ST. JOSEPH'S COLLEGE (AUTONOMOUS)

BENGALURU-27

Estd.1882

Recognised as "College of excellence" by UGC
Re-accredited with A^{++} grade and 3.79/4.00 CGPA by NAAC
Awarded DBT star status and DIS FIST grant
By Ministry of Science and Technology, GOI

DEPARTMENT OF BIOTECHNOLOGY

Funded by the DBT (Dept. of Biotechnology, Government of India) Star College scheme since 2014 and elevated to Star Status
Funded by the the Govt of Karnataka Vision Group for Science and Technology (VGST) project

SYLLABUS 2018-2021

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE
SYLLABUS -2018 -2021

CLASS	YEAR	SEMESTER	PAPERTITLE AND PAPERCODE	No of hrs /wk	No of hrs /sem	Credits
B.Sc	**I**	**I**	**BT 118**: Fundamentals of Biochemistry and Microbiology	4	60	4
		II	**BT 218:** Cell Biology and Genetics	4	60	4
B.Sc	**II**	**III**	**BT 318**: Molecular Biology and Biophysics	4	60	4
		IV	**BT 418**: Bio-Statistics	2	30	2
			BTOE 418: Biotechnology Now and Beyond	2	30	2
B.Sc	**III**	**V**	**BT 5118**: Immunology	3	45	3
		V	**BT 5218**: Genetic engineering and Bioinformatics	3	45	3
B.Sc	**III**	**VI**	**BT 6118**: Entrepreneurship, Industrial and Medical Biotechnology	3	45	3
		VI	**BT 6218**: Plant, Environmental and Animal Biotechnology	3	45	3

PRACTICAL

CLASS	YEAR	SEMESTER	PRACTICAL PAPER TITLE AND PAPER CODE	No of hrs /Wk	No of hrs /Sem	Credits
B.Sc	**I**	**I**	**BTP 118**: Techniques in Biochemistry and Microbiology	3	33	1.5
		II	**BTP 218:** Techniques in Cell Biology and Genetics	3	33	1.5
B.Sc	**II**	**III**	**BTP 318**: Techniques in Molecular Biology	3	33	1.5
		IV	**BTP 418**: Biostatistics	3	33	1.5
B.Sc	**III**	**V**	**BTP 5118**: Techniques in Immunology	3	33	1.5
		V	**BTP 5218**: Techniques in Genetic engineering and Bioinformatics	3	33	1.5
B.Sc	**III**	**VI**	**BTP 6118**: Industrial Biotechnology	3	33	1.5
		VI	**BTP 6218**: Project work	3	33	1.5

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

Semester	**I SEMESTER**
Paper code	**BT 118**
Paper Title	**Fundamentals of Biochemistry and Microbiology (30 + 30 hrs)**
Number of teaching hrs per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**4**

This paper 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 and estimation of biomolecules.

BIOCHEMISTRY ***30 hrs***

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-Carbohydrates **4 hrs**

Classification, structure of monosaccharides (trioses-PGA, DHAP, pentoses-Ribose, Deoxy-Ribose and hexoses-Glucose, Galactose, Fructose), Disaccharides-Sucrose, Maltose, Lactose and Polysaccharides-Starch, Glycogen, Occurrence and functions. 3 hrs

Active Learning: Blood glucose control-Role of insulin and glucagon, Glucose Uptake, Types of GLUT with functions 1 hr

UNIT 3-Proteins **7 hrs**

Classification and Structure of Amino acids, Zwitter ion concept, Isoelectric pH, Concept of pKa and Buffers 3 hrs

Levels of organization of proteins- Peptide Bond, Primary and secondary structure, Tertiary and quaternary structures, Denaturation. 2 hrs

Principles of extraction and purification of proteins – salt and solvent precipitation, Dialysis for protein purification. 1 hr

Active Learning-Classification of proteins based on structure, function and composition 1 hr

UNIT 4-Enzymes **5 hrs**

Classification – types and functions, enzyme units. Cofactors – types, examples (NAD, FAD) with functions. 1 hr

Active site, Role of tertiary structure; Specificity–absolute, stereo, group, Mechanisms of enzyme catalysis-Models: Lock and Key and Induced fit. 2 hrs

Concepts of Km and Vmax. Enzyme inhibition – competitive, uncompetitive and Non-competitive 2 hrs

UNIT 5-Lipids **5 hrs**

Classification, functions and biological role of lipids 2 hrs

Classification and Structure of fatty acids 1 hr

Properties of triacylglycerols and test for purity of lipids. 1 hr

Properties of phospholipids, sphingolipids, glycolipids, steroids and amphipathic lipids 1 hr

UNIT 6-Nucleic Acid **5 hrs**
Chemical composition, structures; nucleosides, nucleotides; Watson & Crick model,
Types of DNA – A, B and Z 3 hrs
Types of RNA with structure and functions 2 hrs

UNIT 7-Hormones **2 hrs**
Definition, Classification (Exo/Endo/Paracrine; Peptide/Steroid) with examples 1 hr
Hormones of the Hypothalamus, Anterior and Posterior Pituitary with target organs and functions; Nature of hormone-receptor interaction 1 hr

UNIT 8-Vitamins **1 hr**
Active learning-Classification, Sources, RDA, functions and deficiencies 1 hr

MICROBIOLOGY ***30 hrs***

UNIT 1-Microbiology-Then and Now **2 hrs**
Historical evolution of microbiology, Recent Advances

UNIT 2-Control of Microorganisms **4 hrs**
Control by physical agents, chemical agents, antibiotics and other chemotherapeutic agents.
Introduction to antibiotic resistance

UNIT 3-Taxonomy **4hrs**
Introduction to classification of bacteria (Bergey's Manual), GC Content and chemotaxonomy.
Basics of conventional and modern taxonomy 3 hrs
Active learning: Identifying the Bacteria from Bergey's manual. 1 hr

UNIT 4-Prokaryotic microorganisms **10 hrs**
Bacteria-Cell wall, Capsule, Flagella, Fimbriae, Pili, Plasmids, Endospore, Reserve food.
Characteristics of E.*coli* and Mycoplasma 5 hrs
Virus-Classification, T-Even structure, life cycle of bacteriophage lytic and lysogeny, Characteristics and epidemiology of HIV 5 hrs

UNIT 5-Eukaryotic microorganisms **5 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, Introduction to algal Biotechnology 3 hrs
Active learning: Searching algal specimen from your locality. 2 hrs

UNIT 6-Nutrition and growth **5 hrs**
Autotrophic and Heterotrophic bacteria, Growth phases, Synchronous growth, Arithmetic growth, continuous growth, measurement of growth. 4 hrs
Active learning- Bacteria in extreme environments. 1 hr

Reference
Principles of Biochemistry by Lehninger
Biochemistry by Stryer
Principles of biology by Brooker, Wiemaier Graham and Stiling
Microbiology by Pelczar
Microbiology by Frobisher

PRACTICAL I-30 hrs

BTP118: Techniques in Biochemistry and Microbiology

1. Preparation of media: NA, NB, PDA, and RBA
   Instruments: Microscope, Autoclave, Hot air oven, Laminar Air Flow, Incubator, Colony counter and pH meter
2. 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: Spread plate method
3. Study of colony characteristics of bacteria and fungi from air and water sample.
   Staining techniques using pure cultures isolated: Bacteria- Gram staining
4. Fungal staining – Lactophenol blue staining
5. Pure culture techniques: Streak plate (5 different types), preparation for Biochemical tests of cultures.
6. Introduction to molarity, molality and normality, Calculations for solution preparations. Instruments: Handling of colorimeter and spectrophotometer.
7. Estimation of proteins by Lowry's method/Biuret method.
8. Estimation of Reducing Sugars by DNS method.
9. Estimation of DNA by Diphenylamine method.
10. Estimation of RNA by Orcinol method.

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

Semester	**II SEMESTER**
Paper code	**BT 218**
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-Cell Structure **1 hr**
Cell Sizes, Prokaryotic and Eukaryotic cell structure

UNIT 2-Plasma Membrane **4 hrs**
Components of cell membranes: Phospholipids, Proteins, Carbohydrates and Cholesterol
Structure of the plasma membrane: Fluid Mosaic Model 1.5 hrs
Characteristics of cell membranes and Membrane transport 1.5 hrs
Active learning exercise*: Diffusion and Osmosis* 1 hr

UNIT 3-Nucleus and the Endomembrane System **6 hrs**
Structure of the nucleus: Nuclear envelope, Lamina, Nuclear Pore Complex 1.5 hrs
Packaging of DNA, Chromosomes 1 hr
Structure and function of the nucleolus 0.5 hr
The Endomembrane system and the organelles involved: The Secretory, Endocytic and Lysosomal pathways, Ribosomes, ER, Golgi and Lysosomes 3 hrs

UNIT 4-Mitochondria and Cell Energetics **5 hrs**
Structure of Mitochondria, Pathways of Energy Production, ATP and its structure 2 hrs
Cellular Respiration: Overview of Glycolysis, TCA cycle, Electron transport chain and Chemiosmotic coupling; Overall energy balance 3 hrs

UNIT 5-Chloroplast and Photosynthesis **6hrs**
Structure of the chloroplast, Photosynthetic pigments and Photosystems 1 hr
Light dependent reactions: Cyclic & non cyclic electron transport, photophosphorylation 2.5 hrs
Carbon Fixation: RubisCO, Calvin Cycle, Photorespiration, C3/C4/CAM plants 2.5 hrs

UNIT 6-Cytoskeleton and Cell Communication **2 hrs**
Structure and functions of microtubules, intermediate filaments and actin filaments

UNIT 7-Signal transduction **2 hrs**
General features of cell signaling and types of cell signaling, Signaling molecules and cellular receptors 1 hr
Signal transduction and Cellular response 1 hr

UNIT 8-The Cell Cycle **4 hrs**
Stages of the cell cycle: Events of the G1, S, G2 and M phases 1 hr
Cell cycle check points, Regulators of the cell cycle: Cyclins and CDKs 2 hrs
Active Learning exercise: Cancer and the cell cycle 1 hr

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; Recombination frequency, Two point test cross and three point test cross.

UNIT 4- Sex Determination, Sex Linkage and Pedigree Analysis **7 hrs**
Sex determination in animals and plants; Dosage compensation- Proof of the Lyon hypothesis, dosage compensation in Drosophila; Sex linkage Pedigree analysis-Penetrance and expressivity, family tree, dominant inheritance, recessive inheritance; Problems. 6 hrs

Active Learning: Sex linked genes in human beings-Hemophilia, colour blindness, the fragile X syndrome; Genes on X and Y chromosomes. 1 hr

UNIT 5- Population Genetics **2 hrs**
Theory of Allele frequencies (Gene and genotypic frequencies)-The Hardy-Weinberg principle, Speciation-Definition of species and mode of speciation (allopatric, sympatric) 1 hr
Active Learning: Gene pool, Application of the Hardy – Weinberg principle and Exceptions-Natural selection, Random genetic drift. 1 hr

UNIT 6- Chromosomal Aberrations **5 hrs**
Numerical chromosomal aberrations– Euploidy**,** polyploidy. Aneuploidy- Trisomy, monosomy, nullisomy, disomy, tetrasomy; **Structural chromosomal aberrations-** Deletions and Duplication of chromosome segments; Rearrangement of chromosome structure - inversion, translocation. 4 hrs
Active Learning: Procedure to detect aneuploidy in human fetuses; Examples of aneuploid humans. 1 hr

Reference

Cell biology:

2015 Principles of Biology, Edition 2, Brooker, Widmaier, Graham and Stiling
2002. Essential Cell Biology-Alberts, Garland science, 1998.
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
Fundamentals of Genetics, B.D. Singh, Kalyani Publishers

PRACTICAL II-30 HRS

BTP 218: Techniques in Cell biology and Genetics

1. Staining of Buccal mucosa for Barr bodies.
2. Blood grouping.
3. Introduction to mitosis and study of mitotic chromosomes.
4. Introduction to meiosis and study of meiotic chromosomes.
5. Introduction to Micrometry and measurement of cells-Onion cells/yeast cells.
6. Introduction to Hemocytometry and counting of yeast cells.
7. Karyotyping of the human chromosomes.
8. Isolation of chloroplast.
9. Culturing techniques, identification and handling of Drosophila melanogaster.
10. Preparation and Staining of salivary gland chromosomes in Drosophila.

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

Semester	**III SEMESTER**
Paper code	**BT 318**
Paper Title	**Molecular Biology and Biophysics (45 + 15 hrs)**
Number of teaching hrs per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**4**

This course deals with the fundamentals of Molecular Biology, gene expression and Biophysics. **Scope:** 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 DNA isolation. The topic in Biophysics gives insights to the Physics, chemical and computational aspects used in applications for biological studies.

MOLECULAR BIOLOGY ***45 hrs***

UNIT 1: DNA Structure and function **6 hrs**

Griffith's, Avery and Hershey - Chase experiments 1 hr
Active learning exercise: Analysis of data from classical experiments that led to the discovery of DNA structure 1 hr
The race to enumerate the structure of DNA,
Watson and Crick's model of the DNA double helix 2 hrs
DNA Compaction and Structure of eukaryotic chromosomes/eukaryotic gene 2 hrs

UNIT 2: DNA Replication **8hrs**

Semiconservative model of replication (Meselson & Stahl experiment),
Bidirectionality and semi-discontinuous nature of replication 2 hrs
Replication fork 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 2 hrs
Active learning exercise: PCR and molecular medicine 1 hr

UNIT 3: DNA Damage and repair **8 hrs**

Radiation Damage, DNA instability, Oxidative damage, Alkylation Damage 2 hrs
Introduction to mutagens, types of mutagens (chemical, physical and biological) 1 hr
Active learning exercise*:* Mutations and Cancer 1 hr
Photoreactivation, Excision Repair, Mismatch repair and SOS response 2 hrs
Non homologous end joining and Homologous recombination to repair
Double stranded DNA breaks 2 hrs

UNIT 4: Gene expression: Transcription **8 hrs**

Promoters, General Transcription factors, DNA binding domains 1 hr
Bacterial Transcription Initiation, Elongation and Termination 2 hrs
Eukaryotic RNA Polymerases, Promoters, Eukaryotic Transcription Initiation,
Elongation and Termination 2 hrs
Active learning exercise: Experimental techniques to study promoter activity 1 hr
Processing of eukaryotic mRNAs-Capping, Splicing and Polyadenylation 2 hrs

UNIT 5: Gene expression: Translation **8 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 2 hrs
Active learning exercise*:* Gene editing 1 hr
Post translational processing of proteins 1 hr

UNIT 6: Gene regulation **7 hrs**
Concept of regulation, overview of gene regulation 1 hr
Prokaryotic Gene Regulation-Lac and Trp operons 2 hrs
Eukaryotic Gene Regulation- Regulatory promoter elements, changes in chromatin structure and DNA methylation 2 hrs
Active learning exercise: Designing a gene circuit 1 hr
RNA interference in gene regulation 1 hr

BIOPHYSICS ***15 hrs***

UNIT 1: Microscopy **5 hrs**
Principle, design, resolution, numerical aperture and magnification of compound microscope.
Principle and design of Phase contrast and Fluorescence microscope. 3 hrs
Electron microscope- Principle and design of TEM and SEM. Specimen preparation for electron microscope. 2 hrs

UNIT 2: Analytical techniques **4 hrs**
Principles and applications of:
Chromatography (Paper, thin-layer, column, HPLC) 3 hrs
Centrifugation (rpm and g, Ultracentrifugation) 1 hr

UNIT 3: Spectroscopic techniques **3 hrs**
Principles and applications of: UV, visible spectroscopy, X-ray crystallography

UNIT 4: Isotopes **3 hrs**
Introduction, Types, their importance in biological studies, measure of radioactivity, GM counters & Scintillation counting

Reference
Molecular Biology:
Genes to Proteins, Burton E Tropp, Fourth Edition
Genomes 3.0, T.A Brown
Principles of Biology, Brooker, Widmaier, Graham and Stiling
Biophysics:
Essentials of Biophysics: P. Narayanan,
Biophysical Chemistry: Principles and Techniques: Upadhyay, Upadhyay and Nath

Practical III- 30 hrs

BTP318: Techniques in Genetic Engineering-I

1. Introduction to DNA Isolation and Discussion of Cheek cell DNA isolation (Protocol A)
2. Preparation of buffers and Cheek cell DNA Isolation
3. Agarose Gel electrophoresis
4. Presentation of DNA isolation protocol B by students groups and calculations
5. Calculations and preparation of buffers for protocol B
6. DNA isolation by student groups using Protocol B
7. Analysis/Comparison of DNA quality and concentration, Agarose gel electrophoresis
8. Understanding Protein Structure and SDS PAGE
9. Extraction of total protein from dal / lentil samples
10. SDS PAGE

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

Semester	**IV SEMESTER**
Paper code	**BT 418**
Paper Title	**Biostatistics**
Number of teaching hrs per week	**2**
Total number of teaching hrs per semester	**30**
Number of credits	**2**

This course paper is 30hrs of component in Biostatistics**.**

Scope: Data and statistics are an integral part of biology due to their necessity for appropriate experimental design, testing hypothesis, and drawing accurate inferences. This course will teach students foundational concepts allowing them to use Biostatistics for the above purposes. The lab component will give students hands-on experience in using software for statistical analyses.

BIOSTATISTICS ***30 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 **6 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 **3 hrs**
Correlation concept and applications; Regression concept and applications

UNIT 7-Hypothesis Testing **6 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

Reference
Principles of Biostatistics By Rosner
Biostatistics by Khan and Khanum

Practical IV-30 Hrs
BTP418: Biostatistics

1. Sampling, collecting, and documenting data
2. Visualization of data, relation between variables and plotting data by hand.
3. Introduction to software
4. Central tendencies and measures of dispersion
5. Basics of probability
6. Distributions I – Normal distribution
7. Distributions II– Binomial and Poisson distribution
8. Correlation and Regression
9. Hypothesis testing, Student's t-test, Chi-squared test and ANOVA.
10. Integration of various methods and tools.

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

Semester	**IV SEMESTER**
Paper code	**BT OE 418B**
Paper Title	**Biotechnology Now and Beyond (45 + 15 hrs)**
Number of teaching hrs per week	**2**
Total number of teaching hrs per semester	**30**
Number of credits	**2**

The paper is offered by the department in the CBCS component for all students other than Life science combinations.

BIOTECHNOLOGY: NOW AND BEYOND	***30 hrs***
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-	
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:	**4 hrs**
Databases	1 hr
Sequencing	2 hrs
Human genome project	1 hr
UNIT 7- Biotechnology in the media:	**2 hrs**
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	1 hr
Bt Cotton scenario in India	1 hr
UNIT 10 - Pharmacovigilance - Pharmacovigilance 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: Will be provided in class for each section.

DEPARTMENT OF BIOTECHNOLOGY
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Semester	**V SEMESTER**
Paper code	**BT 5118**
Paper Title	**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 in-depth 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 1.5 hrs
Collaboration between innate and adaptive immunity 0.5 hr
Organs involved - Central lymphoid organs — bone marrow, thymus 1 hr
Peripheral lymphoid tissues — spleen, lymph nodes, GALT and MALT 2 hrs

UNIT 2-Immunoreactive Cells: **4 hrs**

Introduction to Macrophages, Granulocytes, NK Cells 1 hr
T cells — Markers, Functions of T cell subsets — TH, CTLs — mode of action, TR. 1 hr
B cells — Markers, ontogeny, heterogeneity; Activation, B cell differentiation-Memory B cells, Plasma cells 2 hrs

UNIT 3-Antigens: **2 hrs**

Kinds of Antigens, Epitopes and paratopes, Factors affecting immunogenicity

UNIT 4-Immunoglobulins: **5 hrs**

Elucidation of Immunoglobulin structure, Structure and functions of immunoglobulins-IgA, IgM, IgD, IgG, IgE 3 hrs
Isotypes, Allotypes, Idiotypes, Ig Receptors 1 hr
Active learning-Description and raising of polyclonal and monoclonal antibodies 1 hr

UNIT 5-Immunogenes: **4 hrs**

Germline vs Somatic mutation theory, Dryer-Bennet experiments 1 hr
Tonegawa's experiment, Class switching 1 hr
Immunogene structure, Generation of antibody diversity- combinatorial, junctional 2 hrs

UNIT 6-Antigen-Antibody Interactions **2 hrs**

Antigen and Antibody interactions — forces involved, affinity and avidity 1 hr
Active learning-Precipitation and Agglutination 1 hr

UNIT 7-Complement system: **3 hrs**
Description of trigger and proteins involved 1 hr
Classical pathway 1 hr
MBL and Alternate pathway, terminal pathway 1 hr

UNIT 8-Major Histocompatibility Complex: **2 hrs**
Structure of MHC I and MHC II molecules 1 hr
Cellular distribution of MHC molecules, role in immune responsiveness, disease 1 hr

UNIT 9-Antigen Processing and Presentation: **3 hrs**
Self-restriction of T cells, Types and Function of Antigen Presenting cells 1 hr
Antigen Processing Pathways- Endocytic and Endogenous Processing Pathways 2 hrs

UNIT 10-Humoral Immunity: **4 hrs**
Primary and secondary response, Role of immunoglobulins in immunity 1 hr
Theories of Antibody production—Instructive theory and Selective theory 1 hr
Somatic hypermutation, Affinity Maturation, Class Switch recombination 2 hrs

UNIT 11- Cell Mediated Immunity: **3 hrs**
Mechanism of cell mediated toxicity, Perforin and Granzyme pathway 2 hrs
Death receptor ligand pathway, ADCC 1 hr

UNIT 12-Immunotolerance: **3 hrs**
Central Tolerance, Peripheral tolerance, Tolerance induction

UNIT 13- Hypersensitivity: **4 hrs**
Characteristics and types 1 hr
Type I — Cells involved, Factors, Diagnosis, Treatment 1 hr
Type II - Types, reasons, Type III, Type IV 2 hrs

UNIT 14-Autoimmune Diseases: **1 hr**
Active learning- Introduction, Factors - Natural, genetic predisposition, Environmental factors, with an example

Reference

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 V-30 hrs

BTP 5118: Methods in Immunology

1. Introduction to blood cells and preparation of blood smear-differential staining.
2. Immunodiffusions- SRID and Rocket immunoelectrophoresis
3. ODD titration and pattern
4. Virtual lab- B cell maturation
5. Immunohistochemistry
6. Agglutination tests- VDRL and WIDAL test
7. Enzyme linked immunosorbant assay (ELISA)
8. Isolation of IgG from eggs
9. Purification of IgG from eggs
10. SDS PAGE of IgG

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

Semester	**V SEMESTER**
Paper code	**BT 5218**
Paper Title	**Genetic engineering and Bioinformatics (30+15 hrs)**
Number of teaching hrs per week	**3**
Total number of teaching hrs per semester	**45**
Number of credits	**3**

Scope: This course gives the student a core understanding of principles and techniques of genetic engineering. In addition, it introduces the discipline of Bioinformatics and gives an understanding of the topics and techniques of bioinformatics commonly used by biologists. The practical component exposes students to a series of experiments involved in a simple genetic engineering task. The bioinformatics practical gives a hands-on experience of the commonly performed analysis of biological data.

GENETIC ENGINEERING ***30 hrs***

UNIT 1- Introduction **1 hr**

Principles of Recombinant DNA Technology & Genetic Engineering techniques (in brief), applications, goals, and ethical issues.

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

Methodology, Advantages and Disadvantages of the following methods of transformation: Competence-Induction, Biolistics, Lipofection, Electroporation, Microinjection, Macroinjection, Silicon carbide fibre vortex, DNA co-precipitation, Sonication, Ultrasonication, Laser Induced, *Agrobacterium* mediated.

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

Restriction Endonucleases and restriction mapping 3 hrs
DNA ligase, Alkaline Phosphatase, Polynucleotide kinase, Terminal transferases, S1 nuclease, Linkers and Adapters,
Polymerases-Klenow fragment, Pol I, *Taq* polymerase, Reverse transcriptase 3 hrs

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

Natural plasmids, PBR322 and PuC19: Design and Advantages. 2 hrs
Cloning Vectors based on bacterial plasmids 3 hrs
Scheme of cloning-restriction, ligation, Lambda Bacteriophages- Insertional vectors and Replacement vectors- features and design. 2 hrs
M13 Bacteriophage- features and designs 1 hr
Cosmids and Phagemids - definition, features, design with examples 1 hr
List of vectors for cloning in Yeasts (*S. cerevesiae*, *P.pastoris)*- features with examples 1 hr
YAC- features and designs 1 hr

UNIT 5- Techniques in cloning and gene analysis **3 hrs**

PCR, Genomic libraries and cDNA libraries, Introduction to molecular markers.
Active learning- Southern blotting

UNIT 6- Techniques related to Genomes **5 hrs**

Techniques of genome sequencing- Sanger, NGS, Nanopore 3 hrs
Applications of genomics 1 hr
Active learning- Genome editing by Crispr-Cas 1 hr

BIOINFORMATICS ***15 hrs***

UNIT 1- Introduction and applications **1 hr**
What is bioinformatics, connections to genes and genomes, applications in genomics, gene expression, protein structure, history of Bioinformatics

UNIT 2- Databases **3 hrs**
Gateway sites (NCBI, EMBL, DDBJ), concept and structure of a database, Examples- Genbank, Uniprot, NCBI Genomes, PDB

UNIT 3- Analysis of sequences **6 hrs**
Similarity searching, global and local alignments; BLAST- concept and applications, algorithm (scoring matrices, penalties etc.), output and interpretation (E-value); Multiple Sequence Alignment (MSA)- concept and applications, CLUSTAL, output and interpretation

UNIT 4- Phylogenetic analysis **2 hrs**
Concept of a phylogeny, connection between MSA and phylogenies (neighbor joining method), **Active learning**-basics of ancestral sequence/trait mapping

UNIT 5- Structure databases **2 hrs**
Protein structure database (PDB)- data format, major features of protein structure, basic principles of docking, principles of homology modeling

UNIT 6- Literature search and Pubmed **1 hr**
Citations, references, and literature search, Pubmed

Reference:
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
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.

Bioinformatics:
Introduction to bioinformatics by Sundararajan and Balaji
Bioinformatics by Murthy
Developing Bioinformatics computer skills by Cynthia Gibas and Per Jambeck O'reilly
Bioinformatics- concepts, skills, and applications, By S.C Rastogi, Namita Mendiratta and Parag Rastogi. CBS publisher
Introduction to Bioinformatics by Arthur M. Lesk. Oxford University Press
Bioinformatics-sequence and genome analysis by David W. Mount. CSH Lab Press

Practical VI- 30 hrs

BTP 5218: Techniques in Genetic Engineering II and Bioinformatics

1. Isolation of plasmid from an assigned organism
2.Single and double restriction digestion of the plasmid DNA (EcoR1, Hind III, BamHI) and its analysis by electrophoresis
3.Purification of an isolated fragment.
4.Amplification by PCR
5.Ligation of a fragment to a restricted vector
6.Preparation of competent cells
7.Transformation of ligated DNA
8.Bioinformatics- Genome Data Viewer, PubMed
9.Sequence analysis- BLAST and CLUSTAL Omega
10.Structure analysis tool- Rasmol

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

Semester	**VI SEMESTER**
Paper code	**BT 6118**
Paper Title	**Entrepreneurship, Industrial and Medical Biotechnology (3+27 +15 hrs)**
Number of teaching hrs per week	**3**
Total number of teaching hrs per semester	**45**
Number of credits	**3**

The course delves into the basic concepts of industrial biotechnology and medical biotechnology with a flavor of entrepreneurship towards these avenues.
Scope: The course introduces the students to microbial, enzyme and food biotechnology at the industry level. Medical biotechnology covers the epidemiological aspects of disease and the technological means to diagnose and treat them.

ENTERPRENEURSHIP ***3 hrs***
Introduction, Opportunity scouting, idea generation, business plan, developing a business model canvas

INDUSTRIAL BIOTECHNOLOGY ***27 hrs***

UNIT 1- Introduction: **1 hr**
Introduction to Industrial Biotechnology, Basic principles of fermentation technology

UNIT 2- Strain Improvement: **3 hrs**
Screening and Isolation of Microorganisms, Maintenance of strains, Improvement (Mutant selection, Recombinant DNA methods)

UNIT 3- Fermentation Media: **2 hrs**
Natural and Synthetic Media, Sterilization techniques – Heat, Radiation and Filtration methods

UNIT 4- Fermenters: **3 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: **3 hrs**
Down Stream Processing (DSP)- Disruption of cells, Separation, Extraction, Strategies for concentration and Purification of products

UNIT 7-Production of Microbial products: **9 hrs**
Brief account of the following products obtained by industrial productions 1 hr each
Alcoholic Beverage–Beer
Organic acid–Citric acid
Antibiotic –Penicillin
Amino acids–Glutamic acid
Vitamin–B12

Fermented Foods –Yoghurt and Cheese
Microbial Foods – Single cell proteins (SCP), **Active learning**-single cell oils (SCO)
Polysaccharides-Xanthan gum
Polyesters-Polyhydroxyalkanoates (PHA)

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 1 hr
Active learning- Steps involved in large scale production of enzymes 1 hr.

UNIT 9-Plant tissue culture: **2 hrs**
Introduction-Totipotency, Phytohormones and its role in invitro propagation;
basic lab requirements, Culture media 1 hr
Micropropagation - Collection, sterilization, preparation and inoculation of explants. 1 hr

MEDICAL BIOTECHNOLOGY ***15 hrs***

UNIT 1- Epidemiology: **2 hrs**
Introduction to epidemiological studies (terminology), Methods of disease transmission and disease cycles, reservoirs of infections, Portals of entry and exit of Pathogens
Epidemiology of Polio

UNIT 2- Pathology: **2 hrs**
Normal human microbiota, microbial colonization, microbial virulence, toxins, hydrolytic enzymes, capsule, adherence factors, invasiveness

UNIT 3- Immunotechnology and Diagnostics: **2 hrs**
Principle: ELISA, Western Blotting, Immunoflourescence, flow cytometry,
Assays: Proliferation assay (lymphocyte, MTT), Cell cytotoxicity, apoptosis

UNIT 4-Vaccines: **2 hrs**
Introduction to vaccines, Active and Passive Immunization 1 hr
Types of vaccines, note on hybrid and conjugate vaccines 1 hr

UNIT 5-Transplantation Biology: **3 hrs**
Antigens involved in graft rejection, Allorecognition — Direct and indirect 1 hr
Graft rejection - Role of APCs, Effector cells, Graft Vs Host Disease (GVHD) 1 hr
Immunosuppressive therapies — Induction Therapy and Maintenance therapy 1 hr

UNIT 6: Cancer Biology: **4 hrs**
Introduction, factors of predisposition, tumour classification, diagnosis (IHC)
Treatment {Monoclonal Antibodies, Non-specific Immunotherapies,
Oncolytic Virus Therapy, **Active learning**-T-cell therapy (CAR-T), and prevention (Cancer Vaccines)}

Reference:

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

Medical Biotechnology

Patrick R Murray, Ken S Rosenthal and Michael A Pfaller (2016) Medical Mircrobiology. Elsevier
Prathiba Nallari and V Venugopal Rao (2010) Medical Biotechnology. Oxford University Press.
Weinberg R A (2007) The Biology of Cancer. Garland Science

Practical VII- 30 hrs

BTP 6118: Industrial Biotechnology

1. Preparation and maintenance of algal and fungal cultures.
2. Preparation of media for plant tissue culture, production of mushrooms
3. Inoculation and incubation of explants
4. Principle and handling of a bioreactor
5. Production of Wine and Estimation of alcohol by specific gravity method.
6. Isolation and culturing of microbes for antibiotic sensitivity test
7. Immobilization of yeast
8. Estimation of citric acid from *Aspergillus niger*
9. Estimation of Lactic acid and Lactose
10. Workshop/Industrial visit-Medical Biotechnology

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

Semester	**VI SEMESTER**
Paper code	**BT 6218**
Paper Title	**Plant, Environmental and Animal Biotechnology (15+15+15 hrs)**
Number of teaching hrs per week	**3**
Total number of teaching hrs per semester	**45**
Number of credits	**3**

This course deals with the application of biotechnology in utilizing plants and animals for bettering human life. The course also introduces the concept of green environment technologies and an insight into the techniques of reclaiming lost air, soil and water health.

Scope: It aims to introduce and familiarize concepts, principles and practices in plant, animal and environmental biotechnology. The practical sessions encompass a project that would answer pertinent questions in the above fields. The exercise provides hands-on experience to formulate research problems, design and conduct experiments as well as draw scientific inferences from the results.

PLANT BIOTECHNOLOGY ***15 hrs***

Unit 1: Plants for Food, Fuel, Feed and Fibre **2 hrs**

Statistics on population, food security etc., Challenges for Agriculture 1 hr

Impact of Biotechnology on Global Agriculture and Sustainability 1 hr

Unit 2: Generation of transgenic plants **3 hrs**

Gene discovery and analysis, plant transformation vectors 1 hr

A transgenic construct: Promoters, terminators, selectable markers, reporter genes 1 hr

Plant transformation techniques- Particle gun method (Rice), *Agrobacterium* mediated Transformation (Tobacco) 1 hr

Unit 3: Transgenic plants **6 hrs**

Herbicide tolerant, Insect resistant and Abiotic stress tolerant transgenic crop plants: Strategies, Case studies 4 hrs

The GM crop debate: Safety, ethics, social perception & acceptance of GM crops 2 hrs

Unit 4: Molecular Pharming **2 hrs**

Plants as host systems for molecular pharming of industrial proteins/ enzymes, therapeutic/ pharmaceutical proteins, edible vaccines etc. Case studies.

Unit 5: Plant secondary metabolites **2 hrs**

Classification and roles of plant secondary metabolites: terpenoids, alkaloids, flavonoids, glycosides, phenolics 1 hr

Active learning- Applications of secondary metabolites, Metabolic engineering 1 hr

ENVIRONMENTAL BIOTECHNOLOGY ***15 hrs***

Unit 1: Air, Water and soil health **2 hrs**

Introduction: Physical, Chemical and biological properties of air, water and soil, Concepts of cleaner bioprocesses, eco-efficiency. 5-R policy. Case studies from Bangalore

Unit 2: Environmental genomics **2 hrs**
Methods (e-DNA, sequencing from environmental samples), Assessment of Biodiversity, Indicator species

Unit 3: Bioremediation **3 hrs**
Introduction, Types (*In situ*, *Ex situ*), Techniques- Bioaugmentation, Biofilters, Bioreactors, Biostimulation, Bioventing, Composting. Examples of organisms used in Bioremediation

Unit 4: Sewage and wastewater treatment **2 hrs**
Overview of sewage treatment processes, Levels of sewage treatment, Anoxic and aerobic secondary treatment processes. Case studies: Strain Improvement

Unit 5: Biocontrol (Biological insecticides) **2 hrs**
NPV, *Bacillus thuringiensis, B. sphaericus, Baculovirus*

Unit 6: Clean energy **2 hrs**
Biofuels: Bioethanol, Biogas, **Active learning**-Clean Energy Initiatives in Karnataka.

Unit 7: Biosensors **2 hrs**
Introduction to environmental Biosensors: biosensors used in detection of heavy metals, nitrogen compounds, pesticides and herbicides

ANIMAL BIOTECHNOLOGY ***15 hrs***

UNIT 1-Introduction to Cell Culture and Cell Lines: **3 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 media components, 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**
Concept of Transgene, Transgenic organism and clones 1 hr
Transfection: Examples involving microinjection and use of Retroviral vectors 2 hrs
Clone and Nuclear transfer (Dolly) 1 hr
Animal models for studying diseases (Cancer as an example) 1 hr

UNIT 3-Expression of mammalian genes: **6 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, Knock out Mice concept and their application in research 2 hrs
Transgenic Cattle, Transgenic Fish 1 hr
Active learning-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, preclinical and clinical trials.
(Take any one product as an example)

Reference:

Plant biotechnology:

Plant Biotechnology- Adrian Slater, Nigel Scott and Mark Fowler, Oxford University Press
Metabolic engineering of plant secondary metabolism, Verpoorte and Alferman, 2000

Environmental biotechnology:

Textbook of Environmental Biotechnology – P K Mohapatra
Environmental Biotechnology – Vallero Daniel
Environmental Biotechnology-New Approaches and Prospective Applications- Marian Petre

Animal biotechnology:

Short Protocols in Molecular Biology, 4th Edn, Ed: Ausubel, Kingston, and Moore, 1999.
Culture of Animal Cells: A Manual of Basic Technique, 4th Edn, by 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.

Practical VIII-30 hrs

BTP6218: PROJECT LAB

Students are divided into small groups and do hands-on projects under the supervision of faculty members. Students plan and execute experiments. Projects are assessed as following:

Practical Internal Assessment:	15 marks
Final exam	15 marks
Project presentation	10 marks
Project report	10 marks