ST. JOSEPH'S COLLEGE (AUTONOMOUS)

BENGALURU-27

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS FOR UNDERGRADUATE COURSE

Re-accredited with 'A' GRADE and 3.73/4 CGPA by NAAC
Recognised by UGC as College of Excellence

FROM 2015 -16 ONWARDS

SUMMARY OF CREDITS

Total hrs in the semester	Credit	Number of hrs per week	Title	Code number
Semester -I				
60	4	4	Introduction to Biochemistry and Microbiology	**BT 115**
33	1.5	3	**Practical -** Techniques in Microbiology	**BTP 115**
Semester -II				
60	4	4	Kinetics, Metabolism and Applied Microbiology	**BT 215**
33	1.5	3	**Practical -** Biochemistry and Applied Microbiology	**BTP 215**
Semester -III				
60	4	4	Cell Biology and Genetics	**BT 315**
33	1.5	3	**Practical -** Techniques in Cell Biology and Genetics	**BTP 315**
Semester -IV				
30	2	2	Molecular Biology	**BT 415**
33	1.5	3	**Practical -** Extraction and analysis of biomolecules	**BTP 415**
30	2	2	Biotechnology Now and Beyond	**BTOE 416**
Semester -V				
45	3	3	Cellular Immunology	**BT 5115**
33	1.5	3	**Practical -** Methods in Immunology	**BTP5112**
45	3	3	Genetic engineering ,Biophysics**,** Bioinformatics and Entrepreneurship	**BT 5215**
33	1.5	3	**Practical -** Techniques in Genetic engineering and Bioinformatics	**BTP5212**

Semester -VI				
45	3	3	Industrial Biotechnology and Animal biotechnology	**BT 6115**
33	1.5	3	**Practical -** Industrial Biotechnology	**BTP6115**
45	3	3	Bio-Statistics and Plant Biotechnology	**BT 6215**
33	1.5	3	**Practical -** Project work	**BTP6215**

PATTERN OF QUESTION PAPER
B.Sc end Sem EXAMINATION, BIOTECHNOLOGY
Time 2.5 Hrs **Max marks -70**

I. Explain/Define any Ten of the following **2x10=20**
Number of questions to be asked-12only
II. Write short notes on any FIVE of the following **6x5=30**
Number of question to be asked-7only
III. Answer in detail any TWO of the following **10x2=20**
Number of questions to be asked -2 with internal choice only

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**I SEMESTER**
Paper Code	**BT 115**
Paper Title	**Introduction to Biochemistry and Microbiology (30hrs + 30hrs)**
Number of teaching hrs per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**4**

This course aims to introduce students to basic concepts in Biochemistry and Microbiology, with key emphasis on classification and functions of biochemical macromolecules & taxonomy and morphology of prokaryotic and eukaryotic microorganisms.
Scope: The course is tailored for undergraduate students of Biotechnology and Biochemistry. It deals with key concepts in Biochemistry and Microbiology, besides providing opportunities for hands on experiments involving isolation culturing and study of microorganisms.

UNIT 1-Introduction: **2 hrs**

Biochemical evolution, Prebiotic reactions and molecules, Urey Miller Experiment. 1 hr
Biochemical composition of living organisms, Role of matter in biological systems,
Chemical bonds in biological systems. 1 hr

UNIT 2-Proteins: **6 hrs**

Classification and Structure of Amino acids, Zwitter ion concept, Isoelectric pH,
Concept of pK, Peptide bond, Biological functions of oligopeptides. 3 hrs
Classification of proteins based on structure, function and composition. 2 hrs
Levels of organization of proteins, Primary and secondary structure
Tertiary and quaternary structures, Denaturation. 1 hr

UNIT 3-Carbohydrates: **4 hrs**

Classification, structure of Monosaccharides (trioses, tetroses, pentoses and hexoses) 2 hrs
Disaccharides and Polysaccharides, Occurrence and functions. 1 hr

UNIT 4-Lipids: **4 hrs**

Classification, examples, triglycerides, properties, structure. Biological role of lipids.
Structure of triacylglycerides and fatty acids (C16 to C20), saturated and unsaturated.
Saponification, Iodine number, Rancidity, Basic structure of glycolipids and phospholipids

UNIT 5-Hormones: **4 hrs**

Definition, Classification (Exo/Endo/Paracrine; Protein/Peptide/Steroid) with examples 1 hr

Hormones of the Hypothalamus, Pituitary; Nature of hormone-receptor interaction 1 hr
Role and origin of Insulin, Glucagon, GH 2 hrs

UNIT 6-Nucleic acids: **4 hrs**
Chemical composition, structures; nucleosides, nucleotides; Watson & Crick model 1 hr
Types of DNA – A, B and Z 0.5 hr
Types of RNA, functions and structures, secondary and tertiary structure of tRNA; 1 hr
rRNA, functions; Role of radiolabels for nucleic acids 0.5 hr

UNIT 7-Enzymes: **4 hrs**
Classification – types and functions, enzyme units. 1 hr
Active site, Role of tertiary structure; Specificity–absolute, stereo, group and low 1 hr
Mechanisms of enzyme catalysis-Models: Lock and Key and Induced fit. 1 hr
Cofactors – types, examples (NAD, FAD) with functions. 1 hr

UNIT 8-Vitamins: **2hrs**
Sources, functions and deficiencies; Active forms as precursors for coenzymes

Microbiology **30 hrs**
UNIT 1-Microbiology and Microscopy **5 hrs**
Historical evolution of microbiology
Contributions of Leeuwenhoek, Pasteur, Koch, Lister, Flemming, Khorana, Kohler 2 hrs
Bright/Dark field/Phase contrast/Fluorescent microscopy, 3 hrs
Transmission and scanning electron microscopy

UNIT 2-Control of Microorganisms **2hrs**
Control by physical agents, chemical agents, antibiotics and other chemotherapeutic agents

UNIT 3-Taxonomy **3 hrs**
Introduction to classification of bacteria (Bergey's Manual), GC Content and chemotaxonomy Basics of conventional and modern taxonomy.

UNIT 4-Prokaryotic microorganisms **10hrs**
Cell wall of bacteria, Capsule Flagella, Fimbriae, Pili, Endospore, Reserve food
Characteristics of Cyanobacteria and Mycoplasma
Classification, T-Even structure, life cycle of bacteriophage lytic and lysogeny
General Characteristics of Pathogenic virus- Polio, HIV

UNIT 5-Eukaryotic microorganisms **4 hrs**
Protozoa-general features, pathogenic protozoans, life cycle of plasmodium.
General characteristics of Fungi, Introduction to Yeasts and its economic importance
General characteristics of Algae, Economic importance of red algae

UNIT 6-Nutrition and growth **4 hrs**
Autotrophic and Heterotrophic bacteria, Growth curve-Synchronous growth,

Arithmetic growth, continuous growth; Chemostat and Turbidostat

UNIT 7- Microbial inter relations **2 hrs**

Symbiosis, Parasitism, Commensalism

References: Principles of Biochemistry by Lehninger
Biochemistry by Stryer
Molecular Cell Biology by Harvey Lodish
Molecular Biology of the Cell by Alberts
Practical Biochemistry by Wilson and Walker
Microbiology by Pelczar
Microbiology by Frobisher

PRACTICAL I (BTP 115)

Each session will consist of three hours.

Techniques in Microbiology

Session I: Lab rules, Handling and cleaning of glassware
Preparation of media: NA, NB, PDA, and Rose Bengal agar with antibiotics
Instruments: Autoclave, Hot air oven, Laminar Air Flow, Incubator, Colony counter and pH meter.

Session II: Pouring of prepared media and preparation of media plates and slants.
Isolation of organisms from air by air exposure method
Isolation of organisms from water by: Pour plate, streak plate method

Session III: Study of colony characteristics of bacteria and fungi from air and water sample.
Pure culture techniques: Streak plate (5 different types)
Stab culture and slant culture.

Session IV: Staining techniques using pure cultures isolated. Bacteria- Gram staining,

Session V: Fungi staining - Lactophenol blue staining; Selection of one culture-fungi and bacteria per batch of 3 to be maintained and studied until the end of the semester.

Session VI: Preparation for Biochemical tests of cultures: Sugar metabolism for acid and gas production.

Session VII: A) IMViC test B) Oxidase

Session VIII: C) Triple sugar test D) Gelatinase test.

Session IX: E) Starch hydrolysis F) Catalase test.

Session X: Cleaning of plates and maintenance of cultures

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**II SEMESTER**
Paper Code	**BT 215**
Paper Title	**Kinetics, Metabolism and Applied Microbiology (30hrs + 30hrs)**
Number of teaching hrs per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**4**

The course deals with the theory of enzyme kinetics and metabolic pathways of organic macromolecules, besides introducing the student to the basics of agricultural, food and environmental microbiology.
Scope: This course is designed for undergraduate students of Biotechnology, Biochemistry and Microbiology. It aims to familiarize the student with basics of enzyme kinetics and metabolic pathways, besides introducing them to various fields of applied microbiology. The practical sessions give the student hands on training in selected biochemical techniques.

Kinetics and Metabolism **30 hrs**

UNIT 1-Bioenergetics: **4 hrs**

Free Energy changes, Phosphate group transfers and ATP, High energy molecules
Biological Oxidation reduction reactions, Coupled reactions

UNIT 2-Enzyme kinetics **8 hrs**

Factors affecting enzyme reactions (temp, pH, ions, changes in structure of proteins) 2 hr
Michaelis Menton equation (derivation), Km, Vmax 2 hr
Line Weaver Burke Plot, Significance and uses 2 hr
Enzyme inhibition – competitive, uncompetitive and non competitive 2 hr

Metabolism: **15 hrs**

UNIT 3-Carbohydrates: 4 hrs

Glycolysis, TCA Cycle, Glycogenesis, Glycogenolysis; Role of PFK in regulation,
Glycogen for regulation of blood Glucose levels.
Glycogen storage diseases– Hers & McArdle's, Energy calculation in Glycolysis and TCA

UNIT 4-Lipids: 3 hrs

β and ω oxidation of lipids, Sources of Acetyl CoA for Fatty Acid biosynthesis,
Biosynthesis of Palmitate. Role of Asprin as drug.

UNIT 5-Proteins: 8 hrs

Protein turn over briefly–function of different proteases, role of Ubiquitin,
Deamination, transamination and decarboxylation of amino acids with structures 2 hrs
Urea cycle, (Cycle only) inborn errors due to defective amino acid metabolism–
Alkaptonuria, Albinism, Hyperlysinemia, Phenylketouria. 3 hrs

Principles of extraction and purification of proteins – salt and solvent precipitation,
Dialysis for protein purification 3hrs

UNIT 6-Signal Transduction: **3 hrs**

General principles of cell signaling, Types, Cell/Target and its response to signals 1hr
Signal molecules- hormones, neurotransmitters, NO, CO, its origin, chemical nature
Receptor types –hydrophilic & hydrophobic
Main classes of cell surface receptors, Role of NO 1hr
Pathways: Epinephrine & Vasopressin 1hr

Applied Microbiology **30 hrs**

UNIT 1-Epidemiological Studies **2 hrs**

Introduction to Epidemiological studies (terminologies used)
Methods of disease transmission and disease cycles, Reservoirs of infections,
Epidemiology of AIDS, Portals of entry and exit of pathogens

UNIT 2-Pathology **7 hrs**

Normal human micro biota, microbial colonization, microbial virulence: toxins,
hydrolytic enzymes, capsule, adherence factors, invasiveness, phagocytosis. 3 hrs
Pathological aspects of Streptococci, Corynebacterium, Clostridium,
Enteric bacteria, Mycobacterium, Neisseria and Treponema. 4 hrs

UNIT 3-Microbes In Agriculture **5 hrs**

Introduction to Nitrogen fixing bacteria-Rhizobium 1 hr
Phosphorus solubilizing agents –VAM 1 hr
Anabaena –importance in agriculture 1 hr
Disease causing microbes- *Xanthomonas oryzae*, *Puccinia spp,* Banana bunchy top virus 2 hrs

UNIT 4-Microbes In Food **4 hrs**

Microbial examinations, Chemical properties
Preservation of foods: Techniques
Food poisoning: Botulism, Staphylococcal, Salmonellosis, Mycotoxins

UNIT 5-Environmental Microbiology **12 hrs**

Bioremediation 2 hrs
Microbial degradation of xenobiotics (DDT, PCB) 1.5 hrs
Sewage and wastewater microbiology 2 hrs

Microbial insecticides: NPV, *Bacillus thuringiensis, B. sphaericus, Baculovirus*	2 hrs
Microbial removal of heavy metals: precipitation of metal sulphides by SRB.	1 hr
Bioleaching-recovery of metals from ores	1.5 hrs
Solid Waste Management-composting, biogas	2 hrs

Reference text books:

Biochemistry:

Principles of Biochemistry by Lehninger
Biochemistry by Powar and Chatwal
Biochemistry by Satyanarayana

Microbiology:

Molecular biotechnology by Bernad R. Glick and J. Pasternak
Medical Microbiology by Patrick R Murray, Ken S Rosentha *et .al*

Refer to books under references for Microbiology, Semester I

PRACTICAL II (BTP 215)

Biochemistry and Applied Microbiology

Each session will consist of three hours.

Session I: Lab rules; Introduction to molarity, molality and normality, Calculations

Session II: Introduction to glassware pipettes etc. Preparation of solutions of different normality, molarity and molality

Preparations of stocks and diluting of stocks to the required concentration

Session III: Introduction to pH and preparation of buffers. Instruments: pH meter and introduction to colorimeter and spectrophotometer.

Session IV: Estimation of proteins by Lowry's method.

Session V: Estimation of Reducing Sugars by DNS method.

Session VI: Estimation of DNA by Diphenylamine method

Session VII: Estimation of RNA by Orcinol method

Session VIII: Staining and study of Rhizobium cultures

Session IX: Study of food spoilage part A **-**Preparation of media and inoculation

Session X: Study of food spoilage part B -study of bacteria from above obtained cultures

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**III SEMESTER**
Paper Code	**BT 315**
Paper Title	**Cell Biology and Genetics (30 + 30 hrs)**
Number of teaching hrs per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**4**

This course introduces the student to the structure, physiological properties and organelles of eukaryotic cells and teaches the basics of Mendelian and Population Genetics.
Scope: The Cell Biology and Genetics course is structured for undergraduate Biotechnology, Biochemistry and Genetics students. The Cell Biology section deals with the basics of cellular and organelle structure and function, besides introducing molecular events in signal transduction and the cell cycle. The Genetics section of the course deals exhaustively with Mendelian genetics and introduces population genetics.

Cell biology **30 hrs**

UNIT 1-Introduction to Cell **2 hrs**

Cells: Origin, Structure, Metabolism, and Reproduction

Molecular composition of cells- carbohydrates, lipids, proteins and nucleic acids

UNIT 2-Cell membrane structure and functions **2 hrs**

Isolation & analysis of plasma membrane, molecular organization-lipids and membrane proteins, Molecular model of Fluid Mosaic Model, Membrane functions of permeability and transport.

UNIT 3-Cytoskeleton and Structural frame work **3 hrs**

Cytoskeletal elements-Structure and function of microtubules, shaping, transport, morphogenesis and cellular motility; Structure and function of intermediate filaments-Cell strength

Structure and function of actin filaments-Cell crawling and muscle contraction

Cytoskeletal architecture of epithelial cells.

UNIT 4-Cell surface and Cellular Communications **3 hrs**

The cell coat and extra cellular materials; Intercellular junctions-Microvilli, Tight junctions, Desmosomes; Gap junctions and cell–cell surface adhesion;

Intercellular communication in action-The action of motoneurons

UNIT 5-Signal transduction **1 hr**

Role of membrane receptors-Second messengers (Ca ions, G proteins)
Defects in G protein-Cholera and whooping cough

Organelles of cells

UNIT 6-Mitochondria and Cell Energetics **4 hrs**

Morphology, structure and chemical composition; Functions of mitochondria: ETC and Overall energy balance

UNIT 7-Chloroplast and Photosynthesis **3hrs**

Structure, molecular organization of chloroplast; The light reaction of photosynthesis-Chlorophylls, Carotenoids and Proteins; Photosystems I and II; The CO_2 fixing dark reactions; Photorespiration and C_4 plants.

UNIT 8-Endoplasmic Reticulum **2 hrs**

The rough endoplasmic reticulum-Morphology, structure and functions
The smooth endoplasmic reticulum-Morphology, structure and functions

UNIT 9-Golgi Complex **2 hrs**

Morphology and structure of Golgi complex, Brief mention of Functions

UNIT 10-Lysosomes and Microbodies **2 hrs**

Characteristics of Lysosomes and enzyme content, Function of Lysosomes;
Morphology and enzyme content of Peroxisomes

UNIT 11-Ribosomes **2 hrs**

Chemical organization and structure of Ribosomes, Numbers and Concentrations;
Brief mention of Functions

UNIT 12-Nucleus **2 hrs**

The nucleus and nucleoid-Nuclear envelope, nuclear pore complex, the nucleolus, nucleosome. Structure of chromosomes, heterochromatin and euchromatin, centromere, DNA satellite and telomere.

UNIT 13-Cell Cycle and Control of cell number **2 hrs**

Interphase-The G1, S and G2 phase molecular events of the cell cycle; Control of cell division-Molecular regulation of the G2/M cell cycle; Control point and Apoptosis

Genetics **30 hrs**

UNIT 1-Mendelian Genetics **4 hrs**

Mendel's study of heredity-Mendel's experiments, Symbols and terminology, dominance, recessiveness; Principle of segregation, Monohybrid cross, Principles of Independent assortment - Dihybrid ratio, Trihybrid ratio, Application of Mendel's Principles-The Punnett square method, the probability method and the chi-square test; Problems.

UNIT 2-Extension of Mendelism **6 hrs**

Allelic variation and gene function-incomplete dominance and co-dominance; Multiple alleles-

ABO blood type alleles in humans, Rh factor alleles in humans; Genotypic interaction-Epistasis, Pleiotropy, Problems, Extra nuclear inheritance-inheritance of plastid and kappa particles

UNIT 3-Linkage and Crossing over **3 hrs**

Introduction, detection of linkage, factors affecting recombination frequency, cytological basis of crossing over, crossing over in four strand stage, relation between chiasma and crossing over; Two point test cross and three point test cross, Recombination frequency.

UNIT 4- Sex Determination, Sex Linkage and Pedigree Analysis **8 hrs**

Sex determination-Pattern and sex chromosomes, Sex determination in human beings, flowering plants; Dosage compensation-Proof of the Lyon hypothesis, dosage compensation for Drosophila; Sex linked genes in human beings-Haemophilia, colour blindness, the fragile X syndrome; Genes on X and Y chromosomes; Pedigree analysis-Penetrance and expressivity, family tree, dominant inheritance, recessive inheritance; Problems.

UNIT 5- Population Genetics **3 hrs**

Gene pool, Theory of Allele Frequencies (Gene and genotypic frequencies)-The Hardy-Weinberg principle, Application of the Hardy – Weinberg principle and Exceptions-Natural selection, Random genetic drift; Speciation-Definition of species and mode of speciation (allopatric, sympatric)

UNIT 6- Chromosomal Aberrations **6 hrs**

Numerical chromosomal aberrations– Euploidy**,** polyploidy- Sterile polyploids, fertile polyploids, Tissue specific polyploidy and Polyteny; Aneuploidy- Trisomy, monosomy, nullisomy, disomy, tetrasomy; Procedure to detect aneuploidy in human foetuses; Examples of aneuploid humans. **Structural chromosomal aberrations-**Deletions and Duplication of chromosome segments; Rearrangement of chromosome structure - inversion, translocation

References

Cell biology

Molecular Biology of the Cell-Alberts, Fourth edition Garland science, 2002. Essential Cell Biology-Alberts, Garland science, 1998.

Cell biology-A short course-Stephen R. Bolsover.second edition, Wileyliss, 2004

The Cell-A Molecular approach-Geoffrey M Cooper, ASM press, 1997.

Genetics

Principles of Genetics-Snustad, Simmons, third edition, Wiley 2003.

Principles of Genetics-Robert H Tamarin, seventh edition Tata Mcgraw Hill, 2002.

Genetics-A.V.S.S. Sambamurty, Narosa, 1999

Genetics Principles and Analysis, Daniel L H, Elizabeth W Jones John and Burlett publishers, 1998.

Principles of Genetics-Gardner, eighth edition, 2002

PRACTICAL III (BTP 315)

Techniques in Cell biology and Genetics

Session I: Lab rules, use of microscope and staining of Buccal mucosa for Barr bodies.
Session II: Blood grouping.
Session III: Introduction to mitosis and study of mitotic chromosomes.
Session IV: Introduction to meiosis and study of meiotic chromosomes.
Session V: Introduction to Micrometry and measurement of cells-Onion cells/yeast cells.
Session VI: Introduction to Haemocytometry and counting of yeast cells.
Session VII: Karyotyping of the human chromosomes.
Session VIII: Isolation of chloroplast.
Session IX: Culturing techniques and handling of Drosophila melanogaster.
Session X: Preparation and Staining of salivary gland chromosomes in *Drosophila*.

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**IV SEMESTER**
Paper Code	**BT 415**
Paper Title	**MOLECULAR BIOLOGY -30 hrs**
Number of teaching hrs per week	**2**
Total number of teaching hrs per semester	**30**
Number of credits	**2**

This course deals with the fundamentals of Molecular Biology and gene expression. The Molecular Biology segment deals with basic concepts and introduces the discipline to the undergraduate student. It also provides the student a clearer understanding of the central dogma of molecular biology and methods of gene regulation. The practical sessions train the student in selected basic techniques in genetic engineering.

UNIT 1- DNA STRUCTURE AND FUNCTION **2 hrs**

Griffith's, Avery et al. and Hershey and Chase experiments 1 hrs

Watson and Crick's model of the DNA double helix 1 hr

UNIT 2-DNA REPLICATION **6 hrs**

Semiconservative model of replication (Meselsohn& Stahl experiment), Bidirectionality and semi-discontinuous nature of replication 2 hrs

Replication fork, DNA Polymerases and the main scheme of DNA replication 1 hr

Replication in Prokaryotes: Initiation, elongation and termination 2 hrs

Replication in Eukaryotes: Initiation, elongation and termination, Telomeres, Telomerase 1 hr

UNIT 3-DNA DAMAGE AND REPAIR **5 hrs**

Radiation Damage, DNA instability, Oxidative damage, Alkylation Damage 1 hr

Introduction to mutagens, types of mutagens (chemical, physical and biological) 2 hr

Direct repair- Photoreactivation, Excision Repair, Mismatch repair and SOS response2 hrs

UNIT 4- TRANSCRIPTION **7 hrs**

Eukaryotic gene structure, Promoters, General Transcription factors, DNA binding domains 1 hr

Bacterial Transcription Initiation, Elongation and Termination (Intrinsic, Rho dependent) 2 hrs

Eukaryotic RNA Polymerases, Promoters 0.5 hr

Eukaryotic Transcription Initiation, Elongation and Termination 1.5 hrs

Processing of eukaryotic mRNAs-capping, Splicing and Polyadenylation 1 hr

UNIT 5- TRANSLATION **6 hrs**

Structure of Ribosomes, Transfer RNA, Aminoacylation, mRNA and the Genetic Code, 2 hrs
Translation Initiation, Elongation and Termination in Prokaryotes 2 hrs
Translation Initiation, Elongation and Termination in Eukaryotes 1 hr
Post translational processing of proteins 1hr

UNIT 6- GENE REGULATION **4 hrs**

Overview of gene regulation 1 hr
Prokaryotic Gene Regulation-Lac and Trp operons 1.5 hrs
Eukaryotic Gene Regulation- Regulatory promoter elements, changes in chromatin structure and DNA methylation 1.5 hrs

REFERENCE TEXT BOOKS

Molecular Biology

Molecular Biology-Genes to Proteins: Burton E Tropp
Genes VIII-Lewin
Molecular biology of the cell - Bruce Alberts
Molecular Cell Biology by Harvey Lodish
Genomes 3.0- T. A Brown
Molecular Biology: Schaum series

PRACTICAL V (BTP 415)
Extraction and analysis of Bimolecules

Session I	:Calculations and Preparation of solutions
Session II	:DNA extraction from cheek cells
Session III	: Electrophoresis of extracted Genomic DNA
Session IV	: DNA extraction from plant samples: Cauliflower or spinach.
Session V	: Genomic DNA extraction from bacterial cells.
Session VI	: Extraction and estimation of protein from liver samples, using Acetone precipitation/Lowry's method
Session VII	: Extraction and estimation of protein from plant material, using Ammonium sulphate precipitation/Bradford reagent
Session VIII	: SDS-PAGE
Session IX	: Extraction of RNA from yeast cells
Session X	: DNA extraction/Protein sample-Any sample

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**IV SEMESTER**
Paper Code	**BTOE 416**
Paper Title	**BIOTECHNOLOGY NOW AND BEYOND**
Number of teaching hrs per week	**2**
Total number of teaching hrs per semester	**30**
Number of credits	**2**

The term 'Biotechnology' may sound futuristic. This paper deals with the introduction to biotechnology that will interest student to understand the application of this field today. Biotechnology has a role in the daily life and there is areas one need to know about. The paper covers a clear introduction for the area in the first units. The content will help students understand genes, genetic diseases, drug reactions and genetically modified crops.

Unit 1-The Cell: **2 hrs**
Cell theory: The basic unit of life, structure of a cell (general, plant and animal)-1 hr
General account of living cells-1 hr

Unit 2-DNA: **2 hrs**
Discovery of DNA as a genetic material-1 hr
Structure of DNA-1 hr

Unit 3- Genes and Genomes: **2 hrs**
Gene concept, concept of genomes-1 hr
Model organism and their genomes -1 hr

Unit 4- Applications of DNA studies: **4 hrs**
In Agriculture, Environment, Food and forensics- 1 hr each

Unit 5- Genetic Engineering and Cloning: **4 hrs**
Aim, scope and principles of genetic engineering-1 hr
GE Insulin-1 hr
Introduction to cloning –Example Dolly -2 hr

Unit 6- Bioinformatics: **4hrs**
Databases-1 hr,
Sequencing-2 hr,
Human genome project-1 hr

Unit 7- Biotechnology in the media : **2hrs**

Unit 8- Bioethics, Biosafety and IPR: **2 hrs**

Social, Moral and Environmental ethics, Biosafety, Biosafety guidelines -1 hr
IPR and patent process -1 hr

Unit 9- Genetically Modified Crops: **2 hrs**

Introduction to BT cotton-1hr

Bt Cotton scenario in India-1hr

Unit 10 -Pharmacovigilance **2 Hrs**

Pharmacovigilance programme in India-1 hr

Introduction to adverse drug reactions-1 hr

Unit 11- Genetic diseases: **2 hrs**

Introduction to common genetic disorders-1 hr
Genetic counseling and diagnostics-1 hr

Unit 12-Stem Cells biology: **2 hrs**

Introduction to stem cells-1 hr
Applications and ethical issues-1 hr

Reference –

1. Biotechnology Now And Beyond-(Contact department for copy of the reference book)

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**V SEMESTER**
Paper Code	**BT-5 115**
Paper Title	**Essential Immunology**
Number of teaching hrs per week	**3**
Total number of teaching hrs per semester	**45**
Number of credits	**3**

This course deals with the fundamentals of Immunology. It familiarizes the student with basics of the human immune system and immune response.
Scope: This course is designed for undergraduate students of Biotechnology. It outlines the basics and builds into an indepth understanding of both humoral and cellular immune responses. The practical sessions allow for hands on training in immunological experiments.

UNIT 1-The Immune System **5 hrs**

Types of immunity-Innate and Acquired, Barriers involved in innate immunity – anatomic, physiologic, phagocytic, inflammatory. 1.5hrs

Collaboration between innate and adaptive immunity 0.5hrs

Organs involved - Central lymphoid organs – bone marrow, thymus 1hr

Peripheral lymphoid tissues – spleen, lymph nodes, GALT and MALT 2hrs

UNIT 2-Immunoreactive Cells **4hrs**

Introduction to Macrophages, Granulocytes, NK Cells 1hr

T cells – Markers, Functions of T cell subsets – TH, CTLs – mode of action, TR. 1hrs

B cells – Markers, ontogeny, heterogeneity; Activation, B cell differentiation – Memory B cells, Plasma cells 2hrs

UNIT 3- Antigens **2hrs**

Kinds of Antigens, Epitopes and paratopes, Factors affecting immunogenicity

UNIT 4-Immunoglobulins **4hrs**

Elucidation Of Immunoglobulin structure, Structure and functions of immunoglobulins – IgA, IgM, IgD, IgG, IgE 2hr

Isotypes, Allotypes, Idiotypes, Ig Receptors 1hr

Description and raising of polyclonal and monoclonal antibodies 1hr

UNIT 5-Immunogenes **3hrs**

Germline vs Somatic mutation theory, Dryer-Bennet experiments 1hr

Tonegawa's experiment, Class switching 1hr

Immunogene structure, Generation of antibody diversity- combinatorial, junctional 1hr

UNIT 6-Antigen-Antibody Interactions **3hrs**

Antigen and Antibody interactions – forces involved, affinity and avidity, 1hr

Precipitation and Agglutination and its applications 2hrs

UNIT 7- Complement system **3hrs**

Description of trigger and proteins involved 1hr

Classical pathway 1hr

MBL and Alternate pathway, terminal pathway 1hr

UNIT 8- Major Histocompatibility Complex **2hrs**

Structure of MHC I and MHC II molecules 1hr

Cellular distribution of MHC molecules, role in immune responsiveness, disease 1hr

UNIT 9-Antigen Processing and Presentation **3hrs**

Self Restriction of T cells, Types and Function of Antigen Presenting cells 1hr

Antigen Processing Pathways- Endocytic and Endogenous Processing Pathways 2hrs

UNIT 10-Humoral Immunity **3hrs**

Primary and secondary response, Role of immunoglobulins in immunity 1hr

Theories of Antibody production–Instructive theory and Selective theory 1hr

Somatic hypermutation, Affinity Maturation, Class Switch recombination 1hrs

UNIT 11- Cell Mediated Immunity **2hrs**

Mechanism of cell mediated toxicity, Perforin and Granzyme pathway 1hr

Death receptor ligand pathway, ADCC 1hr

UNIT 12-Immunotolerance **2hrs**

Central Tolerance, Peripheral tolerance, Tolerance induction

UNIT 13- Hypersensitivity **3hrs**

Characteristics and types 1hr

Type I – Cells involved, Factors, Diagnosis, Treatment 1hr

Type II - Types, reasons, Type III , Type IV 1hr

UNIT 14-Vaccines **2hrs**

Introduction to vaccines, Active and Passive Immunization 1hr

Types of vaccines, note on hybrid and conjugate vaccines 1hr

UNIT 15-Autoimmune Diseases **1hr**

Introduction, Factors – Natural, genetic predisposition, Environmental factors, with an example

UNIT 16-Transplantation Immunology **3hrs**

Antigens involved in graft rejection, Allorecognition – Direct and indirect 1hr

Graft rejection - Role of APCs, Effector cells, Graft Vs Host Disease (GVHD) 1hr

Immunosuppressive therapies – Induction Therapy and Maintenance therapy 1hr

References:

- Immunology by Richard A. Goldsby,Thomas J.Kindt, Barbara A. Osborne & Janis Kuby
- Immunology by Ivan M. Roitt, Jonathan Brostoff & David K. Male
- Immunology: Essential and Fundamental by Sulabha Pathak & Urmi Palan.
- Immunology a comprehensive review: Darla J. Wise & Gordon R. Carter-Anebooks
- Lecture notes in Immunology: Ian Todd & Gavin Spicket
- Microbiology and Immunology: Monica Gandhi et.al., Blackwell publishing.
- Schaum's Immunology : George R.Pinchuk
- Essential Immunology: Viva books private Ltd

Practical-BTP-5115

- **Methods in Immunology**

Session I : Introduction to blood cells and preparation of blood smear
Session II: Introduction to gel electrophoresis
Session III: Immunodiffusions: SRID
Session IV: ODD titration
Session V : ODD pattern
Session VI: Rocket immunoelectrophoresis
Session VII : VDRL test syphillis
Session VIII : WIDAL test for typhoid
Session IX: Enzyme linked immunosorbantassay (ELISA){Dot ELISA}
Session X : SDS PAGE of purified immunoglobulin

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**V SEMESTER**
Paper Code	**BT 5 215**
Paper Title	**Genetic Engineering and Biophysics, Bioinformatics and Entrepreneurship (25+20 hrs)**
Number of teaching hrs per week	**3**
Total number of teaching hrs per semester	**45**
Number of credits	**3**

This course deals with more advanced concepts of Genetic engineering and also introduces the disciplines of Biophysics and Bioinformatics, besides briefly discussing entrepreneurship in Biotechnology.

Scope: This course is tailored for undergraduate students of Biotechnology. It gives the student a clearer understanding of the principles and techniques involved in Genetic Engineering. The course also introduces the student to Bioinformatics, Biophysics and scientific entrepreneurship. The practical sessions provide hands on training and demonstration of selected techniques in Genetic Engineering, besides introducing bioinformatics techniques and programs. The purpose of this paper is also to prepare a ground where the students view Entrepreneurship as a desirable and feasible career option. In particular the paper seeks to build the necessary competencies and motivation for a career in Entrepreneurship.

Competence-Induction and significances, Microinjection, Lipofection, Electroporation

Genetic Engineering **25 hrs**

UNIT 1-Introduction **1 hr**

Principles of Recombinant DNA Technology & Genetic Engineering –Techniques (in brief), its applications, goal and ethical issues; Concept of Vectors and Restriction Endonucleases

UNIT 2-General Methods of Transformation **4 hrs**

Macroinjection, Sonication, Silicon carbide fibre vortex, DNA coprecipitation, Ultrasonication, Laser Induced, Use of *Agrobacterium* (Methodology, Advantages and Disadvantages)

UNIT 3-Tools in Genetic Engineering **6hrs**

Restriction Endonucleases 1 hr

DNA ligase, Linkers and Adapters, Alkaline Phosphatase, Polynucletide kinase, Terminal transferases, S1 nuclease 1 hr

Polymerases-Klenow fragment, Pol I, *Taq* polymerase, Reverse transcriptase 1 hr

Roles of RNAse (Definition, types, features, mode of action, application) 3 hrs

UNIT 4-Vectors for cloning **11hrs**

Natural plasmids, list of plasmids and this sites,PBR322 and PuC19 : Design and Advant 2 hr
Cloning Vectors based on bacterial plasmids, Scheme of cloning-restriction, ligation 3hrs
Lambda Bacteriophages-Insertional vectors and Replacement vectors Features, Design. 2 hrs
M13 Bacteriophage-Features, Design, Advantages 1hr
Cosmids, Phagemids and Phasmids- Definition, features, design with examples 1 hr

List of vectors for cloning in *Saccharomyces cerevesiae*-Feature, Examples 1hr

Unit 5 Techniques in cloning and gene analysis **3hrs**
Genomic libraries ,cDNA libraries and PCR

Biophysics **10 hrs**

UNIT 1-Introduction **1 hr**
Scope and development of Biophysics

UNIT 2-Analytical techniques **4 hrs**
Principles and applications of
a) Chromatography (Paper, thin-layer, column)
b) Centrifugation (rpm and g, Ultracentrifugation)

UNIT 3-Spectroscopic Techniques **3 hrs**
UV, visible spectroscopy, X-ray crystallography

UNIT 4-Isotopes **2 hrs**
Types, their importance in biological studies, measure of radioactivity, GM counters & Scintillation counting

UNIT 5-Bioinformatics **8hrs**

Concept and structure of databases

Introduction to the human genome project and components of the genome

Introduction to the gateway sites (NCBI, EMBL and DDBJ).

Types of nucleic acid sequences–Genebank

Protein Data Bank (PDB)–in the context of protein structural biology

Data retrieval: Example of research literature and demonstrations in PubMed Introduction to sequence analysis, significance, motif analysis and phylogenic comparisons

Concept and methods of sequence comparisons in general: BLAST and CLUSTALW, pair wise sequence comparison, Scoring matrices, Gap Penalties, Global Alignment, Local Alignment,

UNIT 6-Entrepreneurship **2 hrs**

Introduction, Opportunity scouting, idea generation, business plan

Reference text books:

Genetic Engineering

Watson, J.D., Tooze, J. and Kurtz, D.T., Recombinant DNA: A short Course, Scientific American Books, New York.

T. A. Brown, Essential Molecular Biology a Practical Approach -Oxford University Press T. A. Brown, Genomes

Bruce Alberts, Molecular Cell Biology

Ernst L. Winnacker, From Genes to Clones: Introduction to Gene technology
Principles of Gene Manipulation and Introduction to Genetic Engineering, 3rd Ed,
Purohit,S.S., Biotechnology Fundamentals and Application- Himalaya Publications.
Glick & Pasternack, Molecular Biotechnology.

Biophysics:

P. Narayanan, Essentials of Biophysics

Upadhyay, Upadhyay and Nath, Biophysical Chemistry: Principles and Techniques

Bioinformatics:

Introduction to bioinformatics by Sundararajan and Balaji
Bioinformatics by Murthy

Developing Bioinformatics computer skills by Cynthia Gibas and Per Jambeck O'reilly April 2001: first edition.

Bioinformatics-concepts, skills, and applications, By S.C Rastogi, Namita Mendiratta and Parag Rastogi. CBS publisher 2003: First edition

Introduction to Bioinformatics by Arthur M. Lesk. Oxford University Press 2002: 1st edition.
Bioinformatics-sequence and genome analysis by David W. Mount. CSH Lab Press, 2001

Practical VI: (BTP 5-215)

Techniques in Genetic Engineering II and Bioinformatics

Session I **:** Isolation of plasmid from an assigned organism

Session II **:** Single and Double Restriction digestion of the plasmid DNA (Eco, R1, Hind III, BamHI) and its analysis by Electrophoresis

Session III **:** Ligation of a fragment to a restricted vector

Session IV **:** Preparation of competent cells

Session V **:** Transformation of ligated DNA

Session VI **:** PCR

Session VII : Ion exchange chromatography

Session VIII **:** Bioinformatics-PubMed, Mapviewer

Session IX **:** Pairwise alignment-Blast and CLUSTAL-W

Session X **:** Structure analysis tool

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**VI SEMESTER**
Paper Code	**BT 6 115**
Paper Title	**Industrial and Animal Biotechnology (30 + 15) hrs**
Number of teaching hrs per week	**3**
Total number of teaching hrs per semester	**45**
Number of credits	**3**

This course introduces the student to basic concepts and techniques of Industrial biotechnology and animal biotechnology. The course deals with Microbial, Enzyme and Food biotechnology at the industry level, besides introducing basics of animal tissue culture, transgenic animals and pharmaceuticals.
Scope: This course is structures as an introductory course in industrial and animal biotechnology for the undergraduate Biotechnology students. It gives the student a feel of the industrial applications of biotechnology and the techniques involved.

Industrial Biotechnology

UNIT 1- Introduction **1 hr**

Introduction to Industrial Biotechnology, Basic principles of fermentation technology

UNIT 2- Strain Improvement **2 hr**

Screening and Isolation of Microorganisms, Maintenance of strains, Improvement (Mutant selection, Recombinant DNA methods)

UNIT 3- Fermentation Media **2 hr**

Natural and Synthetic Media, Sterilization techniques – Heat, Radiation and Filtration methods

UNIT 4- Fermenters **4 hrs**

Design of fermenters, Types of fermenters, Factors affecting fermentation-Aeration, Agitation, Temperature regulation, Mass transfer, Oxygen transfer and Filtration method.

UNIT 5- Type of Fermentation **2 hrs**

Solid State fermentation, submerged fermentation, batch fermentation, fed-batch fermentation, continuous fermentation, Immobilized enzyme and cell bioreactors.

UNIT 6-Process Development **4 hrs**

Shake flask fermentation, Down Stream Processing (DSP)- Disruption of cells, Separation, Extraction, Concentration and Purification of products

UNIT 7-Production of Microbial products **8 hrs**

Brief account of the following products obtained by industrial microbiological fermentation Alcoholic Beverage–Beer

Organic acid–Citric acid
Antibiotic –Penicillin
Amino acids–Glutamic acid
Vitamin–B12
Brief account of Steroid biotransformation

UNIT 8-Enzyme Biotechnology **2 hrs**

Introduction to enzymes – examples of enzymes from animal, plant and microbial source
Industrial uses of amylase enzyme
Introduction to bulk and fine enzymes, steps involved in large scale production of enzymes

UNIT 9- Fermented Foods **4 hrs**

Fermented Foods –Yoghurt and Cheese
Microbial Foods – Single cell proteins (SCP), single cell oils (SCO)

UNIT 11-Microbial Products **1 hr**

Production of Polysaccharides (Xanthan gum) and polyesters Polyhydroxyalkanoates (PHA)

Animal Biotechnology **15 hrs**

UNIT 1-Introduction to Cell Culture and Cell Lines: **2 hrs**

Scope of animal tissue culture
Lab requirements for Aseptic conditions

Balanced Salt Solution, Culture Media-Natural media, Complex media,Chemically defined media; Advantage and disadvantage of Serum in media; Importance of the different media components for the growth of animal cells.

Explant isolation and culture, Primary culture, Secondary culture, Transformed cell lines, Continuous cell lines; Enzymatic and mechanical disaggregation of cells. Cryopreservation, Thawing.

UNIT 2-Concept of Transgene and Transgenics **5 hrs**

Transgene, Transgenic organism, Mosaic organisms

Transfection: Calcium phosphate precipitation, Direct DNA (pronuclear) microinjection

(Transgenic mice), Nuclear transfer (Dolly), Ballistic DNA injection, Lipofection, Electroporation, Retroviral vectors, Animal models for studying diseases (Cancer as an example)

UNIT 3-Expression of mammalian genes: **7 hrs**

Vector, Gene construct, Promoters, Scorable and Selectable markers, Targeted gene transfer,

Transgene integration-Gene disruption (Positive-Negative Selection) and Gene displacement,
Detection of Transgene 2 hrs
Transgenic Mice –expression of foreign genes and their application in research 2 hrs

Transgenic Cattle, Transgenic Fish. 2 hrs
Prerequisites for setting up an animal house and bioethics 1 hr

UNIT 4-Production of Pharmaceuticals 1 hr

Introduction, Strategies to optimize product yield, Downstream Processing, pharmacokinetics & pharmacodynamics, drug formulation, pre clinical trials and clinical trials.
Take any one product as an example

Reference books:

Animal biotechnology

Short Protocols in Molecular Biology, 4th Edition, Ed: Ausubel, Kingston, and Moore, 1999. Culture of Animal Cells: A Manual of Basic Technique, 4th Edn, by R. Ian Freshney, 2000. Molecular Biotechnology: Primrose.

Animal Cell biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press. Animal Biotechnology: Murray Moo-Young (1989), Pergamon Press, Oxford.

Industrial Biotechnology

Sullia S. B& Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Ltd. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers Glaser A.N & Nilaido.H (1995) Microbial Biotechnology, W.H Freeman & Co.

Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers

Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp

Stanbury P.F, Whitaker H, Hall S.J (1997) Principles of Fermentation Technology., Aditya Books (P) Ltd

Practical VII (BTP 6-115)-Industrial and plant Biotechnology

Session I : Preparation and maintenance of algal and fungal cultures.
Session II : Preparation of media for plant tissue culture
Session III : Inoculation and incubation of explants
Session IV : Principle and handling of a bioreactor
Session V : Production of Wine and Estimation of alcohol by specific gravity method.
Session VI : MBRT from milk. (Whole day, 8 hrs)
Session VII : Isolation and culturing of microbes for antibiotic sensitivity test
Session VIII : Immobilization of yeast
Session IX : Estimation of citric acid from *Aspergillus niger*
Session X : Estimation of Lactic acid and Lactose

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE

Semester	**VI SEMESTER**
Paper Code	**BT 6 215**
Paper Title	**Bio-Statistics and Plant Biotechnology (25+20 hrs)**
Number of teaching hrs per week	**3**
Total number of teaching hrs per semester	**45**
Number of credits	**3**

This course introduces the student to basic concepts and techniques of Industrial biotechnology and animal biotechnology. The course deals with Microbial, Enzyme and Food biotechnology at the industry level, besides introducing basics of animal tissue culture, transgenic animals and pharmaceuticals.
Scope: This course is structures as an introductory course in industrial and animal biotechnology for the undergraduate Biotechnology students. It gives the student a feel of the industrial applications of biotechnology and the techniques involved

Bio-Statistics **25 hrs**

UNIT 1-Introduction **2 hrs**

Definition of selected terms Scale of measurements, Methods of collecting data, Presentation of data statistical Tables, Need for reduction of data.

UNIT 2-Measures of Central Tendencies **5 hrs**

Measures of averages and location: Mean, Median, Mode

UNIT 3-Measures of Dispersion **5 hrs**

Range, quartile deviation, Mean deviation, Variance & Standard deviation, Coefficient of Variance

UNIT 4-Population and Sampling Techniques **3 hrs**

Concepts of statistical population and sample need for sampling studies; Simple procedures of random sampling; Methods of sampling;

UNIT 5-Probability **4 hrs**

Basic concepts; Basic theorems of probability addition and multiplication theorems; Conditional probability, Bayes Theorems; Probability distribution definition & applications; Binominal distribution and its application; Poisson distribution and its

application; Normal distribution and its application

UNIT 6-Correlation and Regression **2 hrs**
Correlation concept and applications; Regression concept and applications
UNIT 7-Hypothesis Testing **4 hrs**
Logic of statistical standard error estimation testing of hypothesis; Tests of significance: Normal deviate tests (Z test); Student's "t" test; Chi-Squared test; F. test and analysis of variance; Statistics in Genetics

Plant Biotechnology **20 hrs**
UNIT 1-Molecular Aspects of Plant Tissue Culture **10 hrs**
Introduction -Totipotency, Phytohormones and its role in *invitro* propagation; basic lab requirements. 2 hrs
Culture media; Micropropagation-Collection, sterilization, preparation and inoculation of explants 2 hrs
Callus-organogenesis and embryogenesis; nucellus, embryo, meristem, anther and hairy root culture 4 hrs
Protoplast culture and somatic hybridization; Cybrid 2 hrs

UNIT 2-Transgenic Plants **8 hrs**
Introduction, gene constructs-A typical plant gene, promoter/enhancers, reporter genes, Vectors for transgenic plants 2 hrs
Transformation techniques- *Agrobacterium* mediated gene transfer (case study), Particle gun method with reference to rice, pollen transformation 2 hrs
Biochemical production-Hirudin, Phytase 1 hr
Introduction into development of Bt crops-herbicide resistance, stress resistance 2 hrs
GM strategies for development of Bt Cotton 1 hr

UNIT 3-Molecular Markers and Maps **2 hrs**
Primer design, RFLP, application of RFLP, RAPDs, DNA fingerprinting
(All topics is with its application on plants)

Reference Books:
Bio-Statistics
Principles of Biostatistics By Rosner
Biostatistics by Khan and Khanum
Plant Biotechnology
The Law & Strategy of Biotechnology Patents, Sibley Kenneth
Molecular Biotechnology - Glick and Pasternak
Plant Biotechnology–H D Kumar
Biotechnology Fundamentals and Application- Purohit, Himalaya Publications.
Plant Tissue Culture –M.K.Rasthan

PRACTICAL VIII (BTP 6215)

Project based practical

1. Students, with the guidance of teachers, select topics in relation to the subject. Once the topic is approved by the staff members the project will be conducted during practical hours in the biotechnology lab itself.
2. Every week a review of work will be taken for PIA marks.
3. The practical exam will be based on questions from project work.
4. Dissertations should be submitted at the end of semester

Industrial visit in the 5^{th} or the 6^{th} semester. Visit the following areas-plant research, animal research, microbial research, fermentation industries.