

Department of Biotechnology

B.Sc. Biotechnology

Four-Year Undergraduate Programme

FYUP (Eight-Semester Course) as per NEP

Course Contents & Syllabus

[For the students enrolled in the 2026-27 academic session onwards]

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[For the 2nd year (3rd & 4th Semester) students of academic session 2025-26]



Hemvati Nandan Bahuguna Garhwal University

(A Central University)

Srinagar Garhwal-246174 (Uttarakhand)

COURSE STRUCTURE AND CREDIT DISTRIBUTION

First Year (First & Second Semester)

Course Category	Semester-I				Semester-II			
	Subject/Title	No. of paper	Credits		Subject /Title	No. of paper	Credits	
			T	P			T	P
Discipline Specific core (2 subjects)	DSC-I (Major)	Biomolecules	3	1	DSC-II (Major)	Introductory Biotechnology	3	1
	DSC-I (Minor)	Biomolecules	3	1	DSC-II (Minor)	Introductory Biotechnology	3	1
M.D/I.D (Minor)-1 Subject	MD/ID (M)-I	Basics of Biomolecular Interaction	3	1	MD/ID (M)–II	Biotechnology for Human Welfare	3	1
M.D/I.D (General)	MD/ID (G)-I		3	-	MD/ID (G) –II		3	-
SEC/AEC	AEC-Communication Skills or AMSC		3	-	AMSC or AEC-Communication Skills		3	-
VAC	Understanding and connecting with environment Or Life Skills & personality development		2	--	Understanding and connecting with environment Or Life Skills & personality development		2	-
Total			17	3			17	3
NHEQF Level 4.5	Student on exit after successfully completing first year (i.e., securing minimum required 40 credits + 4 Credits in one vocational course/skills-enhancement course) will be awarded “Undergraduate Certificate” of one year, in related field/discipline/subject							
The student may opt for Communication Skills in one semester, and any one course from Additional Multidisciplinary skill Course (SEC--AMSC) in the other semester.								
AMSC- Additional Multidisciplinary Skill Course (is offered as SEC)								
List of Additional Multidisciplinary Skill course (SEC-AMSC) courses: Following are the courses which will be offered by the University under AMSC under the 4-year U.G. programme. University may add new courses under AMSC in future along with the following courses:								
1. Plant Nursery Development and Management 2. Basic Yoga practices 3. Physical Education and Sports Management 4. Regional Folklores and their cultural context 5. Indian traditional music 6. Tour and travel Operations								
Communication Skills- AEC ‘Communication Skills’ course will be offered in Hindi, English and Sanskrit Languages, student may opt any one language for studying the course								
Life Skill & Personality Development – VAC Understanding and connecting with environment- VAC								

Second Year (Third & Fourth Semester)

Course Category	Semester-III				Semester-IV			
	Subject/Title	No. of paper	Credits		Subject /Title	No. of paper	Credits	
			T	P			T	P
Major-I (One Subject) Major	DSC-III (Major)	Elementary Microbiology	4	1	DSC-V (Major)	Basics of Molecular Biology	4	1
Minor-I (One Subject)	DSC-III (Minor)	Elementary Microbiology	3	1	DSC-IV (Minor)	Basics of Molecular Biology	3	1
DSC (Major-Skill-based Course)	DSC-SEC-IV (Major)	Cell and Tissue Culture	3	-	DSC-SEC-VI (Major)	Enzymology	3	-
M.D/I.D (Minor)	MD/ID (M)-III	Fundamentals of Cell Biology	3	1	MD/ID (M)-IV	Fundamentals of Genetics	3	1
AEC (Language based courses)	Indian, Modern, Regional Language-I		2	-	Indian, Modern, Regional Language-II		2	-
VAC/AEC	AEC-Indian Knowledge System Or VAC-Culture, traditions and moral values		2		AEC-Indian Knowledge System Or VAC-Culture, traditions and moral values		2	-
Total			17	3		6	17	3
NHEQF Level 5	Student on exit after successfully completing Second year (i.e., securing minimum required 80 credits + 4 Credits in one vocational course/skills-enhancement course of 4 credits) will be awarded “Undergraduate Diploma” of two year, in related field/discipline/subject.							
IKS- Indian Knowledge System- AEC								
Culture, Traditions and Moral Values- VAC								
Students are required to study both courses — Indian Knowledge System (IKS) and Culture, traditions and moral values — during the 3rd and 4th semesters. However, they will have the flexibility to study one course in each semester.								
IMR Language- ‘Indian, Modern, Regional Language’- Hindi, Sanskrit and English (Student have to study 2 different languages in the second year with one language in one semester and other language in another semester). One additional course titled “Heritage of Indian Languages” shall be offered, which students may opt for in lieu of any one prescribed language course, subject to the applicable regulations of the programme.								
The department will offer a 3-credit SEC Major course as either a fully theory-based or fully practical-based module.								
Note: Student will continue with the same Discipline specific major & Minor in the second year (III & IV Semester) as studied in the first year (I & II semester) of the FYUP.								

Programme Learning Outcomes of the Biotechnology U.G. Programme

Programme Learning Outcomes of Biotechnology U.G. Programme Qualification descriptions are outcomes and attributes that learners achieve through learning acquired during a programme of study. These descriptors are specific to each programme and designed to capture the knowledge, skills, attitudes, and values acquired through it. These outcomes include disciplinary-area-specific skills, generic skills, and transferable global skills. Students should demonstrate these skills upon completing the U.G. programme for the Certificate, Diploma, and Degree with Research qualification. They also focus on knowledge and skills that prepare students for further study, employment, and citizenship. Programme learning outcomes outline the minimum essential learning required to complete a programme of study, ensuring comparability of learning levels and academic standards across colleges/universities. They provide a broad picture of graduates' competence in a given programme of study. Here are 8 Programme Learning Outcomes (PLOs) for undergraduate (B.Sc.)

Students of this programme will be able to:

PLO1. Demonstrate Comprehensive Knowledge: Acquire comprehensive knowledge of core concepts, theories, and methodologies in Biotechnology, including the potential to analyze and synthesize knowledge across sub-fields.

PLO2. Critical Thinking and Problem-Solving Abilities: Apply the ability to effectively evaluate biotechnological principles, data, and evidence to identify, analyze, and solve complex disciplinary and interdisciplinary problems.

PLO3. Effective Communication and Interpersonal Skills: Exhibit ability in written, oral, and visual communication to articulate ideas, research findings, and arguments clearly and persuasively in diverse disciplines in various professional and social contexts.

PLO4. Research and Analytical Abilities: Apply advanced research methodologies and techniques in Biotechnology, both qualitative and quantitative, to conduct original and ethical anthropological research, contributing to new knowledge and skills.

PLO5. Ethics and Social Responsibility: Endorse ethical practices in biotechnological research, including admiration for social diversity and academic integrity, while addressing contemporary challenges.

PLO6. Interdisciplinary Approach and Competence: Apply biotechnological insights to broader interdisciplinary contexts for addressing complex and emerging global challenges by developing collaborative teams and the capability to lead with vision and accountability.

PLO7. Employability and Lifelong Learning: Develop and employ professional skills, including teamwork, leadership, and adaptability to organize for employment or entrepreneurial opportunity in academia, industry, and socio-cultural areas, and engage in lifelong learning to stay updated in a dynamic scientific or non-scientific world.

PLO8. Global and Cultural Awareness: Demonstrate an understanding of cultural and global diversity knowledge in local, national, and international contexts for inclusivity, cultural preservation, and environmental sustainability.

B.Sc. Biotechnology Semester-I

Core Course: Paper-I Biomolecules (SOLS/BT/DSC (Major)-I)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic concepts, definition, and characteristics of biomolecules. • Understand the structure, classification, and function of carbohydrates, amino acids, lipids, and vitamins. • Analyse and apply the knowledge of these biological macromolecules in terms of their importance in metabolism and related research. • Evaluate the role of these biological macromolecules in the various biological functions.

Paper-I Biomolecules
(Course Code: SOLS/BT/DSC-I Major)

No. of Credit: 3

UNIT-I (Cr-0.75)

Introduction to biomolecules: Major types of biomolecules and their importance in the living system.

Concept of nucleic acids: Structure, types and function, Nucleoside and Nucleotide structure, Watson and Crick model, Chargaff's Rule, Melting Temperature.

UNIT-II (Cr-0.75)

Carbohydrates: Definition, classification, structure. Monosaccharides and oligosaccharides. Homopolysaccharides and Heteropolysaccharides. Important functions of polysaccharides.

UNIT-III (Cr-0.75)

Amino acids: Classification, Structure, and properties of amino acids, Ramachandran Plot. Protein Structure: Peptide bond and its properties, Primary, secondary, tertiary, and quaternary structure.

UNIT-IV (Cr-0.75)

Lipids: Structure, properties, and function. Difference between saturated and unsaturated fatty acid, phospholipids; Saponification, acid value, esterification.

Vitamins: Water and fat-soluble vitamins, functions, and deficiency symptoms.

Recommended Books:

1. Satyanarayana U., Chakrapani U. Biochemistry. 2021. 6th ed. Elsevier.
2. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman & Co.
3. Das D. Biochemistry. 2025. 14th ed. Academic Publishers.
4. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

SOLS/BT/DSC-I (P) (Major) Biomolecules (Practical)

(Cr. -1)

1. Qualitative tests for different carbohydrates.
 2. Qualitative tests for lipids.
 3. Qualitative tests for different amino acids.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-I

Core Course: Paper II Biomolecules (SOLS/BT/DSC (Minor)-I)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic concepts, definition, and characteristics of biomolecules. • Understand the structure, classification, and function of carbohydrates, amino acids, lipids, and vitamins. • Analyse and apply the knowledge of these biological macromolecules in terms of their importance in metabolism and related research. • Evaluate the role of these biological macromolecules in the various biological functions.

**Paper-II Biomolecules
(Course Code: SOLS/BT/DSC-I Minor)**

No. of Credit: 3

UNIT-I (Cr-0.75)

Introduction to biomolecules: Major types of biomolecules and their importance in the living system.

Concept of nucleic acids: Structure, types and function, Nucleoside and Nucleotide structure, Watson and Crick model, Chargaff's Rule, Melting Temperature.

UNIT-II (Cr-0.75)

Carbohydrates: Definition, classification, structure. monosaccharides and oligosaccharides. Homopolysaccharides and Heteropolysaccharides. Important functions of polysaccharides.

UNIT-III (Cr-0.75)

Amino acids: Classification, Structure, and properties of amino acids, Ramachandran Plot.

Protein Structure: Peptide bond and its properties, Primary, secondary, tertiary, and quaternary structure.

UNIT-IV (Cr-0.75)

Lipids: Structure, properties, and function. Difference between saturated and unsaturated fatty acid, phospholipids; Saponification, acid value, esterification.

Vitamins: Water and fat-soluble vitamins, functions, and deficiency symptoms.

Recommended Books:

1. Satyanarayana U., Chakrapani U. Biochemistry. 2021. 6th ed. Elsevier.
2. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman & Co.
3. Das D. Biochemistry. 2025. 14th ed. Academic Publishers.
4. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

SOLS/BT/DSC-I (P) (Minor) Biomolecules (Practical)

(Cr. -1)

1. Qualitative tests for different carbohydrates.
 2. Qualitative tests for lipids.
 3. Qualitative tests for different amino acids.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-I**Core Course: Paper III Basics of Biomolecular Interaction (SOLS/BT/MD/ID (M)-I)**

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basics and concepts of various biomolecules and their interactions. • Understand the properties and functions of biomolecules in biological systems. • Apply the knowledge of biomolecules and their interaction to other molecules for their analysis and biotechnological research. • Evaluate the basic characteristics of biomolecules, the mechanism of interactions, and their function for potential biotechnological applications.

Paper-III Basics of Biomolecular Interaction
(Course Code: SOLS/BT/MD/ID (M)-I)

No. of Credit: 3**UNIT-I (Cr-0.75)**

Water and biomolecular interaction: Chemical structure and properties of water, Hydrophobic and hydrophilic interactions of water, water as a universal solvent, and the role of water in various biological functions.

UNIT-II (Cr-0.75)

Chemical bonds in biological systems: Classification of biological interactions, role of covalent bonds, ionic bonds, H-bonds, disulphide, Van der Waals interactions, and importance of weak interactions in biological systems.

UNIT-III (Cr-0.75)

Biomolecular recognition: Significance, forces involved, specificity and affinity in biomolecular interactions. Mechanism and applications of various interactions, including enzyme-substrate interactions, receptor-ligand binding, and antigen-antibody interactions.

UNIT-IV (Cr-0.75)

Acids, bases, and buffers in biological systems: Concept of acids, bases, and physiological pH.
 pK – definitions and their significance in biological systems, mechanism and roles of buffer systems in biological fluids, and their importance.

Recommended Books:

1. Satyanarayana U., Chakrapani U. Biochemistry. 2021. 6th ed. Elsevier.
2. Nelson D.L., Cox, M.M. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman & Co.
3. Das D. Biochemistry. 2025. 14th ed. Academic Publishers.
4. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

SOLS/BT/MD/ID (M)-I (P) Basics of Biomolecular Interaction (Practical) (Cr. -1)

1. Observation of hydrophilic and hydrophobic substances.
 2. Use of pH meter and its calibration.
 3. Preparation of buffers.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-II**Core Course: Paper IV Introductory Biotechnology (SOLS/BT/DSC-II (Major))**

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic knowledge of the history, definition, and scope of biotechnology, • Understand the principles and applications of biotechnology in various sectors. • Apply the theories of biotechnology to analyse the diverse challenges related to industry, society, and environment. • Evaluate the importance of biotechnology in human welfare.

Paper-IV Introductory Biotechnology
(Course Code: SOLS/BT/DSC-II Major)

No. of Credit: 3**UNIT-I (Cr-0.75)**

Fundamentals of biotechnology: Indian and World History, definition and scope of Biotechnology, introduction to biological macromolecules, including nucleic acids and proteins, and the Central Dogma.

Principles of Genetic engineering and advances in molecular biology technology & Bioprocess technology.

UNIT-II (Cr-0.75)

Industrial applications of biotechnology: Basic process of the production of alcoholic beverages, antibiotics, enzymes, biofuels, and biopolymers, and their producers.

Basic introduction to the applications of biotechnology in the diagnostics of diseases and therapeutic strategies.

UNIT-III (Cr-0.75)

Biotechnology in agriculture: Introduction to the Genetically Modified (GM) crops, and their applications. Risk and safety regulatory issues in the use of GM crops, bio-fertilizers, and bio-pesticides.

UNIT-IV (Cr-0.75)

Marketing of biotechnological products: Biotechnological Products in India; quality parameters; quarantine procedures for export, market integration, safety, and licensing for import and export of biotechnological products. Role of Bioentrepreneurship in the biotechnology industry.

Recommended Books:

1. Brown T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley Blackwell.
2. Arumugam N., Kumaresan V. Fundamentals of Biotechnology. 2016. 1st ed. Saras Publication.
3. Dubey R.C. Advanced Biotechnology. 2014. 1st ed. S Chand & Company.
4. Singh B.D. Biotechnology: Expanding Horizons. 2012. 1st ed. Kalyani Publishers.

SOLS/BT/DSC-II (P) (Major) Introductory Biotechnology (Practical)**(Cr. -1)**

1. Demonstration of laminar air flow, and autoclave, etc.
 2. Survey and listing of important biotechnology products available in the market.
 3. Demonstration of agarose gel electrophoresis.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-II**Core Course: Paper V Introductory Biotechnology (SOLS/BT/DSC-II Minor)**

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic knowledge of the history, definition, and scope of biotechnology, • Understand the principles and applications of biotechnology in various sectors. • Apply the theories of biotechnology to analyse the diverse challenges related to industry, society, and environment. • Evaluate the importance of biotechnology in human welfare.

Paper-V Introductory Biotechnology
(Course Code: SOLS/BT/DSC-II Minor)

No. of Credit: 3**UNIT-I (Cr-0.75)**

Fundamentals of biotechnology: Indian and World History, definition & scope of Biotechnology, introduction to biological macromolecules, including nucleic acids and proteins, and the Central Dogma.

Principles of Genetic engineering and advances in molecular biology technology & Bioprocess technology.

UNIT-II (Cr-0.75)

Industrial applications of biotechnology: Basic process of the production of alcoholic beverages, antibiotics, enzymes, biofuels, and biopolymers, and their producers.

Basic introduction to the applications of biotechnology in the diagnostics of diseases and therapeutic strategies.

UNIT-III (Cr-0.75)

Biotechnology in agriculture: Introduction to the Genetically Modified (GM) crops, and their applications. Risk and safety regulatory issues in the use of GM crops, bio-fertilizers, and bio-pesticides.

UNIT-IV (Cr-0.75)

Marketing of biotechnological products: Biotechnological Products in India; quality parameters; quarantine procedures for export, market integration, safety, and licensing for import and export of biotechnological products. Role of Bioentrepreneurship in the biotechnology industry.

Recommended Books:

1. Brown T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley Blackwell.
2. Arumugam N., Kumaresan V. Fundamentals of Biotechnology. 2016. 1st ed. Saras Publication.
3. Dubey R.C. Advanced Biotechnology. 2014. 1st ed. S Chand & Company.
4. Singh B.D. Biotechnology: Expanding Horizons. 2012. 1st ed. Kalyani Publishers.

SOLS/BT/DSC-II (P) (Minor) Introductory Biotechnology (Practical)**(Cr. -1)**

1. Demonstration of laminar air flow, and autoclave, etc.
 2. Survey and listing of important biotechnology products available in the market.
 3. Demonstration of agarose gel electrophoresis.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-II

Core Course: Paper VI Biotechnology for Human Welfare (SOLS/BT/MD/ID (M)-II)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic definition, concept, and scope of biotechnology in human welfare. • Understand the principles of biotechnology, along with ethics and biosafety issues. • Apply the theories of biotechnology in the analysis of complex biological systems in agriculture, industries, and environmental management. • Evaluate genetic engineering prospects and innovations in diverse areas of biotechnology.

Paper-VI Biotechnology for Human Welfare
(Course Code: SOLS/BT/MD/ID (M)-II)

No. of Credits: 3

UNIT-I (Cr-0.75)

Introduction to biotechnology: Definition and scope of Biotechnology, Interdisciplinary nature of Biotechnology, Basic concepts of chromosomes and genes, Genetic diversity of microorganisms, yeast, plants, and animals.

UNIT-II (Cr-0.75)

Introduction to genetic engineering: Basic concepts of gene cloning, steps and techniques involved in genetic engineering, genetically modified organisms, and their biotechnological applications.

UNIT-III (Cr-0.75)

Applications of biotechnology: Biotechnological innovations in disease diagnostics, advancements in therapeutic strategies, novel vaccine development, agriculture, industry, and environmental management.

UNIT-IV (Cr-0.75)

Ethics & biosafety in biotechnology: Social, moral and ethical issues related to Biotechnology. Regulatory authorities for biotechnological research and development, the concept of biosafety, and the safety levels.

Recommended Books:

1. Brown T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley Blackwell.
2. Arumugam N., Kumaresan V. Fundamentals of Biotechnology. 2016. 1st ed. Saras Publication.
3. Dubey R.C. Advanced Biotechnology. 2014. 1st ed. S Chand & Company.
4. Singh B.D. Biotechnology: Expanding Horizons. 2012. 1st ed. Kalyani Publishers.

SOLS/BT/MD/ID (M)-II (P) Biotechnology for Human Welfare (Practical) (Cr. -1)

1. Demonstration of good laboratory practices and disposal methods.
 2. Demonstration of agarose gel electrophoresis.
 3. Demonstration of basic equipments of biotechnology lab.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-III

Core Course: Paper VII Elementary Microbiology (SOLS /BT/DSC-III Major)

Course Credits	04 (Four)
Course Learning Outcomes	• Learn the basic concepts and fundamentals of elementary microbiology. • Understand the characteristics and significance of microorganisms. • Analyse and apply the knowledge of these microbes in terms of their biological importance and in industrial product formation. • Evaluate the role of these microbes in human welfare.

**Paper-VII Elementary Microbiology
(Course Code: SOLS /BT/DSC-III Major)**

No. of Credits: 4

UNIT-I (Cr-1)

Historical developments, Overview of and Scope of Microbiology; Introduction to the microbial world, Prokaryotic and eukaryotic cells, Staining and microscopic observation of microorganisms.

UNIT-II (Cr-1)

Bacterial cell structure, Nutritional modes, and reproduction in bacteria. General overview of the structure and reproduction of viruses.

UNIT-III (Cr-1)

Media for microbial culture (Selective, Differential, and Enriched media), Isolation and enumeration of bacteria, preparation of pure culture (Pour plate, Spread plate and Streak plate methods) and use of aseptic conditions.

UNIT-IV (Cr-1)

Microorganisms as causative agents of various infectious diseases, Methods for control of microorganisms (sterilization, disinfection, antisepsis).
Use of microbes in production of various industrial products.

Recommended Books:

1. Willey J., Sherwood L., Woolverton C.J. Prescott's Microbiology. 2023. 10th ed. McGraw-Hill Education.
2. Tortora G.J., Funke B.R., Case C.L. Microbiology: An Introduction. 2019. 13th ed. Chicago, Pearson.
3. Dubey R.C., Maheshwari D.K. A Text Book of Microbiology. 2013. 1st ed. S Chand Publishing.
4. Pelczar M.J., Chan E.C.S., Krieg N.R. Microbiology. 2025. 7th ed. Affiliated East-West Press.

SOLS/BT/DSC-III (P) (Major) Elementary Microbiology (Practical)

(Cr. -1)

1. Preparation of culture media.
 2. Methods of Isolation of bacteria from different sources.
 3. Gram's staining.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-III**Core Course: Paper VIII Elementary Microbiology (SOLS/BT/DSC-III Minor)**

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic concepts and fundamentals of elementary microbiology. • Understand the characteristics and significance of microorganisms. • Analyse and apply the knowledge of these microbes in terms of their biological importance and in industrial product formation. • Evaluate the role of these microbes in human welfare.

Paper-VIII Elementary Microbiology
(Course Code: SOLS /BT/DSC-III Minor)

No. of Credits: 3**UNIT-I (Cr-1)**

Historical developments, Overview of and Scope of Microbiology; Introduction to the microbial world, Prokaryotic and eukaryotic cells, Staining and microscopic observation of microorganisms.

UNIT-II (Cr-1)

Bacterial cell structure, Nutritional modes, and reproduction in bacteria. General overview of the structure and reproduction of viruses.

UNIT-III (Cr-0.5)

Media for microbial culture (Selective, Differential, and Enriched media), Isolation and enumeration of bacteria, and use of aseptic conditions.

UNIT-IV (Cr-0.5)

Microorganisms as causative agents of various infectious diseases, Methods for control of microorganisms (sterilization, disinfection, antiseptics).

Recommended Books:

1. Willey J., Sherwood L., Woolverton C.J. Prescott's Microbiology. 2023. 10th ed. McGraw-Hill Education.
2. Tortora G.J., Funke B.R., Case C.L. Microbiology: An Introduction. 2019. 13th ed. Chicago, Pearson.
3. Dubey R.C., Maheshwari D.K. A Text Book of Microbiology. 2013. 1st ed. S Chand Publishing.
4. Pelczar M.J., Chan E.C.S., Krieg N.R. Microbiology. 2025. 7th ed. Affiliated East-West Press.

SOLS/BT/DSC-III (P) (Minor) Elementary Microbiology (Practical)**(Cr. -1)**

1. Preparation of culture media.
 2. Methods of Isolation of bacteria from different sources.
 3. Gram's staining.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-III

Core Course: Paper IX Cell & Tissue Culture (SOLS/BT/DSC-SEC-IV Major)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the concepts and fundamentals of cell and tissue culture. • Understand the basics of cell culture in animal and plant development. • Analyse and apply the knowledge of cell culture in terms of its various biotechnological applications. • Evaluate the role of cell culture in sustainable development.

Paper-IX Cell & Tissue Culture
(Course Code: SOLS/BT/DSC-SEC-IV Major)

No. of Credits: 3

UNIT-I (Cr-0.75)

Cell Culture: Laboratory organization of tissue culture lab, sterilization techniques, aseptic conditions, and care. Media components and types for cell culture. Primary and Secondary cell culture.

UNIT-II (Cr-0.75)

Applications of Animal Cell Culture: Concepts of Stem cells and application, monoclonal antibody production.

UNIT -III (Cr-0.75)

Plant Tissue Culture: Concept of totipotency, history of plant tissue culture, media components and types, and different phytohormones.

UNIT-IV (Cr-0.75)

Applications of Plant Tissue Culture: Clonal propagation, Somatic Embryogenesis and artificial seed, and protoplast culture, Preservation of plant genetic resources and germplasm conservation.

Recommended Books:

1. Razdan M.K. Introduction to Plant Tissue Culture. 2003. 2nd ed. Science Publishers, Inc.
2. Masters J.R.W. Animal Cell Culture: A Practical Approach. 2023. 3rd ed. Oxford University Press.
3. Capes-Davis A, Freshney R.L. Culture of Animal Cells. 2021. 8th ed. John Wiley.
4. Sasidhara R. Animal Biotechnology. 2024. 2nd ed. MJP Publisher.

B.Sc. Biotechnology Semester-III

Core Course: Paper X Fundamentals of Cell Biology (SOLS/BT/MD/ID(M)-III)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic concepts and fundamentals of cell biology. • Understand the cellular organization of cells and their development. • Analyse and apply the knowledge of cell biology in terms of their biological functions. • Evaluate the role of cellular processes in the cell cycles and its regulation.

**Paper-X Fundamentals of Cell Biology
(Course Code: SOLS/BT/MD/ID(M)-III)**

No. of Credits: 3

UNIT-I (Cr-0.75)

Historical perspectives of cell biology, Cell theory, Structure of prokaryotic and eukaryotic cells: microbial, plant, and animal cells.

UNIT-II (Cr-0.75)

Structure and functions of the Cell wall, Plasma membrane, Endoplasmic reticulum, Nucleus, Golgi complex, Peroxisomes, Lysosomes, Mitochondria, Cytoskeleton, and Chloroplast.

UNIT-III (Cr-0.75)

Cell cycle and its regulations, Mitosis, and Meiosis.

UNIT-IV (Cr-0.75)

Cell differentiation, apoptosis, and cancer (benign and malignant).

Recommended Books:

1. Hadin J., Bertoni P.B., Kleinsmith L.J. Becker's World of the Cell. 2021. 10th ed. Pearson Education.
2. De Robertes E.D.P., De Robertis E.M.P. Cell and Molecular Biology. 1987. 8th ed. Lee & Febiger.
3. Johnson A., Alberts B., Morgan D., Roberts, K., Raff M., Walter P., Heald R. Molecular Biology of the Cell. 2022. 7th ed. W W Norton & Company.
4. Cooper G., Adams, K. The Cell: A Molecular A. 2023. 9th ed. Oxford University Press.

SOLS/BT/MD/ID (M)-III (P) Fundamentals of Cell Biology (Practical)

(Cr. -1)

1. Study of permanent slides of mitosis and meiosis.
 2. Onion root tip slide preparation to study stage of mitosis.
 3. Study of model of cell organelles.
- Any other related practical based on the facility.

B.Sc. Biotechnology Semester-IV**Core Course:** Paper XI Basics of Molecular Biology (SOLS/BT/DSC-V Major)

Course Credits	04 (Four)
Course Learning Outcomes	• Learn the basic concepts and fundamentals of molecular biology. • Understand the essentials of biological molecules and molecular processes. • Analyse and apply the knowledge of molecular biology in biotechnology applications. • Evaluate the role of molecular biology in genetic engineering via advanced biotechnology approaches.

Paper-XI Basics of Molecular Biology
(Course Code: SOLS/BT/DSC-V Major)

No. of Credits: 4**UNIT-I (Cr-1)**

Importance of Molecular Biology, Nucleic acids: DNA and RNA—basic structure, types and properties; organization of genetic material in prokaryotes and eukaryotes. Central Dogma of Molecular Biology. Denaturation and renaturation of DNA.

UNIT-II (Cr-1)

DNA replication – Meselson-Stahl experiment as evidence of semi-conservative replication. Basic mechanism of DNA replication, bidirectional and unidirectional replication, and key enzymes involved in prokaryotes and eukaryotes.

UNIT-III (Cr-1)

Transcription: basic mechanism in prokaryotes and eukaryotes; types and functions of RNA.

UNIT-IV (Cr-1)

Genetic code and its properties. Translation in prokaryotes and eukaryotes including basic steps and role of ribosome and tRNA. Operon system.

Recommended Books:

1. Karp G., Iwasa J., Marshall W. Cell and Molecular Biology: Concepts & Experiments. 2020. 9th ed. John Wiley & Sons.
2. Watson J.D. Molecular Biology of the Gene. 2025. 9th ed. Affiliated East-West Press.
3. Krebs J.E., Goldstein E.S., Kilpatrick S.T. Lewin's GENES XII. 2017. 12th ed. Johns and Bartlett Publishers, Inc.

SOLS/BT/DSC-V (P) (Major) Basics of Molecular Biology (Practical)**(Cr. -1)**

1. DNA isolation.
 2. Agarose Gel preparation and Electrophoresis.
 3. Estimation of DNA purity by spectroscopy.
- Any other related experiment based on the facility.

B.Sc. Biotechnology Semester-IV**Core Course:** Paper XII Basics of Molecular Biology (SOLS/BT/DSC-IV Minor)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic concepts and fundamentals of molecular biology. • Understand the essentials of biological molecules and molecular processes. • Analyse and apply the knowledge of molecular biology in biotechnology applications. • Evaluate the role of molecular biology in genetic engineering via advanced biotechnology approaches.

Paper-XII Basics of Molecular Biology
(Course Code: SOLS/BT/DSC-IV Minor)

No. of Credits: 3**UNIT-I (Cr-0.75)**

Importance of molecular biology, DNA and RNA—basic structure, types and properties and Organization of DNA. Central Dogma of Molecular Biology.

UNIT-II (Cr-0.75)

DNA replication; types of replication (Conservative, semiconservative, non-conservative), Replication in Prokaryotes and Eukaryotes.

UNIT-III (Cr-0.75)

Transcription in Prokaryotes and Eukaryotes.

UNIT-IV (Cr-0.75)

Translation in Prokaryotes and Eukaryotes. Operon system

Recommended Books:

1. Karp G., Iwasa J., Marshall W. Cell and Molecular Biology: Concepts & Experiments. 2020. 9th ed. John Wiley & Sons.
2. Watson J.D. Molecular Biology of the Gene. 2025. 9th ed. Affiliated East-West Press.
3. Krebs J.E., Goldstein E.S., Kilpatrick S.T. Lewin's GENES XII. 2017. 12th ed. Johns and Bartlett Publishers, Inc.

SOLS/BT/DSC-IV (P) (Minor) Basics of Molecular Biology (Practical)**(Cr. -1)**

1. DNA isolation.
 2. Agarose Gel preparation and Electrophoresis.
 3. Estimation of DNA purity by spectroscopy.
- Any other related experiment based on the facility.

B.Sc. Biotechnology Semester-IV

Core Course: Paper XIII Enzymology (SOLS/BT/DSC-SEC-VI Major)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic enzymes, types, characteristics, and their role. • Understand the enzyme mechanism and catalytic function in biological processes. • Analyse and apply the knowledge of enzymology in various biotechnology applications. • Evaluate the role of enzymes in biological activities and functions.

Paper-XIII Enzymology
(Course Code: SOLS/BT/DSC-SEC-VI Major)

No. of Credits: 3

UNIT-I (Cr-0.75)

Enzymes: History, classification, properties, holoenzyme, apoenzyme, cofactor, coenzyme, prosthetic group and factors affecting enzyme activity.

UNIT-II (Cr-0.75)

Enzyme substrate complex: Concept of E-S complex, binding sites, active site, specificity, lock and key model, induced fit model, and inhibitors.

UNIT-III (Cr-0.75)

Allosteric enzymes: Nature and properties, Qualitative description of concerted and sequential models, cooperativity, Ribozymes, and Zymogens,

UNIT-IV (Cr-0.75)

Enzyme Technology: Methods for large scale production of enzymes, Concept of immobilized enzymes and their application.

Recommended Books:

1. Berg J., Gregory G.J., Justin H., John T., Lubert S. Biochemistry. 2023. 10th ed. W H Freeman & Co Ltd.
2. Murray R.K., Bender D.A., Botham K.M., Kennelly P.J., Rodwell V.W. Harper's Illustrated Biochemistry. 2009. 28th ed. McGraw-Hill.
3. Voet D., Voet J.G. Biochemistry. 2010. 4th ed. John Wiley & Sons Inc.
4. Price N., Stevens L. Fundamentals of Enzymology. 1989. 2nd ed. Oxford University Press.

B.Sc. Biotechnology Semester-IV**Core Course:** Paper XIV Fundamentals of Genetics (SOLS/BT/MD/ID(M)-IV)

Course Credits	03 (Three)
Course Learning Outcomes	• Learn the basic concepts, scope, and history of genetics. • Understand the necessities of genetics in the organization of organisms and biological processes. • Analyse and apply the knowledge of genetics in broad biotechnology applications. • Evaluate the role of genetics in human welfare.

Paper-XIV Fundamentals of Genetics
(Course Code: SOLS/BT/MD/ID(M)-IV)

No. of Credits: 3**UNIT-I (Cr-0.75)**

Definition and scope of genetics: History of Mendel's experiments, Mendel's Laws of heredity and inheritance, Reasons of Mendel's success, Dominance and recessive traits, back cross and test cross.

UNIT-II (Cr-0.75)

DNA as a genetic material

Chromosome structure: Histones, Nucleoid and Solenoid body, Euchromatin and Heterochromatin.

UNIT-III (Cr-0.75)

Giant chromosome: Polytene and Lampbrush chromosome.

Fine structure of Gene: Muton, Recon, Cistron.

UNIT-IV (Cr-0.75)

Cytoplasmic Inheritance, Sex linked inheritance, Mutation, and genetic disorders.

Recommended Books:

1. Brooker R.J. Genetics: Analysis and Principles. 2023. 8th ed. McGraw-Hill College.
2. Krebs J.E., Goldstein E.S., Kilpatrick S.T. Lewin's GENES XII. 2017. 12th ed. Johns and Bartlett Publishers, Inc.
3. Snustad D.P., Simmons M.J. Principles of Genetics. 2015. 7th ed. John Wiley & Sons Inc.
4. Gangane S.D. Human Genetics. 2025. 7th ed. Elsevier.
5. Watson J.D. Molecular Biology of the Gene. 2025. 9th ed. Affiliated East-West Press.

SOLS/BT/MD/ID (M)-IV (P) Fundamentals of Genetics (Practical)**(Cr. -1)**

1. To observe different stages of mitosis and meiosis using permanent slides.
 2. To prepare slides of cell division from onion root tip.
 3. Numerical related to Mendel's laws.
- Any other related practical based on the facility.