ST JOSEPH'S UNIVERSITY, BENGALURU-27.

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

For Batch 2024-2027

(STATE EDUCATION POLICY)

SUMMARY OF CREDITS IN Biotechnology

DEPARTMENT OF BIOTECHNOLOGY (UG) (2024-2027)								
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	BT124	Introduction to Biomolecules and Microorganisms	45	03	03	40	60	100
Practical		Techniques in Biochemistry and Microbiology	33	03	02	25	25	50
Total Number of credits:			**05**					
Semester2	**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	BT224	Fundamentals of Cell Biology and Analytical Techniques	45	03	03	40	60	100
Practical		Techniques in Cell Biology	33	03	02	25	25	50
Total Number of credits:			**05**					

BIOTECHNOLOGY UG SYLLABUS-SEP-2024 onwards

Semester	**I**
Paper Code	**BT124**
Paper Title	**Introduction to Biomolecules and Microorganisms**
Number of Teaching Hours per week	**03 hours Theory and 03 hours Practical**
Number of Teaching hours per semester	**45**
Number of Credits	**3 + 2**

Objective of the Paper: This paper has two course subjects. The syllabus covers Biochemistry in both practical and theoretical aspects. It introduces biomolecules that are vital for understanding cell systems and thus providing the foundations of employing them in the industry. This paper also aims to introduce students to basic concepts in Microbiology, with key emphasis on instrumentation and analytical techniques used in microbial laboratories. The course also covers key concepts in antimicrobial agents and assessment of antimicrobial activity, besides providing opportunities for hands-on experiments involving isolation, culturing, control and study of microorganisms.

Content of Course: BT124: Introduction to Biomolecules and Microorganisms	
Biomolecules	**30Hrs**
Unit 1: Introduction	**2 hrs**
Introduction to Biochemical evolution, Prebiotic reactions and molecules, Urey Miller Experiment. Biochemical composition of living organisms, Role of matter in biological systems, Chemical bonds in biological systems.	1 hr 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. **Active Learning**: Blood glucose control-Role of insulin and glucagon, Glucose Uptake, Types of GLUT with functions	3 hrs (1 hr)
Unit 3: Proteins	**7 hrs**
Classification and Structure of Amino acids and proteins, Zwitter ion concept, Isoelectric pH, Concept of pKa and Buffers Levels of organization of proteins- Peptide Bond, Primary and secondary structure, Tertiary and quaternary structures, Denaturation. **Active Learning**- Analysis of Stable Structures of Proteins	4 hrs 2 hrs (1 hr)
Unit 4: Enzymes	**6 hrs**

Classification – types and functions, enzyme units. Factors affecting Enzyme Action. Cofactors – types, examples (NAD, FAD) with functions. Active site, Role of tertiary structure. Mechanisms of enzyme catalysis-Models: Lock and Key and Induced fit. Concepts of Km and Vmax. Enzyme inhibition – competitive, uncompetitive and Non-competitive	2 hr 2hrs 2hrs
Unit 5: Lipids	**5 hrs**
Classification, functions and biological role of lipids Classification and Structure of fatty acids Properties of phospholipids, sphingolipids, glycolipids, steroids, amphipathic lipids, cholesterol **Active Learning**: Properties of triacylglycerols and test for purity of lipids.	2 hrs 1 hr 1 hr (1 hr)
Unit 6: Nucleic Acid	**6 hrs**
Chemical composition, structures; nucleosides, nucleotides; Watson & Crick model, Types of DNA – A, B and Z Types of RNA (mRNA, tRNA) with structure and functions **Active Learning**: Discussion on the original paper of Watson and Crick	3 hrs 2hr (1 hr)
Introduction to Microorganisms	**15 hrs**
Unit 1: History of Microbiology	**1 Hr**
The past and present of Microbiology, Case study on HIV's evolutionary past	
UNIT 2-Prokaryotic microorganisms and Viruses	**5 Hrs**
Bacteria-Cell wall, Capsule, Flagella, Fimbriae, Pili, Plasmids, Endospore, Reserve food. Virus- General Characteristic, life cycle of bacteriophage -lytic and lysogeny Active Learning- Structure and lifecycle of viruses	2 hr 2 hr (1hr)
UNIT 3-Eukaryotic microorganisms	**2 Hrs**
General characteristics of Algae, Fungi and Protozoa	
Unit 4- Microbial growth and Control	**3 Hrs**
Microbial growth-Growth curve and kinetics Sterilization techniques- Definition of terms, Physical methods- Heat & radiation Chemical Methods- Alcohol, aldehydes, phenols, halogen, sterilizing gases as antimicrobial agents	1 hr 2 hrs
Unit 5- Antimicrobial agents and Microbial resistance	**4 hrs**
Mode of action of antimicrobial agents: Antifungal agents- Amphotericin B and Griseofulvin Antibacterial agents- Plazomicin and Imipenum Mechanism of multi-drug resistance **Active Learning:** Antiviral agents- Amantadine and Acyclovir	2 hrs 1 hr (1 hr)

Practical II: BTP124: Techniques in Biochemistry and Microbiology

1. Introduction to molarity, molality and normality, Calculations for solution preparations, Instruments: Handling of pipettes, burettes, colorimeter and spectrophotometer.
2. Estimation of Reducing Sugars by DNS method.
3. Estimation of protein by Biuret method.
4. Enzyme Analysis, Kinetics.

5. Handling and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology and Biotechnology laboratory.
6. Preparation of culture media for bacterial and fungal isolations, plate preparations and open air culture.
7. Colony characteristics study of bacteria and fungi from air exposure plate.
8. Bacteria– Gram staining Staining techniques, Fungi – Lacto-phenol cotton blue staining
9. Pure culturing techniques: Plating techniques and maintenance of individual cultures.
10. Biochemical Tests – IMViC, Starch hydrolysis, Catalase test, Gelatin hydrolysis, TSI agar and amylase production.

Text Books / References

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
10. Microbiology- Concepts and applications by Paul A. Ketchum, Wiley Publications
11. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications
12. Introductory Biotechnology-R.B Singh C.B.D. India (1990)
13. Fundamentals of Bacteriology - Salley
14. Frontiers in Microbial technology-P.S. Bison, CBS Publishers.
15. Biotechnology, International Trends of perspectives A. T. Bull, G.
16. General Microbiology –C.B. Powar
17. Principles of Biochemistry by Lehninger
18. Biochemistry by Stryer
19. Brooker, Wiemaier G, Stiling, Principles of Biology

Semester	**II**
Paper Code	**BT224**
Paper Title	**Fundamentals of Cell Biology and Analytical Techniques**
Number of Teaching Hours per week	**03 hours Theory and 03 hours Practical**
Number of Teaching hours per semester	**45**
Number of Credits	**3 + 2**

Objective of the Paper: This paper has been designed to expose students to a broad range of cell biological themes. The topics will be covered in depth, with references to the relevant techniques and disease implications. These will provide the students a firm handle of cell biological principles and the ability to understand and analyze diverse biological phenomenon.

Fundamentals of Cell Biology	30 Hrs
Unit 1: Cell biology basics	**2 hours**
Cell theory, cell size and volume, cellular organization Eukaryotes vs prokaryotes, compartmentalization.	1 hr 1 hr
Unit 2: Cell structure and function	**4 hours**
Introduction to eukaryotic cells, basics of cell organelles Nucleus, ER and Golgi complex, endomembrane system, mitochondria and chloroplast **Active Learning**: Endosymbiotic theory.	1 hr 2 hrs (1 hr)
Unit 3: Plasma membrane and transport	**4 hours**
Structure of the plasma membrane and associated proteins, membrane permeability Active and passive transport, facilitated diffusion and transport proteins, tonicity and osmoregulation	2 hrs 2 hrs
Unit 4: Cellular energetics	**4 hours**
Introduction to metabolism (anabolism and catabolism), ATP and reaction coupling, C3 and C4 cycles, overview of cellular respiration Oxidative phosphorylation and the electron transport chain, fermentation and anaerobic respiration **Active Learning**: Evolution of photosynthesis	2 hrs 1 hr (1 hr)

Unit 5: Cell communication	**5 hours**
Introduction to cell signaling and general principles Ligands and receptors, GPCR signaling (yeast mating type signaling), feedback and homeostasis Endocrine pathways and long- distance communication, HPA axis.	2 hrs 2 hrs 1 hr
Unit 6: Cell cycle and regulation	**5 hours**
Cell cycle overview, interphase and mitotic phases Cell cycle checkpoints and tumor suppressors Introduction to meiosis, synapsis and crossing-over **Active Learning**: Cell cycle dysregulation in cancer	1 hr 1 hr 2 hr (1 hr)
Unit 7: Cell cytoskeleton and tissue formation	**4 hours**
Filaments and tubules Organization of cytoskeletal elements Cell movement Plant cell wall **Active Learning**: Role of the extracellular matrix in tissue formation.	1 hr 1 hr 1 hr (1 hr)
Unit 8: Cell death	**3 hours**
Definition of life and death, accidental and programmed cell death Apoptosis: brief introduction and physiological importance Cell viability and tests for cell death.	1 hr 1 hr 1 hr
Analytical Techniques	**15 hours**
Unit 9: Basic principles	**2 hours**
Units of measurement, electrolytes and pH, quantitative biological measurements.	2 hrs
Unit 10: Cell disruption and centrifugation	**3 hours**
Methods of cell lysis: physical and chemical, Basic principle of sedimentation, types of centrifugation, preparative versus analytical centrifugation.	1 hr 2 hrs
Unit 11: Microscopy	**3 hours**
Light microscopy, magnification, numerical aperture, resolution Fluorescent proteins and live cell imaging, fluorescence microscopy Electron Microscopy	1 hr 1 hr 1 hr

Unit 12: Chromatography	**3 hours**
Principles of chromatography and performance parameters, adsorption and partition chromatography, size-exclusion chromatography, affinity chromatography **Active Learning**: High-performance liquid chromatography.	2 hrs (1 hr)
Unit 13: Electrophoresis	**2 hours**
Discussion on matrices, agarose electrophoresis, SDS and native PAGE	
Unit 14: Basics of spectroscopy	**2 hours**
Ultraviolet and visible light spectroscopy **Active Learning**: Fluorescence spectroscopy.	1 hr (1 hr)

Practical: BTP224: Techniques in Cell Biology

1) Calculation of cell number using a hemocytometer
2) Effect of cell size on diffusion using agarose gel.
3) Sedimentation: isolation of chloroplasts
4) Staining of mitochondria (Janus Green) in cheek cells.
5) Mitosis: Onion root tip
6) Meiosis: Anthers
7) Osmosis: RBC/yeast
8) Chromatography: TLC of amino acids
9) Micrometry
10) Electrophoresis: agarose gel electrophoresis of dyes

Reference text

Molecular Cell Biology, Eighth Edition, 2016, Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Angelika Amon; Kelsey C. Martin

Principles and techniques of Biochemistry and Molecular Biology, Seventh Edition, 2010 Keith Wilson and John Walker.