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 VGST, Government of Karnataka, Support grant
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UG Syllabus

2021-24

DEPARTMENT OF BIOTECHNOLOGY
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE
SYLLABUS -2021-24

CLASS	YEAR	SEMESTER	PAPERTITLE AND PAPERCODE	No of hrs /wk	No of hrs /sem	Credits
B.Sc	**I**	**I**	**BT 121**: Fundamentals of Biochemistry and Microbiology	4	60	4
		II	**BT 221:** Cell Biology and Genetics	4	60	4
B.Sc	**II**	**III**	**BT 321**: Molecular Biology and Biophysics	4	60	4
		IV	**BT 421**: Biostatistics	2	30	2
			BTOE 421:Biotechnology Now and Beyond	2	30	2
B.Sc	**III**	**V**	**BT 5121**: Immunology	3	45	3
		V	**BT 5221**: Genetic engineering and Bioinformatics	3	45	3
B.Sc	**III**	**VI**	**BT 6121**:Entrepreneurship, Industrial andMedical Biotechnology	3	45	3
		VI	**BT 6221**: 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 121**:Techniques in Biochemistry and Microbiology	3	33	1
		II	**BTP 221:** Techniques in Cell Biology and Genetics	3	33	1
B.Sc	**II**	**III**	**BTP 321**: Techniques in Molecular Biology	3	33	1
		IV	**BTP 421**: Biostatistics	3	33	1
B.Sc	**III**	**V**	**BTP 5121**: Techniques in Immunology	3	33	1
		V	**BTP 5221**:Techniques in Genetic engineering and Bioinformatics	3	33	1
B.Sc	**III**	**VI**	**BTP 6121**:Industrial Biotechnology	3	33	1
		VI	**BTP 6221**: Project work	3	33	1

Part B

B.Sc. CBB/CZBT CURRICULUM

Courses and course completion requirements	No. of credits
General English	12
Second language: Introductory Kannada/Kannada/ Hindi/ Sanskrit/ Tamil/ Additional English/French/German.	12
Biotechnology	34
Chemistry	34
Botany/Zoology	34
Open elective courses (non-professional)	6
Foundation courses	
Term paper	
Soft skills (IGNITORS)	
Human resource development (HRD)/Theology	
Outreach activity	
Extra and Co-curricular activities	

DEPARTMENT OF BIOTECHNOLOGY (UG)
(2021-2024)

Semester 1	Code Number	Title	No. of Hours of Instructions	Number of Hours of teaching per week	Number of credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT121	Fundamentals of Biochemistry and Microbiology	60	4	4	30	70	100
Practical	BTP121	Techniques in Biochemistry and Microbiology	30	3	1	15	35	50
Total Number of credits:					**5**			
Semester 2	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT221	Cell Biology and Genetics	60	4	4	30	70	100
Practical	BTP221	Techniques in Cell Biology and Genetics	30	3	1	15	35	50
Total Number of credits:					**5**			
Semester 3	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT321	Molecular Biology and Biophysics	60	4	4	30	70	100
Practical	BTP321	Techniques in Molecular Biology	30	3	1	15	35	50
Total Number of credits:					**5**			
Semester 4	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT421	Biostatistics	30	2	2	15	35	50
Practical	BTP421	Biostatistics	30	3	1	15	35	50
Total Number of credits:					**3**			
Semester 5	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of Credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT5121	Immunology	45	3	3	30	70	100
Practical	BTP5121	Methods in Immunology	30	3	1	15	35	50
Theory	BT5221	Genetic Engineering and Bioinformatics	45	3	3	30	70	100
Practical	BTP5221	Techniques in Genetic Engineering & Bioinformatics	30	3	1	15	35	50
Total Number of credits:					**8**			
Semester 6	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT6121	Entrepreneurship, Industrial and Medical	45	3	3	30	70	100

		Biotechnology						
Practical	BTP6121	Industrial Biotechnology	30	3	1	15	35	50
Theory	BT6221	Plant, Environmental and Animal Biotechnology	45	3	3	30	70	100
Practical	BTP6221	Project Lab	30	3	1	15	35	50
Total Number of credits:					**8**			

SUMMARY OF CREDITS IN BIOTECHNOLOGY

CORE COURSES (CC)	
Course Title	**Code Number**
Fundamentals of Biochemistry and Microbiology	BT 121
Cell Biology and Genetics	BT 221
Molecular Biology and Biophysics	BT 321
Biostatistics	BT 421
Immunology	BT 5121
Genetic Engineering and Bioinformatics	BT 5221
Entrepreneurship, Industrial and Medical Biotechnology	BT 6121
Plant, Environmental and Animal Biotechnology	BT 6221

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)	
Course Title	Code Number
GENERIC ELECTIVE COURSES (GSE)/ Can include open electives offered	
Course Title	Code Number
Biotechnology Now and Beyond	BTOE 4121
SKILL ENHANCEMENT COURSE (SEC)	
Course Title	Code Number
Research Based Learning	
The Art of Seeing and Observing	
VALUE ADDED COURSES (VAC)	
Course Title	Code Number
Plant phytochemical analysis	
Online courses offered or recommended by the department to be listed	
Course Title	Code Number

COURSE OUTCOMES AND COURSE CONTENT

Semester	**I**
Paper Code	**BT121**
Paper Title	**Fundamentals of Biochemistry & Microbiology**
Number of teaching hours per week	**04 + 03**
Total number of teaching hours per semester	**60**
Number of credits	**04 + 1**

Objective of the Paper:

This paper aims to introduce students to basic concepts in Biochemistry and Microbiology, with key emphasis on classification and functions of biochemical macromolecules and taxonomy and morphology of prokaryotic and eukaryotic microorganisms.

Scope: The course is tailored for undergraduate students and 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.

Syllabus: BT121: Fundamentals of Biochemistry and Microbiology (60 hours)

Unit	**Content**	**Teaching Hours**
BIOCHEMISTRY		**30 Hrs**
UNIT 1-Introduction	Biochemical evolution, Prebiotic reactions and molecules, advanced evolutionary theories.	1 hr
	Biochemical composition of living organisms, Role of matter in biological systems, Chemical bonds in biological systems	1 hr
UNIT 2- Carbohydrates	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	1hr
UNIT 3- Proteins	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	1hr

UNIT 4-Enzymes	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	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 Acids	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	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	Active learning-Classification, Sources, RDA, functions and deficiencies	1 hr
MICROBIOLOGY		**30 hrs**
UNIT 1- Then and Now	Historical evolution of microbiology, Recent Advances	2 hrs
UNIT 2 -Taxonomy	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 3-Prokaryotic microorganism	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	5hrs
UNIT 4-Eukaryotic microorganisms	Protozoa-general features, pathogenic protozoans, life cycle of plasmodium. General characteristics of *Fungi*, Introduction to *Yeast's* and its economic importance. General characteristics of *Algae* , Introduction to *Spirulina*	3 hrs
	Active learning: Searching algal specimen from your locality	2 hrs
UNIT 5-Nutrition and growth	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

UNIT 5-Control of Microorganisms	Control by physical agents, chemical agents, antibiotics and other chemotherapeutic agents. Introduction to antibiotic resistance	4 hrs

PRACTICAL I: BTP121: Techniques in Biochemistry and Microbiology (**30 hrs)**

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

COURSE OUTCOMES for BT121: Fundamentals of Biochemistry and Microbiology

After successful completion of the course, students will:

CO1	Gain an understanding of the structural organization, classifications and basic functions of biochemical macromolecules that form the basis of life.
CO2	Develop an appreciation of the diversity of the microbial world and understand the basic characteristics of Bacteria, Fungi, Algae and Viruses, besides techniques for the growth and control of different classes of microbes.
CO3	Understand the principles of extraction of major biomolecules, prepare solutions based on concentration concepts, and be able to colorimetrically estimate the concentrations of different biomolecules by preparation of standard graphs.
CO4	Be able to determine and calculate growth parameters in bacteria, understand the basis of molecular interactions and build on them, besides selecting and implementing microbial control methodologies for basic laboratory purposes.
CO5	Acquire competence to design and prepare different culture media, design

	methodology to isolate and culture microorganisms and have a good grasp of various techniques for identification of bacteria and fungi.

BLUEPRINT for BT121: Fundamentals of Biochemistry and Microbiology

Chapter No./Unit No.	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter
BIOCHEMISTRY		
1. Introduction	2	3
2. Carbohydrates	4	8
3. Proteins	7	13
4. Enzymes	5	8
5. Lipids	5	8
6. Nucleic Acid	5	8
7. Hormones	2	3
8. Vitamins	1	2
MICROBIOLOGY		
1. Microbiology then and now	2	3
2. Control of Microorganisms	4	8
3. Taxonomy	4	8
4. Prokaryotic microorganisms	10	18
5. Eukaryotic microorganisms	5	8
6. Nutrition and growth	5	8
Total marks excluding bonus questions		**70**
Total marks including bonus questions		**106**

COURSE OUTCOMES AND COURSE CONTENT

Semester	II
Paper Code	**BT221**
Paper Title	**Cell Biology and Genetics**
Number of teaching hours per week	**04 + 03**
Total number of teaching hours per semester	**60**
Number of credits	**04 + 1**

Objective of the Paper:

This course introduces students to the structural and functional foundations of prokaryotic and eukaryotic cells and teaches the basics of Mendelian and Population Genetics. The Cell Biology section deals with cellular and organellar structure and function, besides dealing with the molecular events in cell communication and the cell cycle. The Genetics section of the course deals exhaustively with Mendelian genetics and provides an introduction to population genetics.

Syllabus: BT221:Cell Biology and Genetics (60 hours)

Unit	Content	Teaching Hours
CELL BIOLOGY		**30 Hrs**
UNIT 1- Cell Structure	Cell Sizes, Prokaryotic and Eukaryotic cell structure	1 hr
UNIT 2- Plasma Membrane	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	Ultrastructure of the nucleus: Nuclear envelope, Lamina, Nuclear Pore Complex, Nucleolus and Chromatin	2 hrs
	Packaging of DNA, Chromosomes	1 hr
	The Endomembrane system and the organelles involved: The Secretory, Endocytic and Lysosomal pathways, Ribosomes, ER, Golgi and Lysosomes	3 hrs
UNIT 4-	Structure of Mitochondria, Pathways of Energy Production, ATP	2 hrs

Mitochondria and Cell Energetics	and its structure	
	Cellular Respiration: Overview of Glycolysis, TCA cycle, Electron transport chain and Chemiosmotic coupling; Overall energy balance	3 hrs
UNIT 5- Chloroplast and Photosynthesis	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 & Cell Communication	Structure and functions of microtubules, intermediate filaments and actin filaments	2 hrs
UNIT 7- Signal transduction	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	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	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.	4 hrs
UNIT 2- Extension of Mendelism	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	6 hrs
UNIT 3- Linkage and Crossing over	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	3 hrs
UNIT 4- Sex Determination, Sex Linkage and	Sex determination in animals and plants; Dosage compensation-Proof of the Lyon hypothesis, dosage compensation in Drosophila; Sex linkage Pedigree analysis-Penetrance and	6 hrs

Pedigree Analysis	expressivity, family tree, dominant inheritance, recessive inheritance; Problems.	
	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	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	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

PRACTICAL II: **BTP221:** Techniques in Cell Biology and Genetics (**30 hrs)**

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

COURSE OUTCOMES FOR BT221: CELL BIOLOGY AND GENETICS

After successful completion of the course, students will:

CO1	Gain a nuanced understanding of cellular architecture and diversity of prokaryotic and eukaryotic cells, as well as insights into the ultrastructure, and roles of cellular organelles in various cellular functions.
CO2	Develop a deeper appreciation for the complexity and intricacy of cellular structure and function, and be able to form cross disciplinary connections relevant to cell structure and function.
CO3	Have a profound understanding of concepts in classical genetics and its exceptions, as well as a basic knowledge of population genetics and applications of linkage in quantitative genetics.
CO4	Be able to perform a variety of laboratory techniques routinely used for counting, staining and visualizing cells, be able to prepare and identify stages in mitotic and meiotic slides and answer questions pertaining to karyotypes and model organisms.
CO5	Achieve competence in undergraduate level problem solving skills relevant to the disciplines of cell biology and genetics.

BLUEPRINT FOR BT221: CELL BIOLOGY AND MICROBIOLOGY

Chapter/Unit Number and Title	Number of Teaching Hours (as mentioned in the syllabus)	Maximum Marks for which Questions are to be framed from this chapter
CELL BIOLOGY		
1. Cell Structure	1	2
2. Plasma membrane	4	6
3. Nucleus and the Endomembrane System	6	11
4. Mitochondria and Cell Energetics	5	10
5. Chloroplast and Photosynthesis	6	10
6. Cytoskeleton and Cell Communication	2	4
7. Signal transduction	2	4
8. The Cell Cycle	4	6
GENETICS		
1. Mendelian Genetics	4	7
2. Extension of Mendelism	6	11
3. Linkage and Crossing over	3	5
4. Sex Determination, Sex Linkage and Pedigree Analysis	8	14
5. Population Genetics	3	5
6. Chromosomal Aberrations	6	11
Total marks excluding bonus questions		**70**

Total marks including bonus questions	**106**