Maa Shakumbhari University, Saharanpur

Syllabus of the Subject

Biotechnology

For Four Year Undergraduate Program (FYUP)

(As per guidelines of Common Minimum Syllabus by U.P. Government according to National Education Policy-2020 amended with GO-2090/70-3-2024-09(01) Dated: 02-09-2024)

Members, Board of Studies (Biotechnology)

S. No.	Name	Designation	College/University	Signature
1.	Prof. Garima Jain	Dean Science	D.A.V. (P.G). College, Muzaffarnagar	
2.	Prof. Anju Panwar	Convener	D.A.V. (P.G). College, Muzaffarnagar	18th March, 25
3.	Dr. Charu Tyagi	Member	D.A.V.(P.G.) College, Muzaffarnagar	18/03/25
4.	Dr. Sanjay Arora	Member	S.D.(P.G.) College, Muzaffarnagar	Attended Online
5.	Dr. Rachna Tyagi	Member	D.A.V.(P.G.) College, Muzaffarnagar	18/03/25
6.	Prof. Bindu Sharma	External expert	Ch. Charan Singh University Campus, Meerut	–
7.	Dr. Punjab Malik	External expert	Meerut College, Meerut.	–

Semester-wise Titles of Papers

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Certificate course					
1st	I		Fundamentals of Biotechnology	Theory	4
			Fundamentals of Biotechnology Lab.	Practical	2
			Cell Biology	Theory	4
			Cell Biology Lab.	Practical	2
			Minor Elective (Other faculty)	Theory	6
			Vocational Skill Development course	Theory	3
			Co-curricular Course	Theory	2
		Total Credits:23			
	II		General Microbiology	Theory	4
			General Microbiology Lab	Practical	2
			Biochemistry and metabolism	Theory	4
			Biochemistry and metabolism Lab.	Practical	2
			Vocational Skill Development course	Theory	3
			Co-curricular Course	Theory	2
		Total Credits:17			
First Year Total credits: 40					

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Diploma					
2nd	III		Genetics	Theory	4
			Genetics Lab.	Practical	2
			Animal and Plant Physiology	Theory	4
			Animal and Plant Physiology Lab	Practical	2
			Minor Elective (Other Faculty)	Theory	6
			Vocational Skill Development course .	Theory	3
			Co-curricular Course	Theory	2
		Total Credits:23			
	IV		Analytical Techniques in Biology	Theory	4
			Analytical Techniques in Biology Lab.	Practical	2
			Molecular Biology	Theory	4
			Molecular Biology Lab	Practical	2
			Co-curricular Course	Theory	2
			Research Project		3
		Total Credits:17			
Second Year Total credits: 40					

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Degree in Bachelor of Science					
3rd	V		Bioprocess Technology	Theory	4
			Immunology	Theory	4
			Bioprocess Technology and Immunology Lab	Practical	2
			Plant Biotechnology	Theory	4
			Animal Biotechnology	Theory	4
			Plant and Animal Biotechnology Lab	Practical	2
			Total Credits:20		
	VI		Genomics and Proteomics	Theory	4
			Recombinant DNA Technology	Theory	4
			Genomics, Proteomics and Recombinant DNA Technology Lab	Practical	2
			Microbial Biotechnology	Theory	4
			Bioinformatics	Theory	4
			Microbial Biotechnology and Bioinformatics Lab.	Practical	2
			Total Credits:20		
Third Year Total credits: 40					

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Four Year Undergraduate Program					
4th	VII		Advanced Biological Chemistry	Theory	4
			Biostatistics	Theory	4
			Enzymes and Enzyme Technology	Theory	4
			Genetic Engineering	Theory	4
			Practical	Practical	4
			Total Credits:20		
	VIII		Bacteriology and Virology	Theory	4
			Molecular Genetics	Theory	4
			Environmental Biotechnology	Theory	4
			Research Methodology	Theory	4
			Practical	Practical	4
			Total Credits:20		
Fourth Year Total credits: 40					

Rachna

Programme/Class: Certificate	**Year:** First; **Subject:** Biotechnology	**Semester:** First
Course Code:	**Course Title:** Fundamentals of Biotechnology	

- After successful completion of the course, student will be able to understand the basic concept of biotechnology and the elementary techniques used in biotechnology
- This will further create student's interest in the field of biotechnology, will provide knowledge about different fields of biotechnology and will encourage him/her to decide his area of interest.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Biotechnology: Definition, Origin and History, Traditional and Modern Biotechnology, Major scientific discoveries in biotechnology, Interdisciplinary nature of Biotechnology,	60
II	Branches of Biotechnology, Importance of Biotechnology, commercial potential, Biotechnology in India and its global trends.	
III	Introduction to Genetic Engineering, Restriction endonuclease. Ligases, Alkaline phosphatase, Transcriptase, Reverse transcriptase, RNA polymerase, DNA polymerase, Cloning Vectors.	
IV	Biotechnology and its application: Applications of biotechnology in Agriculture, medicine, environment, veterinary sciences, food industry, chemical industry, pharmaceutical industry forensic science; Bioremediation and waste treatment biotechnology.	
V	Biotechnology in diagnostics and therapeutics. Biotechnological innovations with vaccine development, PCR, DNA sequencing and fingerprinting.	
VI	Emerging fields of biotechnology: nanobiotechnology, bioinformatics, pharmacogenomics, regenerative medicine, therapeutic proteins, bio-robotics, biosensors.	
VII	Brief account of safety guidelines and risk assessment in biotechnology; Social, moral and ethical issues related to biotechnology.	
VIII	Scope of Biotechnology Research- Biotechnology Institutions in India, Biotechnology Industry, Biotechnology Startup, Incubation centres for Biotechnology and Biotechnology Success Stories.	

Suggested reading

1. P.K. Gupta, Biotechnology and Genomics, Rastogi Publications, Meerut
2. H. D. Kumar, Modern Concepts of Biotechnology, Vikas Publishing House, New Delhi.
3. J.E. Smith, Biotechnology, Cambridge University Press.
4. R.P. Singh, Introductory Biotechnology, Central Book Depot, Allahabad.
5. K. Trehan, Biotechnology, Wiley Eastern Ltd., Delhi.
6. B. D. Singh, Biotechnology, (2007), Kalyani Publication, New Delhi.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate	Year: First; Subject: Biotechnology	Semester: First
Course Code:	Course Title: Fundamentals of Biotechnology Lab.	
Credits: 2	Core: Compulsory	
Max. Marks: 100	Min. Passing Marks: As per University norms	

Unit	Topics
	1. Laboratory safety – General rules and regulations 2. Basic instruments required in Biotechnology Laboratory 3. Demonstration of Laminar air flow, autoclave, etc. 4. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow 5. Preparation of solutions, buffers – sensitivity, specificity, accuracy 6. Preparation of Media and Glassware Bacterial growth media- Nutrient broth, Nutrient agar plates, butts and slants 7. Demonstration of PCR 8. Isolation of DNA 9. Restriction digestion of DNA 10. Visit to a biotech company/ waste water treatment plant/ Field trip and awareness programs on environmental pollution by different types of wastes and hazardous materials.

Programme/Class: Certificate	Year: First; Subject: Biotechnology	Semester: First
Course Code:	Course Title: Cell Biology	

After successful completion of the course, student will be able to:

- Learn structure and functions of cell, its organelles and role of cytoskeleton.
- Understand chemical composition of biological membranes and membrane transport.
- Understand the cell cycle, mitosis, meiosis, and regulation mechanisms with

Credits:4	Core: Compulsory
Max. Marks: 100=75(UE)+25(CIE)	Min. Passing Marks: As per University norms

Unit	Topics	Total No. of Lectures
I	History of cell biology, General structure and differences between prokaryotic and eukaryotic cell: Similarities and differences between plant and animal cells; different kinds of cells in plant and animal tissues. Compartmentalization of eukaryotic cells, cell fractionation.	60
II	Cell Membrane and Permeability: Chemical components and organization of biological membranes, membrane as a dynamic entity, cell recognition and membrane transport.	
III	Membrane vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. golgi complex: Structure, biogenesis and functions.	
IV	Lysosomes: Vacuoles and micro bodies: Structure and functions of Ribosomes, Mitochondria, Chloroplasts.	
V	Structure and organization of nucleus, nuclear membrane, organization of	

	chromosomes-structural organization of chromatids, centromere, chromatin, telomere, nucleosomes, euchromatin and heterochromatin, specialized structures- polytene and lampbrush chromosome	
VI	Cell division - Cell cycle, mitosis and meiosis, regulations of cell cycle and check points and proteins involved in cell cycle check points. Basics in cell signaling- ligand molecules and receptors, G protein coupled receptors, Tyrosine kinase receptor, apoptosis and necrosis.	
VII	Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.	
VIII	Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer..	

Suggested Reading

1. Molecular Biology of The Cell- B Albert, A Johnson, J Lewis, M Raff, K Roberts & P Walter.; G.S. Garland Science Taylor & Francis Group NY 10001-2299
2. Cell and Molecular Biology- G. Karp.; John Wiley & Sons, Inc. NY
3. Molecular Cell Biology, H. Lodish, A. B.P. Matsudaira C.A. Kaiser, M. Krieger, M. P. Scott, L. Zipursky, J. Darnell.; W.H. Freeman & Com., NY.
4. The World of the Cell- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test 10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate	**Year:** First; **Subject:** Biotechnology	**Semester:** First
Course Code:	**Course Title:** Cell Biology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No. of hrs.
	1. Study the effect of temperature and organic solvents on semi permeable membrane. 2. Demonstration of dialysis. 3. Study of plasmolysis and de-plasmolysis. 4.Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source. 5. Study of structure of any Prokaryotic and Eukaryotic cell. 6. Cell division in onion root tip/ insect (grasshopper) gonads. 7. Vital Staining of Mitochondria with Janus green B. 8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions. 9. Demonstration of diversity of cell types (Muscle, Neuron) 10. Cell counting method- Animal cell: Haemocytometer	60

Programme/Class: Certificate	**Year:** First; **Subject:** Biotechnology	**Semester:** Second
Course Code:	**Course Title:** General Microbiology	

After successful completion of the course, student will be able to:

- Understand the basics of microbiology and microbial classification
- Culture different bacteria and know how to preserve them
- Understand culturing of viruses and viral pathogenesis
- Understand general characteristics and classification of algae, fungi and protozoa
- Retrieve and use cotemporary information related to microbial world

Credits:4	**Core:** Compulsory	
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms	
Unit	**Topics**	**Total No. of Lectures**
I	Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used, including molecular approaches, Microbial phylogeny and classification of bacteria.	**60**
II	Microbial Diversity: Distribution and characterization Prokaryotic and of Eukaryotic cells, Morphology and cell structure of major groups microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.	
III	Cultivation and Maintenance of microorganisms: Nutritional categories, Isolation, purification of micro-organisms, methods of preservation. Control of Microorganisms: By physical, chemical and chemotherapeutic agents	
IV	Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.	
V	Microbial metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. Genetic recombination in bacteria: Transformation, Transduction and Conjugation.	
VI	Pathogenic Microorganisms – List of common bacterial, fungal and viral diseases of human beings [Name of the disease, causative pathogen, parts affected] Control of Microorganisms: By physical, chemical and chemotherapeutic Agents	
VII	Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.	
VIII	Food microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods. Introduction to microbial ecology.	

Suggested Reading

1. Pelczar M J., Chan, E.C.S., Krieg, NR. Microbiology, McGraw-Hill publisher
2. Willey, J. Sherwood L, Woolverton C, Prescott Microbiology. 10th Edition, McGraw Hill Publisher, Columbus, OH
3. Ananthanarayan and Paniker A text book of Microbiology, :10th Edition. Orient Blackswan Publisher, Delhi
4. Tortora GJ, Funke BR, and Case CL. Microbiology: An Introduction. 9 th edition. Pearson Education.
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. 5th edition. McMillan.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test

10 marks for presentation along with assignment 05 marks for Class interactions

Programme/Class: Certificate	**Year:** First; **Subject:** Biotechnology	**Semester:** Second
Course Code:	**Course Title:** General Microbiology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No. Of Hrs.
	1. Sterilization, disinfection, safety in microbiology laboratory 2. Preparation of media for growth of various microorganisms 3. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop. 4. Methods of Isolation of bacteria from different sources. 5. Identification and culturing of various microorganisms 6. Staining and enumeration of microorganisms 7. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen sources 8. Determination of bacterial cell size by micrometry. 9. Enumeration of microorganism - total & viable count. 10. Isolation of enzyme producing microorganisms	60

Programme/Class: Certificate	**Year:** First; **Subject:** Biotechnology	**Semester:** Second
Course Code:	**Course Title:** Biochemistry and Metabolism	

After successful completion of the course, student will be able to:

- Learn the chemistry of carbohydrates, lipids, proteins, amino acids and nucleotides.
- Understand the basics of enzymes.
- Understand the metabolism of carbohydrate and proteins
- Understand primary, secondary structure of DNA and RNA

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Chemical foundation of biology: Acid, Base, Buffer, pH, pK, Properties of water, Introduction to Biomolecules. Types of chemical bonds, Covalent and non-covalent interactions in biology.	60
II	Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different level of structural organization of proteins, Fibrous and globular proteins.	
III	Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides.	
IV	Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, cerebrosides, gangliosides,	

	Prostaglandins, Cholesterol.
V	Properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines, Double helical model of DNA, structure of A, B & Z - DNA, denaturation and renaturation of DNA.
VI	Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metallozymes, ribozymes, monomeric, oligomeric and multimeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity.
VII	Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Oxidative phosphorylation. ß-oxidation of fatty acids.
VIII	Amino acid Metabolism – Amino acid breakdown, amino acid deamination, transamination, Urea cycle, glucogenic & ketogenic amino acids.

Suggested reading

1. Harper's Illustrated Biochemistry. - P.J. Kennelly, K.M. Botham, O.P. McGuinness & V.W. Rodwell.; McGraw Hill
2. Lehninger Principles of Biochemistry -D.L. Nelson & M.M. Cox.; W.H. Freeman and Co.
3. Biochemistry -G. Zubay.; Wm. C. Brown
4. Biochemistry – Lubert Stryer.; W.H. Freeman and Co.
5. Biochemistry-D. Voet and J.G. Voet.; John Willy & Sons

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate	**Year:** First; **Subject:** Biotechnology	**Semester:** Second
Course Code:	**Course Title:** Biochemistry and Metabolism Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total

	1. Preparation of normal and molar solutions and buffers. 2. To study activity of any enzyme under optimum conditions. 3. To study the effect of pH, temperature on the activity of salivary amylase enzyme 4. Estimation of blood glucose by glucose oxidase method. 5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission. 6. Separation of Amino acids by paper chromatography. 7. Qualitative tests for Carbohydrates, lipids and proteins 8. Estimation of reducing and total sugar by DNS and H2SO4-phenol methods. 9. Determination of pH value of a weak acid by titrating with strong base. 10.Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.	No. of hrs. 60

Programme/Class: Diploma	**Year:** Second **Subject:** Biotechnology	**Semester:** Third
Course Code:	**Course Title:** Genetics	
After successful completion of the course, student will be able to: • Describe fundamentals of genetics and understand relationship between phenotype and genotype in human genetic traits; • Understand Chromosome and genomic organization. • Describe the basics of genetic mapping.		
Credits:4	**Core:** Compulsory	
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No. of Lectures
I	Historical developments in the field of genetics. Organisms suitable for genetic experimentation. Cell Cycle: Mitosis and Meiosis. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, test and back crosses, Pedigree analysis.	60
II	Allelic interactions: Concept of dominance, incomplete dominance, co-dominance, semi- dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal phenotype genes, penetrance and expressivity. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis, duplicate genes and inhibitory genes.	
III	Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, cytological detection of Crossing over, significance of Crossing over.	
IV	Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition -unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, Genetic organization of	

	prokaryotic and Eukaryotic genome. Chromosome morphology, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.	
V	Chromosomal variation in Number & Structure – Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants, Aneuploidy in Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera, Deletion, Duplication, Inversion, Translocation, Position Effect, Centromeric & Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being, Chromosomal aberrations & evolution.	
VI	Chromosome and gene mutations: Definition, types and causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants	
VII	Structural and numerical determination, changes in chromosomes, chromosomal aberrations, Sex determination and linkage. Environmental factors and differentiation, Barr bodies, dosage compensation, genetic balance theory. Sex-linked inheritance. Genetic linkage, crossing over and chromosome mapping, Extra chromosomal inheritance: Rules of extra nuclear inheritance,	
VIII	Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law, allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.	

Suggested Reading

1. Hartl, D. L.& Jones, E. W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett.
2. Pierce, B. A. (2005). Genetics: A Conceptual Approach. New York: W.H. Freeman.
3. Tamarin, R. H., & Leavitt, R. W. Principles of Genetics. Dubuque, IA: Wm. C. Brown.
4. Smith, J. M. (1998). Evolutionary Genetics. Oxford: Oxford University Press.
5. Principles of Genetics - Gardner et al.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Diploma	**Year:** Second **Subject:** Biotechnology	**Semester:** Third
Course Code:	**Course Title:** Cell Biology and Genetics Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No of hrs.
	1. Genetics problems based on Mendel's law and deviations 2. Genetics problems based on monohybrid and dihybrid cross 3. Genetics problems based on Gene mapping 4. Genetics problems based on Transposable elements. 5. Genetics problems based on population genetics 6. Ames test for mutagenesis. 7. Pedigree charts of some common characters like blood group, colour Blindness. 8. Demonstration of Sex chromatin in buccal smear. 9. Karyotype preparation/Karyotyping with the help of photographs. 10. Preparation of polytene chromosomes from salivary gland of Chironomus larvae.	60

Programme/Class: Diploma	**Year:** Second; **Subject:** Biotechnology	**Semester:** Third
Course Code:	**Course Title:** Animal and Plant Physiology	

After successful completion of the course, student will be able to:

- Understand the Mechanism of digestion & absorption, Composition of blood and functions of heart, Mechanism of muscle contraction, Nervous and endocrine coordination and Functions of Different endocrine glands.
- Understand the organization of plants from the level of cells through tissues, tissue systems, and organs, Physiological mechanisms involved in the uptake and transport of water, the translocation of food by plants and fundamentals of Photosynthesis.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice. Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.	60
II	Circulatory system: Composition of blood, Plasma proteins & their role, blood cells, haemopoesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.	
III	Muscular system: physiology and osmoregulation, Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None principle, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Functions of nephron and Mechanism of urine formation.	
IV	Nervous and endocrine coordination mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters	

	Mechanism of action of hormones (insulin and steroids) Different endocrine glands- Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.	
V	Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active Group transport, translocation (phosphotransferase system).	
VI	Phytohormones: Biosynthesis, Mode and Mechanism of Action, Biological functions, Perception and Signalling (Auxins, Cytokinins, Gibberellins, Ethylene, Absicic Acid, Brassino steroids).	
VII	Photosynthesis: Photosynthetic pigments, concept of photo systems, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation:C3, C4 and CAM cycles, photorespiration, physiology of bacterial photosynthesis.	
VIII	Nitrogen fixation, nitrate reduction and ammonium assimilation in plants. phytohormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization.	

Suggested reading

1. "Animal Physiology" by N Arumugam and A Mariakuttikan
2. "Essentials of Animal Physiology" by S C Rastogi
3. "Principles of Animal Physiology" by Moyes/Schulte
4. "Animal Physiology" by Schmidt-Nielsen
5.Plant Physiology by Taiz L, and Zeiger E, (2006), Sinauer Associates, Inc.
6. Fundamentals of Plant Physiology - V.K.Jain, S Chand Pub.,New Delhi, India.
7.Introduction to Plant Physiology by Hopkins, W.G. and Huner, P.A. 2008 John Wiley and Sons
8.Plant Physiology by Salisbury, F.B. and Ross, C.W. 1991 Wadsworth Publishing Co. Ltd

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Program/Class: Diploma	**Year:** Second **Subject:** Biotechnology	**Semester:** Third
Course Code:	**Course Title:** Animal and Plant Physiology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No of Hrs.
	1. Demonstration of aseptic technique: Work place for aseptic handling; packing glassware (flasks, test tubes, pipettes, petri dishes) for sterilization; aseptic transfer of liquids (pipetting from flask to test tube). 2. Determination of activities of digestive enzymes viz. Amylase, Pepsin, Trypsin, Lipase etc. 3. Study of effect on activity of any enzyme of various factors like pH, Temperature, Activator, Inhibitor 4. Routine human blood tests like RBC, WBC, DWBC, Hb content, blood sugar. 5. Osmosis by potato osmoscope experiment 6. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoeo/ Tradescantia. 7. Structure of stomata (dicot & monocot) 8. Determination of rate of transpiration using cobalt chloride method and by Ganongs' potometer 9. Demonstration of ascent of sap/Transpiration pull. 10. Effect of Temperature on membrane permeability by colorimetric method.	60

Programme/Class: Diploma	**Year:** Second **Subject:** Biotechnology	**Semester:** Fourth
Course Code:	**Course Title:** Analytical Techniques in Biology	

After successful completion of the course, student will be able to:

- Grasp intricate water properties, pH, and acid-base theories thoroughly.
- Master spectroscopy techniques for precise biomolecule analysis.
- Proficiently employ chromatography methods for effective biomolecule separation.
- Apply advanced bio-physical techniques for accurate structure prediction
- Grasp intricate water properties, pH, and acid-base theories thoroughly.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	General Biophysical methods – Measurement of pH, Radioactive labelling & counting, Autoradiography.	60
II	Solutions: Water- Structure and interaction, water as solvent, Bronsted Lowry concept of acid and bases, ionization, Buffer: Henderson-Hasselbalch equation, biological buffer system (bicarbonate, phosphate buffers and Tris buffers), Determination of molecular weight- molarity, molality, normality, equivalent weight	
III	Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM),	
IV	Centrifugation – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems, Rate-Zonal centrifugation, sedimentation equilibrium	

	Centrifugation.	
V	Principle and law of absorption fluorimetry, colorimetry, spectrophotometry, Basic principles, Beer-Lamberts law, instrumentation and application of UV-Vis and IR spectroscopy,	
VI	Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.	
VII	Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting.	
VIII	Bio-Physical Techniques: Crystallography: basic concepts & laws, symmetry of elements in crystal X–ray crystallography, determination of crystal structure. Fluorescence: concepts, emission, chemi-luminescence, luminometry. NMR-2D & 3D structure prediction.	

Suggested reading

1. Skofronick, J.G., Turn, S.Q., & Szuminsky, N.J. (2014). Fundamentals of Analytical Chemistry (9th ed.). Cengage Learning.
2. Christian, G.D., & O'Reilly, J.E. (2018). Instrumental Analysis (7th ed.). Waveland Press.
3. Skoog, D.A., Holler, F.J., & Crouch, S.R. (2007). Principles of Instrumental Analysis (6th ed.). Brooks/Cole.
4. Harris, D.C. (2015). Quantitative Chemical Analysis (9th ed.). W. H. Freeman.
5. Townshend, A. (2015). Chromatographic and Electrophoretic Techniques (5th ed.). Butterworth-Heinemann.
6.. Jennings, K.R. (2015). Analytical Atomic Absorption Spectroscopy (2nd ed.). Academic Press.
7. Jenkins, R., & Snyder, L.R. (2013). Introduction to X-ray Powder Diffractometry (2nd ed.). Wiley.
8. Freeman, A., & Hall, A.J. (2019). Basic Analytical Chemistry (2nd ed.). Royal Society of Chemistry.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Diploma	**Year:** Second **Subject:** Biotechnology	**Semester:** Fourth
Course Code:	**Course Title:** Analytical Techniques in Biology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100=~~75(UE)+25(CIE)~~	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total
	1. Operating shakers, incubators, pH meters, and centrifuges. 2. Preparing buffers such as Phosphate, Acetate, and Citrate. 3. Performing density gradient centrifugation. 4. Executing Poly Acrylamide Gel Electrophoresis for proteins. 5. Staining SDS-PAGE gels using Coomassie Brilliant Blue and silver staining methods. 6. Preparation of the sub-cellular fractions of rat liver cells. 7. Utilizing column chromatography for separation. 8. Implementing thin-layer chromatography. 9. Estimating nucleic acid content via colorimetric methods. 10. Inducing physical mutations using UV irradiation.	No. of Hrs. 60

Programme/Class: Diploma	**Year:** Second **Subject:** Biotechnology	**Semester:** Fourth
Course Code:	**Course Title:** Molecular Biology	

After successful completion of the course, student will be able to:

- Understand the structure of various types of DNA and RNA.
- Understand DNA replication mechanisms in prokaryotes and eukaryotes.
- Learn the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures 60
I	Introduction to Molecular Biology, Types of genetic materials- Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and chase, John Cairns experiment, Meselson- Stahl experiment, Central dogma of life	
II	DNA as genetic material, Structure of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, Replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.	
III	DNA damage and repair: Causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.	
IV	RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains	
V	Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA	

	splicing	
VI	Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code: characteristics and properties, Wobble hypothesis.	
VII	Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation,	
VIII	Post transcriptional modifications. Inhibitors of transcription. Posttranslational modifications of proteins. protein degradation, Inhibitors of protein synthesis.	

Suggested reading

1. Molecular Biology of The Cell, - Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter, G.S. Garland Science Taylor & Francis Group
2. Cell and Molecular Biology: Concepts and Experiments. G. Karp, John Wiley & Sons.
3. Molecular Biology of the Gene - J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick, Pearson Education (Singapore) Pvt. Ltd. Delhi
4. Molecular Cell Biology. H. Lodish, A. Berk P. Matsudaira Chris A. Kaiser, M. Krieger M. P. Scott, L. Zipursky, J. Darnell.: W.H. Freeman & Com., NY.
5. Cell and Molecular Biology-P.K. Gupta Pub: Rastogi Publication India.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Diploma	**Year:** Second **Subject:** Biotechnology	**Semester:** Fourth
Course Code:	**Course Title:** Molecular Biology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100=~~75(UE)+25(CIE)~~	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No. of Hrs.
	1. Preparation of solutions for Molecular Biology experiments. 2. Isolation of chromosomal DNA from bacterial cells. 3. Isolation of Plasmid DNA by alkaline lysis method 4. Extracting DNA from eukaryotes such as Saccharomyces cerevisiae. 5. Agarose gel electrophoresis of genomic DNA & plasmid DNA. 6. Preparation of restriction enzyme digests of DNA samples. 7. Quantifying DNA content. 8. Isolating total RNA from bacterial samples. 9. Demonstration of AMES test or reverse mutation for carcinogenicity 10. Polymerase Chain Reaction	60

Programme/Class: Degree	**Year:** Third; **Subject:** Biotechnology	**Semester:** Fifth
Course Code:	**Course Title:** Bioprocess Technology	

After completion of the course the students will be able to

- Understand fundamentals of Microbial Growth Kinetics, Mass Transfer and Downstream Processing and Kinetics and Engineering of Sterilization.
- Understand Basic concepts of bioreactors
- Recovery and purification of products

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Principles of Bioprocess technology – Introduction and history of traditional and modern bioprocess technology. General concepts of fermentation technology – Outline of an integrated bioprocess and various unit operations. Industrially important microbes: Isolation, Screening & Preservation techniques – Slant culture, spore culture, overlaying culture with mineral oil, Lyophilization, Cryopreservation – Strain improvement – mutation, protoplast fusion & rDNA techniques for strain development– Maintenance of Industrially important microbes.	60
II	Introduction to fermentation - Types of fermentation processes (Submerged & solid static) - Media formulation - Synthetic and complete media, Sterilization (batch & continuous) – Air, Filter and Media sterilization – Operation: Inoculum preparation and sampling. Fermenters: Design and types.	
III	Microbial Growth Kinetics: Thermodynamic principles, Stationary cell growth, Growth yield. Specific growth rate, Product yield, Saturation constant, Biomass energetics, Yield equations based on YG. YO2, YATP, Maintenance energy. Growth kinetics of batch, fed-batch. plug flow and continuous culture, High cell density cultures: Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non- growth associated product synthesis.	
IV	Bioreactors and Scale up: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors.	
V	Reactor Dynamics and reactors with non-ideal characteristics; Translation of	

	laboratory, pilot and plant scale data Criteria for translation between two scale of operation, Scale- up practices; Manual and automatic control system, on-line and off-line analytical instruments.	
VI	Kinetics and Engineering of Sterilization: Kinetics of media sterilization, design of batch sterilization process, D-time, Z- value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration.	
VII	Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introduction to transport mass transfer, mass phenomena, Gas-liquid resistances, and determination of oxygen transfer coefficient;	
VIII	Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.	

Suggested reading

1. Biochemical Engineering: Aiba and Hemphery transfer
2. Biochemical Engineering Fundamentals: J. E.Bailey and D. F.Ollis
3. Principles of Microbes and Cell Cultivation: S. John Pirt
4. Bioprocess Engineering Principles: Pauline M. Doran
5. Principles of fermentation technology: P.F. Stanbury and A. Whitekar

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

amme/Class: Degree	**Year:** Third **Subject:** Biotechnology	**Semester:** Fifth
Course Code:	**Course Title:** Immunology	

After successful completion of the course, student will be able to:

- Understand the basic principles of immune system
- Understand the nature of antigen and antibodies, and antigen
- Understand the basic techniques to identify antigens.
- Understand the basis of allergy and allergic diseases
- Understand the importance of vaccines

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Basic immunology: Historical perspectives, Cells and organs of the immune system	
II	Components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, genetic basis for antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity. T-lymphocytes& immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-	

	lymphocyte differentiation, Antibody affinity, maturation, class switching, assembly of T-cell receptor genes by somatic recombination.	60
III	Immune Response - An overview, Humoral& Cellular immune responses,	
IV	Regulation of immunoglobulin gene expression - clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription,	
V	Major Histocompatibility complexes - class I & class II MHC antigens, immunity to different antigen processing. Immunity to infection organisms, pathogen defence strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.	
VI	Vaccines & Vaccination - adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization.	
VII	Auto-immune diseases – autoimmunity & auto-immune diseases, factors contributing development of auto-immune diseases, mechanism of development, breakdown of self-tolerance, rejection of transplants, molecular mimicry, diagnosis & treatment of auto-immune diseases, replacement therapy, suppression of auto- immune processes, nature of auto-antigens, immunodeficiency, AIDS	
VIII	Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.	

Suggested Reading

1. Kindt TJ, Goldsby RA and Osborne BA- Kuby's Immunology. W.H. Freeman and Co., New York
2. Abbas AK, Lichtman AH and Pillai S-Cellular and Molecular Immunology. Elsevier, USA.
3. Coico R and Sunshine G- Immunology: A Short Course. Wiley-Liss, 6th Ed.
4. Delves P, Martin S, Burton D and Roitt IM- Roitt's Essential Immunology. Wiley- Blackwell Publication.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

Program/Class: Degree	**Year:** Third **Subject:** Biotechnology	**Semester:** Fifth
Course Code:	**Course Title:** Bioprocess Technology and Immunology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100	**Min. Passing Marks:** As per University norms	

Topics	Total No. of Hrs.
1. Fermenter design and structure. 2. Inoculum preparation and sterilization 3. Isolation of lactic acid bacteria from curd. 4. Determination of thermal death rate constant and decimal reduction time for E. coli. 5. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein. 6. Total leucocytes count and Total RBC count 7. Haemagglutination assay 8. Haemagglutination inhibition assay 9. Separation of serum from blood 10. Double immunodiffusion test using specific antibody and antigen.	60

Programme/Class: Degree	**Year:** Third; **Subject:** Biotechnology	**Semester:** Fifth
Course Code:	**Course Title:** Plant Biotechnology	

After completion of the course the students will be able to:

- Have a strong foundation of basics of Plant Biotechnology
- Understand Embryo, Callus, Organs, Cell and Protoplast culture
- Understand the principles, practices and applications of, transgenic plant generation, plant tissue culture, plant genomics, and genetic transformation.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Conventional breeding for crop improvement- Introduction, Domestication, Methods of Plant Breeding- Hybridization, Clonally Propagated Species, Breeding Enhancements Marker-Assisted Selection, Mutation Breeding. Plant genome organization, organization of chloroplast genome, cytoplasmic male sterility, genetic male sterility.	60
II	Introduction to Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation: advantages and disadvantages of micropropagation, Axillary bud proliferation, Meristem and shoot tip culture, organogenesis and embryogenesis.	
III	In vitro haploid production, Anther culture, significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.	
IV	Protoplast Isolation, Viability and fusion Methods, Protoplast development, regeneration frequency,	
V	Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization and limitations. Soma-clonal variation and its applications.	
VI	Plant Growth Promoting bacteria: direct and indirect methods for plant growth promotion.	
VII	Genetic engineering of plants - Gene constructs, Vectors- Plasmid vectors	

	and plant viral vectors (CaMV, Gemini virus, Tobacco Mosaic virus), cloning vectors for higher plants - Genetic manipulation using Agrobacterium tumefaciens. Gene transfer in plants - Electroporation, Particle Gun Method, Microinjection, Polyethylene glycol mediated transformation, Chloroplast transformation, terminator seed technology.	
VIII	Applications of transgenic plants- Pest resistance, Herbicide resistance, virus resistance, Fungal and bacterial resistance, Delay of fruit ripening, Salt & drought tolerance, improvement of crop yield and Quality, Improved nutrition. Biocontrol and biofertilizers	

Suggested Reading

1. An Introduction to Plant Tissue Culture: M K Razdan., Pub: Oxford (India).
2. Plant Tissue Culture HD Kumar, Pub: Agro Bios. India
3. Plant Tissue Culture: Kalyan Kumar De: Pub: The New Central Book Agency, Calcutta, India
4. Fundamentals of Plant Biotechnology – Amla Batra, Pub: Capital Publishing Co.

Suggested (CIE) methods Total marks: 25

10 marks for Test 10 marks for presentation along with assignment

05 marks for Class interactions

Programme/Class: Degree	**Year:** Third; **Subject:** Biotechnology	**Semester:** Fifth
Course Code:	**Course Title:** Animal Biotechnology	

After completion of the course the students will be able to

- Understand the principles, practices and application of animal biotechnology in Tissue Engineering, and biopharmaceuticals.
- Learn different gene delivery methods to deliver foreign gene in plants and animals
- Know about different products of transgenic animals
- Understand the principles of gene therapy

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Introduction, history, basic concepts of animal cell culture, primary cell culture and established cell lines, maintenance of cultures, requirements of animal cell culture, media - natural (clots, biological fluids and tissue extracts) and synthetic (serum containing media, serum free media, chemically defined media, protein free media).	60
II	Basic techniques of mammalian cell culture, disaggregation of animal tissues - mechanical, enzymatic and EDTA, evolution of cell line, monolayer culture, suspension culture, immobilized culture, organ culture - plasma clot, raft method, agar gel, grid method, embryo culture, maintenance of cell culture.	
III	Gene transfer methods in Animals: Microinjection, Embryonic Stem cell, Viral mediated gene transfer	
IV	Introduction to transgenesis. Transgenic Animals: Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Production of useful proteins in transgenic animals, Sericulture basics and production of useful proteins through sericulture.	
V	Animal propagation Artificial insemination, Animal Clones. Conservation Biology: Embryo transfer techniques.	

VI	Introduction to Stem Cell Technology and its applications.	
VII	Genetic modification in Medicine: gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.	
VIII	Animal diseases Coccidiosis and Trypanosomiasis (cattle) -Mad cow, Anthrax, Foot and Mouth, Lumpy skin, Bluetongue; (Poultry)- Newcastle; Bird flu, Avian Influenza, Marek's disease Role of biotechnology in disease control.	

Suggested Reading

1. Culture of Animal Cells, R. I Freshney, Pub: Wiley-Liss. John W. & Sons.
2. Animal Cell Culture-Practical Approach. Ed. John R. W. Masters, Pub: OXFORD
3. Animal Cell Culture Techniques Ed. Martin Clynes. Pub: Springer

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Program/Class: Degree	**Year:** Third **Subject:** Biotechnology	**Semester:** Fifth
Course Code:	**Course Title:** Plant and Animal Biotechnology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100=~~75(UE)+25(CIE)~~	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No. of hrs.
	1. Sterilization techniques: Glass ware sterilization, Media sterilization, Laboratory sterilization. 2. Sources of contamination and decontamination measures. 3. Preparation of: • simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid. • complex nutrient medium (Murashige and Skoog's medium) • Hanks Balanced salt solution • Preparation of Minimal Essential Growth medium 4. Surface sterilization and inoculation of tobacco leaf explants on MS medium for shoot regeneration. 5. To select, prune, sterilize and prepare an explant for culture. 6. To demonstrate various steps of Micropropagation. 7. Isolation of endophytic bacteria/fungi from plants 8. Microbial population in rhizospheric soil of various crops. 9. Isolation of lymphocytes for culturing. 10. Dye exclusion assay- Trypan blue assay and cell counting using Hemocytometer.	60

Programme/Class: Degree	**Year:** Third **Subject:** Biotechnology	**Semester:** Sixth

Course Code:	**Course Title:** Genomics and Proteomics	
After successful completion of the course, student will be able to: • Explain the properties of genetic materials and storage and processing of genetic information. • Analyze genomic data and explain biological phenomena based on comparative genomics. • Design transcriptomics and proteomics experiments for studying differential gene expression and related analysis. • Utilize advanced proteomics techniques for protein characterization and understand their applications in drug development.		
Credits:4	**Core:** Compulsory	
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms	
Unit	**Topics**	**Total No. of Lectures**
I	Origin and Evolution of genomics: - Origin of genomics, the first DNA genomes, micro collinearity and lack of it, DNA based phylogenetic trees, genomes and human evolution, evolution of nuclear and organellar (mitochondrial and Chloroplast genome, the concept of minimal genome and possibility of synthesizing it.	**60**
II	Molecular maps of genomes and comparative genomics: - Genetic maps, physical maps, EST and transcript maps, functional maps, comparative genomics and collinearity/synteny in maps	
III	Whole Genome sequencing: - Whole genome shotgun sequencing, clone-by-clone or 'hierarchical shotgun' sequencing, microbial, plant and animal genomes. Annotation of whole genome sequence and functional genomics: - In silico methods, insertion mutagenesis (T-DNA and transport insertion), TILLING, management of data, gene expression and transcript profiling, EST contigs and unigene sets, use of DNA chips and microarrays	
IV	Pharmacogenomics: - Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, use of SNP in pharmacogenomics, pharmacogenomics and industry. (6)	
V	Study and Scope: - Introduction, definition concepts and approaches of proteomics studies and activities	
VI	Quantitative and Qualitative proteome analysis technique: - Separation technique2DPAGE, 2-DE (BN-PAGE), image analysis, Mass-spectrophotometry, LC-TMS, MALDI, and SALDI	
VII	Protein interaction and Protein complex: - Protein interaction, DNA- Protein interaction, Yeast two hybrid system and their applications.	
VIII	Drug Discovery and Development: - Current issues, drug targets, Drug efficacy, Drug toxicology, Protein chips and Antibody array Cancer Proteomics: - An overview of cancer, origin and types of cancer, oncogenes, tumour suppressor genes, proteomics in cancer research, future approaches of proteomics and cancer research.	

Suggested Reading

1. DNA Cloning: A Practical Approach, D.M. Glover, B.D. Hames, IRL Press, Oxford.
2. Molecular Cloning: A laboratory Manual Vol. 1-3, - J. Sambrook & Russel. Pub: Cold Spring Harbor Laboratory Press, NY.
3. Molecular Biotechnology-S.B. Primrose, Blackwell Scientific Publishers, Oxford
4. Principals of Gene Manipulation Scientific Publishers, Oxford S. Primrose, R.

Twyman & Bob Old Pub: Blackwell
5. Essential Molecular Biology: A practical Approach, Vol. 1,2-T.A. Brown.
6. Molecular Biology: A Project Approach - Susan J. Karcher,
Gene Cloning: An Introduction - T.A. Brown.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Degree	**Year:** Third **Subject:** Biotechnology	**Semester:** Sixth
Course Code:	**Course Title:** Recombinant DNA Technology	

After successful completion of the course, student will be able to:

- Gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.
- Understand gene concept, plasmids, and wide range of techniques, especially modern molecular tools in diagnosis.
- Understand various techniques of genetic engineering and their applications in biological research, diagnostics as well as in biotechnology industries.
- Understand the basic principles of PCR

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	**Topics**	**Total No. of Lectures**
I	Characterization of Nucleic acid (DNA and RNA), Quantification, Radio-labelling of nucleic acids, labelling by primer extension, DNA sequencing: Maxam-Gilbert (Chemical) and Sanger- Nicolson (dideoxy/ enzymatic) sequencing method, Pyrosequencing.	60
II	Restriction Enzymes: Types and uses of restriction endonuclease, classification Restriction mapping. DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and ligases.	
III	Vectors. Plasmid vectors, Bacteriophage, expression vectors, other vectors, Construction of genomic and c-DNA libraries, Joining of DNA Fragments to vectors, cohesive and blunt end Ligation, adaptors, and linkers.	
IV	Principle of hybridization. Northern blotting, Southern blotting, Western blotting. Polymerase chain reaction, Restriction fragments length polymorphism, RAPD, AFLP, MAP.	
V	Expression systems: methods of Transformation, codon optimization, host engineering. Strategies of gene delivery, in vitro translation, expression in bacteria, yeast, expression in insects and mammalian cells.	
VI	Functional analysis of genes, Genetic engineering in Yeast, Plants – Transgenic plants, Reporter gene for basic research, Genetic engineering in	

	Animals – Transgenic animals, Uses of transgenic animals, Knockout mice	
VII	Gene Therapy: Somatic gene therapy, Delivery techniques – Ex vivo & In vivo, Delivery vectors – viral & Non-viral, Germinal gene therapy, Limitations and ethical considerations.	
VIII	Molecular diagnostics, Hybridization techniques – Micro-arrays, Fluorescence in situ hybridization (FISH), Genetic testing, types; Pre-implantation genetic diagnosis, Newborn screening, Prenatal diagnosis, medical procedures – Amniocentesis, Chorionic villus sampling. Forensic testing: DNA Fingerprinting, Restriction Fragment Length Polymorphism (RFLP) analysis.	
V	Production of monoclonal antibody, Engineered antibodies- Humanized antibodies-monoclonal antibodies for cancer diagnostics and therapy-Immunotoxins	

Suggested Reading

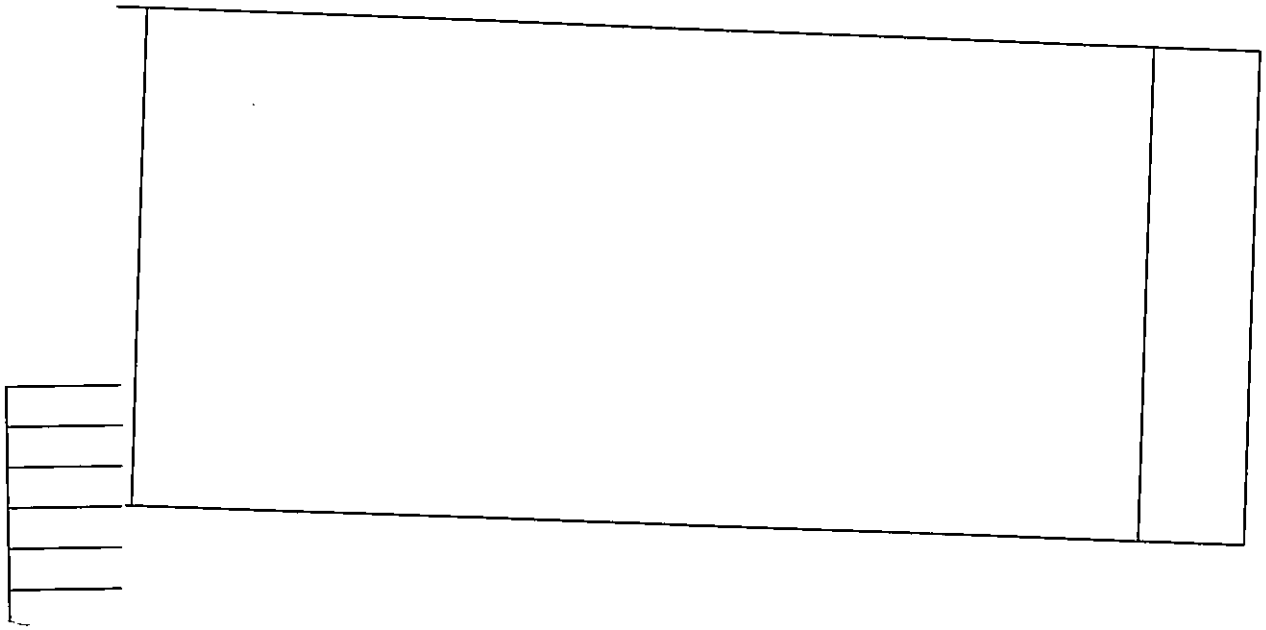
1. Principles of Gene Manipulations: Old and Primrose Blackwell Scientific Publications.
2. Molecular Biotechnology: S.B. Primrose. Blackwell Scientific Publishers.
3. Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes: S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA.: Bernard R. Glick and Jack J. Pastemak, ASM Publications.
5. Genetic Engineering: Janke k. swtlow

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Program/Class: Degree	**Year:** Third **Subject:** Biotechnology	**Semester:** Sixth
Course Code:	**Course Title:** Genomics, Proteomics and Recombinant DNA Technology Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100=~~75(UE)+25(CIE)~~	**Min. Passing Marks:** As per University norms	

Unit	Topics	Total No. of hrs.
	1.Use of SNP databases at NCBI and other sites 2. Use of OMIM database 3. Detection of Open Reading Frames using ORF Finder 4. Proteomics 2D PAGE database 5. Software for Protein localization. 6. Native PAGE and SDS-PAGE 7. Transformation of E. coli. cells (colour selection of transformants with or without inserts) X -gal and IPTG. Mini plasmid DNA preparation (this DNA can be digested and religated) 8. Restriction digestion. 9. Competent Cell preparation. 10. DNA Ligation.	60



Programme/Class: Degree	Year: Third; Subject: Biotechnology	Semester: Sixth
Course Code:	Course Title: Microbial Biotechnology	

After completion of the course the students will be able to

- Comprehend role of industrial biotechnology in improving microbial cells as factories
- Know the production aspects of commodity chemicals, pharmaceuticals and fine chemicals
- Apply knowledge of microorganisms in commercial production of flavours, microbial pigments and enzymes.

Credits:4	Core: Compulsory
Max. Marks: 100=75(UE)+25(CIE)	Min. Passing Marks: As per University norms

Unit	Topics	Total No. of Lectures
I	Microbial genetics: Replication, regulation of bacterial gene expression, mutations, genetic transfer, role of bacteria in cancer,	60
II	DNA amplification using PCR – manipulation of gene expression in prokaryotes- increasing protein production – expression and application in E. coli	
III	Nature of microbial polysaccharides, mechanism of synthesis; microbial transformation of steroids and sterols: screening for microbial products; microorganism for waste treatment; Immobilization of microalgae for pollutant removal	
IV	Role of microorganisms in fermented products - organisms used for fermented food products. Microbial production of yoghurt, cheese, beer and wine. Microbial fermentation of tea, coffee and cacao. Health aspects of fermented foods.	
V	Microbial production of amino acids, antibiotics, microbial enzymes, Probiotics, organic acids; immobilized microbial cells and fine chemicals. Strain improvement, culture preservation and inoculum development. Elementary principles of microbial reaction engineering.	
VI	Microbes in agribiotechnology (livestock and transgenic plants); Introduction to bio-insecticides, candidate microbiology insecticides; biofertilizers, inoculant manufacture	
VII	Diagnostic clinical microbiology (emerging and re-emerging infectious	

	diseases, microscopy, culture & sensitivity);	
VIII	Microbial leaching of ores, Bioweapons and Bio-shields, Microbial biocatalyst and microbial fuel cells. Microbial fuels (biohydrogen, bioethanol and biomethane), Nutraceuticals from algae, Algal Pigments and Genetics of secondary metabolite production	

Suggested Reading

1 Microbiology-Principles and exploration, Black JG, Prentice Hall,
2. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company.
3. Biochemical Engineering Fundamentals JE Baily & DF Ollis, McGraw Hill Book Co. New York.
4. Bioprocess Engineering: Basic Concepts (2nded), ML Shuler, & F Kargi, Prentice Hall, Engelwood Cliffs.

Suggested (CIE) methods :Total marks: 25
10 marks for Test 10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Degree	**Year:** Third **Subject:** Biotechnology	**Semester:** Sixth
Course Code:	**Course Title:** Bioinformatics	

After successful completion of the course, student will be able to:

- know effective use of Office package -word, excel, ppt and publisher etc
- understand basics and practical use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
- critically analyse and interpret results of their studies with the help of bioinformatical tools.

Credits:4 **Core:** Compulsory

Max. Marks: 100=75(UE)+25(CIE) **Min. Passing Marks:** As per University norms

Unit	**Topics**	**Total No. of Lectures**
I	Introduction to computers: Types, general characteristics, input/output units, memory, internal representation of data (binary, octal and hexa-decimal system, bits and bytes). Brief idea of operating systems: Disc operating systems (DOS), UNIX and its versions (Linux), WINDOWS and its upgraded versions.	60
II	Introduction to networking: LAN (local area network), WAN (wide area network), MAN (metropolitan area network) including www (world wide web). Microsoft (MS) office and its applications: Introduction to MS Excel and its applications for statistical analyses with particular reference to agricultural data (tabular and graphical representation of data, analyses of variance, regression and correlation); introduction to MS Word and its application for document preparation; power Point and its application for preparing presentations	
III	Introduction to statistical packages: Introductory knowledge of SPSS (Statistical Package for the Social Sciences), SAS (Statistical Analysis Software) packages for statistical analysis of agricultural data, handling software for data analyses.	
IV	History of Bioinformatics. Sequence Information Sources, EMBL	

	GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web	
V	An overview of bioinformatics: Introduction, objective of bioinformatics, kind of data used in bioinformatics, multiplicity of data and redundancy, major bioinformatics databases, data integration, data analysis.	
VI	Sequence and structure databases: Nucleic acid data bases (EMBL, GenBank, DDBJ), protein data bases (SWISS-PROT, TrEMBL PIR-PSD, UniProt as a single database), URLs (Uniform resource locators) of databases, SWISS-2DPAGE, KEGG, COGS, PROSITE, etc. Sequence cluster database (Prodom, Cluster, SYSTERS, ProtoMap); structure databases (CCDC, DSSP, SCOP, CATH, etc.).	
VII	Alignment of sequences: Introduction to sequence analysis, models for sequence analysis (local, global, end free space alignment and gap penalty), introduction to applications of dot matrices, application of FASTA and BLAST programmes (introduction, BLAST output, significance of BLAST results, recommended steps in BLAST, BLAST programmes), comparison between FASTA and BLAST programmes, Assembly of nucleotide sequences.	
VIII	Access to literature: Bibliographic databases; (Boolean searching, limiting searches, history functions to combine different searches); databases (PubMed/MEDLINE; ISI Citation Database, Current contents®; BIOSIS Previews; Pascal; EMBASE; The Cochrane Reviews, AGRICOLA, Agripedia etc.); PubMed and other databases; on-line access to abstracts and full text of articles; online books; free and paid access).	

Suggested reading

1. Bioinformatics: A practical guide to the analysis of genes & Proteins - Ed. Andreas. Computer-Schaum Series Publication.
2. Bioinformatics: Sequence and Genome Analysis. Mount, D. Cold Spring Harbor Laboratory Press, New York
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Baxevanis, A.D. and Ouellette, B.F. John Wiley and Sons, New Jersey, USA.
4. Introduction to Bioinformatics: Lesk, A.M. Oxford University Press, UK,
5. Bioinformatics: Concepts, Skills and Applications. Rastogi, S.C., Mendiratta, N., and Rastogi, R. CBS Publishers, New Delhi, India

Suggested (CIE) methods :Total marks: 25
10 marks for Test 10 marks for presentation along with assignment
05 marks for Class interactions

Program/Class: Degree	**Year:** Third; **Subject:** Biotechnology	**Semester:** Sixth
Course Code:	**Course Title:** Microbial Biotechnology and Bioinformatics Lab.	
Credits: 2	**Core:** Compulsory	
Max. Marks: 100	**Min. Passing Marks:** As per University norms	

Unit	**Topics**	Tot

	1.Microbial population enumeration techniques 2. Biochemical identification of unknown bacteria 3. Nucleic acid and plasmid isolation 4. PCR and Electrophoresis 5. Microbial Production of citric acid and antibiotics. 6. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR). 7. Understanding and using: PDB, Swissprot, TREMBL 8. Using various BLAST and interpretation of results. 9. Retrieval of information from nucleotide databases. 10. Multiple sequence alignment using Clustal W	al No of hrs. 60

Programme/Class: FYUP	**Year:** Fourth **Subject:** Biotechnology	**Semester:** Seventh
Course Code:	**Course Title:** Advanced Biological Chemistry	
After successful completion of the course, student will be able to: • To understand protein biochemistry, secondary metabolites and how their functions are governed by their structures. • To help students to understand the applications of enzymes and secondary metabolites in the biological field.		
Credits:4	**Core:** Compulsory	
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks**: As per University norms	

Unit	Topics	Total No. of Lectures
I	Protein Chemistry: Structure of Proteins: Study of protein motifs and protein families. Specific protein structures in details- Keratin, Collagen, Myoglobin and Haemoglobin. Protein folding mechanisms and Pathways, Factors affecting stability- Molten globule, energy funnel, chaperons. Protein misfolding and diseases. Protein –protein interaction and protein –DNA interaction (DNA binding motifs- helix-turn-helix, leucine zipper, zinc finger, helix-loop helix)	60
II	Enzymes: Stereospecificity, ES complex formation. Multienzyme complexes Enzyme Activity, factors influencing enzyme activity, Enzyme inhibition Mechanism of enzyme action and Enzyme regulation. Enzyme kinetics- Rate of reactions, steady state enzyme kinetics, Michaelis-Menten Equation - form and derivation. Significance of Vmax and Km, K/cat. Bi-substrate reactions. Clinical and Industrial Applications of enzymes, Enzyme Engineering.	
III	Phytochemistry Naturally occurring compounds: Fatty acids, Alkaloids, Terpenoids, Steroids, Flavonoids, Anthocyanins, Carbohydrates, Complex compounds, Essential oils. Secondary Metabolism, primary metabolite as precursors of secondary Metabolite. Pathways for secondary Metabolite: Mevalonate pathways, Shikimate Pathway. Isoprene Unit Pathways (IPP), Secondary Metabolites: Alkaloids, Phenolics, Terpenoids	
IV	Extraction methods – Physical and chemical a. Extraction of Phytochemicals: Maceration, Soxhlet extraction, Steam distillation, Hydro	

	distillation, Wax extraction, Fractional crystallization, Fractional distillation, Spinning band distillation etc. b. Analysis of Crude Extracts and Pure Phytochemicals: Physical Methods, Elemental analysis, Chromatographic Techniques, Spectral methods	

Suggested reading

1. Proteins: Biotechnology and Biochemistry, Gary Walsch, Wiley, USA
2. Trease and Evans' Pharmacognosy, William Charles Evans, Saunders Ltd. USA.
3. Metabolic Engineering: Principles and Methodologies. Gregory N Stephanopoulos, Aristos A Aristidou, Jens Nielsen. Publisher: Academic Press, San Diego, US
4. Fundamentals of Biochemistry. Donald Voet &Judith Voet, John Wiley and Sons, Inc. USA.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: FYUP	**Year:** Fourth **Subject:** Biotechnology	**Semester:** Seventh
Course Code:	**Course Title:** Biostatistics	

After successful completion of the course, student will be able to:

- Collect, classify, analyse and present data sets.
- Apply hypothesis testing to the data and perform appropriate statistical tests.
- Develop skills in analysis of qualitative and quantitative data.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	**Topics**	**Total No. of Lectures**
I	Biological variables, parameters of statistical data display. Types of scales: linear, power, log, circular (with biological examples) Curves and Equations: Linear, saturating, sigmoid, exponential, logistic, power, multinomial, algebraic, differential, partial differential	60
II	Sampling methods; Types of sampling; random sampling, Probability and non-probability sampling, stratified sampling, etc. Power analysis and sample size calculations, Statistical data distribution, normal and skewed distribution, coefficient of skewness, moments and Kurtosis. Principles of hypothesis testing, significance level, null hypothesis, Type I and Type II errors	
III	Statistical design of experiments, single and multifactorial designs, fractional factorial designs. Principles of experimental designs; randomization, replication and local control; Complete, incomplete and randomized block designs; Covariance and correlation, Pearson"s, Kendal"s and Spearman"s correlations, use of correlation and regression in biological analyses. Univariate, Bivariate and Multivariate data; linear, multilinear, and non-linear regression, generalized linear model and other models of regression analysis (nonparametric regression, Bayesian linear regression, etc.)	
IV	Statistical Methods: T-test family and Z-test, Chi-square test, Analysis of variance table (ANOVA) and Kruskal Wallis test, Mann–Whitney U test, Duncan"s multiple range test,	

Suggested reading

1. Billingsley, P. (1986). Probability and Measure. New York: Wiley.
2. Rosner, B. (2000). Fundamentals of Biostatistics, Boston, MA: Duxbury Press
3. P.S.S. Sunderrao and J. Richards-An introduction to Biostatistics, Prentice Hall a. Pvt. Ltd. India
4. Campbell R.C.- Statistics for Biologists, Cambridge University Press, Cambridge.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: FYUP	**Year:** Fourth **Subject:** Biotechnology	**Semester:** Seventh
Course Code:	**Course Title:** Enzyme and enzyme technology	

After successful completion of the course, student will be able to:

- Understand classification and specificity of enzymes.
- Learn mechanism of enzyme action and enzyme kinetics.
- Explore various industrial applications of enzymes.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Enzyme classification and nomenclature general properties of Enzymes like effect of PH, temperature, ions etc Extraction assay and purification of Enzymes Steady State Kinetics Michaelis Menten Lineweaver Burk, Eadie Hofstee and Hanes Woolf equations and km value	60
II	Enzyme inhibitors pre steady state kinetics fast kinetics to elucidate the intermediates and rate limiting steps flow and relaxation methods enzyme specificity evidences for enzyme substrate complex nucleophilic and electrophilic attack roll of metal lines in enzyme catalysis	
III	Mechanism of enzyme action lysozyme chymotrypsin DNA polymerases RNA as zymogens and enzyme activation. allosteric interactions and product inhibition complex kinetics and analyses membrane bound enzymes extraction essay lipid protein interaction and effect of fluidity on enzyme activity	
IV	Coenzyme clinical and industrial applications of Enzymes immobilization of Enzymes and their applications ribosomes and their applications enzyme engineering	

Recommended Books

1. Enzyme Technology, M.F. Chaplin and C. Bucke, Cambridge University Press.
2. Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis, R.A. Copeland, John Wiley and Sons Inc.
3. Enzymes Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer
4. Enzyme Kinetics: Behaviour and Analysis of Rapid Equilibrium and Steady State Enzyme Systems, I.H. Segel, Wiley- Inter-science.
5. Industrial Enzymes & their applications, H. Uhlig, John Wiley and Sons Inc

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions

Programme/Class: FYUP	**Year:** Fourth **Subject:** Biotechnology	**Semester:** Seventh
Course Code:	**Course Title:** Genetic Engineering	
After successful completion of the course, student will be able to: • apply molecular biology techniques in developing recombinant molecules. • understand the concept of genetically modified organisms. • develop the basic understanding of advanced molecular biology techniques		
Credits:4	**Core:** Compulsory	
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks**: As per University norms	

Unit	**Topics**	**Total No. of Lectures**
I	Impact of genetic engineering in modern society; endo and exonucleases, Rase, restriction endonucleases and methylases; DNA ligase, E coli DNA polymerase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; linkers; adaptors; homo-polymeric tailing, labelling of DNA: hybridization techniques, fluorescence in situ hybridization Different types of vectors: Plasmids, Bacteriophages m13 mp vectors, phagemids, Lambda vectors; Insertion and Replacement vectors, Cosmids, Artificial chromosome vectors (YACs; BACs), Expression vectors: pMAL, GST, pET-based vectors, Baculovirus and Pichia vectors system, yeast vectors, shuttle vectors	60
II	Principles of PCR, primer design; fidelity of thermostable enzymes, DNA polymerases, types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; PCR in molecular diagnostics for viral and bacterial detection;	
III	Insertion of foreign DNA into host cells, transformation, electroporation, transfection; transduction- viral vectors; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; genomic arrays, cDNA arrays and oligo arrays; DNase footprinting; methyl interference assay, chromatin immunoprecipitation	
IV	Gene silencing techniques; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts, Genome editing by CRISPR-CAS with examples, Gene therapy – ex vivo, in vivo, DNA fingerprinting, genetically engineered biotherapeutics and vaccines and their manufacturing.	

Suggested reading

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Glick and Patten, ASM Press
2. Principles of gene manipulation and genomics. Sandy Primrose and Richard Twyman,

Blackwell Publishing. 3. Gene cloning and DNA analysis: An introduction. T. A Brow. Willey-Blackwell Publications. 4. From genes to genomes. Concepts and applications of DNA Technology. J. W. Dale, M.V. Schantz, N. Plant. Willey-Blackwell Publications
Suggested Continuous Internal Evaluation (CIE) methods Total marks: 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions

PRACTICAL

(Credits: 4)

- Extraction, purification and characterization of protein: Beta galactosidase
- Extraction and assay of enzyme activity
- Isolation, precipitation and dialysis
- Characterization by Native and SDSPAGE.
- Calculation of Km and Vmax of purified enzyme
- Calculation of frequency using formula and pivot method
- Measures of skewness and measures of Kurtosis (grouped and ungrouped data).
- Paired and unpaired t -test and Z test

- Chi-square test
- Pearson Correlation and Regression
- ANOVA – One way and two-way
- Isolation of enzyme from plants/ bacteria.
- Estimation of enzyme activity and ammonium sulphate fractionation/ centrifugation-based size fractionation.
- Determination of pH optima for an enzyme.
- Effect of temperature on enzymatic activity.
- Enzyme immobilization.
- Restriction mapping of plasmid DNA
- Genetic Transfer by Conjugation
- Polymerase Chain Reaction and analysis by agarose gel electrophoresis
- Preparation of competent cells and their transformation with standard plasmids
- Vector and Insert Ligation
- Southern hybridization

Programme/Class: FYUP	**Year:** Fourth **Subject:** Biotechnology	**Semester:** Eighth	
Course Code:	**Course Title:** Bacteriology and Virology		
After successful completion of the course, student will be able to: • understand the basic concepts of bacterial and viral classification, • understand structure, pathology and applications of bacteria in different fields			
Credits:4	**Core:** Compulsory		
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms		
Unit	**Topics**		**Total No. of Lectures**
I	Bacteria: Morphological types, cell walls of Gram positive, Gram negative, archaea and L-forms; antigenic properties of cell wall; capsule types, composition and function. General account of major groups of bacteria like Spirochetes, Mycoplasmas, Actinomycetes, Rickettsia, Myxobacteria, Cyanobacteria.		
II	Bacteriological techniques, Pure culture isolation: Streaking, serial dilution plating methods; cultivation, maintenance and preservation of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria. Nutritional requirements in bacteria; Culture media: components of media, natural		

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	and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media	
III	Virology: Brief outline on discovery of viruses, Classification, nomenclature and ultrastructure of plant viruses; brief details of plant viruses like TMV, Cauliflower Mosaic Virus and Potato virus X; transmission of plant viruses. Classification, nomenclature and ultrastructure of animal and human viruses. Brief details of RNA viruses Picorna, Ortho, Myxo, Para-myxo, Toga viruses, Rhabdo, Rota, HIV and Oncogenic Viruses; DNA viruses; Pox, Herpes, Adeno SV40; Hepatitis viruses, viral vaccines.	60
IV	DNA and RNA viruses, Replication of different group of viruses; Cultivation of viruses in embryonated eggs, experimental animals and cell cultures. Assay of viruses: physical and chemical methods (Protein, nucleic acid, radioactivity, electron microscopy), Infectivity assay (plaque method, end point method). Bacteriophage structural organization; Lytic and lysogenic cycles (molecular mechanisms), bacteriophage typing and its application in bacterial genetics; brief details on m13, Mu, T, Lambda and P1 phage.	

Recommended Books

1.Textbook of bacteriology, Ricky Parks, Syrawood Publishing House,
2. Principles and Practice of Bacteriology, Paul Jaxon Ed. Murphy and Moore Publishing
3. Introduction to Modern Virology EPZ, Nigel Dimmock, Andrew Easton and Keith Leppard Blackwell Publishing,
4. Basic Virology, Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, Blackwell Publishing,

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: FYUP	**Year:** Fourth- **Subject:** Biotechnology	**Semester:** Eighth
Course Code:	**Course Title:** Molecular Genetics	

After successful completion of the course, student will be able to:

- explain the concepts of DNA replication, DNA damage and repair, and gene expression in eukaryotic and prokaryotic organisms.
- take a family history and construct and interpret a pedigree.
- understand different laboratory techniques to investigate genetic material and their advantages and limitations.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of
I	Genetic Material: DNA and RNA as genetic material (experimental evidences), structure of DNA (including Z-DNA and- Sasisekharan's RL model), super coiling of DNA, Different type of RNAs and their roles, difference between DNA and RNA	
II	DNA Duplication (in prokaryotes and Eukaryotes): Unwinding proteins,	

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	Role of RNA Polymerases and DNA polymerases in prokaryotic and eukaryotic DNA replication, Semiconservative, Discontinuous and Bi-directional replication, RNA primers, Role of proteins in prokaryotic and eukaryotic DNA replication,	**Lect ures**
III	Organization of Genetic Material: Chromosome ultra structure and nucleosome concept, packing of DNA as nucleosomes in eukaryotes, techniques used for discovery of nucleosome, structure and assembly of nucleosomes, solenoid, phasing of nucleosomes, DNA concept and C-value paradox, repetitive and unique sequences, overlapping, pseudo, crying and split genes, satellite DNA's, selfish DNA	**60**
IV	Genetic Code (including mitochondrial genetic code): Deciphering of code in vitro and in vivo (use of mutations-base replacement, frame-shift and suppressor mutation)	

Recommended Books

1.Genetics: Analysis of genes and genomes, Hartl DA & Jones EW, Jones & Bartlett Publ
2. Molecular biology of the cell, Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P., Garland Science
3. Gene IX, Lewin B, John Wiley and Sons, (2006).
4. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).
5. Biochemistry & Molecular Biology of Plants, Buchanan BB, Gruissen W & Jones RL, ASPP

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Diploma	**Year:** Second; **Subject:** Biotechnology	**Semester:** Eighth
Course Code:	**Course Title:** Environmental Biotechnology	

After successful completion of the course, student will be able to:

- understand the concepts of biotic and abiotic factors of the environment and the principles of biodiversity.
- know about sustainable development goals, Environmental Impact assessment, environmental laws and policies.

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	**Topics**	**Total No. of Lect**
I	Introduction to environmental Science, Natural energy resources and their exploitation, Pollution and Environment, Environmental components, Carbon foot prints, Causes and consequences of climate change (global warming, Ozone hole, Sea level rise),	
II	Waste management: waste water analysis - BOD, COD, waste water treatment plant, Activated sludge process and its mathematics,	

	Solid waste management: Sources and types, Impact of solid waste disposal, Recycle, Reuse and Recovery solutions Bioremediation- Principle, types, advantages, limitations and applications, Factors affecting Bioremediation. Xenobiotic degradation by microbes (enzymes involved), Biomining, Bio-methanation, Bioleaching. Bio plastic technology, Bio plastic types, Phytoremediation	ures 60
III	Environment monitoring Remote sensing: Principle, objectives, types and applications Energy sources for remote sensing, Environmental Informatics Environmental Impact Assessment: Objectives, Classification, and Guidelines. Environmental Audit: Types and general methodology, International and Indian Eco-standards ISO14000 series.	
IV	Environmental Laws and Policies International: in view of global concerns, objectives of laws/regulations, Stockholm conference, Nairobi declaration, Rio conference, India: Environmental Policy, Anti-Pollution Acts: The water Act. 1974, The Air Act 1981, The Environment Protection Act 1986	

Recommended Books

1.Alternative Energy: S. Vandana; APH Publishing Corporation
2. Bio-Energy Resources: Chaturvedi; Concept Pub.
3.Renewable Energy – Environment and Development: M. Dayal; Konark Pub. Pvt. Ltd.
4.Water Sheds, Cambridge University Press Wiley & Sons Limited
5.Ecology: Principal & Application - Chapman, Pub: Cambridge Univ. Press

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: FYUP	**Year:** Fourth **Subject:** Biotechnology	**Semester:** Eighth
Course Code:	**Course Title:** Research Methodology	

After successful completion of the course, student will be able to:

- Learn and follow the ethical guidelines while doing research avoid plagiarism in research publications.
- Write a comprehensive literature review on a given research topic.
- Write a crisp research proposal or research project independently

Credits:4	**Core:** Compulsory
Max. Marks: 100=75(UE)+25(CIE)	**Min. Passing Marks:** As per University norms

Unit	Topics	Total No. of Lectures
I	Introduction to Research Methods: Types of research philosophies (positivist, interpretivist, pragmatist and realistic), various steps in scientific research, Scientific temper and attitude, Experimental Design, Defining Controls, deductive and inductive reasoning; reductionist and holistic approaches of scientific research	60
II	Scientific Methodology: Problem identification, Critical thinking, hypothesis formulation and hypothesis testing (Power analysis) Difference between hypothesis, reasoning, theory and scientific law	
III	Research in Practice: Literature review, Journals, Conference Proceedings, Journal Impact factor, Citation Index, h, g, h-g index, Reading a scientific	

	paper. Research Ethics: Social implications of research, bio-safety issues Animal experimentation ethics, wild-life ethics and human experimentation ethics. Data fudging and plagiarism: Use of URKUND, Turnitin and iThenticate software	
IV	Scientific Communication: Importance and Types, Logical organization of scientific data and documentation. Different modes of scientific communication: Scientific Writing, Report Writing: Types of research reports, Research Proposal writing, Research paper writing, Thesis writing. Oral forms of scientific Communication-Popular and Scientific talks, Poster presentations, Organizing Presentation Material, Use of audio-visual aids in presentation. Elements of presentation preparation. Legal forms of communication in science: Plagiarism and scientific misconduct, Ethics in scientific communication, patent submissions.	

Recommended Books

1. Scientific Writing and Communication Papers, Proposals, and Presentations: H. Hofmann New York: Oxford University Press, 2010, pp. xv–xvi.
2. "Building graduate capabilities to communicate research and plans successfully," T. L. J. Ferris, E. Sitnikova, and A. H. Duff, Int. J. Eng. Educ., vol. 26, no. 4, pp. 891–899, 2010
3. The Craft of Scientific Writing, Michael Alley, Springer,
4. The Scientists Guide to Writing, Stephen B. Heard, Princeton University Press,
5. Research Methods: A Process of Inquiry: Anthony M. Graziano, Michael L. Raulin, Pearson Publication, Delhi

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

PRACTICAL

(Credits: 4)

- To study ultrastructure of animal viruses- Pox, Influenza, Rabies and TMV
- Qualitative and quantitative detection of bacteriophages
- Animal virus titration by Hemagglutination test
- Isolation of the following types of bacteria from natural samples. Identification of the bacteria to at least the Genus level using the Bergey"s Manuals-Mesophilic bacteria/Thermophiles/Anaerobes

- Chlorella or Spirulina culture establishments and study of its growth using suitable parameters
- PCR amplification of genomic DNA.
- Reverse-transcription – polymerase chain reaction.
- Western Blot of regulatory protein of cell cycle / apoptosis.
- Preparation of metaphase chromosomes from cultured lymphocytes and cell lines.
- Genetic fidelity of tissue culture plants with RAPD markers
- Removal and estimation of pollutant from soil/water samples by bio-stimulation/ phytoremediation
- Qualitative and quantitative estimation of biodegradation of pesticide/ insecticide/fungicide.
- Determination of chemical oxygen demand of sewage sample
- Determination of biological oxygen demand of sewage sample
- Determination of dissolved oxygen concentration of water sample
- Estimation of Total suspended solids of waste water
- Study of soil characteristics: Colour/texture/Water holding capacity/pH/Alkalinity/Organic content
- Acquisition of "Google Earth" images for the known and unknown area for land use - land cover mapping 1 10 Review on EIA case study.
- Review writing/ Report writing
- Scientific presentation of research paper from reputed journal.

- ***Students who want to opt for 4- year UG Degree, Honours with research (and has secured 75% marks in the subject in all the three years) will choose any three of the above given theory papers of VII and VIII semester (4 credits**

each) along with research project (4 credits each) in both VII & VIII Semester.

- *Under the Apprenticeship/Internship embedded UG degree programme the student should complete a Training Programme (1200 hrs. -40 credits) through NATS or from equivalent Organisation. The degree holder has to do 1-year PG Programme. It is purely optional for the University, to run and give this degree.