

The University of Burdwan



**Syllabus for 4-Year Honours in
Biotechnology**
**under Curriculum and Credit Framework for Undergraduate
Programmes (CCFUP) as per NEP, 2020
with effect from 2023-24**

SEMESTER WISE & COURSE WISE CREDIT DISTRIBUTION STRUCTURE UNDERCCFUP AS PER NEP, 2020

| 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 | BIOT1011: Fundamental of Biotechnology | 4 | 3 | 0 | 1 | 75 | 40 | 20 | 15 |
| | Minor Course | 100-199 | BIOT1021: Human Welfare | 4 | 3 | 0 | 1 | 75 | 40 | 20 | 15 |
| | Multi/Inter disciplinary | | BIOT1031: Introduction to Biotechnology | 3 | 2 | 1 | 0 | 50 | 40 | 0 | 10 |
| | Ability Enhancement Course (AEC) [L ₁ -1 MIL] | | 1041: Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu or EquvInt. Course from SWAYAM/Any other UGC-recognized platform | 2 | 2 | 0 | 0 | 50 | 40 | 0 | 10 |
| | Skill Enhancement Course (SEC) | | BIOT1051: Molecular Diagnostic and Forensic Techniques | 3 | 2 | 1 | 0 | 50 | 40 | 0 | 10 |
| | Common Value Added (CVA) Course | | CVA1061: 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 | BIOT2011: Biochemistry and Metabolism | 4 | 3 | 0 | 1 | 75 | 40 | 20 | 15 |
| | Minor Course | 100-199 | BIOT2021: Developmental Biology | 4 | 3 | 0 | 1 | 75 | 40 | 20 | 15 |
| | Multi/Interdisciplinary | | BIOT2031: Biotechniques | 3 | 2 | 1 | | 50 | 40 | 0 | 10 |
| | Ability Enhancement Course (AEC)[L ₂ -1] | | ENGL2041: Functional English or EquvInt. Course from SWAYAM/ /Any other UGC-recognized platform | 2 | 2 | 0 | 0 | 50 | 40 | 0 | 10 |
| | Skill Enhancement Course (SEC) | | BIOT2051: Fermentation Technology | 3 | 2 | 1 | 0 | 50 | 40 | 0 | 10 |
| | Common Value Added (CVA) Course | | CVA2061: Understanding India/Digital & technological solutions/Health& Wellness, Yoga Education, Sports& Fitness | 4 | 3/3 | 1/0 | 0/1 | 100 | 80/60 | 0/20 | 20 |
| Total | | | | | | | | | | | |
| | | | | 20 | | | | 400 | | | |

Major

Semester -I

BIOT1011

Fundamental of Biotechnology

CR 4 Full Marks 75 (Th. 40 + Prac. 20 + IA. 15)

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.

Theory

CR.- 3, Marks- 40

| | |
|---|------|
| 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 |

Practical

CR.-1, Marks- 20

- 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**

BIOT1021 Human Welfare

CR 4 Full Marks 75 (Th. 40 + Prac. 20 + IA. 15)

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.

Theory

CR.- 3, Marks- 40

| | |
|---|------|
| Industrial production of alcohol and antibiotic (Penicillin). | 10 L |
| Application of Biotechnology in Agriculture, N ₂ 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 |

Practical

CR.-1, Marks- 20

(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.

N.B. ** Exclusively for students of B.Sc. Biotechnology

Multi/Interdisciplinary Course

BIOT1031 Introduction to Biotechnology

CR 3 Full Marks 50 (Th. 40 + IA. 10)

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.

Theory

CR.- 3, Marks- 40

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

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

Skill Enhancement Course

BIOT1051 Molecular Diagnostic and Forensic Techniques

CR 3 Full Marks 50 (Th. 40 + I.A. 10)

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.

Theory

CR.- 3, Marks- 40

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

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).

Semester II

Major

BIOT2011 Biochemistry and Metabolism

CR 4 Full Marks 75 (Th. 40 + Prac. 20 + IA. 15)

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.

Theory

CR.- 3, Marks- 40

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

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

Proteins: 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

Practical

CR.-1, Marks- 20

- 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 Outcome

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- SwadashivamManikap

****Minor**

BIOT2021 Developmental Biology

CR 4 Full Marks 75 (Th. 40 + Prac. 20 + IA. 15)

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.

Theory

CR.- 3, Marks- 40

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 germ layers Development of behavior: constancy & plasticity, Extra embryonic membranes, placenta in Mammals. 10L

Practical

CR.-1, Marks- 20

(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.

N.B. ** Exclusively for students of B.Sc. Biotechnology

Multi/Inter disciplinary Course

BIOT2031

Biotechniques

CR 3 Full Marks 50 (Th. 40 + IA. 10)

Course Objective

- ❖ To teach students with a comprehensive understanding of the fundamental principles of basic instruments including microscopy, spectroscopy, and chromatography.
- ❖ To provide students with a foundation in the basic concepts of culture techniques.

Theory

CR.- 3, Marks- 40

| | |
|--|------|
| Analytical techniques: Microscopy, Spectroscopy, Chromatography, Electrophoresis (Agarose and PAGE), PCR and Q-PCR | 10 L |
| Culture techniques: Plant, Animal and Microbes (<i>E. coli</i> , <i>Saccharomyces cerevisiae</i> , Influenza) | 10 L |
| Isolation of genomic DNA and plasmid DNA | 10 L |
| Methods of gene transfer: Electroporation, Gene gun technique, Agrobacterium mediated genetransfer. | 10 L |

Course outcome

This course will equip students with the fundamental knowledge of biotechniques, which will prepare them to use these techniques in their future careers.

Suggested readings

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

Skill Enhancement Course

BIOT2051 Fermentation Technology

CR 3 Full Marks 50 (Th. 40 + IA. 10)

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.

Theory

CR.- 3, Marks- 40

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. 15L

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

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

Proposed pool of subjects for Multi/Interdisciplinary courses

- Computer Applications
- Computer Science
- Geography
- Business Administration
- Mathematics

Students can choose multi/interdisciplinary courses from the above-mentioned pool of subjects provided that the chosen subject is available in the college concerned.

SEMESTER WISE & COURSE WISE CREDIT DISTRIBUTION STRUCTURE UNDER CCFUP AS PER NEP, 2020

| 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 |
| III | Major/DS Course (Core) | 200-299 | BIOT 3011: Cell Biology | 5 | 4 | 0 | 1 | 75 | 40 | 20 | 15 |
| | | | BIOT 3012: Mammalian Physiology | 5 | 4 | 0 | 1 | 75 | 40 | 20 | 15 |
| | Minor Course | 200-299 | 3021: Vocational Education & Training | 4 | | | | 75 | | | 15 |
| | Multi/Inter disciplinary | | BIOT3031: Scope of Biotechnology | 3 | 3 | 0 | 0 | 50 | 40 | 0 | 10 |
| | Ability Enhancement Course (AEC) [L ₁ -2 MIL] | | 3041: Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu or Equvlnt. Course from SWAYAM/Any other UGC-recognized platform | 2 | 2 | 0 | 0 | 50 | 40 | 0 | 10 |
| | Skill Enhancement Course (SEC) | | BIOT3051: Enzymology | 3 | 3 | 0 | 0 | 50 | 40 | 0 | 10 |
| | Total | | | 22 | | | | 375 | | | |

| 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 |
| IV | Major/DS Course (Core) | 200-299 | BIOT4011: Plant Physiology | 5 | 4 | 0 | 1 | 75 | 40 | 20 | 15 |
| | | | BIOT4012: Genetics | 5 | 4 | 0 | 1 | 75 | 40 | 20 | 15 |
| | | | BIOT4013: General Microbiology | 5 | 4 | 0 | 1 | 75 | 40 | 20 | 15 |
| | Minor Course** <i>N.B. ** Exclusively for students of B.Sc. Biotechnology</i> | 200-299 | BIOT4021: Biophysics & Instrumentation | 4 | 3 | 0 | 1 | 75 | 40 | 20 | 15 |
| | Minor Course** <i>N.B. ** Exclusively for students of B.Sc. Biotechnology</i> | | BIOT4022: Human Genetics | 4 | 3 | 0 | 1 | 75 | 40 | 20 | 15 |
| Ability Enhancement Course (AEC)[L ₂ -2] | | ENGL4041: Language and Creativity or Equvlnt. Course from SWAYAM/ /Any other UGC-recognized platform | 2 | 2 | 0 | 0 | 50 | 40 | 0 | 10 | |
| Total | | | | 25 | | | | 425 | | | |

Semester-III

Major BIOT 3011: Cell Biology

CR 5 Full Marks: 75 (40+20+15)

Course Objective

- ❖ To study the cellular details and chromosomal morphology
- ❖ To learn the endo-membrane system and cytoskeleton
- ❖ To study the cell cycle and cancer biology in details

Theory

CR- 4, Marks: 40

1. Cellular basis of life: Cell doctrine, cells in general, diversity of cell size and shape, cell theory; structure of eukaryotes and prokaryotes cells (including viruses).

6L

2. Cellular information: The nucleus (ultra-structure), the organization of chromosomes (euchromatin and heterochromatin), nucleosome concept and chromosome packaging, Chromatosome.

6L

3. The cell surface: Plasma membrane, membrane fluidity, movement across plasma membrane, Modification of plasma membrane (Plasmodesmata and desmosome); Plants and bacterial cell walls; an outline of extracellular substances of animal cells.

10L

4. Endo-membrane system: Endoplasmic reticulum, Mitochondria, Golgi apparatus, Chloroplast, lysosomal system, plant cell vacuoles, microbodies structure and function.

10L

5. The cytoskeleton: Microtubules, microfilaments and intermediate filaments.

6L

6. Introduction to cell cycle: Phases, check points; Mitosis & Meiosis.

4L

7. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecules basis of cancer.

8L

Practical

CR.-1, Marks- 20

1. Preparation of Meiotic Chromosome from grasshopper.
2. Preparation of Mitotic Chromosome from onion root tip.
3. Preparation of Meiotic Chromosome from *Rhoeo discolor*.
4. Preparation and study of polytene chromosome from *Drosophila/Chironomous* salivary gland.
5. Study of sex chromatin through preparation of Barr body from buccal epithelium and Drumstick from blood film.
6. Study of chromosomal aberration induced by BHC & pesticide in onion root tips.
7. Artificial induction of polyploidy/aneuploidy in onion root through colchicine exposure.

Suggested readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 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.

Course Outcome

This paper holds great significance for students as it provides them with essential knowledge of cell and cancer biotechnology and its potential for career development in fundamental research.

Major BIOT 3012: Mammalian Physiology

CR 5, Full Marks 75 (40+20+15)

Course objective:

The course objective is to study the different physiological systems of mammals such as

- ❖ Digestion and Respiration system
- ❖ Circulatory system
- ❖ Muscular physiology and Nervous and endocrine system

Theory

CR-4, Marks: 40

Digestion and Respiration

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice
Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, high altitude adaptation, Chloride shift. **10L**

Circulation

Composition of blood, Plasma proteins, lymph & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Cardiac output, cardiac cycle, Origin & conduction of heartbeat. **10L**

Muscle physiology and osmoregulation

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle **contraction**.

10L

Excretion and Osmoregulation

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation & Osmoregulation in vertebrates

6L

Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters, Mechanism of action of hormones (insulin and steroids) Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

14L

Practical

CR-1, Marks: 20

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of salivary amylase
6. Hemoglobin estimation [Sahli's method]

Suggested Reading

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons, Inc.

Course Outcome:

After successful completion of the course, the student will be able to: Explain human anatomy and physiology: describe cellular levels of organization, and the basics of biochemistry and cell biology.

Minor Course

3021: Vocational Education & Training

CR-4 (Full Marks: 75)

Multi/Interdisciplinary BIOT3031: Scope of Biotechnology CR-3 Full Marks: 50(40+10)

Course Objectives:

- ❖ Students develop global competencies in the area of basic and applied biological sciences.
- ❖ Enhancing the subject knowledge of students by using traditional and modern ICT based teaching methods and learning by doing

Theory

Marks: 40

1. A basic idea on plant and agriculture Biotechnology and its scope, Plant tissue culture techniques and its applications: genetically modified crop, Horticulture, forestation and conservation. 15L
2. Biotechnology in animal husbandry and poultry – Transgenic animals, milk and meat production, food biotechnology, leather technology. 15L
3. Basic idea on microbial morphology, Industrial production of ethanol. Basic idea on Biofertilizer and biopesticide 10L
4. Health Biotechnology: Diagnostic, Therapeutics, Vaccine production, Biotechnology assisted health aids 10L

Course Outcome:

There is an immense career scope in Biotechnology and some of the major job opportunities in Biotechnology include, Forensic Science Technicians, Medical Scientists, Microbiologists, Environmental Biotechnologist, Geneticist, Molecular Biotechnologist, Epidemiologist, R&D Scientists.

Suggested Readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
4. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
5. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
7. Salisbury, Whitaker and Hall. Principles of fermentation Technology.

Ability Enhancement Course (AEC): MIL (L₁-2)

CR 2 Full Marks: 50 (40+10)

Skill Enhancement Course BIOT3051: Enzymology

CR 3 Full Marks: 50 (40+10)

Course Objectives:

- ❖ The major learning objective of the course is to understand the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell.

Theory

MARKS-40

UNIT - I

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of K_m and V_{max} and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy. **(20L)**

UNIT – II

Enzyme regulation: Product inhibition, feedback control, covalent modification. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme- eg. Fatty Acid synthase **(15L)**

UNIT – III

Enzyme Technology: Methods for large scale production of enzymes. Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Methods for protein sequencing (Edman's degradation). **(15L)**

Suggested Readings

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
4. Biochemistry by Mary K.Campbell& Shawn O.Farrell, 5th Edition, Cengage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

Course outcome

The major learning objective of the course is to understand the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell. At the conclusion of the course students should be able to: Describe and use the equations of enzyme kinetics. Describe the methods used in enzyme kinetics. Describe the principles of enzyme inhibition. Describe the mechanisms of enzyme catalysis. Describe the catalytic mechanisms employed by the well-characterized enzymes. Describe the mechanisms of enzyme regulation

Semester-IV

Major Course

BIOT4011: Plant Physiology

CR 5 Full Marks 75 (40+20+15)

Course objective:

Aims of the course is to study different physiological activities of plant like

- ❖ Plant water relationship and idea on micro & macro nutrients
- ❖ Photosynthesis, photorespiration, nitrogen metabolism
- ❖ Plant growth and development

Theory

CR-4, Marks: 40

Plant water relations and micro & macro nutrients

20L

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

Carbon and nitrogen metabolism

15L

Photosynthesis- Photosynthetic pigments, concept of two photo systems, photophosphorylation, calvin cycle, C4 cycle, CAM plants, SAM, photorespiration, compensation point, Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Growth and development

15L

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxin, gibberellin, cytokinin, abscisic acid, ethylene), Physiological role and mode of action, seed dormancy and seed germination, concept of flowering - role of photoperiodism, vernalization and phytohormones.

Practical

CR-1, Marks: 20

1. Study of evolution of oxygen during photosynthesis
2. Demonstration of opening & closing of stomata.
3. Preparation of root nodules from a leguminous plant.
4. Seed viability test using TTC.
5. Study of rate of transpiration per unit area of leaf.

Suggested Readings:

1. Hopkins, W.G. and Huner, P.A. Introduction to Plant Physiology. John Wiley and Sons.
2. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, latest edition, W.H. Freeman and Company, New York, USA.
3. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd.
4. Taiz, L. and Zeiger, E. Plant Physiology, latest edition, Sinauer Associates Inc .MA, USA

Course Outcome:

Encourage students to understand the different physiological aspect of plant in details which will be helpful for them for further study.

BIOT4012: Genetics

CR 5 Full Marks 75 (40+20+15)

Course objective:

- ❖ To build knowledge on the fundamentals of genetics, heredity, or inheritance.
- ❖ Understand how genes and chromosomes function.
- ❖ To build the foundation on the understanding of biological principles.
- ❖ To develop the understanding of life processes - survival and maintenance.

Theory

CR-4, Marks: 40

UNIT I

15 L

Mendelian genetics: Monohybrid, di-hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance and expressivity

UNIT II

8 L

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

UNIT III

15 L

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation

(reciprocal and Robertsonian), General concept of epigenetics, position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy.

UNIT IV

12 L

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, multiple crossing over Genetic mapping.

Practical

CR-1, Marks: 20

1. Study of *Rhoeo* translocation.
2. Pedigree charts of some common characters like blood group, color blindness and PTC testing.
3. Study of polyploidy in onion root tip by colchicine treatment.

Suggested reading

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
 2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
 3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
 4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

Course Outcome:

Studying genetics provides you with specialist subject knowledge, as well as skills in scientific protocol, biological research and laboratory practice, which is essential if you intend to pursue a career in a genetics-related job.

BIOT4013: General Microbiology

CR 5 Full Marks 75 (40+20+15)

Course objective:

- ❖ To understand the basics of microbiology
- ❖ Describe diversity of microorganisms, bacterial cell structure and function, microbial growth and metabolism, and the ways to control their growth by physical and chemical means
- ❖ To complement the students with the basic knowledge about microbial growth.

Theory

CR-4, Marks: 40

UNIT I

Fundamentals, History of Microbiology. (10L)

Classification of microorganisms: Microbial taxonomy, criteria used to include molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II (10 L)

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III (15 L)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction- Binary fission, sporulation, budding. Transformation, Transduction and Conjugation, Endospores.

UNIT IV (15 L)

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents (antibacterial, antifungal, & antiviral and their mode of action) Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented 3 Foods.

Practical CR-1, Marks: 20)

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

Suggested readings

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.

4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Course Outcome:

- ❖ Students will gain knowledge about the different cell organelles of microorganisms and their detailed functions.
- ❖ Students will also study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.
- ❖ Students will learn about the biomolecules by studying their structures and types.

****Minor Course**

BTOT4021: Biophysics & Instrumentation

CR 4 (3+1) Full Marks 75 (40+20+15)

Course objective:

The course is designed in such a way so that the students can learn:

- ❖ Biophysics and mathematics applicable to instrumentation in biotechnology laboratories.
- ❖ Techniques for isolation and identification of various biomolecules.
- ❖ The modern concept of microscopy.

Theory

CR-3, Marks: 40

General Biophysical methods – Measurement of pH, radioactive labeling & counting, autoradiography 5 L

Separation & Identification of Materials, Concept of Chromatography; Partition chromatography, paper chromatography, adsorption chromatography, TLC, GLC, ion exchange chromatography, gel permeation chromatography, HPLC, affinity chromatography; gel electrophoresis- polyacrylamide and agarose gel electrophoresis. 15 L

Centrifugation - Basic principle of centrifugation, ultracentrifuge (preparative, analytical), factors affecting sedimentation velocity, standard sedimentation coefficient.

10 L

Microscopy- Light microscopy, bright & dark field microscopy, phase contrast microscope, fluorescence microscopy, transmission electron microscope (TEM), scanning electron microscope (SEM). 10 L

Spectroscopy-UV visible spectroscopy, principle, Lambert-Beer Law, working Principle of colorimeter, spectrophotometer, fluorometer, use of spectroscopy in quantification of biomolecules (protein, DNA, haemoglobin, chlorophyll) 10 L

Practical

CR-1, Marks: 20

1. Separation techniques- centrifugation, chromatographic separation of sugars and amino acids (paper and thin layer chromatography) & electrophoresis (DNA and protein).
2. General concept of colorimeter and spectrophotometer

Suggested readings

1. Principles and Techniques of Biochemistry and Molecular Biology by K.Wilson and J. Walker.
2. Molecular Spectroscopy by Jack D.Gray Beal

Course Outcome:

- ❖ On successful completion of this course, students are expected to be able to:
- ❖ understand the basic concepts of quantitative instrumentation.
- ❖ recognize how quantitative instrumentation can be built, to be applied to explore our understanding in different fields and contribute to the further development of modern equipment.

****Minor Course**

BIOT4022: Human Genetics

CR 4 (3+1) Full Marks 75 (40+20+15)

Course Objective:

To develop and understanding and skill in the mechanics of inheritance, patterns of inheritance, and Mendelian inheritance in humans

Theory

CR-3, Marks: 40

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINES & LINES, middle repetitive multiple copy genes, noncoding DNA. (14 L)

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants,

variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy. (16 L)

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X- syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance. (14 L)

Population genetics: Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies (6 L)

Practical

CR-1, Marks: 20

1. Buccal smear study and staining methods for Barr bodies
2. PTC testing in a population and calculation of allele and genotype frequencies.
3. Isolation of genomic DNA (mammalian system)
4. Construction of Restriction digestion maps from data provided.

Suggested readings

1. Genetics- Strachan & Read
2. Human Genetics: Thompson & Thompson

Course Outcome:

- ❖ Students will be taught Mendelian genetics, their principles and gene interaction. They learn about chromosomal.
- ❖ Aberrations and structure of chromosomes The student will gain a basic
- ❖ Understanding on human genetics and hereditary

N.B. ** Exclusively for students of B.Sc. Biotechnology

Ability Enhancement Course (AEC)[L₂-2]

CR 2 , Full Marks 50 (40+10)