

**CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY
KANPUR**

**Programme: B.Sc. Biotechnology (AEDP)
Apprenticeship Embedded Degree Programme**

Course Structure (Effective from 2026-27)

Semester - I

Code	Paper	Courses	Credits
B300101T	Core Course-1	Cell Biology	4
B300102T	Core Course-2	Fundamentals of Biochemistry	4
B300103T	Core Course-3	Basics of Microbiology	4
B300104T	Minor	Bioinstrumentation	3
B300105P	Practical	Practical in Cell Biology, Biochemistry & Microbiology	3
Z011101	Co-curricular Course	First Aid & Basic Health	2
Total Credits			20

Semester - II

Code	Paper	Courses	Credits
B300201T	Core Course-1	Genetics & Molecular Biology	4
B300202T	Core Course-2	Enzymology	4
B300203T	Core Course-3	Industrial Biotechnology	4
B300204T	Minor	Biostatistics & Data Sciences	3
B300205P	Practical	Practical in Genetics, Molecular Biology, Enzymology & Industrial Biotechnology	3
Z021201	Co-curricular Course	Human Values and Environment Studies	2
Total Credits			20

Note: 1. Total Credits 40 till Semester II.

2. Student is entitled for Certificate in Faculty after successful completion of first two semesters


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Semester - III

Code	Paper	Courses	Credits
B300301T	Core Course-1	Immunology & Immunotechnology	4
B300302T	Core Course-2	Bioinformatics	4
B300303T	Core Course-3	Cell & Tissue Culture	4
B300304T	Minor	Biosafety & Bioethics	3
B300305P	Practical	Practical in Immunology & Bioinformatics	3
Z031301	Co-curricular Course	Physical Education and Yoga	2
		Total Credits	20

Semester - IV

B300401T	Core Course-1	Diagnostic Techniques	4
B300402T	Core Course-2	Food Biotechnology	4
B300403T	Core Course-3	Genetic Engineering	4
B300404T	Minor	Entrepreneurship and IPR	3
B300405P	Practical	Practical in Diagnostic Techniques, Food Biotechnology & Genetic Engineering	3
Z010101	Co-curricular Course	Food Nutrition & Hygiene	2
		Total Credits	20

Note: 1. Total Credits 80 till semester IV.

2. Student is entitled for Diploma in Faculty after successful completion of four semesters.

Semester - V

Code	Courses	Credits
B300501T	Allied MOOC Course	2
B300502A	Apprenticeship-I	23
	Total Credits	25

Semester - VI

Code	Courses	Credits
B300601T	Allied MOOC Course	2
B300602A	Apprenticeship-II	23
	Total Credits	25

Note: 1. Total Credits 130 till semester VI.

2. Student is entitled for Three-Year B.Sc. in Biotechnology AEDP degree after successful completion of six semesters.





Programme Outcomes:

An **Apprenticeship-Embedded Degree Program (AEDP) in Biotechnology** bridges academic learning and industry practice by integrating hands-on, on-the-job training with a university curriculum.

Through this program, students build technical proficiency and industry-ready skills.

- **PO 1: Core Domain Knowledge** Acquire and apply fundamental concepts of Biotechnology, including Molecular Biology, Cell Biology, Biochemistry, Microbiology, Immunology, Genetic Engineering, and Bioinformatics.
- **PO 2: Industry-Ready Technical & Lab Skills** Demonstrate competence in handling sophisticated laboratory equipments, executing bioprocess operations, and applying modern analytical tools in alignment with Good Laboratory Practices (GLP) and standard industrial protocols.
- **PO 3: On-the-Job Problem Solving** Identify, analyze, and troubleshoot real-time technical bottlenecks or manufacturing glitches during the industrial apprenticeship period, bridging the gap between theory and industry application.
- **PO 4: Data Analytics and Computational Skill** Interpret complex biological data, execute statistical validation, and effectively leverage modern technological integrations (like AI and data processing software) for research and product quality control.
- **PO 5: Workplace Professionalism & Adaptability** Adapt seamlessly to corporate and manufacturing environments, demonstrating an understanding of industrial workplace hierarchies, timeline management, and structural teamwork.
- **PO 6: Communication and Documentation** Communicate scientific data effectively through oral presentations and technical writing, and maintain highly precise industry records like batch manufacturing files, standard operating procedures (SOPs), and project logs.
- **PO 7: Bioethics, Biosafety, and Regulatory Compliance** Understand and execute legal, ethical, and biosafety guidelines (like GMO handling) while practicing professional integrity regarding Intellectual Property Rights (IPR) and plagiarism.
- **PO 8: Environmental Sustainability** Design and evaluate biotechnological solutions that support green processes, addressing global socio-economic and environmental challenges through sustainable development.
- **PO 9: Entrepreneurship and Innovation** Develop business acumen, market analysis capabilities, and an innovative mindset necessary to foster startups or manage independent incubation projects.
- **PO 10: Life-Long Learning** recognizes the rapidly evolving nature of biotechnology and cultivates an active interest in continuous self-directed learning to stay updated with industrial advancements.

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Programme: B.Sc. Biotechnology	Year: First	Semester: First Paper-I
Course Code: B300101T	Course Title: Cell Biology	
Course Outcomes: Upon successful completion of this course, students will be able to:		
• CO 1: Explain Cellular Architecture, Describe the fundamental principles of cell theory, differentiate between plant and animal cells, and explain the structure, function, and energy utilization of major cell organelles and components. • CO 2: Analyze the molecular models and biochemical composition of the plasma membrane, and evaluate how various transport mechanisms regulate solute movement. Cellular signal transduction mechanisms and cell adhesion molecules. • CO 3: Describe Chromosomal Organization and Variations, illustrate the chemical composition and structural hierarchy of chromosomes and distinguish between different chromatin types, special chromosomes and chromosome banding patterns. • CO 4: Compare the mechanisms of mitosis and meiosis, and critically evaluate the components of the cell cycle control system that regulate cell division.		
Credits: 4	MAJOR	
Max. Marks: 25+75	Min. Passing Marks: 10+25	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

Unit	Topic	No. of Lectures (60 hrs)
I	Basics of Cell Biology (Structure & Function): Discovery of cell and Cell Theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome and microbodies; Ribosome; Centriole; Nucleus; Chemical components of a cell; Catalysis and use of energy by cells.	15
II	Membrane Structure & Transport: Models of membrane structure, Membrane lipids, proteins and carbohydrates; Solute transport by Simple diffusion, Facilitated diffusion and Active transport; Extracellular matrix and cell adhesion; Brief account of importance of signal transduction and role of secondary messenger.	15




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III	Chromosomes: Chemical composition, structural organization of chromatids, centromeres, telomeres, chromatin, nucleosome organization, euchromatin and heterochromatin, special chromosomes (e.g. polytene chromosomes, lampbrush chromosomes and B chromosomes), chromosome banding patterns.	15
IV	Cell Cycle: An overview of cell cycle; Mitosis and meiosis; Components of cell cycle control system; Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Apoptosis in relation to Cancer.	15

Suggested Reading:

Text Books:

- Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., Walter, P., Wilson, J., & Hunt, T. (2022). *Molecular biology of the cell* (7th ed.). W. W. Norton. ISBN: 978-0393884821.
- EDP De Robertis and EMF De Robertis. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, 9780781734936, 0781734932, (2006)

Reference Books:

- Gerald Karp, Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc, 9780470483374, 0470483377 (2010)
- G.M. Cooper, and R.E. Hausman. The Cell: A Molecular Approach. 5th Edition. ASM Press 780878931064, 0878931066 (2009)
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Online links for study and reference materials:

- <http://www.open2study.com/cellbiology>
- <https://nptel.ac.in/courses/102103012/>
- Cell Biology - Course (swayam2.ac.in)

Programme: B.Sc. Biotechnology	Year: First	Semester: First Paper-II
Course Code: B300102T	Course Title: Fundamentals of Biochemistry	
Course Outcomes: Upon successful completion of this course, students will be able to: CO 1: Explain the structural characteristics, properties, and classifications of amino acids and proteins, and analyze the hierarchical levels of protein organization along with the thermodynamic forces that drive protein folding, denaturation, and renaturation.		

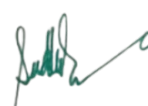



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• CO 2: Differentiate between the structures, properties, and biological roles of monosaccharides, disaccharides, and polysaccharides, including the specialized functions of structural, storage, and glycoconjugate complexes in living organisms. • CO 3: Describe the structural components, physical-chemical properties, and biological significance of nucleotides, and analyze the structural variations of DNA (A, B, and Z forms) along with the mechanisms of DNA stabilization, denaturation, and renaturation. • CO 4: Classify lipids and fatty acids based on their nomenclature and structural properties, and evaluate the specific functions of complex lipids such as phospholipids, sphingolipids, prostaglandins, and cholesterol in cellular membranes and signaling pathways. • CO 5: Understanding the concept of bioenergetics & the metabolism of carbohydrate, lipids and proteins.	
Credits: 4	MAJOR
Max. Marks: 25+75	Min. Passing Marks: 10+25
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	Topic	No. of Lectures (60 hrs)
I	Amino acids and Protein Structure and properties of Amino acids. Types of proteins and their classification. Forces stabilizing protein structure. Different Level of structural organization of proteins. Denaturation and renaturation of proteins.	10
II	Carbohydrates: Structure, function and properties of Monosaccharides, Disaccharides and Polysaccharides. Structural polysaccharides: cellulose and chitin; storage polysaccharides starch and glycogen; glycosaminoglycans; glycoconjugates; proteoglycans, glycoproteins and glycolipids.	10
III	Nucleic acids: Structure and functions of Nucleic acids (DNA and RNA), nucleotides, nucleosides, purines and pyrimidines, biologically important nucleotides. Double helical model of DNA structure and forces stabilizing DNA double helical structure, A, B and Z- DNA, denaturation and renaturation of DNA.	10
IV	Lipids: Structure and functions of Lipids. Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, cholesterol.	10
V	Metabolism: Concept of bioenergetics, Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron	20




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	Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids. Protein degradation to amino acids, urea cycle	
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Suggested Readings:

Text Books:

- Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). W.H. Freeman. ISBN 978-1319108243.
- Berg, J.M., Tymoczko, J.L., Gatto, G.J., Jr., & Stryer, L. (2019). *Biochemistry* (9th ed.). W.H. Freeman and Company, New York.

Reference Books:

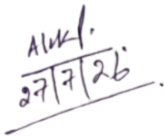
- Voet, D. and Voet, J.G., *Biochemistry*, (2004). 3rd Edition, John Wiley & Sons, Inc.USA,
- Satyanarayana, U. (2008). *Biochemistry* (3rd ed.). Books & Allied Ltd. ISBN 978-8187134800

Online links for study & reference materials:

- <https://www.coursera.org/learn/energy-metabolism>
- <https://nptel.ac.in/courses/102106087>

Programme: B.Sc. Biotechnology	Year: First	Semester: First Paper-III
Course Code: B300103T	Course Title: Basics of Microbiology	
Course Outcomes: Upon successful completion of this course, students will be able to:		
CO 1: Overview the foundational historical milestones in microbiology, and apply morphological, physiological, and molecular characteristics to classify bacteria according to Bergey’s Manual while evaluating their role as model organisms in human life. CO 2: Correlate the structural components of the prokaryotic cell including the cell wall, external appendages and internal inclusions with their biological functions and differentiate clearly between Gram-positive, Gram-negative, eubacteria, and archaebacteria. CO 3: Classify microorganisms based on their nutritional requirements, explain the physical and chemiosmotic mechanisms of nutrient uptake, calculate bacterial growth kinetics, and evaluate methods used to control microbial growth. CO 4: Describe the pathways of microbial metabolism, compare the diverse bacterial photosynthetic mechanisms and fixation strategies, and analyse the biochemical mechanisms driving bacterial fermentation and inorganic nutrient assimilation.		
Credits: 4	MAJOR	
Max. Marks: 25+75	Min. Passing Marks: 10+25	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		



Unit	Topic	No. of Lectures (60 hrs)
I	History and Scope of Microbiology Major events leading to the establishment of science of microbiology, identification of microorganisms on the basis of morphological, physiological, biochemical, immunological and molecular characteristics; bacterial classification according to Bergey's Manual of Systemic Bacteriology, Koch's postulates, relevance of microbiology to human life, microorganisms as model organisms.	15
II	Structure of Prokaryotic Cell Overview of prokaryotic cell (size, shape and arrangement of the cell); structure of bacterial cell wall; structures external to cell wall (capsules, slime layer, pili and fimbriae, flagella, prosthecae); structures internal to cell wall (inclusion bodies, magnetosomes, nucleoid, mesosome); spores and cysts; differences between Gram +ve and Gram -ve bacteria, archaebacteria and eubacteria.	15
III	Growth and Nutrition in Bacteria Nutritional types in microorganisms on the basis of sources of carbon, energy and electrons/hydrogen; Uptake of nutrients by bacterial cells; passive diffusion, facilitated diffusion, group translocation; chemiosmotic theory and active transport; iron uptake, phases of bacterial growth curve; physical and chemical agents to control bacterial growth.	15
IV	Microbial Metabolism Overview of microbial metabolism; types of photosynthesis in bacteria; photosynthetic machinery of bacteria (Bacteriochlorophyll, carboxysomes, bacterial reaction center, electron transport); photosynthetic fixation of CO ₂ in bacteria; bacterial fermentation; assimilation of inorganic phosphorus, sulfur and nitrogen.	15

Suggested Readings:

Text Books:

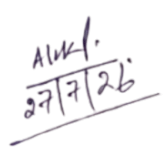
- Pelczar, M. J. Jr., Chan, E. C. S., Krieg, N. R., & Aneja, K. R. (2001). *Pelczar's Microbiology* (6th rev. ed.). Medtec Science Press. ISBN-10: 9393168865; ISBN-13: 978-9393168863
- Salle, A. J. (2007). *Fundamental principles of bacteriology* (7th ed.). Tata McGraw-Hill. ISBN 978-0070995628

Reference Books:

- Willey, J. M., Sandman, K. M., & Wood, D. H. (2022). *Prescott's Microbiology* (12th ed.). McGraw Hill. ISBN 1265123039 (ISBN-13 978-1265123031)
- General Microbiology by Stanier. Ingraham, Wheelis, Painter: Macmillan Press Ltd.

Online links for study & reference materials:

- <https://nptel.ac.in/courses/102103015>





Programme: B.Sc. Biotechnology	Year: First	Semester: First Paper-IV
Course Code: B300104T	Course Title: Bioinstrumentation	
Course Outcomes: Upon successful completion of this course, students will be able to:		
CO 1: Understand and compare the fundamental principles and mechanics of centrifugation; simple, phase contrast, fluorescence, and electron microscopy (SEM and TEM) for imaging biological and material structures. CO 2: Explain the principles of electromagnetic radiation and light absorption. Apply spectroscopic techniques to elucidate molecular structures, quantify elements, and analyze qualitative chemical profiles. CO 3: Demonstrate a clear understanding of the principles of separation science across various chromatographic modalities and execute appropriate chromatographic methods for the isolation, purification, and analytical estimation of complex biological. CO 4: Evaluate and apply specific electrophoretic and immunochemical techniques (including Agarose Gel, SDS-PAGE, PFGE, Isoelectric Focusing, and Western Blotting) for molecular weight estimation, protein/nucleic acid resolution, and specific target detection. CO 5: Understanding biosensors and nanotechnology and their applications.		
Credits: 3	MINOR	
Max. Marks: 25+75	Min. Passing Marks: 10+25	
Total No. of Lectures-Tutorials-Practical (in hours per week): 3-0-0		

Unit	Topic	No. of Lectures (45 hrs)
I	Centrifugation, Microscopy and Spectroscopy Centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles. Simple Microscopy, phase contrast microscopy, fluorescence and electron microscopy (SEM and TEM) Spectroscopic Techniques-Electromagnetic radiation; principle of absorption of light; principle and application of UV-Visible spectroscopy and IR spectroscopy; Fourier transform infrared spectroscopy; Fluorescence spectroscopy; NMR; Atomic absorption spectroscopy; Mass spectroscopy; Raman spectroscopy.	15
II	Chromatography Techniques Principle and application of paper chromatography; thin layer chromatography; gel filtration chromatography, column chromatography ion-exchange chromatography; affinity chromatography; Gas chromatography; high-performance	15




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	liquid chromatography (HPLC).	
III	Electrophoresis & Immunological methods Principle of electrophoresis; agarose gel electrophoresis; sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE), pulse field gel electrophoresis, immune electrophoresis, isoelectric focusing, western blotting.	10
IV	Introduction to Biosensors and Nanotechnology and their applications.	5

Suggested Readings:

- Wilson, K., & Walker, J. M. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology* (7th ed.). Cambridge University Press. <https://doi.org/10.1017/CBO9780511841477>
- Upadhyay, A., Upadhyay, K., & Nath, N. (2009). *Biophysical chemistry: Principles and techniques* (3rd ed.). Himalaya Publishing House.
- Lakowicz, J. R. (2006). *Principles of fluorescence spectroscopy* (3rd ed.). Springer. <https://doi.org/10.1007/978-0-387-46312-4>
- Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2014). *Introduction to spectroscopy* (5th ed.). Cengage Learning.

Online links for study & reference materials:

<https://nptel.ac.in/courses/102103044>

Programme: B.Sc. Biotechnology	Year: First	Semester: First Paper-V
Course Code: B300105P	Course Title: Practical in Cell Biology, Biochemistry & Microbiology	
Course Outcomes: Upon successful completion of this course, students will be able to:		
• CO 1: Apply standard laboratory safety protocols and demonstrate practical proficiency in essential lab techniques, including accurate pipetting, equipment handling, and the preparation of biological buffers. • CO 2: Observe and differentiate cellular structures, successfully identifying prokaryotic and eukaryotic cell morphologies, the stages of mitosis in plant tissues and specialized structures like polytene chromosomes. • CO 3: Calculate and prepare precise chemical solutions (molar, normal, and percentage) and apply the theoretical concepts of pH and buffering to practical biochemical scenarios. • CO 4: Execute qualitative biochemical assays to accurately estimate and identify biological macromolecules, including specific tests for carbohydrates (e.g., Osazone test), proteins, and lipids (acid value determination). • CO 5: Understand and operate fundamental microbiological instrumentation while strictly adhering to microbiological safety and sterilization techniques. • CO 6: Perform core microbiological procedures, including the preparation of nutrient media, isolation and purification of bacteria from environmental samples (using streak plate and serial dilution methods) and morphological characterization via Gram		

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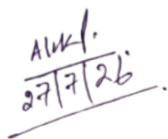
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Credits: 3		Practical
Max. Marks: 25+75		Min. Passing Marks: 10+25
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3		
Unit	Topic	No. of Lectures (90 hrs)
I	Experiments in Cell Biology • Introduction to safety measures in Laboratories. • Preparation of solutions and buffers. • Equipment handling and pipetting. • Study of structure of any prokaryotic and Eukaryotic cell. • Preparation & Observation of Polytene Chromosomes from <i>Drosophila</i>/chironomous Larvae. • Study of mitosis in onion root tip.	30
II	Experiments in Biochemistry • Qualitative Estimation of given sugar sample. • Qualitative Estimation of protein • Determination of acid value of oil. • Osazone test for Carbohydrates. • Preparation of solutions - To prepare molar, normal and percentage solution • Theory and application of buffers & pH.	30
III	Experiments in Microbiology • Safety measures in microbiology laboratory. • Introduction to different sterilization techniques. • Staining method: Gram staining • Study of instruments: Compound Microscope autoclave, Hot air oven, pH meter, Laminar airflow. • Preparation of Nutrient Agar and isolation of Bacteria. • Isolation and purification of micro-organisms (bacteria) from soil, water, air by streak plate method and serial dilution method.	30

Suggested Readings:

- Practical manual on Cell Biology by P.K. Gupta
- Practical manual on Cell Biology by Karp
- Practical Biochemistry by Pamela Jha
- Laboratory manual of Microbiology and Biotechnology by K.R. Aneja





Programme: B.Sc. Biotechnology	Year: First	Semester: First Paper-VI
Course Code: Z011101	Course Title: First Aid and Basic Health	
Course Outcomes: After successful completion of course, students will be able to: • Learn the skill needed to assess the ill or injured person. • Learn the skills to provide CPR to infants, children and adults. • Learn the skills to handle emergency child birth • Learn the Basic sex education help young people navigate thorny questions responsibly and with confidence. • Learn the Basic sex education help youth to understand Sex is normal. It's a deep, powerful instinct at the core of our survival as a species. Sexual desire is a healthy drive • Help to understand natural changes of adolescence • Learn the skill to identify Mental Health status and Psychological First Aid		
Credits: 2	Compulsory	
Max. Marks: 40+60	Min. Passing Marks: 40	

Unit	Topic	No. of Lectures Total= 30
I	Basic First Aid Aims of first aid & First aid and the law. Dealing with an emergency, Resuscitation (basic CPR). Recovery position, Initial top to toe assessment. Hand washing and Hygiene Types and Content of a First aid Kit	2 (Theory) 10 (Practical)
II	First AID Technique Dressings and Bandages. Fast evacuation techniques (single rescuer). Transport techniques.	
III	First aid related with respiratory system Basics of Respiration. No breathing or difficult breathing, Drowning, Choking, Strangulation and hanging Swelling within the throat, Suffocation by smoke or gases and Asthma.	
IV	First aid related with Heart, Blood and Circulation Basics of the heart and the blood circulation. Chest discomfort, bleeding. First aid related with Wounds and Injuries Type of wounds, small cuts and abrasions Head, Chest, Abdominal injuries First aid related with Bones, Joints Muscle related injuries Amputation, Crush injuries, Shock Basics of the skeleton, Joints and Muscles. Fractures (injuries to bones).	

Suggested readings:

Indian First Aid Manual-<https://www.indianredcross.org/publications/FA-manual.pdf>

- Red Cross First Aid/CPR/AED Instructor Manual
- <https://mhfa.com.au/courses/public/types/youthedition4/>

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