SEMESTER WISE & COURSE WISE CREDIT DISTRIBUTION STRUCTURE UNDER NEP, 2020 at UG LEVEL (HONOURS with RESEARCH)

Semester	Course Type	Level	Name of the Course	Credit	Lect.	Tuto.	Pract./Viva	Full Marks	Distribution of Marks		
									Theory	Pract. / Tuto./ Viva-voce	Internal Assessment
I	Major/DS Course (Core)	100-199	Major 1: Fundamental of Biotechnology	4	3		1	75	40	20	15
	Minor Course	100-199	Minor 1: Human Welfare	4	3		1	75	40	20	15
	Multidisciplinary			3	2	1	0	50	40	0	10
	Ability Enhancement Course (AEC) [L_1-1 MIL]		Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu or Equvlnt. Course from SWAYAM	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC)		SEC 1: Molecular Diagnostic and Forensic Techniques	3	2	1	0	50	40	0	10
	Common Value Added (CVA) Course		Environmental Science/ Education	4	3	0	1	100	60	20	20
	Total			**20**				**400**			

Semester	Course Type	Level	Name of the Course	Credit	Lect.	Tuto.	Pract. /Viva	Full Marks	Distribution of Marks		
									Theory	Pract. / Tuto./ Viva-voce	Internal Assessment
II	Major/DS Course (Core)	100-199	Major 2: Biochemistry and Metabolism	4	3	0	1	75	40	20	15
	Minor Course	100-199	Minor 2: Developmental Biology	4	3	0	1	75	40	20	15
	Multidisciplinary			3	2	1		50	40	0	10
	Ability Enhancement Course (AEC)[L_2-1]		English or Equvlnt. Course from SWAYAM	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC)		SEC 2: Fermentation Technology	3	2	1	0	50	40	0	10
	Common Value Added (CVA) Course			4	3/3	1/0	0/1	100	80/60	0/20	20
Skill based vocational course (addl. 4 Cr) during summer term for 8 weeks, who will exit the programme after securing 42 cr.											
For UG Certificate 42 cr + Additional 4 cr (work based vocational course) = 46 cr. Students are allowed to re-enter within 3 years within the stipulated max. period of 7 years											
	Total			**20**				**400**			

Semester I

Major 1

Course Objective

- To explore the historical practices and everyday applications of Biotechnology in order to gain a comprehensive understanding of its principles.
- To apply biotechnology effectively in diverse fields such as health, food, agriculture, and medicine.
- To learn the importance of ethics and regulatory issues while practicing Biotechnology.

3 CR
Marks 50 (40+10)

Fundamental of Biotechnology (Theory)

Introduction to Biotechnology- History, Trends in Biotechnology	6 L
Branches of Biotechnology- Animal Biotechnology, Computational Biotechnology, Environmental Biotechnology, Forensic Biotechnology, Industrial Biotechnology, Microbial Biotechnology, Medical Biotechnology, Nanobiotechnology, Plant and Agricultural Biotechnology, Pharmaceutical Biotechnology.	15 L
Brief Introduction to Genomics and Proteomics	4 L
Basic Introduction to Gene Manipulation- GMO	4 L
Ethics in Biotechnology, IPR and Bio-entrepreneurship	6 L
Careers in Biotechnology	5 L

1 CR
Marks 25 (20 +5)

Practical

- Basic principles of Biotechnology laboratory protocols and biosafety measures.
- Preparation of solutions based on molarity, molality, normality, percentage, and dilutions.
- Preparation and properties of different buffer solutions.
- Preparation and sterilization of culture media for animal, microbes and plant.
- Demonstration of basic fundamental instruments essential for experiments including pH meter, colorimeter, light microscope, centrifuge and electrophoresis.
- Calibration of basic laboratory equipment like pH meter and colorimeter.

Suggested readings

- Biotechnology Fundamentals by Firdous Alam (3rd Edition).
- Introduction to Biotechnology by William J. Thieman and Michael A. Palladino
- Biotechnology: Expanding Horizons by B. D. Singh
- Biotechnology: Academic Cell Update Edition by David P. Clark and Nanette J. Pazdernik

Course Outcome

This paper holds great significance for students as it provides them with essential knowledge of biotechnology and its potential for career development. The main objective is to make students familiar with wide scope of Biotechnology such as microbial biotechnology, recombinant DNA technology, plant and animal biotechnology, computational biotechnology, genomics, and proteomics. By gaining a comprehensive understanding of these branches, students will be equipped to make informed decisions regarding their field of study and future career paths within the biotechnology domain.

Minor 1
Course Objective

- To develop a comprehensive understanding of the fundamental principles and applications of biotechnology in addressing human welfare challenges.
- To examine the role of biotechnology in enhancing healthcare, including the development of advanced diagnostics, therapeutics, and personalized medicine.
- To explore the contributions of biotechnology to food security and sustainable agriculture.

3 CR
Marks 50 (40+10)

Human Welfare

Industrial production of Alcohol and antibiotic (Penicillin). 10 L

Application of Biotechnology in Agriculture, N2 fixation, transfer of pest resistance genes to plants. 8 L

Application of biotechnology in environments: e.g., chlorinated and non-chlorinated organic pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB. 12L

Application of Biotechnology in forensic science: e.g., solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing. 4 L

Application of Biotechnology in health, basic concept of therapy. 8 L

1 CR
Marks 25 (20 +5)

Practical

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

- Study of ethanolic fermentation using Baker's yeast
- Study of a plant part infected with a microbe
- Isolation and analysis of DNA from minimal available biological samples
- Preparation of root nodules from a leguminous plant
- Dissertation based on applications of biotechnology (*any one topic from theory syllabus*) and viva-voce to be conducted on whole syllabus of the practical paper.

Course Outcome

This course aims to provide students with comprehensive knowledge of biotechnological approaches applied to various aspects of human welfare. This course will introduce societal aspect of the subject Biotechnology. By gaining insights into these approaches, students will be better prepared for their future careers and job opportunities.

Suggested readings

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
- Salisbury, Whitaker and Hall. Principles of fermentation Technology.

Skill Enhancement Course 1

Course objective

- To gain knowledge of the fundamental concepts and techniques used in molecular diagnostics, including polymerase chain reaction (PCR) and DNA sequencing,
- To explore the applications of molecular techniques in forensic investigations, including DNA profiling, forensic DNA analysis, and forensic pathology.

3 CR
Marks 50 (40 +10)

Molecular Diagnostic and Forensic Techniques (Theory)

Molecular methods in Clinical Microbiology, Applications of PCR, RFLP, Hybridization (Nucleic acid base) methods, Immunofluorescent, Immune diagnostic test. 8 L

Enzyme Immunoassay- Enzymes available for Enzyme immune assays and conjugation of enzymes: General Idea. Solid phases used in Enzyme Immunoassays. Homogeneous and Heterogenous Enzyme Immunoassays. Enzyme Immune Histochemical Techniques. Use of Monoclonal and Polyclonal Antibodies in Enzyme Immunoassays. 12 L

Introduction and Principles of Forensic Science and Techniques. Forensic Science Laboratory and its Organization and Services. Tools and Techniques in Forensic Science. Forensic Entomology. Criminology- Causes of crime and role of modus operandi in investigation. Injury types, methods of assessing various types of death. 12 L

Principles of DNA Fingerprinting: Role of satellite DNA, Different types of repetitive sequences in Fingerprinting. Application of DNA Fingerprinting in Forensic media. 6 L

Tutorial

Course Outcome

This course is designed to provide students with basic knowledge of various aspects of biotechnology and its applications specifically in the domains of health Biotechnology including forensic science. By acquiring knowledge from this course, students will be equipped to apply these techniques effectively in their future employment opportunities.

Suggested readings

- Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
- M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
- S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
- W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
- R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
- W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

Interdisciplinary subject

Course Objective

- To develop a comprehensive knowledge of the fundamental concepts and theories that underpin Biotechnology.
- To gain an understanding of the historical development and milestones in biotechnology, as well as its current and future impact on various fields.
- To understand the ethical considerations, safety protocols, and regulatory frameworks associated with biotechnological practices.

3 CR
Marks 50 (40+10)

Introduction to Biotechnology

History of Biotechnology: Applications and scope of Biotechnology in global market. 6 L

Structure and Function Biomolecules and their estimation: Carbohydrate- Sugar and their derivatives; Protein; amino acids, Lipids; fatty acids, glycerol and cholesterol, Nucleic acids; nucleotides**.** 10 L

Genetics: Mendelian genetics, Linkage and crossing over, Gene mapping and mutation. 10 L

Cell and organisms: Cell structure and components, Organization of life, Cell division, Cell cycle and cellular properties, reproduction 14 L

Tutorial

Course outcome

Encourage students to understand the interconnectedness of Biotechnology and other scientific fields, and to develop a thirst for knowledge and a lifelong commitment to learning in the field of biotechnology.

Suggested readings

- Introduction to Biotechnology by William J. Thieman and Michael A. Palladino
- Biotechnology: Expanding Horizons by B. D. Singh

Semester II

Major 2

Course Objective

- The objective of this course is to provide students with a comprehensive understanding of the fundamental principles including the structure, function, and metabolism of biological molecules and applications of biochemistry.

3 CR
Marks 50 (40+10)

Biochemistry and Metabolism (Theory)

Carbohydrates: Definition; structure of carbohydrates- monosaccharide, aldohexoses and ketohexoses with examples; Howarth structure, anomeric structures of D-glucose, mutarotation, pyranose and furanose rings. Oligo- and polysaccharides, reducing (maltose) and non-reducing (sucrose), disaccharides; glycoproteins, proteoglycans. 8 L

Carbohydrates metabolism: Reaction, energetic & regulation: Glycolysis: Fate of pyruvate under aerobic & anaerobic condition. Pentose phosphate pathway & its digestion. Gluconeogenesis, Glycogenolysis & Glycogen synthesis. TCA Cycle, Electro transfer chain, Oxidative phosphorylation, beta oxidation of fatty acids. 6 L

Amino acids: Peptides and proteins; structures and important properties, classification of amino acids, important physical and chemical properties of amino acids (optical isomerism, UV-absorption, ionization, reactions due to amino group and carboxyl group). Primary structure of peptides. Primary, secondary, tertiary and quaternary structures, classification of proteins (based on solubility and composition). C and N terminal amino acid determination. 10 L

Lipids: Definition, distinction between fats and oils, structure of lipids (fatty acids, glycerolipids, sphingolipids). 5 L

Nucleic acids: Structure of nucleic acids; nucleosides, nucleotides, primary structure, A, B and Z form of DNA; preliminary idea of secondary structures of RNA and DNA; melting point and denaturation of DNA. 5 L

Enzymes: Definition of enzymes, important terms (enzyme unit, specific activity), classification of enzymes; physico-chemical properties, factors affecting activity; mechanism of enzyme action, coenzymes, cofactors. 6 L

1 CR
Marks 25 (20 +5)

Practical

- Qualitative tests for sugars, amino acids, proteins & lipids; separation of amino acids by PC/TLC methods.
- Quantitative estimation of sugars (DNS method) and proteins (Folin-Phenol).
- Isolation and quantification of DNA (diphenylamine method) and RNA (orcinol method) analysis, saponification value of fat.
- Quantitative assay for protease & catalase from plant source.
- To study the effect of Ph, Temperature on the activity of salivary amylase

Course Outcomes

Students will gain a comprehensive understanding of the basic principles of biochemistry, including the structure, function, and metabolism of biological molecules. Students will gain a deep understanding of the major metabolic pathways involved in energy production, including glycolysis, the citric acid cycle, oxidative phosphorylation, and photosynthesis. Overall, successful completion of this biochemistry course will equip students with a strong foundation in the principles and applications of biochemistry, preparing them for further studies or careers in various fields.

Suggested readings

- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
- Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
- Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
- Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
- Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
- Biochemistry Practical- Plummer
- Biochemistry Practical- Swadashivam Manikap

Minor 2

Course Objective

- To gain knowledge of the fundamental principles and concepts of developmental biology, including the stages of embryonic development and the cellular and molecular mechanisms involved.

- To examine the cellular processes, such as cell division, differentiation, migration, and tissue patterning, that contribute to organogenesis and tissue formation.

3 CR
Marks 50 (40+10)

Developmental Biology (Theory)

Scope of studying developmental biology in biotechnological applications, Gametogenesis and Fertilization- Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization-Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk. 10 L

Early embryonic development- Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos. 10 L

Embryonic Differentiation- Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens. 10 L

Organogenesis- Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behavior: constancy & plasticity, Extra embryonic membranes, placenta in Mammals. 10 L

1 CR
Marks 25 (20 +5)

Practical

- *(Principle & concepts can be demonstrated through videos/virtual labs or other materials)*
- Identification of developmental stages of chick and frog embryo using permanent mounts
- Preparation of a temporary stained mount of chick embryo.
- Study of developmental stages of Anopheles. [From permanent slides or photomicrographs]
- Study of the developmental stages of Drosophila from stock culture/ photographs.
- Study of different types of placenta [Photographs or models].

Course outcome

By the end of this course on Developmental Biology, students will be able to describe the key stages and processes involved in the development of multicellular and understand the role of genetics and epigenetics in developmental processes, including the regulation of cell

differentiation and tissue patterning. organisms. This course will also teach the importance of studying Developmental Biology in Reproductive Engineering.

Suggested readings

- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
- Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

Skill Enhancement Course 2

Course Objectives

- To comprehend the practical application of different process techniques in large-scale bioprocessing.
- To acquire the skills and knowledge necessary for aseptic transfer, inoculum development, and upstream processing in fermentation processes.
- To gain an understanding of various fermentation processes used to produce value-added products utilizing low-value substrates as raw materials, employing microorganisms or enzymes as biocatalysts.

3 CR
Marks 40 (30+10)

Fermentation Technology (Theory)

Production of industrial chemicals, biochemicals and chemotherapeutic products. gluconic acid, Biofuels: Biogas, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial insecticides. 15 L

Microbial products of pharmacological interest, steroid transformations. Secondary metabolism – its significance and products. Enzyme and cell immobilization techniques in industrial processing. 15 L

Purification & characterization of proteins, Upstream and downstream processing. 10 L

Tutorial

Course outcome

This course aims to provide students with comprehensive information on various industrial techniques associated with food technology and microbial biotechnology. The knowledge gained will equip students for future employment in diverse industries.

Suggested reading

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
- Salisbury, Whitaker and Hall. Principles of fermentation Technology.