for bioremediation
- 2.2 Biofertilizers
- 2.3 Biopesticides
- 2.4 Biofuels
- 2.5 Bioleaching & enrichment of ores by microorganisms ( Gold, Copper and Uranium)

**Recommended books:**

1. Human Molecular Genetics –Tom Strachen and A P Read, Bios Scientific 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. Plant Cell, Tissue and Organ Culture Applied and Fundamental Aspects by Y.P.S. Bajaj and A. Reinhard
7. Molecular Biotechnology-Glick
8. Concepts in Biotechnology - By D. Balasubramanian, C.F.A. Bryce, K.Dharmalingam, J. Green and Kunthala Jayaraman
9. Biodegradation and bioremediation Academic press By:San Diego
10. Biotechnology in the sustainable environment,Plenumpress, NY
11. Biotechnology-U.Satyanarayana
12. Plant Tissue Culture and its Biotechnological Applications By W. Barz, E. Reinhard, M.H. Zenk
13. Plant Tissue Culture By Akio Fujiwara
14. Frontiers of Plant Tissue Culture By Trevor A. Thorpe
15. Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan