

RUNGTA INTERNATIONAL SKILLS UNIVERSITY
SCHOOL OF LIFE SCIENCES
Department of Biotechnology
MSc Biotechnology

Course Code	Course Title	L	T	P	C
RU-500-13-0005	Advanced Cell Biology	2	1	2	4
Pre-requisite	NIL	Syllabus version			
Certification Mapping		1.0			
Course Objectives					
It focuses on understanding cell theory, the structure and functions of prokaryotic and eukaryotic cells, and the role of organelles. It also covers cellular processes such as motility, cytoskeletal organization, the cell cycle, apoptosis, differentiation, immunity, stem cell biology, and cancer development.					
Course Outcomes					
At the end of this course students will be able to:					
<ol style="list-style-type: none"> 1. Explain the structural and functional organization of prokaryotic and eukaryotic cells, membranes, and organelles. 2. Demonstrate knowledge of membrane transport mechanisms, including pumps, carriers, channels, endocytosis, and exocytosis. 3. Analyze the role of organelles (nucleus, mitochondria, chloroplasts, ER, Golgi, lysosomes) in energy metabolism, genetic regulation, and biogenesis. 4. Evaluate the role of the cytoskeleton (microtubules, actin filaments, intermediate filaments) in cell shape, motility, and intracellular transport. 5. Interpret the regulatory mechanisms of the cell cycle, cell differentiation, apoptosis, and gametogenesis. 6. Apply the concepts of cell regulation and signaling to understand stem cell biology, immune responses, and the development of cancerous cells. 					
Unit 1	Introduction & Cell Diversity	7 hours			
Diversity of cell size and shape. Cell theory. Structure of Prokaryotic and Eukaryotic cells - Isolation and Growth of Cells. Membrane Structure and Function; Structural models; Composition and dynamics; Transport of ions and Macromolecules; Pumps, Carriers and Channels. Endo- and Exocytosis; Membrane Carbohydrates and their Significance Cellular organelles - Plasma membrane, Cell Wall, their Structural Organization. Cellular recognition; Cellular Junctions and Adhesions; Structure and Functional Significance of Plasmodesmata					
Unit 2	Cellular Organelles	7 hours			
Nucleus – Structure and function of Nuclear Envelope, Lamina and Nucleolus; Chromatin organization and Packaging. Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship; Mitochondrial DNA and male sterility; Origin and evolution. Chloroplast – Structure-function relationship; Chloroplast DNA and its significance; Chloroplast Biogenesis; Origin and Evolution					
Unit 3	Endomembrane System & Cellular Motility	7 hours			
Structure and function of Microbodies, Golgi Apparatus, Lysosomes and Endoplasmic Reticulum. Organization and role of Microtubules and Microfilaments; Cell Shape and					

Motility. Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.		
Unit 4	Cellular Regulation and Development	7 hours
Cell Cycle and control mechanisms: Cyclin-dependent Protein Kinases, Cyclin-Cdk Complexes. Cellular basis of Differentiation and Development - Gametogenesis and Fertilization. Programmed Cell Death (Apoptosis)		
Unit 5	Differentiation of Specialized Cells	7 hours
Stem cell differentiation; Blood cell formation; Fibroblasts and their Differentiation. Cellular basis of Immunity; Differentiation of cancerous cells and role of proto-oncogenes.		
Total Lecture hours:		35 hours
Text Book(s)		
<ol style="list-style-type: none"> Cell and Molecular Biology, by C.B. Powar, Himalaya Publishing House, 2025. Cell and Molecular Biology, by P.K. Gupta, Rastogi Publications, 2022. 		
Reference Book(s)		
<ol style="list-style-type: none"> Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, and Scott C. P. (W. H. Freeman, 8th edition, 2016) Cell and Molecular Biology: Concepts and Experiments by Gerald Karp (John Wiley & Sons, 8th edition, 2015) The Cell: A Molecular Approach by Cooper and Hausman (Sinauer Associates, 8th edition, 2019) 		

Tutorial Sheet – (Total: 12 Hours)
Summary Table

Unit	Hours	Key Focus
Unit 1	2 hrs	Cell theory, diversity of cell size/shape, prokaryotic & eukaryotic cells, membranes, transport, cell wall, junctions & adhesions
Unit 2	2 hrs	Nucleus (structure, chromatin, nucleolus), mitochondria (respiratory chain, ATP synthase, DNA, origin), chloroplasts (DNA, biogenesis, evolution)
Unit 3	2 hrs	Endomembrane system (ER, Golgi, lysosomes, microbodies), cytoskeleton (microtubules, actin, intermediate filaments), motility, molecular motors, ECM
Unit 4	2 hrs	Cell cycle regulation (cyclins, Cdks), differentiation & development (gametogenesis, fertilization), apoptosis
Unit 5	2 hrs	Stem cells, blood cell formation, fibroblast differentiation, immunity, cancer cells & proto-oncogenes

Unit-wise Tutorial Table

Unit	Topic	Activities	Hours
Unit 1	Introduction & Cell Diversity	Study cell theory, diversity of cell size/shape; structure of prokaryotic & eukaryotic cells; membrane structure, transport mechanisms; endo-/exocytosis; cell wall, junctions, adhesions, plasmodesmata	2 hrs
Unit 2	Cellular Organelles	Learn structure & function of nucleus, chromatin, nucleolus; mitochondria (respiratory chain, ATP synthase, DNA, origin & evolution); chloroplast (DNA, biogenesis, origin & evolution).	2 hrs
Unit 3	Endomembrane System & Cellular Motility	Analyze microbodies, Golgi, lysosomes, ER; study cytoskeletal elements (microtubules, actin, intermediate filaments); motility, molecular motors, extracellular matrix	2 hrs
Unit 4	Cellular Regulation & Development	Explore cell cycle regulation (cyclins, Cdks); programmed cell death (apoptosis); processes of gametogenesis, fertilization, and differentiation.	2 hrs
Unit 5	Differentiation of Specialized Cells & Applications	Understand stem cell differentiation; blood cell formation; fibroblast differentiation; cellular basis of immunity; cancer cell differentiation & proto-oncogenes.	2 hrs



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Course Code	Course Title	Contact Hours :
RU-500-13-0005	Advanced Cell Biology (Lab)	2
Lab Course Objectives		Credits : 1
<p>This course trains students in laboratory safety and equips them with practical skills in cell culture, staining, and slide preparation. It also focuses on microscopic examination of cellular structures and understanding cell division processes like mitosis and meiosis through experimental studies.</p>		
Laboratory Course Outcomes		
<p>After completion of the lab, students will be able to:</p> <ol style="list-style-type: none"> 1. Demonstrate safe handling of laboratory equipment and adherence to laboratory rules. 2. Perform bacterial culture and staining techniques to study microbial cells. 3. Prepare and examine temporary slides of plant cells (onion peel) under a microscope. 4. Prepare and examine temporary slides of human cheek epithelial cells. 5. Identify different types of cells present in a leaf sample. 6. Prepare and analyze mitotic stages from onion root tip squashes. 7. Calculate and interpret the abnormal mitotic index in onion root tip cells. 8. Prepare and analyze meiotic stages from young anthers of <i>Allium cepa</i>. 9. Determine and evaluate the meiotic index in flower buds of <i>Allium cepa</i>. 		

List of practicals:

Unit/Lab	Topic/Exercise
Unit 1:	Introduction & Cell Diversity
Lab 1	Demonstration of laboratory safety rules, tools, and handling of equipment in biotechnology laboratory
Lab 2	Perform bacterial cell culture and staining
Unit 2:	Cellular Organelles
Lab 3	Preparation of temporary stained slide of onion peel cells (plant cell study)
Lab 4	Preparation of temporary stained slide of cheek squamous epithelial cells (animal cell study)
Unit 3:	Endomembrane System & Cellular Motility
Lab 5	Identification of different types of cells in leaf samples
Lab 6	Preparation and study of mitotic stages from onion root tip squash
Unit 4:	Cellular Regulation and Development
Lab 7	Determination of abnormal mitotic index from onion root tip cell.
Lab 8	Preparation and study of meiotic stages from young anthers of <i>Allium cepa</i>
Unit 5:	Differentiation of Specialized Cells
Lab 9	Determination of meiotic index in flower buds of <i>Allium cepa</i>

Reference Books for Lab Practice:

- **"Cell and Molecular Biology"** by C.B. Powar, Himalaya Publishing House (2025 Edition)
- **"Cell and Molecular Biology"** by P.K. Gupta, Rastogi Publications (2022 Edition)
- **"Molecular Cell Biology"** by Harvey Lodish et al., W.H. Freeman (8th Edition, 2016)
- **"Cell and Molecular Biology: Concepts and Experiments"** by Gerald Karp, John Wiley & Sons (8th Edition, 2015)
- **"The Cell: A Molecular Approach"** by Geoffrey M. Cooper and Robert E. Hausman, Sinauer Associates (8th Edition, 2019)

NOTE : One mini project is compulsory. Students must select and implement any one project from the list given below.

S.No.	Project Title	Objective	Tech Stack	Expected Outcome
1	Cell Counting & Analysis	Program/lab exercise to count and categorize different cell types in a sample	-Count cells in slides - Identify plant vs animal cells - Calculate percentages	Microscope, Slides, Stains, Image Analysis Software
2	Mitotic Index Calculation	Determine mitotic index from onion root tip cells	- Prepare slides - Count dividing vs total cells - Calculate mitotic index	Microscope, Stains, Counter
3	Meiotic Index Calculation	Study meiotic stages and calculate meiotic index in flower buds	- Identify meiotic stages - Calculate meiotic index - Graph results	Microscope, Stains, Slides
4	Cell Type Identification	Identify different cell types in plant and animal tissues	- Prepare stained slides - Identify cell structures - Record observations.	Microscope, Stains, Slides
5	Bacterial Culture Observation	Observe growth patterns of bacterial cultures	- Culture bacteria - Observe colony morphology - Document results	Laminar Airflow, Incubator, Stains

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Course Code	Course Title	L	T	P	C
RU-500-13-0006	Biomolecules	2	1	2	4
Pre-requisite	NIL	Syllabus version			
Certification Mapping		1.0			
Course Objectives					
The objectives of biochemistry and molecular biology are to study the structure, classification, and functions of biomolecules, enzymes, nucleic acids, and key metabolic pathways, along with their roles in cellular processes. They also highlight the contributions of scientists and provide insights into modern trends like nanotechnology, biosensing, and biomolecular simulations.					
Course Outcomes					
At the end of this course students will be able to:					
<ol style="list-style-type: none"> 1. Students will be able to explain the structure, classification, and metabolic pathways of major biomolecules. 2. Students will understand the contributions of Indian and global scientists in the development of biochemistry. 3. Students will demonstrate knowledge of enzyme kinetics, inhibition, and hormonal regulation 4. Students will be able to describe the structure, synthesis, and functions of nucleic acids and chromosomes. 5. Students will gain practical skills in qualitative and quantitative biochemical testing and chromatography. 6. Students will be able to relate modern trends like nanotechnology and biomolecular simulation to biological applications. 					
Unit 1	Introduction to Chemical foundation of Biology	8 hours			
<ol style="list-style-type: none"> 1. Biomolecules, general concept, history, principles of thermodynamics and analytical techniques used in biochemistry. 2. Indian Scientists and Indian Knowledge System- Kamala Sohonie, Bires Chandra Guha, Har Gobind Khorana, Darshan Ranganathan, Manju Ray & G.N. Ramachandran. 3. Other Scientists and Their Contributions- Francis Crick, Luis Federico Leloir, James D. Watson, Paul D. Boyer Etc. 4. Future Trends- Nanotechnology and Biosensing, Biomolecular Simulation, Bio-based Materials for Tissue Engineering 					
Unit 2	Structure and function of Carbohydrates	7 hours			
<ol style="list-style-type: none"> 1. Carbohydrates: Classification, Structure (Stereochemistry, Epimers, and Properties of Mono-Saccharides (Pentose & Hexose), Oligosaccharides and Polysaccharides (Glycogen & Cellulose). 2. Metabolism Of Sugar- Glycolysis, Glycogenolysis, Glycogenesis, Gluconeogenesis, Glyoxalate Cycle, Kreb Cycle and Electron Transport Chain. 					
Unit 3	Amino acids & Proteins	7hours			

<ol style="list-style-type: none"> 1. Amino Acids and Peptides- Classification, Chemical Reaction, Physical and Chemical Properties. 2. Proteins- Classification, Hierarchy in Structure, Separation, Purification, and End Group Analysis, Ramachandran Map. 3. Metabolism of Proteins- Deamination and Decarboxylation of Protein and Urea Cycle 		
Unit 4	Enzymes and Hormones	7 hours
<ol style="list-style-type: none"> 1. Enzymes- Classification, Co-Enzymes and Their Role, 2. Enzyme Kinetics and Enzyme Inhibition Allosteric Enzyme and Isoenzyme. 3. Hormones- Classification of Hormones: Group I and Group II Hormones, Properties and Function. 		
Unit 5	Lipids and Nucleic Acids	8 hours
<ol style="list-style-type: none"> 1. Lipids- Classification, Structure and Function. 2. Metabolism of Lipids- α, β and Omega Fatty Acid Oxidation. 3. Nucleic Acid- Purines, Pyrimidine, Nucleoside & Nucleotide, Ribose & Pentose Sugar types of Nucleic Acid RNA DNA And Their Structure, Synthesis- Denovo & Salvage Pathway. 		
Total Lecture hours:		37 hours
Text Book(s)		
<ol style="list-style-type: none"> 1. Biochemistry by U. Satyanarayan, 6th Edition, Elsevier (2023). 2. A.C Deb, Fundamentals of Biochemistry, 9th Edition, New Central Book Agency (2001). 3. Todd and Howards Mason- Textbook of Biochemistry, 4th Edition, (2004). 		
Reference Book(s)		
<ol style="list-style-type: none"> 1. Nelson and Cox- Principle of Biochemistry, 5th Edition (2009). 2. Albert L. Lehninger- Biochemistry, 2nd Edition (2005). 3. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition, Wiley (2006). 		

Tutorial Sheet – (Total: 12 Hours)

Summary Table

Unit	Hours	Key Focus
Unit 1	2 hrs	Buffer preparation and role in pH maintenance
Unit 2	2 hrs	Tests for carbohydrates; estimation of carbohydrates; tests for amino acids
Unit 3	2 hrs	Protein estimation; amino acid chromatography; effect of temperature on amylase
Unit 4	2 hrs	Enzyme activity studies; hormonal effects (qualitative/conceptual)
Unit 5	2 hrs	Lipid tests; DNA/RNA extraction and analysis; mini-project work

Unit-wise Tutorial Table

Unit	Topic	Activities	Hours
Unit 1	Introduction to Chemical foundation of Biology	Preparation and standardization of buffer solutions; demonstration of their role in maintaining pH during biochemical reactions.	2 hrs
Unit 2	Structure and function of Carbohydrates	Qualitative tests for carbohydrates (Molisch's, Anthrone, Barfoed's); quantitative estimation of carbohydrates; qualitative tests for amino acids (Millon's & Ninhydrin).	2 hrs
Unit 3	Amino acids & Proteins	Protein estimation using Folin-Lowry/Bradford method; separation of amino acids by paper/TLC chromatography; effect of temperature on amylase activity.	2 hrs
Unit 4	Enzymes and Hormones	Qualitative tests for lipids (Sudan III, saponification, etc.); demonstration of lipid properties and functions.	2 hrs
Unit 5	Lipids and Nucleic Acids	Extraction and qualitative analysis of DNA/RNA; mini-project: biochemical analysis and result interpretation.	2 hrs

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Course Code	Course Title	Contact Hours:
RU-500-13-0006	Biomolecules (Lab)	4
Credits: 2		
Lab Course Objectives		
The experiments involve preparing buffer solutions to study their role in maintaining pH, performing tests for carbohydrates, proteins, amino acids, and lipids, and analyzing enzyme activity by observing the effect of temperature on amylase. Additionally, amino acids are separated and identified using chromatographic techniques.		
Laboratory Course Outcomes		
After completion of the lab, students will be able to:		
<ol style="list-style-type: none"> 1. Prepare and standardize buffer solutions, demonstrating understanding of pH and its role in biochemical systems. 2. Perform qualitative tests to identify carbohydrates using Molisch's, Anthrone, and Barfoed's tests. 3. Quantitatively estimate carbohydrates using Benedict's test and interpret results accurately. 4. Conduct qualitative tests for amino acids using Millon's test and Ninhydrin reaction. 5. Estimate protein concentration using spectrophotometric methods such as Folin-Lowry or Bradford assay. 6. Separate and identify amino acids through paper or thin-layer chromatography techniques. 7. Assess enzyme activity by investigating the effect of temperature on amylase function 8. Perform qualitative tests for lipids and interpret the biochemical significance of results. 9. Demonstrate laboratory ethics, safety practices, teamwork, and effective communication in documenting and reporting experiments. 		

List of Practicals:

Unit/Lab	Topic/Exercise
Unit 1	Introduction to Chemical foundation of Biology
Lab 1	Preparation and standardization of buffer solutions.
Unit 2	Structure and function of Carbohydrates
Lab 2	Molisch's, Anthrone, and Barfoed's test for carbohydrates
Lab 3	Quantitative estimation of carbohydrates (Benedict's test)
Lab 4	Qualitative test for amino acids: Millon's & Ninhydrin reactions
Unit 3:	Amino Acids and Proteins
Lab 5	Protein estimation using Folin-Lowry/Bradford method

Lab 6	Amino acid separation by paper/TLC chromatography
Lab 7	Effect of temperature on amylase enzyme activity
Unit : 4	Enzymes and Hormones
Lab 8	Qualitative tests for lipids (e.g., Sudan III, saponification)
Unit 5:	Lipids and Nucleic Acids
Lab 9	Mini-project: biochemical analysis and result interpretation

Reference Books for Lab Practice:

- *Biochemistry* by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer (Latest Edition)
- *Lehninger Principles of Biochemistry* by David L. Nelson and Michael M. Cox (Latest Edition)
- *Biochemistry* by Donald Voet and Judith G. Voet (Latest Edition)
- *Practical Biochemistry: Principles and Techniques* by Keith Wilson and John Walker (Latest Edition)
- *Harper's Illustrated Biochemistry* by Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil (Latest Edition)

NOTE: One mini project is compulsory. Students must select and implement any one project from the list given below.

S.No.	Project Title	Objective	Tech Stack	Expected Outcome
1	Protein Estimation Analyzer	Estimate protein concentration in unknown samples	Spectrophotometer, Lab instruments	Use spectrophotometry methods (Bradford/Folin-Lowry) - Generate report
2	Biochemical Test Catalog	Develop a catalog of carbohydrate, protein, lipid tests	Lab tests, VS Code for documentation	List reagents, observations, results - Document interpretations
3	Enzyme Activity Tracker	Measure enzyme activity under different pH and temperature conditions	Colorimeter, spreadsheet tools	Record reaction rates - Generate comparison graphs
4	Amino Acid Separation Toolki	Document techniques used for amino acid identification	TLC plates, Chromatography tools	Use chromatography techniques - Record RF values and interpret
5	Virtual Lab Manual	Develop a digital manual of all performed experiments	Word processor / GitHub repo	Step-wise procedure - Observations - Interpretation - Safety practices

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Course Code	Course Title	L	T	P	C
RU-500-13-0007	Microbiology	2	1	2	4
Pre-requisite	NIL	Syllabus version			
Certification Mapping		1.0			
Course Objectives					
This course is designed to introduce students to the foundational history and key contributors in microbiology, including germ theory and Koch's Postulates. It will also teach the principles of microbial growth, genetics, and the characteristics and replication cycles of viruses. Additionally, students will learn about microbial interactions, pathogenic mechanisms, and the principles of sterilization, disinfection, and antimicrobial agents.					
Course Outcomes					
At the end of this course,					
<ol style="list-style-type: none"> 1. Upon completion of this course, students will be able to describe the major historical events and key scientific contributions that shaped the field of microbiology. 2. Students will be able to analyze microbial growth curves and explain the various factors affecting bacterial growth. 3. Students will be able to illustrate the fundamental processes of microbial genetics and differentiate between various methods of bacterial recombination. 4. Students will be able to classify different viruses based on their nucleic acid and compare the lytic and lysogenic life cycles of bacteriophages. 5. Students will be able to explain different types of microbial interactions and identify the causative agents and modes of transmission for common bacterial and viral diseases. 6. Students will be able to evaluate and select appropriate methods of sterilization and disinfection and differentiate the modes of action of various antibiotics and antifungals. 					
Unit 1	Introduction to Microbiology	7 hours			
History and Notable Contributions in the Development of Microbiology i) Spontaneous Generation (Abiogenesis) ii) Biogenesis iii) Germ Theory of Disease iv) Koch's Postulates. Microbes and their Types; Viruses, Bacteria, Fungi and Protozoans Morphology and Classification. Abnormal forms of Bacteria, Archaeobacteria, Mycoplasma and PPLo. Cultivation of bacteria – Nutritional Requirements of Bacteria, Physical Requirements, Different Types of Media & their Preparations.					
Unit 2	Microbial Growth & Control	7 hours			
Bacterial Growth: Growth phases - Generation Time; Kinetics of Growth: Batch Continuous Culture; Factors Affecting Microbial Growth. Concept of Sterilization and Disinfection. Physical and Chemical Methods of Microbial Control. Mode of Action of Antibiotics, Narrow and Broad Spectrum (Penicillin, Ampicillin, Sulfonamide, Vancomycin, Tetracycline, Chloramphenicol), antifungals (Clotrimazole, Fluconazole), Antiretroviral (tenofovir, AZT).					
Unit 3	Microbial Genetics	6 hours			
The Basic Principles of Microbial DNA, replication, transcription and translation. Microbial regulation of gene expression: the trp and lac operon. Bacterial Recombination: Transformation, Conjugation, Transduction, F-duction. Plasmid – Types, Structure, f- factor, Col factor; Plasmid as a Vector for Gene Cloning					

Unit 4	Virology	7 hours
General Characteristics of Viruses: Difference Between Bacteria and Viruses; Components of Viruses; Sizes and Shapes of Different Viruses. Host Range and Specificity; Classification of Viruses Based on the Nucleic Acid Content: DNA (dsDNA; ssDNA) and RNA (ssRNA; dsRNA). Virus like agents: Viroids and prions (Concept and Significance); Viral replication: Replication of T4 Phage; Phage Growth and the Estimation of Phage Numbers; Lytic and Lysogenic Life Cycle of Bacteriophage Lambda		
Unit 5	Microbial Interactions and Diseases	5 hours
Symbiosis of Bacteria; Parasitism, Mutualism, Heterothallism Mycorrhiza: VAM, Cyanobacteria, Protozoa. Bacterial Diseases: Tuberculosis, Pneumonia and UTIs. Viral Diseases: HIV/AIDS, Covid-19, Measels and Chicken Pox		
Total Lecture hours:		33 hours
Text Book(s)		
<ol style="list-style-type: none"> 1. Singh, B. D. (2020). <i>Biotechnology: Expanding Horizons</i>. Kalyani Publication. 2. Singh, B. D., & Singh, R. P. (2021). <i>Principles of Microbiology and Immunology</i>. Kalyani Publication. 		
Reference Book(s)		
<ol style="list-style-type: none"> 1. Prescott, L. M., Harley, J. P., & Klein, D. A. (2001). <i>Microbiology</i> (5th ed.). McGraw Hill. 2. Pelczar, M. J., Jr., Chan, E. C. S., & Krieg, N. R. (2009). <i>Microbiology</i> (5th ed.). Tata McGraw Hill. 		

Tutorial Sheet – (Total: 12 Hours)

Summary Table

Unit	Hours	Key Focus
Unit 1	2 hrs	Classification and Morphology of Microbes
Unit 2	3 hrs	Microbial growth and the role of antibiotics
Unit 3	2 hrs	Recombination in bacteria
Unit 4	2 hrs	Viruses and its life cycle
Unit 5	3 hrs	Diseases caused by microbes

Unit-wise Tutorial Table

Unit	Topic	Activities	Hours
Unit 1	Introduction to Microbiology	<ul style="list-style-type: none"> - Define and classify domains of life. - Discuss microbiology history. - Describe microorganism classification. 	2 hrs
Unit 2	Microbial growth & control	<ul style="list-style-type: none"> - Explain growth curves. - Describe enumeration methods - Discuss growth control. 	3 hrs
Unit 3	Microbial Genetics	<ul style="list-style-type: none"> - Define genetic elements. - Explain genetic recombination. - Discuss plasmids and transposons. 	2 hrs
Unit 4	Virology	<ul style="list-style-type: none"> - Describe virus structure and classification. - Explain lytic and lysogenic cycles - Discuss viral replication. 	2 hrs
Unit 5	Microbial Interactions & Diseases	<ul style="list-style-type: none"> - Define symbiotic relationships. - Discuss pathogenicity and virulence. - Describe infectious diseases. 	3 hrs

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Course Code	Course Title	Contact Hours: 4
RU-500-13-0007	Microbiology (Lab)	Credits: 2
Lab Course Objectives		
<p>This lab course provides hands-on training in fundamental aseptic techniques, including the preparation of media and sterilization of equipment. Students will learn to isolate, culture, and maintain pure microbial cultures from various environmental sources. The course also offers practical experience with microbial staining techniques, measuring bacterial growth, and determining the most probable number (MPN) in water samples, while also demonstrating key concepts like mutation using the Ames test and the principles of antibiotic resistance.</p>		
Laboratory Course Outcomes		
After completion of the lab, students will be able to:		
<ol style="list-style-type: none"> 1. Prepare and sterilize various types of growth media for microorganisms. 2. Perform isolation of pure cultures using plating, streaking, and serial dilution methods. 3. Maintain microbial cultures using slant and stab techniques. 4. Isolate pure microbial cultures from environmental samples like soil and water. 5. Measure bacterial population using turbidity and serial dilution methods. 6. Analyze the effects of temperature, pH, and carbon/nitrogen sources on microbial growth. 7. Perform simple and Gram staining of bacteria and correctly interpret the results. 8. Determine the MPN of a water sample to assess its microbial quality. 9. Conduct the Ames test to study mutation. 10. Assay antibiotics and demonstrate the concept of antibiotic resistance. 		

List of practicals:

Unit/Lab	Topic/Exercise
Unit 1: Introduction to Microbiology	
Lab 1	Preparation of Liquid and Solid Media for Growth of Microorganisms.
Lab 2	Sterilization of Media and Instruments.
Lab 3	Simple Staining and Gram Staining of Bacteria
Unit 2: Microbial Growth & Control	
Lab 4	Isolation and Maintenance of Organisms by Plating, Streaking and Serial Dilution methods. Slants and Stab Cultures. Storage of Microorganisms.

Lab 5	Isolation of Pure Culture from Soil and Water.
Lab 6	Isolation Of Pure Culture in Slant Techniques and by Streak Plate Techniques.
Lab 7	Growth; Growth Curve; Measurement of Bacterial Population by Turbidity and Serial Dilution Methods. Effect of Temperature, pH and Carbon Nitrogen Sources on Growth.
Lab 8	Assay of Antibiotics and Demonstration of Antibiotics Resistance.
Unit 3: Microbial Genetics	
Lab 9	Study of Mutation by Ame's Test.
Unit 4: Virology	
Lab 10	Study the life cycle of viruses
Unit 5: Microbial Interactions and Diseases	
Lab 11	Determination of MPN of Water Sample.

Reference Books for Lab Practice:

- Erkmen, O. (2021). *Laboratory Practices in Microbiology*. Elsevier Inc.
- Microbiology Society. (2016). *Basic Practical Microbiology: A Manual*. Microbiology Society.

NOTE: One mini project is compulsory. Students must select and implement any one project from the list given below.

S.No.	Project Title	Objective	Tools/ Technology Used	Expected Outcome
1	Water Quality Analysis of a Local Source	To collect a water sample and analyze its microbiological safety using the MPN technique.	Lactose broth, brilliant green lactose bile broth (BGLB), Durham tubes, test tube racks, incubator, water sample, petri plates, nutrient agar, pipettes.	An assessment of the microbiological safety of the water and a determination of its suitability for consumption.

2	Study of Antimicrobial Resistance	To investigate antibiotic resistance in bacteria using the Kirby-Bauer disc diffusion method.	Antibiotic discs, petri plates, inoculation loop, nutrient agar, test bacteria, incubator, ruler/calipers.	An evaluation of the effectiveness of different antibiotics and an understanding of antimicrobial susceptibility testing.
3	Soil Microbiology & Isolation	To collect a soil sample to isolate different microbial colonies using streak plating and Gram staining.	Soil sample, sterile test tubes, petri plates, nutrient media, inoculation loop, microscope, glass slides, coverslips, Gram's stain kit.	A successful isolation and identification of microbial diversity in an environmental sample, along with proficiency in Gram staining.
4	Mutation Study using Ames Test	To use the Ames test to assess if a given chemical substance has mutagenic properties.	Salmonella typhimurium strains, sterile petri plates, top agar, minimal glucose media, histidine, biotin, test compounds.	The determination of the mutagenic potential of a substance based on bacterial growth and an application of microbial genetics.
5	Effect of Environmental Factors on Growth	To design an experiment to study how a specific environmental factor (e.g., pH, temperature) affects bacterial growth.	Spectrophotometer, turbidimeter, test tubes, serial dilution tubes, incubator, pH meter, specific growth media.	A clear analysis of the impact of a selected abiotic factor on bacterial growth, supported by a designed and executed controlled experiment.

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Course Code	Course Title	L	T	P	C
RU-500-13-0008	Analytical Techniques in Biotechnology	2	1	2	4
Pre-requisite	NIL	Syllabus version			
Certification Mapping		1.0			
Course Objectives					
<p>Introduce fundamental analytical principles and highlight the importance of qualitative and quantitative methods in biotechnology research and applications. Familiarize students with spectroscopic, chromatographic, and electrophoretic techniques, explaining their principles, instrumentation, and role in biomolecule analysis. Develop understanding of advanced tools such as flow cytometry, biosensors, and microarrays, and their applications in diagnostics, therapeutics, and modern biotechnology. Provide practical exposure to analytical methods for protein purification, characterization, and molecular studies, enhancing problem-solving and experimental skills.</p>					
Course Outcomes					
<p>At the end of this course students will be able to:</p> <ol style="list-style-type: none"> 1. Explain the principles, types, and applications of various analytical techniques like Microscopy used in biotechnology. 2. Perform and apply qualitative and quantitative analytical methods for biomolecules and microbial analysis. 3. Interpret and critically evaluate experimental data obtained from modern analytical instruments. 4. Assess the suitability of different analytical techniques for specific research or industrial applications. 5. Explore emerging trends and innovations in analytical techniques to address biotechnological challenges. 					
Unit 1	Introduction to Analytical Techniques and Microscopy	8 hours			
<p>Analytical techniques: Basics, Types (Qualitative, Quantitative) and Importance of analytical methods in biotechnology. Basic principles of microscopy: Principle and applications of compound, confocal and electron microscopy. Scanning Electron Microscope: Principle and applications of SEM. Transmission Electron Microscope: Principle and applications of TEM</p>					
Unit 2	Spectroscopic Techniques	8 hours			
<p>UV-Visible Spectroscopy: principles, Beer–Lambert law. Fluorescence Spectroscopy: intrinsic and extrinsic fluorophores. Mass Spectrometry – Basics and Biotech Applications. Atomic absorption – Basics and Biotech Applications</p>					
Unit 3	Chromatographic Techniques	7 hours			

Classification of chromatographic methods. Principle, methodology of thin layer and paper chromatography, HPLC. Applications of paper and thin layer chromatography and HPLC. Performance parameter		
Unit 4	Electrophoretic Techniques	7 hours
Electrophoresis-Basics, Principle. Principle, procedure and applications of agarose gel electrophoresis, immunoelectrophoresis. SDS- PAGE for proteins. Iso electric focusing – Basic concept, procedure, applications		
Unit 5	Advance Techniques and Applications	6 hours
Flow cytometry – Principle, instrumentation, applications. Biosensors – types and applications in diagnostics. Microarray – Basic Concept and Applications. Analytical methods in Protein Purifications and Characterization		
Total Lecture hours:		36 hours
Text Book(s)		
<ol style="list-style-type: none"> 1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch “Instrumental Methods of Analysis” Cengage Learning, 2007. 2. Willard, Hobart, et al., “Instrumental Methods of Analysis”. VIIth Edition, CBS, 1986. 3. Fifield F.W. Principles and Practice of Analytical Chemistry. Blackwell, Scientific Publishers,2016 4. U Satyanarayana, Biotechnology, Books and Allied Publication (2005). 		
Reference Book(s)		
<ol style="list-style-type: none"> 1. Sharma, B.K. “Instrumental Methods of Chemical Analysis: Analytical Chemistry”, Krishna Prakashan Media (P) Ltd, 2014 2. Haven, Mary C., et al., “Laboratory Instrumentation “. 4th Edition, Wiley India Pvt Ltd, 2010 3. Philopose P.M. Analytical Biotechnology. Domihant Publishers & distributors, New Delhi, 2016. 		

Tutorial Sheet – (Total: 12 Hours)

Summary Table

Unit	Hours	Key Focus
Unit 1	2 hrs	Understand the basic analytical techniques.
Unit 2	3 hrs	Understand the spectroscopic techniques with biotech applications.
Unit 3	2 hrs	Understand the various chromatographic techniques.
Unit 4	2 hrs	Understand the principle and basics of electrophoresis techniques
Unit 5	3 hrs	Understand application and future trends

Unit-wise Tutorial Table

Unit	Topic	Activities	Hours
Unit 1	Introduction to Analytical Techniques	Research Presentation on Scientist	2 hrs
Unit 2	Spectroscopic Techniques	Perform spectroscopy practical	2 hrs
Unit 3	Chromatographic Techniques	Perform various chromatographic techniques	2 hrs
Unit 4	Electrophoretic Techniques	Perform gel electrophoresis	2 hrs
Unit 5	Advance Techniques and Applications	To study advance techniques and applications in analytical method	2 hrs

Course Code	Course Title	Contact Hours : 4
RU-500-13-0008	Analytical Techniques in Biotechnology (Lab)	Credits : 2
Lab Course Objectives		
<ol style="list-style-type: none"> 1. To develop hands-on skills in using analytical instruments and techniques relevant to biotechnology. 2. To perform qualitative and quantitative analysis of biomolecules such as proteins, nucleic acids, and enzymes. 3. To analyze experimental results accurately and draw meaningful conclusions. 4. To learn standard laboratory practices including safety, documentation, and good laboratory techniques (GLP). 		
Laboratory Course Outcomes		
After completion of the lab, students will be able to:		
<ol style="list-style-type: none"> 1. Demonstrate understanding of the working principles and basic operation of analytical instruments such as UV–Visible spectrophotometer, fluorimeter, mass spectrometer 2. Apply spectroscopic and chromatographic techniques to quantify biomolecules (e.g., proteins, nucleic acids, metabolites) and interpret experimental data -Perform electrophoretic separation of nucleic acids and proteins (agarose gel, SDS-PAGE) and analyze banding patterns for molecular characterization 3. Illustrate the use of advanced techniques like flow cytometry, biosensors, and microarray data analysis in diagnostics and biotechnology applications 4. Design and execute simple purification and assay experiments for proteins/enzymes using precipitation, dialysis, chromatography, and enzyme activity measurement. 		

List of Practical:

Unit/Lab	Topic/Exercise
Unit 1	Introduction To Analytical Techniques
Lab 1	Introduction to basic instruments (Principle standard operation procedure) demonstration and record
Unit 2	Spectroscopic techniques
Lab 2	To Study Beer Lamberts Law
Lab 3	Quantitative estimation of protein by Lowry method
Lab 4	Quantitative estimation of protein by Biuret method
Unit 3	Chromatographic techniques
Lab 5	Separation of amino acids by paper chromatography
Lab 6	Separation of plant pigments by Thin Layer Chromatography (TLC).
Unit 4	Electrophoretic techniques

Lab 7	Separation of proteins by SDS polyacrylamide gel electrophoresis (SDSPAGE).
Lab 8	Isolation of Genomic DNA and analysis by Agarose gel electrophoresis.
Unit 5	Advance techniques and Applications
Lab 9	To Study Flow Cytometry method

Mode of Evaluation for Lab:

- **Continuous Assessment:** Lab performance, viva-voce, practical file/record submission.
- **Lab Tests/Quizzes:** Short practical tests or quizzes during lab sessions.
- **Mini Project Evaluation:** Evaluation of the practical performance.

Reference Books for Lab Practice:

- "K R Aneja, Experiments in Plant pathology and Biotechnology, New Age International Publishers, Fourth Revised Edition, 2003

NOTE :One mini project is compulsory. Students must select and implement any one project from the list given below.

S.No.	Project Title	Objective	Technology	Expected Outcome
1	Development of a Simple Paper Chromatography Model for Plant Pigment Separation	Perform separation of pigments from spinach/flowers using paper chromatography	Paper chromatography setup, solvents, plant extract	Demonstrates basic chromatography principles and visualization
2	Agarose Gel Electrophoresis for DNA Fragment Analysis	Study the separation of DNA fragments by agarose gel electrophoresis	Agarose gel unit, DNA samples, GelDoc	Demonstrates principle, gel preparation, band visualization
3	Testing Protein with Biuret Assay	Perform color test for proteins with Biuret reagent	Test tubes, Biuret reagent, Protein sample	Basic qualitative protein detection method
4	Construction of a Simple pH Sensor using Red Cabbage Extract	Use natural indicator to detect acidity and alkalinity	Red cabbage extract, Filter paper	Shows biosensor principle in simplest form

5	Comparative Study of UV-Vis and Fluorescence Spectroscopy for Protein Quantification	Analyze and compare protein estimation using UV-Vis and fluorescence methods	UV-Visible spectrophotometer, Fluorimeter	Understand sensitivity, accuracy, and applications in biotech
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RUNGTA INTERNATIONAL SKILLS UNIVERSITY
SCHOOL OF LIFE SCIENCES
Department of Biotechnology
MSc Biotechnology

Course Code	Course Title	L	T	P	C
RU-500-13-0009	Biostatistics	2	1	2	4
Pre-requisite	NIL	Syllabus version			
Certification Mapping		1.0			
Course Objectives					
<p>This course introduces students to the fundamental concepts of biostatistics, including its definition, applications in biotechnology, and data presentation. Students will learn to calculate and interpret measures of central tendency and dispersion, understand sampling techniques, and apply correlation and regression analysis. The course also covers the principles of hypothesis testing, including Type I and II errors, and provides training in statistical tests such as the t-test, F-test, Chi-square, and ANOVA for various data analysis scenarios.</p>					
Course Outcomes					
<p>At the end of this course students will be able to:</p> <ol style="list-style-type: none"> 1. Students will be able to define the core concepts of biostatistics and explain its practical applications in the field of biotechnology. 2. Students will be able to perform calculations for descriptive statistics and use these measures to summarize and describe datasets. 3. Students will be able to differentiate between a population and a sample and select an appropriate sampling technique for a given research problem. 4. Students will be able to analyze the relationship between variables by creating scatter diagrams and calculating correlation and regression coefficients. 5. Students will be able to conduct hypothesis tests and draw valid conclusions based on statistical evidence while understanding potential errors. 6. Students will be able to select and apply the appropriate statistical test for a given dataset and interpret the results to solve real-world problems. 					
Unit 1	Introduction to Biostatistics	7 hours			
Definition of Statistics: Fundamentals of Statistics and its Applications to the biotechnology field (Biostatistics), Use and Misuse of Statistics. Data – Definition, Types, Classification and Presentation. Variables- Definition and Types. Descriptive Statistics - Measures of Central Tendency – Mean, Median, Mode.					
Unit 2	Fundamentals of Biostatistics	7 hours			
Measures of Dispersion- Range, Quartile deviation, Mean Deviation, and Standard Deviation and Co-efficient of Variation. Sampling: Statistical Population, Sample from Population, Random Sample, Sampling Techniques. Normal Distribution: Concept and Properties					
Unit 3	Correlation & Regression Analysis	7 hours			
Concept, Properties, Computation, and Applications of Correlation. Understanding of the Scatter Diagram. Simple Linear Correlation, Karl Pearson's Correlation Coefficient, Spearman's Rank Correlation. Linear Regression; Linear Equations; Regression Line. Probability; Normal Probability Distribution					

Unit 4	Hypothesis Testing & Statistical Error	7 hours
Hypothesis Testing: Null and Alternate Hypothesis. Types of Errors: Type I and Type II Error. Precision and Measure of Precision.		
Unit 5	Advanced Statistical Tests & Analysis of Variance	7 hours
Test of Analysis: Test of Significance & Test for Proportion. F-test and t-test and chi-square tests for Goodness of Fit. Analysis of Variance for One and Two-way Classification, Nonparametric Tests		
Total Lecture hours:		35 hours
Text Book(s)		
<ol style="list-style-type: none"> 1. Khan & Khanum. <i>Fundamentals of Biostatistics: Ukaaz Publication</i> (7th Edition). 2. P.K. Banerjee. <i>Introduction to Biostatistics: S. Chand & Company Ltd.</i> (7th Edition). 		
Reference Book(s)		
<ol style="list-style-type: none"> 1. Bernard Rosner. <i>Fundamentals of Biostatistics: Cambridge Learning</i> (8th Edition) 		

Tutorial Sheet – (Total: 12 Hours)

Summary Table

Unit	Hours	Key Focus
Unit 1	2 hrs	Understanding the fundamentals of biostatistics and measures of central tendency
Unit 2	3 hrs	Different deviations and sampling techniques
Unit 3	2 hrs	Correlation coefficient and regression lines
Unit 4	2 hrs	Hypothesis formulation and errors
Unit 5	3 hrs	Parametric and Non parametric tests.

Unit-wise Tutorial Table

Unit	Topic	Activities	Hours
Unit 1	Introduction to Biostatistics	Define Statistics and its application in biotechnology. Classify and present different types of data. Define and differentiate types of variables. Calculate Mean, Median, and Mode.	2 hrs
Unit 2	Fundamentals of Biostatistics	Calculate measures of dispersion (Range, Quartile, Mean, Standard Deviation). Explain sampling techniques and types of samples. Describe the concept and properties of a normal distribution.	3 hrs
Unit 3	Correlation & Regression Analysis	Explain the concept and properties of correlation. Create and interpret scatter diagrams. Compute Karl Pearson's and Spearman's rank correlation coefficients. Formulate and interpret linear regression equations. Define normal probability distribution.	2 hrs
Unit 4	Hypothesis Testing & Statistical Error	Define Null and Alternate Hypotheses. Differentiate between Type I and Type II errors. Explain precision and measures of precision.	2 hrs
Unit 5	Advanced Statistical Tests & Analysis of Variance	Perform tests of significance and proportion. Apply F-test, t-test, and chi-square tests for goodness of fit. Conduct Analysis of Variance for one-way and two-way classifications. Define and describe Nonparametric Tests.	3 hrs

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Course Code	Course Title	Contact Hours: 4
RU-500-13-0009	Biostatistics (Lab)	Credits: 2
Lab Course Objectives		
<p>This lab course is designed to train students in performing and interpreting descriptive statistical calculations both manually and with digital tools. Students will learn to visually analyze data using scatter diagrams and other graphical representations. The course also familiarizes them with various statistical tests, including the t-test and Chi-square test, and enables them to apply the principles of correlation and simple linear regression to analyze relationships between variables.</p>		
Laboratory Course Outcomes		
After completion of the lab, students will be able to:		
<ol style="list-style-type: none"> 1. Calculate descriptive statistics including mean, median, mode, and standard deviation from a sample. 2. Compute the mean and variance for a normal distribution. 3. Find out and calculate the correlation between two variables, such as leaf length and breadth. 4. Create and interpret a scatter diagram to visually represent data and understand correlation. 5. Calculate Pearson's correlation coefficient to quantify the relationship between variables. 6. Perform a simple linear regression analysis on a given sample and form the regression line. 7. Perform the Student's t-test to compare the means of two samples. 8. Perform the Chi-square test to analyze categorical data. 9. Use statistical software to perform calculations and analyses mentioned in the syllabus 		

List of Practicals:

Unit/Lab	Topic/Exercise
Unit 1: Introduction to Biostatistics (Mapped to CO1 and CO2)	
Lab 1	Calculate the mean and median value of a given sample.
Lab 2	Find out the mode value of a given sample.
Unit 2: Fundamentals of Biostatistics (Mapped to CO2 and CO3)	

Lab 3	To calculate the standard deviation from the sample.
Lab 4	To calculate the mean and variance of Normal Distribution sample.
Unit 3: Correlation & Regression Analysis (Mapped to CO4)	
Lab 5	To find out and calculate the correlation of leaf length & breadth of a given leaf sample.
Lab 6	To study correlation by creating a scatter diagram and calculating Pearson's
Unit 4 : Hypothesis Testing & Statistical Error (Mapped To CO5)	
Lab 7	To perform a simple linear regression analysis, form the given sample.
Unit 5: Advanced Statistical Tests & Analysis of Variance (Mapped to CO6)	
Lab 8	To perform the student's t-test for the given leaf sample data.
Lab 9	To perform the Chi-square test for the given data.

Reference Books for Lab Practice:

- Suchmacher, M., & Geller, M. (2012). *Practical biostatistics: A friendly step-by-step approach for evidence-based medicine*. Academic Press.

NOTE: One mini project is compulsory. Students must select and implement any one project from the list given below.

S.No.	Project Title	Objectives	Tools / Technologies	Expected outcome
1	Patient Demographics and Health Status Analysis	<ul style="list-style-type: none"> - To collect and use a dataset of patient demographic and health-related data. - To apply fundamental statistical concepts to describe the dataset. 	Pen, paper, calculator, MS Excel or Google Sheets.	Successful generation of descriptive statistics (mean, median, mode, standard deviation) and graphical representations to summarize the patient dataset.
2	Correlation of Lifestyle Factors with a Health Metric	<ul style="list-style-type: none"> - To investigate the relationship between a lifestyle factor and a health metric. - To analyze if a correlation exists and perform a regression analysis to predict the health metric. 	Pen, paper, calculator, graph paper, MS Excel or statistical software (e.g., SPSS).	A completed scatter diagram, a calculated Pearson's correlation coefficient, and a simple linear regression line that can be used to predict a health metric.
3	Effectiveness of a Hypothetical Intervention	<ul style="list-style-type: none"> - To apply hypothesis testing to determine if a hypothetical intervention has a significant effect on a health outcome. - To define hypotheses, perform a statistical test, and draw a conclusion. 	Pen, paper, calculator, MS Excel.	A clear conclusion about the effectiveness of the intervention based on the calculated test statistic and interpreted p-value from an appropriate statistical test.
4	Comparative Study of Different Plant Treatments	<ul style="list-style-type: none"> - To design a simple experiment to compare the effect of multiple treatments on a single plant type. - To perform a comprehensive statistical analysis based on the F-test. 	Pen, paper, calculator, MS Excel, or statistical software.	A formal experimental design and a conclusion drawn from a one-way ANOVA test about the comparative effects of

				different treatments.
5	Comprehensive Biostatistical Analysis	<ul style="list-style-type: none"> - To acquire and analyze a publicly available biological dataset. - To perform a comprehensive statistical analysis. 	Statistical software (R, Python, SPSS).	<p>A comprehensive report detailing descriptive analysis, correlation and regression analysis, and the results of multiple statistical tests on a given biological dataset.</p>