(Approved in 95th Academic Council meeting held on 25th September 2023)
Vide Resolution No. AC:95:09-23:5

Assam University, Silchar

Four Year Undergraduate Programme

Implemented under NEP 2020

Effective from the Academic Year 2023-24

Syllabus of Biotechnology

Bachelor in Biotechnology with Honours/Honours and Research

Programme Specific Objective

The objective of the Biotechnology program is to provide students with a comprehensive understanding of the principles, techniques, and applications of biotechnology. The program aims to equip students with the necessary knowledge and skills to pursue careers in various sectors of biotechnology, including research, academia, industry, and healthcare. The program also focuses on fostering critical thinking, problem-solving abilities, and effective communication skills among students.

Programme Specific Outcomes

Upon completion of the Biotechnology program, students will be able to:

1. Demonstrate a comprehensive understanding of the principles and concepts of biotechnology, including the fundamentals of cell biology, genetics, immunology, microbiology and molecular biology.
2. Apply theoretical knowledge and practical skills in various areas of biotechnology, such as cell culture, genetic engineering, recombinant DNA technology and bioinformatics.
3. Analyze and interpret data from experiments, research studies, and scientific literature in the field of biotechnology.
4. Apply ethical principles and practices in biotechnology research, considering the social, legal, and environmental implications of biotechnological advancements.
5. Communicate scientific concepts and research findings clearly and effectively through oral presentations, scientific reports, and written documentation.

Table 1: Semester-wise list of Biotechnology DSC Courses

Semester	Course Code	Title of Courses	Credits
I	BTC DSC101T	Cell Biology	3
	BTC DSC102T	Environmental Biotechnology	3
II	BTC DSC151T	Biochemistry	3
	BTC DSC152P	Cell Biology, Biochemistry and Environmental Biotechnology	3
III	BTC DSC201T	Genetics	4
	BTC DSC202T	Animal Cell Culture	4
IV	BTC DSC251T	Bioanalytical Tools	4
	BTC DSC252T	Bioprocess Technology	4
	BTC DSC253P	Genetics and Bioprocess Technology	4
V	BTC DSC301T	Plant Biotechnology	4
	BTC DSC302T	Animal Biotechnology	4
	BTC DSC303P	Plant Biotechnology and Animal Biotechnology	4
VI	BTC DSC351T	Recombinant DNA Technology	4
	BTC DSC352T	Genomics and Proteomics	4
	BTC DSC353T	Bioinformatics	4
	BTC DSC354P	Recombinant DNA Technology and Bioinformatics	4
VII	BTC DSC401T	Nanobiotechnology and Bioengineering	4
	BTC DSC402T	Molecular Diagnostics	4
	BTC DSC403T	Biostatistics	4
	BTC DSC404P	Molecular Diagnostics and Biostatistics	4
VIII	BTC DSC451T	Research Methodology	4
	BTC DSC452T	Ecology and Environment Management	4
	BTC DSC453(A)T	Medical Biotechnology	4
	BTC DSC454(B)T	Bioethics and Biosafety	4
	BTC DSC455T	Research Project/ Dissertation	4

Table 2: Semester-wise list of Biotechnology DSM Courses

Semester	Course Code	Title of Courses	Credits
I	BTC DSM101T	Cell Biology and Biochemistry	3
II	BTC DSM151T	Cell Biology and Biochemistry	3
III	BTC DSM201T	Microbiology and Immunology	3
IV	BTC DSM251P	Cell Biology, Biochemistry, Microbiology and Immunology	3
	BTC DSM252T	Microbiology and Immunology	3
V	BTC DSM301T	Genetics and Molecular Biology	3
	BTC DSM302T	Genetics and Molecular Biology	3
VI	BTC DSM351P	Genetics and Molecular Biology	3
VII	BTC DSM401T	Recombinant DNA Technology	3
VIII	BTC DSM451T	Recombinant DNA Technology	3

Table 3: Semester-wise list of Biotechnology SEC Courses

Semester	Course Code	Title of Courses	Credits
I	BTC SEC101	Microbiology	3
II	BTC SEC151	Immunology	3
III	BTC SEC201	Molecular Biology	3

Table 4: Semester-wise list of Biotechnology IDC Courses

Semester	Course Code	Title of Courses	Credits
I	BTC IDC101T	Biotechnology in Human Welfare	3
II	BTC IDC151T	Human Physiology	3
III	BTC IDC201T	Animal Biotechnology and Plant Biotechnology	3

SYLLABI OF BIOTECHNOLOGY DSC PAPERS

SEMESTER-I

BTC DSC 101T
CELL BIOLOGY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The objective of the course in Cell Biology is to provide students with a comprehensive understanding of the fundamental principles and concepts related to the structure, function, and behavior of cells. The course aims to introduce students to the various components of cells, including organelles, cytoskeletons, and cell membranes, and to explore their roles in cell biology. Additionally, the course aims to familiarize students with key processes such as the cell cycle, nucleic acid structure, cell adhesion, extracellular matrix, and the development and progression of cancer.*

UNIT 1 *(9 Lectures)*

Introduction to cell biology: cell theory; ultrastructure of prokaryotic and eukaryotic cells; cytosol and cytoplasm. **Structure and function of motile cells**: amoeboid, ciliary and flagellar. **Cytoskeletons:** microfilaments, intermediate filaments, and microtubules.

UNIT 2 *(8 Lectures)*

Structure and function of cell organelles: endoplasmic reticulum; golgi complex; mitochondria; chloroplast; ribosomes; lysosomes; peroxisomes and vacuole.

UNIT 3 *(9 Lectures)*

Nucleus: structure and function**. Cell Membrane:** components of biological membranes; fluid mosaic model; cell recognition and membrane transport.

UNIT 4 *(9 Lectures)*

Cell cycle: regulation of cell cycle; mitosis and meiosis; cell cycle check point; cell senescence; programmed cell death. **Nucleic acids:** nucleosides and nucleotides; purines and pyrimidines; physical and chemical properties of nucleic acids; double helical model of DNA.

UNIT 5 *(10 Lectures)*

Cell adhesion molecules: cadherins and integrins. **Extracellular Matrix:** composition and function. **Cancer**: carcinogenesis; agents promoting carcinogenesis; oncogenes; characteristics and molecular basis of cancer; treatment and prevention of cancer.

Course Outcomes: *The Cell Biology course provides a comprehensive understanding of cell structure, organelles, membrane function, cell cycle regulation, nucleic acids, cell adhesion, and cancer. Students will gain knowledge and insights into fundamental cellular processes and their implications in biological systems.*

SUGGESTED READING

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. ASMPress & 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.

BTC DSC 102T

ENVIRONMENTAL BIOTECHNOLOGY

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The objective of the course in Environmental Biotechnology is to provide students with an understanding of the principles and applications of biotechnology in addressing environmental challenges. The course aims to introduce students to various topics such as conventional and modern fuels, sewage and waste treatment, bioremediation techniques, biofertilizers, biocontrol agents, bioleaching, nanotechnology, and environmental monitoring. Through theoretical knowledge and practical examples, the course intends to equip students with the necessary skills to develop sustainable solutions for environmental issues using biotechnological approaches.*

UNIT 1 *(10 Lectures)*

Conventional fuels and their environmental impact: firewood; plant; animal; water; coal and gas. **Modern fuels and their environmental impact**: methanogenic bacteria; biogas; microbial hydrogen production; conversion of sugar to alcohol.

UNIT 2 *(8 Lectures)*

Sewage/Waste treatment: composition of sewage; treatment of municipal waste and industrial effluents. **Waste management and energy production:** composting; vermicomposting; biogas production.

UNIT 3 *(9 Lectures)*

Bioremediation techniques: bioremediation of soil & water contaminated with oil spills, heavy metals and detergents; degradation of cellulose using microbes; degradation of pesticides by microorganisms; phytoremediation and mycoremediation; biostimulation and bioaugmentation. .

UNIT 4 *(8 Lectures)*

Biofertilizers: nitrogen fixers; mycorrhiza; VAM. **Biocontrol agents**: biological control of pests and diseases. **Biopesticides.**

UNIT 5 *(10 Lectures)*

Bioleaching: microbial enrichment of ores (gold, copper and uranium) **Nanotechnology:** principle and applications. **Environmental Monitoring:** use of biosensors, remote sensing and GIS for environmental analysis. .

Course Outcomes: *The Environmental Biotechnology course equips students with a deep understanding of the environmental impact of fuels, sewage composition, waste management techniques, bioremediation methods, biofertilizers, biological control agents, bioleaching, nanotechnology applications, and environmental monitoring tools. By the end of the course, students will have the knowledge and skills to address environmental challenges, contribute to sustainable practices, and make informed decisions in the field of biotechnology and environmental science.*

SUGGESTED READING

1. Odum EP, Barrett GW (2004) Fundamentals of Ecology (5th ed.). Brooks/ Cole Publishers
2. Evans G, Furlong JC (2010) Environmental biotechnology: Theory and application. Oxford: Wiley-Blackwell
3. Fulekar MH (2010) Environmental biotechnology. Science Publishers
4. Jordening HJ, Winter J (2005) Environmental biotechnology: Concepts and applications. Wiley-VCH
5. Rittmann BE, McCarty PL (2001) Environmental biotechnology: Principles and applications. McGraw-Hill
6. Scragg AH (2005) Environmental biotechnology. Oxford University Press
7. Vallero D (2010) Environmental Biotechnology: A Biosystems Approach. Elsevier

SEMESTER-II

BTC DSC 151T
BIOCHEMISTRY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The objective of the course in Biochemistry is to provide students with a comprehensive understanding of the fundamental principles and concepts in biochemistry. The course aims to introduce students to the structure, properties, and functions of biomolecules such as amino acids, proteins, carbohydrates, lipids, and nucleic acids. It also covers topics related to protein purification techniques, enzymology, and carbohydrate metabolism. The course intends to equip students with a solid foundation in biochemistry, enabling them to comprehend the intricate biochemical processes and their significance in cellular functions.*

UNIT 1 *(10 Lectures)*

Amino acids and proteins: structure and properties of amino acids; physical and chemical properties of proteins; different level of structural organization of proteins; forces stabilizing protein structure and shape; fibrous and globular proteins. **Protein purification techniques**: protein extraction and fractionation techniques.

UNIT 2 *(8 Lectures)*

Carbohydrate: structure; properties and function of monosaccharides, disaccharides and polysaccharides. homo and hetero polysaccharides; mucopolysaccharides; glycoproteins and their biological functions.

UNIT 3 *(10 Lectures)*

Lipids: classification and properties of fatty acids; essential fatty acids; phospholipids; glycolipids; steroids. **Nucleic acids:** nucleosides and nucleotides; purines and pyrimidines; physical and chemical properties of nucleic acids; double helical model of DNA; types of DNA.

UNIT 4 *(9 Lectures)*

Enzymes: nomenclature and classification of enzymes; enzyme specificity; lock-and-key model and induced-fit model; active site; factors affecting enzyme activity; activation energy; enzyme inhibition- reversible and irreversible; cofactors; prosthetic groups.

UNIT 5 *(8 Lectures)*

Carbohydrate metabolism: glycolysis; fate of pyruvate under aerobic and anaerobic conditions; pentose phosphate pathway; gluconeogenesis; glycogenolysis TCA cycle; electron transport chain.

Course Outcomes: *The Biochemistry course aims to provide students with a comprehensive understanding of the molecular foundations of life. By the end of the course, students will be able to describe the structure and properties of biomolecules. They will develop an understanding of enzyme nomenclature and classification, along with factors influencing enzyme activity. Furthermore, students will have a comprehensive understanding of the major pathways of carbohydrate metabolism, including glycolysis and the TCA cycle. Through these outcomes, students will be well-equipped to comprehend the intricate molecular processes that underlie biological systems and apply their knowledge to various fields within biotechnology.*

SUGGESTED READING

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

BTC DSC 152P

CELL BIOLOGY, BIOCHEMISTRY AND ENVIRONMENTAL BIOTECHNOLOGY

Contact Hours: 60
Full Marks = 100
Two Experiments are to be performed – one from each part

Course Objective: *The objective of this combined course is to provide students with a comprehensive understanding of the fundamental principles and practical techniques. The course aims to introduce students to cell biology, environmental biotechnology, and biochemistry. The course intends to equip students with practical skills in these areas, enabling them to understand cellular processes, environmental analysis, and biochemical reactions.*

Part A: Cell Biology and Biochemistry

1. Preparation of solutions and buffers.
2. Handling and working principle of simple and compound microscope.
3. Study of mitosis in onion root tips.
4. Study of structure of prokaryotic and eukaryotic cell.
5. To study the effect of pH and temperature on the activity of salivary amylase.
6. Estimation of blood glucose by glucose oxidase method.
7. Estimation of protein by Lowry's method.
8. Separation of amino acids by paper chromatography.

Part B: Environmental Biotechnology

1. Determination of moisture content, pH, particle size, water holding capacity and organic matter content of soil samples.
2. Determination of pH, conductivity and TDS content of water samples.
3. Isolation of microorganisms from soil.
4. Isolation of microorganisms from air
5. Isolation of microorganisms from water.
6. Determination of total coliform bacteria in water sample

Course Outcomes: *The practical course aims to provide students with a comprehensive understanding of fundamental principles and practical techniques in the areas of Cell Biology, Environmental Biotechnology and Biochemistry. By the end of the course, students will be able to prepare solutions and buffers, handle and operate microscopes, study cell division and cell structure, perform tests on soil and water samples, investigate the effects of pH and temperature on enzyme activity, conduct blood glucose and protein estimations and separate amino acids using paper chromatography.*

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
3. Gupta, R & Makhija, S and Toteja R. (2018). Cell Biology : Practical Manual. Prestige Publishers.
4. Patra, J. K., Das, G., Das, S. K., & Thatoi, H. (2020). A Practical Guide to Environmental Biotechnology. Springer.

SEMESTER-III

BTC DSC 201T
GENETICS

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *This course aims to explore the fascinating world of genetics, delving into historical developments and modern concepts. It seeks to enable students to grasp the complexities of genetic interactions, chromosomal structures, mutations, and inheritance patterns.*

UNIT 1 *(12 Lectures)*

Introduction: historical developments in the field of genetics. **Mendelian genetics:** Mendel's experimental design; monohybrid, di-hybrid and tri-hybrid crosses; law of segregation and principle of independent assortment; test and back cross. **Allelic interactions:** concept of dominance; recessiveness; incomplete dominance; co-dominance; semi-dominance; pleiotropy; multiple allele.

UNIT 2 *(7 Lectures)*

Non-allelic interactions: complementary genes; epistasis (dominant & recessive); duplicate genes and inhibitory genes. **Chromosome morphology**: Packaging of DNA molecule into chromosomes; polytene chromosomes and lampbrush chromosomes; concept of cistron, exons and introns; genetic code.

UNIT 3 *(12 Lectures)*

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. **Chromosomal abnormalities in human beings**: aneuploidies of the autosomes - monosomy 5, trisomy 13, trisomy 18 and trisomy 21; aneuploidies of the sex chromosome - Turner syndrome and Klinefelter syndrome

UNIT 3 *(7 Lectures)*

Sex determination and sex linkage: mechanisms of sex determination; environmental factors in sex determination; Barr bodies; dosage compensation; genetic balance theory; fragile-X-syndrome; sex-linked inheritance- haemophilia and colour blindness.

UNIT 5 *(12 Lectures)*

Linkage: complete linkage and incomplete linkage. **Recombination:** definition and types; linkage and recombination of genes in a chromosome. **Crossing over:** cytological basis of crossing over - Stern's Experiment; Molecular mechanism of crossing over. **Extra-**

chromosomal inheritance: maternal inheritance and cytoplasmic inheritance – definition and characteristics. **Hardy-Weinberg principle**: prediction; gene pool; changes in allelic frequencies; allelic and genotype frequencies.

Course Outcome: *Upon completing this course, students will have a profound understanding of genetics, encompassing historical insights and contemporary knowledge. They will be equipped to analyze genetic interactions, interpret chromosome structures, identify mutations, and decipher inheritance patterns. Students will have a solid foundation in genetics for various applications in biology.*

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.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

BTC DSC 202T

ANIMAL CELL CULTURE

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The objective of the Animal Cell Culture course is to provide students with a comprehensive understanding of the principles and techniques involved in animal cell and tissue culture. This course aims to familiarize students with various aspects of cell culture, including culture media, primary and secondary cell cultures, isolation methods, and growth kinetics. It also aims to introduce students to advanced techniques like transfection, cell fusion, and screening methods. Additionally, the course intends to educate students about the production and applications of special secondary metabolites and the technology behind monoclonal antibodies.*

UNIT 1 *(12 Lectures)*

Introduction: metabolic capability of the animal cell; cell culture; organ culture; application of animal cell culture and organ culture. **Culture media:** stimulating natural condition for growth of animal cell; natural media; artificial media; serum containing media; serum free media; physio-chemical properties of culture media.

UNIT 2 *(9 Lectures)*

Cell culture techniques: sterilization; isolation of cells and tissues; mechanical and enzyme disaggregation; primary and secondary. **Primary cell culture:** anchorage dependent growth; non-anchorage dependent growth; adherent vs. suspension culture.

UNIT 3 *(8 Lectures)*

Secondary cell culture: sub-culturing; finite cell line; continuous cell line; growth kinetics of cells in culture. **Cell fusion:** virus-mediated fusion; electrofusion and chemical fusion. **Organ culture technique:** hanging drop and watch glass technique.

UNIT 4 *(8 Lectures)*

Transfection: microinjection; lipofection; electroporation; sonication. **Screening and selection technique:** HAT selection; selectable markers; gene inactivation technique.

UNIT 5 *(8 Lectures)*

Special secondary metabolites: insulin; growth hormone; interferon; TPA; factor VIII. **Hybridoma technology:** monoclonal and polyclonal antibodies; production of monoclonal antibodies; application of monoclonal antibodies.

Course Outcome: *By the end of the course, students should be able to perform animal cell and tissue culture with precision. They will have the skills to analyze cell growth kinetics and understand the production and applications of biotechnological products, such as monoclonal antibodies. This course will prepare students to contribute effectively to research and development in the fields of biotechnology and cell biology.*

SUGGESTED READING

1. Martin Clynes (2012) Animal Cell Culture Techniques. (2012). Germany: Springer Berlin Heidelberg.
2. Butler, M. (2003). Animal Cell Culture and Technology. United Kingdom: CRC Press.
3. Sinha Basant K., Kumar Rinesh (2008) Principles Of Animal Cell Culture: Student Compendium. Textbook Student Edition. India: International Book Distributing Company.
4. C. Macdonald, J. B. Griffiths, R. E. Spier (2013) Animal Cell Technology: Developments, Processes and Products. United Kingdom: Elsevier Science.

SEMESTER-IV

BTC DSC 251T
BIOANALYTICAL TOOL
Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *This course is designed to provide students with a comprehensive understanding of various bioanalytical tools and their applications in biological research. It aims to equip students with the knowledge and skills needed to effectively employ microscopy, spectroscopy, centrifugation, chromatography, and electrophoresis techniques.*

UNIT 1 *(8 Lectures)*

Microscopy: principle, working and application of simple microscopy; phase contrast microscopy; florescence microscopy; electron microscopy (TEM and SEM). **pH meter:** principle and applications.

UNIT 2 *(10 Lectures)*

Spectroscopy: principle, working and application of absorption spectroscopy and emission spectroscopy. **Colorimetry**: principle, working and application of colorimeter. **Spectrophotometry:** principle, working and application of visible, UV and infrared spectrophotometer.

UNIT 3 *(9 Lectures)*

Centrifugation: principle and basic components of a centrifuge; types of rotors; differential centrifugation; density gradient centrifugation. **Cell fractionation techniques**: isolation of sub-cellular organelles and particles.

UNIT 4 *(9 Lectures)*

Chromatography: paper chromatography; thin-layer chromatography; column chromatography - gel filtration chromatography, affinity chromatography, ion-exchange chromatography, gas chromatography and HPLC.

UNIT 5 *(9 Lectures)*

Electrophoresis: starch-gel electrophoresis; polyacrylamide gel electrophoresis (native and SDS-PAGE); agarose-gel electrophoresis; pulse-field gel electrophoresis; immuno-electrophoresis; isoelectric focusing.

Course Outcome: *Upon completing this course, students will possess a solid grasp of diverse bioanalytical tools and their practical applications in biological investigations. They will be understand the basic principle and working of microscopy for precise visualization, spectroscopy for molecular analysis, centrifugation for separation, chromatography for purification, and electrophoresis for molecular profiling. This proficiency will enable them to excel in research and laboratory settings where bioanalytical techniques are fundamental.*

SUGGESTED READING

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.

BTC DSC 252T
BIOPROCESS TECHNOLOGY
Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The course in Bioprocess Technology is designed to introduce students to the fundamental principles and techniques used in the bioprocessing for various applications. It aims to provide a comprehensive understanding of the key components involved in fermentation technology, including microbial culture methods, growth kinetics, bioprocess vessel design and downstream processing.*

UNIT 1 *(9 Lectures)*

Introduction to bioprocess technology: basic principle and components of fermentation technology. **Microbial culture:** batch, fed-batch and continuous culture. **Growth kinetics:** definition and phases of microbial growth.

UNIT 2 *(7 Lectures)*

Bioprocess vessel: basic design and components of a bioprocess vessel; types of culture/production vessels (airlift, cyclone column and packed tower) and their application.

UNIT 3 *(7 Lectures)*

Upstream processing: principles of upstream processing; media preparation; inocula development; strain improvement; sterilization techniques.

UNIT 4 *(10 Lectures)*

Mass transfer: Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. **Bioprocess measurement and control system:** measurement of physical, chemical and biological parameters during fermentation process; computer-aided process control.

UNIT 5 *(12 Lectures)*

Downstream processing: product recovery; stages of downstream processing*:* solid-liquid separation, release of intracellular products, extraction, concentration, purification and formulation. **Application of bioprocess technology:** production of ethanol, amylase, lactic acid and single cell proteins.

Course Outcome: *Upon successful completion of this course, students will be well-versed in bioprocess technology. They will understand the principles of fermentation and be capable of differentiating between batch, fed-batch, and continuous cultures. Additionally, they will have knowledge of bioprocess vessel design and its various applications. Students will also be proficient in upstream processing, including media preparation, inocula development, and sterilization techniques. They will grasp the importance of mass transfer in bioprocessing and be familiar with measurement and control systems. Furthermore, students will comprehend downstream processing stages, such as product recovery, separation, extraction, and purification. This knowledge will enable them to appreciate the broad applications of bioprocess technology in the production of various valuable products.*

SUGGESTED READING

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

BTC DSC 253P
GENETICS AND BIOPROCESS TECHNOLOGY

Contact Hours: 60

Full Marks = 100

Two Experiments are to be performed – one from each part

Course Objective: *The practical course aims to develop essential laboratory skills in genetics and bioprocess technology. Students will learn to prepare and analyze mitosis and meiosis mounts, perform karyotyping, construct pedigree charts, and induce polyploidy in plants. In bioprocess technology, they will isolate and screen microorganisms, construct bacterial growth curves, calculate TDP, and observe ethanol production.*

Part A: Genetics

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Karyotyping with the help of photographs
4. Pedigree charts of some common characters like blood group, color blindness etc.
5. Study of polyploidy in onion root tip by colchicine treatment.

Part B: Bioprocess Technology

1. Isolation of industrially important microorganism from natural resource.
2. Screening of industrially important microorganism.
3. Determination of bacterial growth curve.
4. Calculation of thermal death point (TDP) of a microbial sample.
5. Demonstration of ethanol production.

Course Outcomes: *Upon completion, students will possess practical laboratory skills and knowledge in genetics and bioprocess technology, making them adept at microscopy, genetic analysis, and microbiological techniques. They will also understand the significance of isolating and screening microorganisms for industrial use and gain hands-on experience in bioprocessing-related procedures.*

SUGGESTED READING

1. Thompson, E. A. (1986). Pedigree Analysis in Human Genetics. United Kingdom: Johns Hopkins University Press.
2. Jones, R. N., Rickards, G. K. (1991). Practical Genetics. United Kingdom: Open University Press.
3. Shukla, A. N. (2016). Elements of Bioprocess Technology. India: Discovery Publishing House Pvt Limited.
4. Allman A.R., Demain Arnold L., Bryce C. F. A., El-Mansi E. M. T., El-Mansi Mansi. (2011). Fermentation Microbiology and Biotechnology. United Kingdom: CRC Press.
5. Maheshwari · D.K (2002) Practical Microbiology. (2002). India: S. Chand Limited.

SEMESTER-V

BTC DSC 301T

PLANT BIOTECHNOLOGY

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Plant Biotechnology course is designed to provide students with a comprehensive understanding of the principles and techniques involved in the manipulation of plants for various applications. The objective is to introduce students to plant tissue culture, in vitro haploid production, protoplast isolation and fusion, somaclonal variation, industrial applications of plant tissue culture, and the creation of genetically modified plants.*

UNIT 1 *(10 Lectures)*

Plant tissue culture: definition; general techniques of plant tissue culture; culture media. **Types of culture:** seed culture; embryo culture; callus culture; organ cultures; endosperm culture. **Micropopagation:** meristem and shoot tip culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT 2 *(8 Lectures)*

In vitro **haploid production:** androgenic methods - Anther culture and Microspore culture; Gynogenic haploids - ovule culture and ovary culture; Significance and uses of haploids.

UNIT 3 *(10 Lectures)*

Protoplast isolation and fusion: methods of protoplast isolation (mechanical and enzymatic methods); protoplast purification. **Somatic hybridization:** mechanism of fusion - spontaneous fusion and induced fusion methods; identification and selection of hybrid cells; cybrids..

UNIT 4 *(9 Lectures)*

Somaclonal variation: methods, applications and disadvantages. **Industrial application of plant tissue culture:** secondary metabolite production; synthesis of useful compounds; biotransformation using plant cell culture.

UNIT 5 *(8 Lectures)*

Genetically modified plants: definition; methods of production (Bt cotton, golden rice and flavr savr tomato); advantages; ethical concern.

Course Outcome: *Upon successful completion of this course, students will have a solid grasp of plant biotechnology. They will be able to explain the fundamentals of plant tissue culture and its various techniques, including micropropagation and in vitro haploid production. Students will also understand protoplast isolation, fusion methods, and somatic hybridization, as well as the significance and uses of haploids. They will be familiar with somaclonal variation and its applications, particularly in industrial settings for secondary metabolite production and biotransformation. Additionally, students will comprehend the methods and ethical concerns related to genetically modified plants, such as Bt cotton, golden rice, and flavr savr tomato. This knowledge will equip them to work in various areas of plant biotechnology and contribute to advancements in agriculture and biotechnology.*

SUGGESTED READING

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

BTC DSC 302T

ANIMAL BIOTECHNOLOGY

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Animal Biotechnology course aims to equip students with a comprehensive understanding of biotechnological techniques and their applications in animals. The objective is to introduce students to various gene transfer methods in animals, the production of transgenic animals, the role of biotechnology in managing animal diseases, techniques for animal propagation and cloning, the production of special secondary metabolites, the process of monoclonal antibody production, and the ethical considerations and challenges in gene therapy and human genetic engineering.*

UNIT 1 *(7 Lectures)*

Gene transfer methods in animals: microinjection; embryonic stem cell; retrovirus and retroviral gene transfer method.

UNIT 2 *(12 Lectures)*

Transgenic Animals: introduction; production of transgenic mice, cow, pig, sheep, goat and insect; application of transgenic animals. **Animal diseases need help of biotechnology:** foot and mouth disease, coccidiosis, trypanosomiasis, theileriosis - causative organism, clinical signs, mode of transmission and role of biotechnology.

UNIT 3 *(10 Lectures)*

Animal propagation: artificial insemination; in-vitro fertilization; embryo transfer techniques (e.g. cow). **Animal cloning:** definition and methods (somatic cell nuclear transfer and embryo splitting).

UNIT 4 *(9 Lectures)*

Special secondary metabolites: definition; methods of production (insulin, growth hormones, interferon, tissue plasminogen activator, factor VIII); application of special secondary metabolotes. **Monoclonal antibodies:** definition; production process; application.

UNIT 5 *(7 Lectures)*

Gene therapy: definition; types; application; challenges and ethical issues. **Human genetic engineering:** problems and ethics.

Course Outcome: *Students will gain comprehensive knowledge and skills in animal biotechnology. They will master gene transfer techniques, transgenic animal production, and biotechnological disease management. Additionally, they will become proficient in animal propagation and cloning methods. Students will understand secondary metabolite production, monoclonal antibodies, gene therapy, and ethical considerations in human genetic engineering.*

SUGGESTED READING

1. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
2. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
4. Srivastava, A. K., Singh, R. K. (2018). Animal Biotechnology. India: CBS Publishers & Distributors.
5. Singh, B., Mal, G., Gautam, S. K., Mukesh, M. (2019). Advances in Animal Biotechnology. Germany: Springer International Publishing.

BTC DSC 303P

PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Contact Hours: 60

Full Marks = 100

Two Experiments are to be performed – one from each part

Course Objective: *The course objective for Plant and Animal Biotechnology is to provide students with a comprehensive understanding and practical proficiency in the techniques and principles of biotechnology as applied to both plants and animals. Students will gain hands-on experience in areas such as growth nutrient preparation, explant selection, aseptic techniques, DNA isolation, quantification, and gel electrophoresis. This course aims to prepare students for a range of career opportunities in biotechnology and to contribute to their understanding of this rapidly advancing field.*

Part A: Plant Biotechnology

1. Preparation of simple growth nutrient (knop's medium) and
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. Selection, sterilization and preparation of an explant for culture.
4. Techniques of inculcation under aseptic conditions
5. Determination of seed viability
6. Demonstration of various steps of Micropropagation

Part B: Animal Biotechnology

1. Sterilization techniques: glassware sterilization, media sterilization, laboratory sterilization
2. Preparation of Hanks Balanced salt solution
3. Preparation of Minimal Essential Growth medium
4. DNA isolation from animal tissue
5. Quantification of isolated DNA.
6. Resolving DNA on Agarose Gel.

Course Outcome: *By the end of this combined course in Plant and Animal Biotechnology, students will have acquired practical skills in laboratory techniques essential for both plant and animal biotechnology. These practical competencies will equip students for careers in biotechnology and research.*

SUGGESTED READING

1. Trigiano, R. N., & Gray, D. J. (2015). Plant Tissue Culture Concepts and Laboratory Exercises. CRC Press.
2. Bhojwani, S. S., & Razdan, M. K. (1996). Practical Plant Tissue Culture. Oxford & IBH Publishing.
3. Dutta Gupta, S., & Prakash, Y. S. S. (2013). Plant Tissue Culture and Biotechnology: Emerging Trends. Springer.
4. Freshney, R. I. (2015). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley.
5. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press.

SEMESTER-VI

BTC DSC 351T
RECOMBINANT DNA TECHNOLOGY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The course in Recombinant DNA Technology aims to provide students with a comprehensive understanding of the principles and practical techniques involved in genetic engineering. It seeks to introduce students to the fundamental concepts of recombinant DNA technology, including the use of enzymes, vectors and gene transfer methods. The course also covers advanced topics like PCR, mutagenesis, library construction, and screening. Furthermore, it aims to explore the applications of genetic engineering in animals and plants, including the production of transgenic organisms and therapeutic products.*

UNIT 1 *(10Lectures)*

Introduction: definition, principles and general steps of recombinant DNA technology. **Enzymes used in genetic engineering:** restriction enzyme; ligase; polymerase; alkaline phosphatase; terminal transferase. **Vectors:** plasmid; cosmid; BAC; YAC.

UNIT 2 *(10 Lectures)*

Gene transfer: transformation; microinjection; electroporation; ultrasonication; lipofection; particle bombardment. **Hybridization techniques:** southern blotting; northern blotting**. Library construction and screening:** preparation of genomic and cDNA library, screening of recombinants.

UNIT 3 *(8 Lectures)*

PCR: principle, procedure and applications. **Random and site directed mutagenesis:** PCR based method of site directed mutagenesis; random mutagenesis; production of chimeric proteins.

UNIT 4 *(10 Lectures)*

Applications of genetic engineering in animals: production and applications of transgenic mice, production of therapeutic products – insulin, growth hormone and clotting factors. **Genetic modification in medicine**: definition and types of gene therapy; production of therapeutic products (e.g. human hormones, blood proteins, immune modulators)

UNIT 5 *(7 Lectures)*

Genetic engineering in plants: *Agrobacterium tumefaciens* and *A. rhizogenes*; Ti plasmids; construction of binary vectors and co-integrate vectors; T-DNA transfer and integration.

Course Outcome: *This course in Recombinant DNA Technology equips students with a deep understanding of the principles and techniques central to genetic engineering. They become proficient in working with crucial enzymes, various vectors, and gene transfer methods like transformation and microinjection. Students also master advanced techniques such as PCR, mutagenesis, library construction, and screening. With this knowledge, they can explore the applications of genetic engineering in animals and plants, including creating transgenic organisms and therapeutic products. Overall, this course prepares students for genetic engineering research and its applications in diverse fields like medicine and biotechnology.*

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

BTC DSC 352T
GENOMICS AND PROTEOMICS
Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Genomics and Proteomics course is designed to provide students with a deep understanding of genomics, focusing on chromosome structure, nucleotide sequences, and gene expression analysis. It also covers proteomics, including the study of protein structure, properties, and various analytical techniques. The course aims to familiarize students with DNA sequencing methods and genome sequencing techniques, allowing them to comprehend genome sequence assembly processes. Additionally, it aims to educate students on protein analysis methods, including size determination, covalent structure determination, and proteomic analysis using 2D-PAGE and mass spectrometry-based techniques.*

UNIT 1 *(9 Lectures)*

Introduction to genomics: chromosome structure; eukaryotic nuclear genome; nucleotide sequence composition; satellite DNA; centromere DNA; telomere DNA; human genome project. **Gene expression studies:** microarray and SAGE.

UNIT 2 *(10 Lectures)*

DNA sequencing methods: Maxam and Gilbert method; Sangers method; pyrosequencing. **Genome sequencing methods:** Shotgun and Hierarchical (clone contig) methods. **Genome sequence assembly:** De novo assembly and assembly by reference mapping.

UNIT 3 *(9 Lectures)*

Protein: levels of protein structure; physical and chemical properties of proteins; physical interactions that determine the property of proteins (short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds and hydrophobic interactions).

UNIT 4 *(8 Lectures)*

Determination of protein size: sedimentation analysis; gel filteration; SDS-PAGE; Native PAGE. **Determination of covalent structures:** Edman degradation.

UNIT 5 *(9 Lectures)*

Proteomic analysis: 2D-PAGE (Sample preparation, solubilization, reduction and resolution); Mass spectrometry-based methods for protein identification; application of proteomics in disease research and drug discovery.

Course Outcome: *By the end of this course, students will have a comprehensive knowledge of genomics and proteomics. They will be able to understand chromosome structures, gene expression studies, and DNA sequencing methods. Students will also gain proficiency in proteomic analysis techniques, including 2D-PAGE and mass spectrometry-based methods for protein identification. This course will equip students with the skills required to contribute to genomics and proteomics research and applications in various fields, including biotechnology and bioinformatics.*

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.

BTC DSC 353T
BIOINFORMATICS
Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Bioinformatics course aims to teach students how to use biological databases like GENBANK, EMBL, DDBJ, PDB, and SWISSPROT effectively, along with search tools like BLAST. They will learn to interpret search results, analyze sequences for homology and polymorphisms, perform sequence alignments, and conduct phylogenetic analyses. Additionally, students will gain insights into computer-aided drug design and basic PERL programming for bioinformatics applications.*

UNIT 1 *(7 Lectures)*

Biological database: definition; types and applications. **Nucleotide databases** GENBANK; EMBL; DDBJ. **Protein database**: PDB, SWISSPROT. **Other database:** organism specific database; structural database.

UNIT 2 *(8 Lectures)*

Searching databases: BLAST; types of BLAST; steps involved in BLAST; E-value; BLAST result interpretation; **Sequence analysis:** sequence homology; detecting open reading frames; single nucleotide polymorphisms.

UNIT 3 *(8 Lectures)*

Sequence alignment: global and local alignment; pairwise alignment (BLAST and FASTA) and multiple sequence alignment (Clustal W); Needleman-Wunsch and Smith-Waterman algorithms.

UNIT 4 *(10 Lectures)*

Phylogenetic Analysis: Phylogenetic tree and terminology; different methods of phylogenetic tree prediction - maximum parsimony, distance matrix methods (UPGMA, neighbor joining), maximum likelihood methods.

UNIT 5 *(12 Lectures)*

Computer aided drug designing: drug discovery process; target identification and validation; lead optimization and validation; virtual screening, Lipinski's rule of five; ADMETox screening. **Perl programming:** basic concepts in PERL programming; finding the length, reverse, reverse compliment of a DNA sequence; concatenating DNA fragments; transcription- DNA to RNA; reading DNA/protein from files in FASTA format.

Course Outcome: *After completing this course, students will proficiently utilize biological databases for research and applications. They will conduct precise searches and interpret the results. Students will also perform sequence analysis tasks, including identifying homology and polymorphisms, and master sequence alignment techniques. Furthermore, they will understand phylogenetic analysis methods and grasp the principles of computer-aided drug design. Basic PERL programming skills will enable them to excel in bioinformatics-related tasks.*

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
4. Felsenstein, J. (2004). Inferring Phylogenies. Sinauer Associates.
5. Schwartz, R. L., & Phoenix, T. (2011). Learning Perl. O'Reilly Media.

BTC DSC 354P

RECOMBINANT DNA TECHNOLOGY AND BIOINFORMATICS

Contact Hours: 60

Full Marks = 100

Two Experiments are to be performed – one from each part

Course Objective: *These laboratory course aims to develop practical skills in molecular biology and bioinformatics. Students will learn DNA isolation from plant, bacteria and animal cell. They will also learn the technique of restriction digestion of DNA, southern blotting and PCR. In bioinformatics, students will understand and utilize nucleotide and protein sequence databases, perform BLAST searches, conduct multiple sequence alignments, construct phylogenetic trees, retrieve 3D protein structures, and learn the basics of Perl programming.*

Part A: Recombinant DNA technology

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Isolation of plasmid DNA from *E.coli*
4. Restriction digestion of DNA
5. Qualitative and quantitative analysis of DNA using spectrophotometer
6. Demonstration of PCR
7. Demonstration of Southern blotting technique

Part B: Bioinformatics

1. Understanding and use of nucleotide sequence database: NCBI, EMBL and DDBJ
2. Understanding and use of protein sequence database: PDB and Swissprot
3. Performing BLAST and to find regions of similarity between sequences.
5. Multiple sequence alignment using Clustal W.
6. Phylogenetic tree construction.
7. Retrieval of 3D structure of proteins from PDB, and visualization with appropriate bioinformatics tools (e.g. RasMol).
8. Perl programming: length, reverse, reverse complement, concatenating DNA fragments, DNA to RNA.

Course Outcomes: *Upon completion, students will possess hands-on skills in molecular biology, including DNA and plasmid isolation, DNA analysis, and PCR techniques. They will also have competence in bioinformatics, enabling them to access and utilize nucleotide and protein sequence databases, perform sequence comparisons and alignments, construct phylogenetic trees, visualize protein structures, and apply basic Perl programming for sequence-related tasks. These skills are essential for various applications in genetics and genomics research.*

SUGGESTED READING

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell. Garland Science.
2. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press.
3. Attwood, T. K., & Parry-Smith, D. J. (1999). Introduction to Bioinformatics. Pearson Education.
4. Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G. (1998). Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
5. Felsenstein, J. (2004). Inferring Phylogenies. Sinauer Associates.
6. Schwartz, R. L., & Phoenix, T. (2011). Learning Perl. O'Reilly Media.

SEMESTER-VII

BTC DSC 401T
NANOBIOTECHNOLOGY AND BIOENGINEERING

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The course aims to provide students with a comprehensive understanding of nanobiotechnology and bioengineering, emphasizing the application of nanotechnology within biological contexts and the development of innovative biotechnological solutions. The course is designed to equip the students with the fundamental principles of nanotechnology and its relevance in biology and medicine, comprehend the unique properties of nanoparticles and their wide-ranging applications in biotechnology, evaluate various techniques for nanomaterial synthesis and their interactions with biological systems, and address ethical and safety concerns associated with nanobiotechnology.*

UNIT 1 *(9 Lectures)*

Introduction to Nanobiotechnology: principles of nanotechnology and its relevance to biology and medicine; properties of nanoparticles and their applications in biotechnology; nanomaterial synthesis techniques and their biological interactions.

UNIT 2 *(8 Lectures)*

Nanoparticles in Drug Delivery: use of nanoparticles as drug carriers for targeted therapy; nanoparticle-drug interactions and controlled release systems; challenges and opportunities in nanomedicine.

UNIT 3 *(9 Lectures)*

Nanoscale Biosensors: design and functioning of nanoscale biosensors for biomolecule detection; types of biosensors (optical, electrochemical, and surface plasmon resonance-based sensors); applications of biosensors in healthcare and diagnostics.

UNIT 4 *(9 Lectures)*

Tissue Engineering and Regenerative Medicine: principles of tissue engineering and regenerative medicine; nanomaterials in tissue scaffolds and organ-on-a-chip devices; potential of bioengineered tissues for transplantation and disease modeling.

UNIT 5 *(10 Lectures)*

Emerging Trends and Future Applications: emerging trends in nanobiotechnology, such as nanotherapeutics, nanotoxicology, and nano-based imaging; challenges and regulatory aspects of nanobiotechnology; future prospects and ethical considerations of nanobiotechnology.

Course Outcome: *Upon completion of this course, students should be able to describe the fundamental principles of nanobiotechnology and its applications in biomedicine. They can evaluate the role of nanomaterials in drug delivery and their impact on healthcare. Students will be able to analyze the functioning and potential applications of nanoscale biosensors, and well as learn the principles of tissue engineering and regenerative medicine.*

SUGGESTED READING

1. Niemeyer, C. M., & Mirkin, C. A. (2004). Nanobiotechnology: Concepts, Applications, and Perspectives. Oxford University Press.
2. Vo-Dinh, T. (Ed.). (2017). Nanotechnology in Biology and Medicine: Methods, Devices, and Applications. Wiley-Blackwell.
3. Lanza, R., Langer, R., & Vacanti, J. (2014). Principles of Tissue Engineering. Academic Press.
4. Prasad, P. N. (2012). Introduction to Nanomedicine and Nanobioengineering. Germany: Wiley.
5. Lee, Y., Moon, J. (2020). Introduction to Bionanotechnology. Germany: Springer Nature Singapore.

BTC DSC 402T
MOLECULAR DIAGNOSTICS
Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Molecular Diagnostics course is designed to equip students with a comprehensive understanding of diagnostic techniques used in clinical microbiology and immunodiagnostics. They will learn about enzyme immunoassays, molecular methods such as PCR, RT-PCR, RFLP, and hybridization methods, along with laboratory tests for antimicrobial chemotherapy. Students will also explore antigen and antibody purification, idiotypes, and epitopes, and gain practical skills in immunodiagnostic tests like ELISA, immunofluorescence, and radioimmunoassay.*

UNIT 1 *(10 Lectures)*

Enzyme Immunoassays: overview of enzyme immunoassays; types of enzymes used in immunoassays (horseradish peroxidise and alkaline phosphatase); conjugation of enzymes to antibodies; solid phases in enzyme immunoassays (microplates and membranes); homogeneous vs. heterogeneous enzyme immunoassays; use of polyclonal and monoclonal antibodies.

UNIT 2 *(9 Lectures)*

Molecular Methods in Clinical Microbiology: polymerase chain reaction (PCR) and its applications; reverse transcription PCR (RT-PCR); restriction fragment length polymorphism (RFLP); nuclear hybridization methods; southern blotting; northern blotting; fluorescence in situ hybridization (FISH); microarray analysis.

UNIT 3 *(10 Lectures)*

Laboratory tests for antimicrobial chemotherapy: minimum inhibitory concentration (MIC); minimum bactericidal concentration (MBC). **Micro-dilution and macro-dilution broth procedures:** broth microdilution method (MIC determination). **Diffusion test procedures for susceptibility testing:** disk diffusion method (Kirby-Bauer); agar dilution method. **Tests for bactericidal activity:** time-kill curve assay.

UNIT 4 *(9 Lectures)*

Purification and standardization of antigens and antibodies: protein purification techniques; antibody production and purification. **Idiotypes:** idiotype and anti-idiotype antibodies; application in immunodiagnostics. **Epitope:** design and applications in diagnostic assays.

UNIT 5 *(7 Lectures)*

Immunodiagnostic tests: ELISA (indirect, sandwich, competitive); immunofluorescence (direct and indirect); radioimmunoassay (competitive and non-competitive).

Course Outcome: *By the end of this course, students will be proficient in a wide range of molecular diagnostic techniques. They will understand the principles and applications of enzyme immunoassays, molecular methods in clinical microbiology, and laboratory tests for antimicrobial chemotherapy. Students will learn the technique of antigen and antibody purification, idiotype applications, and epitope design. Additionally, they will be skilled in performing various immunodiagnostic tests, making them well-prepared for careers in molecular diagnostics and clinical microbiology.*

SUGGESTED READING

1. Maggio, E. T. (2018). Enzyme Immunoassay. United States: CRC Press.
2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
3. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
4. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.
5. Clift Ian C. (2020). Clinical Immunodiagnostics: Laboratory Principles and Practices: Laboratory Principles and Practices. Jones & Bartlett Learning.

BTC DSC 403T
BIOSTATISTICS
Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Biostatistics course aims to provide students with essential knowledge and skills in the field of statistics as applied to biological and healthcare sciences. Students will become proficient in understanding the characteristics and capabilities of computers, networking systems, and data types. They will learn methods of collecting and presenting statistical data, including graphical representation. This course will enable students to comprehend measures of central tendency and dispersion, as well as probability distributions. They will gain the ability to perform hypothesis testing, both for small and large sample sizes, and understand correlation and regression analysis.*

UNIT 1 *(10 Lectures)*

Computer: characteristics and capabilities of computers; organization of a computer - input, output and memory; introduction to hardware, software and operating systems. **Networking system:** internet and intranet; LAN, WAN and MAN.

UNIT 2 *(9 Lectures)*

Data: types of data – qualitative and quantitative; collection of data; primary data and secondary data; methods of presentation of statistical data – textual, tabular and graphical; graphical representation of statistical data.

UNIT 3 *(8 Lectures)*

Measures of central tendency: mean; median; mode. **Measures of Dispersion:** absolute measures and relative measures; range; variation; mean deviation; standard deviation.

UNIT 4 *(9 Lectures)*

Probability distribution: classical and axiomatic definition of probability; elementary ideas of binomial, poisson and normal distributions. **Hypothesis Testing:** null hypothesis; alternative hypothesis; confidence level; significance level.

UNIT 5 *(9 Lectures)*

Small sample test and large sample test: t-test; chi-square test; analysis of variance (ANOVA). **Correlation and regression:** definition, properties and types.

Course Outcome: *Upon completing this course, students will have a solid foundation in biostatistics. They will be able to effectively use computers for data analysis and presentation. Students will acquire the skills needed to collect and present statistical data in various formats. They will be proficient in calculating measures of central tendency and dispersion, conducting hypothesis tests, and interpreting results. Additionally, students will understand the principles of probability distributions, correlation, and regression, enabling them to apply statistical methods to real-world problems in biological and healthcare sciences.*

SUGGESTED READING

1. Le, C. T., Eberly, L. E. (2016). Introductory Biostatistics. United Kingdom: Wiley.
2. Banerjee, P. K. (2007). Introduction to Biostatistics (A Textbook of Biometry). India: S. Chand Limited.
3. Antonisamy, B., Premkumar, P. S., Christopher, S. (2017). Principles and Practice of Biostatistics. India: Elsevier India.
4. Gurumani, N. (2021). An introduction to biostatistics. India, MJP Publishers.
5. Rosner, B. (2016). Fundamentals of Biostatistics. United States: Cengage Learning.
6. Kulkarni, A. P. (2019). Basics of Biostatistics. India: CBS Publishers & Distributors.

BTC DSC 404P

MOLECULAR DIAGNOSTICS AND BIOSTATISTICS

Contact Hours: 60

Full Marks = 100

Two Experiments are to be performed – one from each part

Course Objective: *The practical is designed to equip students with hands-on skills in various biological and statistical techniques. Students will learn to analyse DNA fragments and detect DNA sequence variations in biological samples. They will also gain practical experience in the Southern blotting technique, antibiotic susceptibility testing, and some immunology techniques. The students will also learn the basic concept of biostatistics, including the use of statistical software. Additionally, students will learn the concept of t-tests, chi-square tests etc.*

Part A: Molecular diagnostics

1. Perform agarose gel electrophoresis for DNA analysis, including DNA fragment separation and size determination.
2. Detecting variation at the DNA sequence level of biological samples using RFLP technique
3. Perform antibiotic susceptibility test using Kirby-Bauer disk diffusion method
4. Perform time-kill curve assay for determining bactericidal activity
5. Perform ELISA to detect specific antigen or antibody in a sample.
6. Analyze antigen-antibody reactions using the Ouchterlony double immunodiffusion technique.

Part B: Biostatistics

1. Understanding MS Office package (MS words, MS excel and MS powerpoint).
2. Use of statistical software (MS Excel and SPSS) to find central tendency.
3. Use of statistical software for graphical representation of data.
4. Perform and interpret t-tests for means comparison.
5. Perform and interpret chi-square tests for independence.
6. Perform and interpret one-way ANOVA for comparing multiple group means.
7. Correlation analysis and interpretation.

Course Outcome: *Upon completing these practical exercises, students will have acquired essential laboratory skills in molecular diagnostics. Furthermore, students will develop computer-based skills, including using MS Excel and SPSS for data analysis, graphical representation, hypothesis testing (t-tests, chi-square tests), one-way ANOVA, and correlation analysis. These practical skills will enable students to engage in scientific research and data interpretation effectively.*

SUGGESTED READING

1. Leonard Debra G.B. (2016). Molecular Pathology in Clinical Practice (2016). Germany: Springer International Publishing.
2. Charles Strom, Frederick L. Kiechle, Robert M. Nakamura, Wayne W. Grody. (2009). Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory. (2009). Netherlands: Elsevier Science.
3. Alex van Belkum, David H. Persing, Fred C. Tenover, Frederick S. Nolte, Margareta Ieven, Melissa B. Miller, Randall T. Hayden, Yi-Wei Tang. (2020). Molecular Microbiology: Diagnostic Principles and Practice. United States: Wiley.
4. Antonisamy, B., Premkumar, P. S., Christopher, S. (2017). Principles and Practice of Biostatistics. India: Elsevier India.
5. Rosner, B. (2016). Fundamentals of Biostatistics. United States: Cengage Learning.

SEMESTER-VIII

BTC DSC 451T
RESEARCH METHODOLOGY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objectives: *This biotechnology research methodology course is designed to equip students with the essential skills and knowledge required to conduct research effectively in the field of biotechnology. Students will develop a solid foundation in research concepts, including different research types, data collection techniques, and research design. They will also gain practical laboratory skills, learn to handle chemicals safely, and understand the importance of safety protocols. Furthermore, the course will focus on data interpretation and reporting, enabling students to communicate research findings through technical reports, popular reports, and oral presentations.*

UNIT 1 *(10 Lectures)*

Introduction to research methodology: meaning of research; mypes of research (mescriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical); mesearch methods versus methodology; research process; library research; field research; laboratory research; criteria of good research; problems encountered by researchers in India.

UNIT 2 *(10 Lectures)*

General laboratory practices: common calculations in biotechnology laboratories; understanding the details on the label of reagent bottles; molarity and normality of common acids and bases; preparation of solutions; molar, molal and normal solutions; technique of handling micropipettes; knowledge about common toxic chemicals; safety measures in handling common toxic chemicals.

UNIT 3 *(9 Lectures)*

Methods of Data collection: concept of primary and secondary data; collection of primary data; observation method; collection of data through questionnaires; collection of data through schedules; difference between questionnaires and schedules; collection of secondary data; case study method- meaning, characteristics, advantages and limitations.

UNIT 4 *(9 Lectures)*

Research design and sampling: meaning of research design; need for research design; features of a good design; different research designs; important concepts relating to research design; randomized block design; steps in sampling design; probability sampling; systemic sampling; stratified sampling; cluster sampling; characteristics of a good sample design.

UNIT 5 *(7 Lectures)*

Interpretation and report writing: meaning of interpretation; technique of interpretation; precautions in interpretation; significance of report writing; different steps in writing a report; layout of the research report; technical report; popular report; oral presentation.

Course Outcomes: *Upon completing this course, students will have the capability to apply research methodology principles to biotechnology research effectively. Students will gain knowledge on various data collection techniques, including observation, questionnaires, and case studies, enabling them to gather primary and secondary data for research purposes. They will be proficient in laboratory practices, ensuring safety when working with common chemicals used in biotechnology laboratories. Additionally, they will understand different research designs and sampling methods, enabling them to select the most suitable approach for their research. Furthermore, students will be adept at interpreting research findings accurately and conveying results through well-structured research reports and engaging oral presentations. These skills will empower students to contribute to the advancement of biotechnology through research and innovation.*

SUGGESTED READING

1. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. India: New Age International (P) Limited.
2. Panneerselvam, R. (2014). Research Methodology. India: PHI Learning.
3. Kumar, A. (2002). Research Methodology in Social Science. India: Sarup & Sons.
4. Mukherjee, S. P. (2019). A Guide to Research Methodology: An Overview of Research Problems, Tasks and Methods. United States: CRC Press.
5. Krishnaswamy, K. N. (2011). Management Research Methodology: Integration of Principles, Methods and Techniques (For VTU). India: Pearson Education India.

BTC DSC 452T
ECOLOGY AND ENVIRONMENT MANAGEMENT

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Course Objectives: *This course aims to provide students with a comprehensive understanding of environmental science and biotechnology, focusing on the principles governing our environment, energy flow in ecosystems, pollution sources, and sustainable bioprocessing. By the end of this course, students will be equipped with the knowledge and skills needed to analyze environmental challenges critically and apply biotechnological solutions.*

UNIT 1 *(8 Lectures)*

Our Environment: introduction to atmosphere, hydrosphere and lithosphere; principles and concepts of ecosystem; structure of ecosystem; strata of an ecosystem; types of ecosystem including habitats; cybernetics and homeostasis.

UNIT 2 *(9 Lectures)*

Energy transfer in an Ecosystem: food chain; food web; energy budget; production and decomposition in a system; ecological efficiencies; trophic structure & energy pyramids; ecological energetic; principles pertaining to limiting factors; bio-geochemical cycles (N, C, P cycles).

UNIT 3 *(10 Lectures)*

Pollution and environmental health: sources and causes of pollution; human health impacts and ecological impacts of pollution; detection of environmental pollutants; pollution control and mitigation strategies. **Xenobiotics and Pollutants:** definition and classification; sources of xenobiotics; emerging contaminants; impact of xenobiotics on ecosystems and biodiversity; human exposure and health effects.

UNIT 4 *(10 Lectures)*

Microbial fuel cell (MFC): principle and general components of MFC; types of MFC – single double and triple chambered; factors affecting MFC performance; application of MFC. **Biofuel:** definition and generation of biofuels; role of biotechnology in biofuel generation; potential of algae in biofuel generation; examples and uses of industrially produced biofuels; challenges in biofuel generation.

UNIT 5 *(8 Lectures)*

Sustainable bioprocessing: green biotechnology and sustainability; technique of waste-to-energy generation; introduction to nanoparticles-based approaches in waste management and bioenergy production; applications in bioremediation and environmental applications.

Course Outcomes: *By the end of this course, students will understand ecosystems, energy transfer, pollution sources and control, and the impact of xenobiotics on the environment and human health. They will also be familiar with biotechnological solutions for environmental challenges, including microbial fuel cells, biofuels, and sustainable waste management. This knowledge will enable them to address real-world environmental issues effectively.*

SUGGESTED READING

1. Newman, E. I. (2008). Applied Ecology and Environmental Management. Germany: Wiley.
2. Sulphey, M. M., Safeer, M. M. (2014). Introduction To Environment Management. India: Phi Learning.
3. Mukherjee, B. (2000). Environmental Management: Basics and Applied Aspects of Management of Ecological and Environmental Systems. India: Vikas Publishing House.
4. Barrow, C. (2006). Environmental Management for Sustainable Development. United Kingdom: Taylor & Francis.
5. Dash, M. C. (2013). Concepts of Environmental Management for Sustainable Development. India: I.K. International Publishing House Pvt. Limited.
6. Barrow, C. J. (2005). Environmental Management and Development. United Kingdom: Routledge.

BTC DSC 453(A)T
MEDICAL BIOTECHNOLOGY
Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objectives: This course aims to provide students with a comprehensive understanding of medical biotechnology, including gene editing techniques, vaccine development, biopharmaceuticals, and diagnostic methods. It also explores emerging technologies like nanomedicine and AI in healthcare. By the end of this course, students should have a solid grasp of the role of biotechnology in healthcare, ethical considerations, and how it impacts personalized medicine.

UNIT 1 *(8 Lectures)*

Introduction to medical biotechnology: role of biotechnology in healthcare; ethical, legal, and social considerations in medical biotechnology. **Gene editing in medicine:** gene therapy and its applications; CRISPR-Cas9 and genome editing; genetic counselling.

UNIT 2 *(9 Lectures)*

Introduction to vaccines: history of vaccines; basic concept of immunity and immunization; types of vaccines (live attenuated, inactivated, subunit, mRNA and DNA vaccines); mechanisms of vaccine action. **Vaccine development:** preclinical testing and animal models; clinical trials (phase I, II and III).

UNIT 3 *(10 Lectures)*

Biopharmaceuticals and therapeutic proteins: monoclonal antibodies and their applications; therapeutic proteins and their role in medicine; challenges in biopharmaceutical development. **Diagnostic techniques in medical biotechnology:** Single Nucleotide Polymorphism (SNP) genotyping techniques; serological tests and immunoassays; point-of-care diagnostics; role of biotechnology in early disease detection.

UNIT 4 *(8 Lectures)*

Stem cell therapy and regenerative medicine: types of stem cells and their properties; applications of stem cell therapy in medicine; ethical and safety considerations in stem cell research; regenerative medicine and tissue engineering.

UNIT 5 *(10 Lectures)*

Pharmacogenomics and personalized medicine: pharmacogenomics and its significance in drug development; tailoring drug therapies based on genetic information; challenges and ethical considerations in personalized medicine. **Emerging technologies in medical biotechnology:** nanomedicine and its applications; artificial intelligence and machine learning in healthcare; 3D printing and biofabrication.

Course Outcomes: *Upon completion, students will be able to analyze the ethical, legal, and social aspects of medical biotechnology. They will understand gene editing methods such as CRISPR-Cas9, the history of vaccines, and vaccine development stages. Students will also comprehend the role of monoclonal antibodies, diagnostic techniques, and the potential of stem cell therapy. They'll explore the ethical dimensions of stem cell research and appreciate emerging technologies in healthcare, including nanomedicine, artificial intelligence, and 3D printing.*

SUGGESTED READING

1. Glick, B. R. (2020). Medical Biotechnology. United States: Wiley.
2. Khan, F. A. (2014). Biotechnology in Medical Sciences. United Kingdom: Taylor & Francis.
3. Nag, M., Joshi, S., Mukherjee, S. (2022). Contemporary Medical Biotechnology Research for Human Health. Netherlands: Elsevier Science.
4. Godbey, W. (2014). An Introduction to Biotechnology: The Science, Technology and Medical Applications. Netherlands: Elsevier Science.
5. Ahmed Hotiana, M. (2018). The Future of Medical Biotechnology: Use of Techniques Like Stem Cell Therapy and Monoclonal Antibodies for Medical Purposes. Germany: GRIN Verlag.

BTC DSC 454(B)T

BIOETHICS AND BIOSAFETY

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *This course in bioethics and biosafety aims to provide students with a comprehensive understanding of the legal, economic, ethical, and safety aspects related to the biotechnology industry. Students will delve into intellectual property rights and the patenting process in biotechnology. Additionally, the course will explore the intricacies of entrepreneurship in biotechnology, covering product selection, design, development, economic considerations, and cost-benefit analysis. Students will also become well-versed in the regulatory aspects of biotechnology, including excise regulations and biosafety practices. Furthermore, the course will address critical bioethical issues in biotechnology and introduce students to the principles of bioethics and biosafety.*

UNIT 1 *(10 Lectures)*

Intellectual Property Rights: Introduction to Indian Patent Law; World Trade Organization and its related intellectual property provisions; Intellectual/Industrial property; Legal protection of intellectual property in research, Patenting in Biotechnology; Design and development; Economic, ethical and depository considerations.

UNIT 2 *(8 Lectures)*

Entrepreneurship: Selection of a product line; Designing of product; Development processes for quality products, Economics on material and energy requirement; Cost benefit analysis; Stocking of product; Release of product.

UNIT 3 *(8 Lectures)*

Basic regulations of excise: Demand for a given product; Feasibility of its production under given constraints of raw material; Energy input; Financial situations; Export potential.

UNIT 4 *(10 Lectures)*

Bioethics: Necessity of Bioethics; Ethical regulations; Different paradigms of Bioethics – National & International; GEAC; Ethical issues against the molecular technologies; Ethical issues relating to HGP; Ethical issues in connection with NGS.

UNIT 5 *(9 Lectures)*

Biosafety: Introduction to biosafety; Health hazards concerning biotechnology. Introduction to the concept of containment level; Good Laboratory Practices (GLP); Good Manufacturing Practices (GMP).

Course Outcomes: *Upon successful completion of this course, students will have a comprehensive understanding of intellectual property rights and their application in biotechnology, enabling them to navigate the patenting process effectively. They will be equipped with entrepreneurial skills to select, design, and develop biotechnology products, considering economic factors and conducting cost-benefit analyses. Furthermore, students will gain insights into the regulatory framework governing the biotechnology industry, including excise regulations. They will also develop a strong ethical foundation, allowing them to address bioethical dilemmas and make informed decisions regarding biotechnological advancements. Additionally, students will grasp the importance of biosafety in biotechnology, ensuring they can work safely and responsibly in laboratory settings. Overall, this course will prepare students for roles that involve entrepreneurship, regulation, and ethical decision-making in the biotechnology sector.*

SUGGESTED READING

1. Nambisan, P. (2017). An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology. United Kingdom: Elsevier Science.
2. Joshi, R. (2006). Biosafety and Bioethics. India: Isha Books.
3. Goel, D., Parashar, S. (2013). IPR, Biosafety and Bioethics. India: Pearson Education India.
4. Sateesh, M. K. (2013). Bioethics and Biosafety. India: I.K. International Publishing House Pvt. Limited.
5. Singh, A., Singh, A. K. (2012). Intellectual Property Rights and Bio-technology: Biosafety and Bioethics. India: Narendra Publishing House.
6. Biological Safety: Principles and Practices. (2017). United Kingdom: Wiley.
7. Veatch, R. M. (2016). The Basics of Bioethics. United Kingdom: Taylor & Francis.

BTC DSC 455T

RESEARCH PROJECT/ DISSERTATION

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Individual student should be given project work under the guidance of a teacher. The student should submit a report of investigation carried out by him on the problem. The report should include introduction on the topic, review of literature, experimental findings, analysis of data, discussion, conclusion and references.

The student is also required to present the report in front of External and Internal examiners. He/she may use LCD projector, if necessary. This will be followed by a question answer session (Interactions).

Distribution of marks:

Report: 60

- Introduction: 5
- Review of literature: 12
- Experimental findings: 15
- Analysis of data: 12
- Discussion: 8
- Conclusion: 5
- References: 3

Presentation: 25

Interactions: 15

SYLLABI OF BIOTECHNOLOGY DSM PAPERS

SEMESTER-I

BTC DSM 101T
CELL BIOLOGY AND BIOCHEMISTRY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objectives: *The objective of the course in Cell Biology and Biochemistry is to provide students with a comprehensive understanding of the principles and concepts related to the structure, function, and behavior of cells, as well as the fundamental aspects of biochemistry. The course aims to introduce students to the organization and components of cells, including organelles and cell membranes. It also covers essential topics in biochemistry, such as nucleic acids, proteins, carbohydrates, enzymes, and metabolic pathways.*

UNIT 1 *(8 Lectures)*

Introduction to cell biology: cell theory; ultrastructure of prokaryotic and eukaryotic cells. **Cell Membrane:** components of biological membranes; fluid mosaic model; cell recognition and membrane transport.

UNIT 2 *(8 Lectures)*

Structure and function of cell organelles: cytosol; endoplasmic reticulum; golgi complex; mitochondria; chloroplast; ribosomes; lysosomes; peroxisomes; nucleus; nucleolus; vacuole; cytoskeleton.

UNIT 3 *(10 Lectures)*

Nucleic acids: nucleosides and nucleotides; purines and pyrimidines; physical and chemical properties of nucleic acids; double helical model of DNA. **Cell cycle:** regulation of cell cycle; mitosis and meiosis; cell cycle check point; programmed cell death. **Cancer**: carcinogenesis; agents promoting carcinogenesis; oncogenes; characteristics and molecular basis of cancer; treatment and prevention of cancer.

UNIT 4 *(10 Lectures)*

Amino acids and proteins: structure and properties of amino acids; different level of structural organization of proteins; physical and chemical properties of proteins; forces stabilizing protein structure. **Carbohydrate:** structure; properties and function of monosaccharides, disaccharides and polysaccharides.

UNIT 5 *(9 Lectures)*

Enzymes: nomenclature and classification of enzymes; factors affecting enzyme activity; activation energy; enzyme inhibition- reversible and irreversible; cofactors; prosthetic groups. **Carbohydrate metabolism:** glycolysis; TCA cycle; electron transport chain.

Course Outcomes: *By the end of the course, students will have a comprehensive understanding of cell biology, including the ultrastructure of prokaryotic and eukaryotic cells, as well as the components of biological membranes and the structure and function of cell organelles. They will also acquire an understanding on nucleic acids, cell cycle and cancer. Additionally, students will be familiar with the structure, properties, and functions of proteins and carbohydrates. They will have a solid understanding of the major metabolic pathways involved in carbohydrate metabolism, including glycolysis, the TCA cycle, and the electron transport chain.*

SUGGESTED READING

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. ASMPress & 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.
5. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
6. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
7. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

SEMESTER-II

BTC DSM 151T
CELL BIOLOGY AND BIOCHEMISTRY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The objective of the course in Cell Biology and Biochemistry is to provide students with a comprehensive understanding of the principles and concepts related to the structure, function, and behavior of cells, as well as the fundamental aspects of biochemistry. The course aims to introduce students to the organization and components of cells, including organelles and cell membranes. It also covers essential topics in biochemistry, such as nucleic acids, proteins, carbohydrates, enzymes, and metabolic pathways.*

UNIT 1 *(8 Lectures)*

Introduction to cell biology: cell theory; ultrastructure of prokaryotic and eukaryotic cells. **Cell Membrane:** components of biological membranes; fluid mosaic model; cell recognition and membrane transport.

UNIT 2 *(8 Lectures)*

Structure and function of cell organelles: cytosol; endoplasmic reticulum; golgi complex; mitochondria; chloroplast; ribosomes; lysosomes; peroxisomes; nucleus; nucleolus; vacuole; cytoskeleton.

UNIT 3 *(10 Lectures)*

Nucleic acids: nucleosides and nucleotides; purines and pyrimidines; physical and chemical properties of nucleic acids; double helical model of DNA. **Cell cycle:** regulation of cell cycle; mitosis and meiosis; cell cycle check point; programmed cell death. **Cancer**: carcinogenesis; agents promoting carcinogenesis; oncogenes; characteristics and molecular basis of cancer; treatment and prevention of cancer.

UNIT 4 *(10 Lectures)*

Amino acids and proteins: structure and properties of amino acids; different level of structural organization of proteins; physical and chemical properties of proteins; forces stabilizing protein structure. **Carbohydrate:** structure; properties and function of monosaccharides, disaccharides and polysaccharides.

UNIT 5 *(9 Lectures)*

Enzymes: nomenclature and classification of enzymes; factors affecting enzyme activity; activation energy; enzyme inhibition- reversible and irreversible; cofactors; prosthetic groups. **Carbohydrate metabolism:** glycolysis; TCA cycle; electron transport chain.

Course Outcomes: *By the end of the course, students will have a comprehensive understanding of cell biology, including the ultrastructure of prokaryotic and eukaryotic cells, as well as the components of biological membranes and the structure and function of cell organelles. They will also acquire an understanding on nucleic acids, cell cycle and cancer. Additionally, students will be familiar with the structure, properties, and functions of proteins and carbohydrates. They will have a solid understanding of the major metabolic pathways involved in carbohydrate metabolism, including glycolysis, the TCA cycle, and the electron transport chain.*

SUGGESTED READING

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. ASMPress & 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.
5. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
6. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
7. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

SEMESTER-III

BTC DSM 201T
MICROBIOLOGY AND IMMUNOLOGY

Contact Hours: 60
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective*: This Microbiology and Immunology course aims to provide students with a foundational understanding of the microbial world and the immune system. It covers key topics such as microbial classification, growth dynamics, and genetic exchange in bacteria. Additionally, it introduces students to immunology, including innate and adaptive immunity, B and T lymphocyte functions, and antibody production.*

UNIT 1 *(8 Lectures)*

History of microbiology: major discoveries and contributors to the field. **Microbial classification**: criteria for grouping microorganisms. **Overview of microorganisms:** morphology and cell structure of major groups of microorganisms - bacteria, algae, fungi, protozoa and viruses.

UNIT 2 *(8 Lectures)*

Microbial growth: growth curve; generation time, factors affecting growth of bacteria; nutritional categories of micro-organisms **Genetic exchange in bacteria:** conjugation, transformation and transduction.

UNIT 3 *(7 Lectures)*

Microbial culture techniques: preparation of culture media; inoculation; pure culture techniques. **Sterilization techniques:** Physical and chemical methods for sterilization.

UNIT 4 *(10 Lectures)*

Overview of the immune system: innate and adaptive immunity; humoral and cellular immune responses. **Immune components:** B lymphocytes and T lymphocytes; structure of immunoglobulins and T cell receptors. **B-cell activation:** antibody production; class switching and affinity maturation; heavy chain gene transcription.

UNIT 5 *(12 Lectures)*

Antigen recognition and processing: class I & class II MHC molecules; antigen processing and presentation by MHC molecule. **Autoimmune diseases:** organ-specific (Hashimoto's disease, myasthenia gravis) and systemic (systemic lupus erythematosus, rheumatoid arthritis) autoimmune diseases. **Immunodeficiency**: HIV and AIDS. **Introduction to immunodiagnostics**: ELISA; RIA.

Course Outcome: *By the course's end, students will have a solid grasp of microbiological concepts and immunological principles. They will also acquire practical skills in microbial culture techniques. This knowledge equips them for further studies or careers in microbiology, immunology, or related fields.*

SUGGESTED READING

1. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
3. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
4. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
6. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
7. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
8. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
9. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
10. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication

SEMESTER-IV

BTC DSM 251P

CELL BIOLOGY, BIOCHEMISTRY, MICROBIOLOGY AND IMMUNOLOGY

Contact Hours: 60

Full Marks = 100

Two Experiments are to be performed – one from each part

Course Objective: *The practical aim to develop core laboratory skills in the field of cell biology, biochemistry, microbiology and immunology. Students have to prepare various types of reagents and media for the experiments. This practical will enhance their ability to observe and analyze cell division processes. They will conduct experiments to comprehend how factors like pH and temperature influence the activity of enzymes, estimate blood glucose levels using the glucose oxidase method, and determine protein concentrations via Lowry's method. Additionally, students will become well-versed in preparing, staining, and meticulously observing cells under the microscope, gaining valuable insights into microbiological techniques.*

Section A: Cell Biology and Biochemistry

1. Preparation of solutions and buffers.
2. Handling and working principle of simple and compound microscope.
3. Study of mitosis in onion root tips
4. Study of structure of any prokaryotic and eukaryotic cell.
5. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
6. Estimation of blood glucose by glucose oxidase method.
7. Estimation of protein by Lowry's method.
8. Separation of amino acids by paper chromatography.

Section B: Microbiology and Immunology

1. Preparation of media & sterilization methods
2. Serial dilution technique
3. Isolation of bacteria from air, water and soil
4. Grams staining and biochemical characterization of bacteria
5. Antibiotic sensitivity test
6. Perform total count of red blood cells (RBCs) in a blood sample
7. Determination of total leukocyte count (TLC) in a blood sample
8. Perform ELISA to detect specific antigen or antibody in a sample.

Course Outcome: *By the end of these practical exercises, students will have refined their laboratory techniques. They will confidently manage solution preparation, proficiently operate microscopes, and effectively conduct diverse biochemical assays. Moreover, they will acquire a deeper understanding of fundamental biological processes and the capacity to independently plan and execute experiments while grasping the significance of their results.*

SUGGSTED READING

1. Gupta, R & Makhija, S and Toteja R. (2018). Cell Biology : Practical Manual. Prestige Publishers.
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
3. Maheshwari · D.K (2002) Practical Microbiology. (2002). India: S. Chand Limited.
4. Patra, J. K., Das, G., Das, S. K., & Thatoi, H. (2020). A Practical Guide to Environmental Biotechnology. Springer.
5. K, G. D. (2016). Practical Biochemistry. India: Jaypee Brothers Medical Publishers Pvt. Limited.
6. Hay, F. C., Westwood, O. M. R. (2008). Practical Immunology. Germany: Wiley.
7. Balakrishnan, S., Kaliaperumal, K., Duraisamy, S. (2017). Practical Immunology A Laboratory Manual. Germany: LAP LAMBERT Academic Publishing.

BTC DSM 252T
MICROBIOLOGY AND IMMUNOLOGY
Contact Hours: 60
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective*: This Microbiology and Immunology course aims to provide students with a foundational understanding of the microbial world and the immune system. It covers key topics such as microbial classification, growth dynamics, and genetic exchange in bacteria. Additionally, it introduces students to immunology, including innate and adaptive immunity, B and T lymphocyte functions, and antibody production.*

UNIT 1 *(8 Lectures)*

History of microbiology: major discoveries and contributors to the field. **Microbial classification**: criteria for grouping microorganisms. **Overview of microorganisms:** morphology and cell structure of major groups of microorganisms - bacteria, algae, fungi, protozoa and viruses.

UNIT 2 *(8 Lectures)*

Microbial growth: growth curve; generation time, factors affecting growth of bacteria; nutritional categories of micro-organisms **Genetic exchange in bacteria:** conjugation, transformation and transduction.

UNIT 3 *(7 Lectures)*

Microbial culture techniques: preparation of culture media; inoculation; pure culture techniques. **Sterilization techniques:** Physical and chemical methods for sterilization.

UNIT 4 *(10 Lectures)*

Overview of the immune system: innate and adaptive immunity; humoral and cellular immune responses. **Immune components:** B lymphocytes and T lymphocytes; structure of immunoglobulins and T cell receptors. **B-cell activation:** antibody production; class switching and affinity maturation; heavy chain gene transcription.

UNIT 5 *(12 Lectures)*

Antigen recognition and processing: class I & class II MHC molecules; antigen processing and presentation by MHC molecule. **Autoimmune diseases:** organ-specific (Hashimoto's disease, myasthenia gravis) and systemic (systemic lupus erythematosus, rheumatoid arthritis) autoimmune diseases. **Immunodeficiency**: HIV and AIDS. **Introduction to immunodiagnostics**: ELISA; RIA.

Course Outcome: *By the course's end, students will have a solid grasp of microbiological concepts and immunological principles. They will also acquire practical skills in microbial culture techniques. This knowledge equips them for further studies or careers in microbiology, immunology, or related fields.*

SUGGESTED READING

1. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
3. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
4. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
6. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
7. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
8. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
9. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
10. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication

SEMESTER-V

BTC DSM 301T
GENETICS AND MOLECULAR BIOLOGY

Contact Hours: 60
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Genetics and Molecular Biology course aims to provide students with a comprehensive understanding of genetic principles and molecular processes. It covers topics such as Mendelian genetics, allelic interactions, gene mutations, chromosomal abnormalities, DNA replication, RNA structure, transcription, RNA processing, and translation. The course intends to equip students with a solid foundation in genetics and molecular biology, preparing them for further studies or careers in genetics, biotechnology, or related fields.*

UNIT 1 *(9 Lectures)*

Mendelian genetics: Mendel's experimental design; monohybrid, di-hybrid and tri hybrid crosses; law of segregation & principle of independent assortment; Test and back cross. **Allelic interactions:** Concept of dominance, recessiveness, incomplete dominance, co-dominance. **Non-allelic interactions:** complementary genes, duplicate genes and inhibitory genes.

UNIT 2 *(8 Lectures)*

Gene mutations: Definition and types of mutations; causes of mutations; **Variations in chromosomes structure**: deletion, duplication, inversion and translocation (reciprocal and Robertsonian).

UNIT 3 *(10 Lectures)*

Chromosomal abnormalities in human beings: Aneuploidies of the autosomes - Monosomy 5, Trisomy 13, Trisomy 18 and Trisomy 21; Aneuploidies of the sex chromosome - Turner syndrome and Klinefelter syndrome. **Linkage:** Complete linkage and incomplete linkage. **Crossing over:** Molecular mechanism of crossing over - copy choice theory and breakage and reunion theory.

UNIT 4 *(9 Lectures)*

DNA replication: replication of DNA in prokaryotes; rolling circle replication; unique aspects of eukaryotic chromosome replication. **RNA:** structure and function of mRNA, rRNA and tRNA.

UNIT 5 *(9 Lectures)*

Transcription: prokaryotic RNA polymerase; role of sigma factor; promoter; transcription factors; enhancers; initiation, elongation and termination of RNA chains. **RNA processing:** 5' cap formation; polyadenylation and splicing of pre-mRNA. **Translation:** mechanism of initiation; elongation and termination of polypeptides; posttranslational modifications of proteins.

Course Outcome: *By the end of this course, students will have a strong grasp of genetic concepts and molecular mechanisms. They will be able to analyze and interpret genetic data, understand the structure and function of DNA and RNA, and comprehend the processes of transcription and translation. Additionally, they will gain insights into genetic variations, mutations, and chromosomal abnormalities, providing them with valuable knowledge for various applications in genetics and molecular biology.*

SUGGESTED READING

1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. 3rd Edition. John Wiley and Sons Inc.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. 9th Edition. Benjamin Cummings.
3. Russell, P. J. (2009). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
5. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
6. 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.
7. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene, 6th Edition. Cold Spring Harbour Lab. Press, Pearson Pub.

BTC DSM 302T
GENETICS AND MOLECULAR BIOLOGY
Contact Hours: 60
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Genetics and Molecular Biology course aims to provide students with a comprehensive understanding of genetic principles and molecular processes. It covers topics such as Mendelian genetics, allelic interactions, gene mutations, chromosomal abnormalities, DNA replication, RNA structure, transcription, RNA processing, and translation. The course intends to equip students with a solid foundation in genetics and molecular biology, preparing them for further studies or careers in genetics, biotechnology, or related fields.*

UNIT 1 *(9 Lectures)*

Mendelian genetics: Mendel's experimental design; monohybrid, di-hybrid and tri hybrid crosses; law of segregation & principle of independent assortment; Test and back cross. **Allelic interactions:** Concept of dominance, recessiveness, incomplete dominance, co-dominance. **Non-allelic interactions:** complementary genes, duplicate genes and inhibitory genes.

UNIT 2 *(8 Lectures)*

Gene mutations: Definition and types of mutations; causes of mutations; **Variations in chromosomes structure**: deletion, duplication, inversion and translocation (reciprocal and Robertsonian).

UNIT 3 *(10 Lectures)*

Chromosomal abnormalities in human beings: Aneuploidies of the autosomes - Monosomy 5, Trisomy 13, Trisomy 18 and Trisomy 21; Aneuploidies of the sex chromosome - Turner syndrome and Klinefelter syndrome. **Linkage:** Complete linkage and incomplete linkage. **Crossing over:** Molecular mechanism of crossing over - copy choice theory and breakage and reunion theory.

UNIT 4 *(9 Lectures)*

DNA replication: replication of DNA in prokaryotes; rolling circle replication; unique aspects of eukaryotic chromosome replication. **RNA:** structure and function of mRNA, rRNA and tRNA.

UNIT 5 *(9 Lectures)*

Transcription: prokaryotic RNA polymerase; role of sigma factor; promoter; transcription factors; enhancers; initiation, elongation and termination of RNA chains. **RNA processing:** 5' cap formation; polyadenylation and splicing of pre-mRNA. **Translation:** mechanism of initiation; elongation and termination of polypeptides; posttranslational modifications of proteins.

Course Outcome: *By the end of this course, students will have a strong grasp of genetic concepts and molecular mechanisms. They will be able to analyze and interpret genetic data, understand the structure and function of DNA and RNA, and comprehend the processes of transcription and translation. Additionally, they will gain insights into genetic variations, mutations, and chromosomal abnormalities, providing them with valuable knowledge for various applications in genetics and molecular biology.*

SUGGESTED READING

1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. 3rd Edition. John Wiley and Sons Inc.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. 9th Edition. Benjamin Cummings.
3. Russell, P. J. (2009). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
5. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
6. 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.
7. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene, 6th Edition. Cold Spring Harbour Lab. Press, Pearson Pub.

SEMESTER-VI

BTC DSM 351P

GENETICS AND MOLECULAR BIOLOGY

Contact Hours: 60

Full Marks = 100

Two Experiments are to be performed – one from each part

Course Objective: *The practical course aims to develop essential laboratory skills in genetics and bioprocess technology. Students will learn to prepare and analyze mitosis and meiosis mounts, perform karyotyping, construct pedigree charts, and induce polyploidy in plants. In bioprocess technology, they will isolate and screen microorganisms, construct bacterial growth curves, calculate TDP, and observe ethanol production.*

Part A: Genetics

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Karyotyping with the help of photographs
4. Pedigree charts of some common characters like blood group, color blindness etc.
5. Study of polyploidy in onion root tip by colchicine treatment.

Part B: Molecular Biology

1. Preparation of solutions for Molecular Biology experiments
2. Isolation of genomic DNA from plant or animal tissue.
3. Isolation of chromosomal DNA from bacterial cells.
4. Isolation of Plasmid DNA by alkaline lysis method.
5. Agarose gel electrophoresis of genomic DNA.
6. Agarose gel electrophoresis of plasmid DNA.
7. Preparation of restriction enzyme digests of DNA samples.

Course Outcome*: By the end of this course, students will have acquired knowledge of mitosis and meiosis, as well as the technique of karyotyping and pedigree analysis. Students will also acquire practical knowledge on molecular biology, including DNA isolation and agarose gel electrophoresis. This comprehensive understanding of genetics and molecular biology will prepare students for further studies or careers in genetics, biotechnology, and related fields.*

SUGGESTED READING

1. Thompson, E. A. (1986). Pedigree Analysis in Human Genetics. United Kingdom: Johns Hopkins University Press.
2. Jones, R. N., Rickards, G. K. (1991). Practical Genetics. United Kingdom: Open University Press.
3. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

SEMESTER-VII

BTC DSM 401T
RECOMBINANT DNA TECHNOLOGY

Contact Hours: 60
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Recombinant DNA Technology course is designed to provide students with a deep understanding of the principles and techniques involved in genetic engineering. It covers key topics such as restriction enzymes, vectors, gene transfer methods, hybridization techniques, library construction, PCR, DNA sequencing, and applications of genetic engineering in animals and plants. The course aims to equip students with the knowledge and skills required for working with recombinant DNA and genetic modification, preparing them for careers in biotechnology, research, or related fields.*

UNIT 1 *(10 Lectures)*

Introduction: definition and principles of recombinant DNA technology. **Enzymes:** restriction enzymes, ligases and polymerases. **Vectors:** plasmid, cosmid, BAC and YAC. **Gene transfer:** transformation, microinjection, electroporation and ultrasonication.

UNIT 2 *(8 Lectures)*

Hybridization techniques: southern blotting and northern blotting**. Library construction and screening:** preparation of genomic and cDNA library; screening of recombinants.

UNIT 3 *(9 Lectures)*

PCR: principle, procedure and applications. **DNA sequencing methods:** Maxam & Gilbert method and Sangers method.

UNIT 4 *(10 Lectures)*

Genetic engineering in animals: production and applications of transgenic mice, production of therapeutic products (insulin, growth hormone and clotting factors). **Genetic modification in medicine**: gene therapy, in-vivo and ex-vivo gene therapy.

UNIT 5 *(8 Lectures)*

Genetic engineering in plants: *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, binary vectors and co-integrate vectors, T-DNA transfer and integration.

Course Outcome: *By the conclusion of this course, students will have a comprehensive understanding of recombinant DNA technology and its applications. They will be proficient in techniques such as PCR and DNA sequencing, capable of constructing genomic and cDNA libraries, and skilled in screening recombinant DNA libraries. Moreover, students will be well-versed in the use of genetic engineering in animals and plants, including the production of transgenic organisms and therapeutic products. This knowledge will empower them to contribute to advancements in biotechnology and genetic research.*

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

SEMESTER-VIII

BTC DSM 451T
RECOMBINANT DNA TECHNOLOGY

Contact Hours: 60
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Recombinant DNA Technology course is designed to provide students with a deep understanding of the principles and techniques involved in genetic engineering. It covers key topics such as restriction enzymes, vectors, gene transfer methods, hybridization techniques, library construction, PCR, DNA sequencing, and applications of genetic engineering in animals and plants. The course aims to equip students with the knowledge and skills required for working with recombinant DNA and genetic modification, preparing them for careers in biotechnology, research, or related fields.*

UNIT 1 *(10 Lectures)*

Introduction: definition and principles of recombinant DNA technology. **Enzymes:** restriction enzymes, ligases and polymerases. **Vectors:** plasmid, cosmid, BAC and YAC. **Gene transfer:** transformation, microinjection, electroporation and ultrasonication.

UNIT 2 *(8 Lectures)*

Hybridization techniques: southern blotting and northern blotting**. Library construction and screening:** preparation of genomic and cDNA library; screening of recombinants.

UNIT 3 *(9 Lectures)*

PCR: principle, procedure and applications. **DNA sequencing methods:** Maxam & Gilbert method and Sangers method.

UNIT 4 *(10 Lectures)*

Genetic engineering in animals: production and applications of transgenic mice, production of therapeutic products (insulin, growth hormone and clotting factors). **Genetic modification in medicine**: gene therapy, in-vivo and ex-vivo gene therapy.

UNIT 5 *(8 Lectures)*

Genetic engineering in plants: *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, binary vectors and co-integrate vectors, T-DNA transfer and integration.

Course Outcome: *By the conclusion of this course, students will have a comprehensive understanding of recombinant DNA technology and its applications. They will be proficient in techniques such as PCR and DNA sequencing, capable of constructing genomic and cDNA libraries, and skilled in screening recombinant DNA libraries. Moreover, students will be well-versed in the use of genetic engineering in animals and plants, including the production of transgenic organisms and therapeutic products. This knowledge will empower them to contribute to advancements in biotechnology and genetic research.*

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

SYLLABI OF BIOTECHNOLOGY SEC PAPERS

SEMESTER-I

BTC SEC 101
MICROBIOLOGY

Marks = 100 [ESE (50) IT (20) LAB (30)]

Course Objective: *The objective of the course in Microbiology is to provide students with a comprehensive understanding of the field of microbiology, including the history, classification, morphology and cell structure of microorganisms. The course aims to explain the basic concepts of microbial growth, culture techniques and sterilization methods. It also covers various applications of microbiology in environmental, industrial, agricultural, food, and fermented food sectors.*

PART-A: Theory
Contact hours: 30

UNIT 1 *(6 Lectures)*

History of microbiology: major discoveries and contributors to the field. **Microbial classification**: criteria for grouping microorganisms and major taxonomic groups. **Overview of microorganisms:** cell structure of major groups of microorganisms - bacteria, algae, fungi and protozoa; unique features of viruses.

UNIT 2 *(6 Lectures)*

Microbial growth: growth curve; generation time; factors affecting growth of bacteria; nutritional categories of micro-organisms. **Genetic exchange in bacteria:** conjugation transformation and transduction.

UNIT 3 *(5 Lectures)*

Microbial culture techniques: preparation of culture media; inoculation; pure culture techniques. **Sterilization techniques:** Physical and chemical methods for sterilization.

UNIT 4 *(7 Lectures)*

Environmental microbiology: nutrient cycling and biogeochemical processes – e.g. carbon, nitrogen and phosphorous. **Industrial microbiology:** microbial production of antibiotics and enzymes. **Agricultural microbiology:** plant growth promoting bacteria; plant-microbe interactions – e.g. legume-rhizobia interaction; biocontrol agents.

UNIT 5 *(6 Lectures)*

Food Microbiology: important microorganisms in food microbiology; major food born infections; preservation of various types of foods. **Fermented Foods:** Introduction to fermented foods; importance of fermented foods; probiotics and their potential health benefits.

PART-B: Practical /Project/Field work
Contact hours: 30

The following is the list of practicals:

1. Preparation of media & sterilization methods
2. Serial dilution technique
3. Isolation of bacteria from air
4. Isolation of bacteria from water
5. Isolation of bacteria from soil
6. Grams staining and biochemical characterization of bacteria
7. Antibiotic sensitivity test

Course Outcomes: *By the end of the course, students will be familiar with the morphology and cell structure of various microorganisms, including bacteria, algae, fungi, protozoa, and viruses. Students will understand microbial growth and the mechanisms of genetic exchange in bacteria, including conjugation, transformation, and transduction. They will develop proficiency in microbial culture techniques, and attain knowledge on physical and chemical methods of sterilization in microbiological practices. Students will gain knowledge about the role of microorganisms in nutrient cycling and biogeochemical processes. Additionally, students will learn the diverse role of industrial microbiology, agricultural microbiology and food microbiology.*

SUGGESTED READING

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*. 7thedition, 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.

SEMESTER-II

BTC SEC 151
IMMUNOLOGY
Marks = 100 [ESE (50) IT (20) LAB (30)]

Course Objective: *The objective of the course in Immunology is to provide students with a comprehensive understanding of the immune system and its components. The course aims to introduce students to the concepts of immunity and the structure and function of immune cells such as B lymphocytes and T lymphocytes. It covers topics such as antibody production, immunoglobulin gene expression, antigen recognition and processing, autoimmune diseases, immunodeficiency, vaccines and vaccination, and immunodiagnostics. The course intends to equip students with a solid foundation in immunology, enabling them to understand the mechanisms of immune responses and their applications in healthcare and diagnostics.*

PART-A: Theory
Contact hours: 30

UNIT 1 *(7 Lectures)*

Overview of the immune system: innate and adaptive immunity; humoral and cellular immune responses. **Immune components:** B lymphocytes and T lymphocytes; structure of immunoglobulins; T cell receptors. **B-cell activation:** antibody production; class switching and affinity maturation; heavy chain gene transcription.

UNIT 2 *(7 Lectures)*

Regulation of immunoglobulin gene expression: clonal selection theory; allotypes and idiotypes; allelic exclusion; immunologic memory, heavy chain gene transcription; genetic basis of antibody diversity. **Antigen and allergen:** properties and types of antigens - self-antigens, foreign antigens, and allergens; immunogenicity.

UNIT 3 *(5 Lectures)*

Antigen recognition and processing: class I and class II MHC molecules; antigen processing and presentation by MHC molecule.

UNIT 4 *(5 Lectures)*

Autoimmune diseases: examples of organ-specific (Hashimoto's disease, myasthenia gravis) and systemic (systemic lupus erythematosus, rheumatoid arthritis) autoimmune diseases. **Immunodeficiency**: HIV and AIDS.

UNIT 5 *(6 Lectures)*

Vaccines and vaccination: adjuvants; cytokines; types of vaccines (bacterial, viral, recombinant, DNA vaccines); passive and active immunization. **Introduction to immunodiagnostics**: ELISA; RIA; immune-electrophoresis.

PART-B: Practical /Project/Field work
Contact hours: 30

The following is the list of practicals:

1. Perform total count of red blood cells (RBCs) in a blood sample
2. Determination of total leukocyte count (TLC) in a blood sample
3. Determination of differential leukocyte count (DLC) in a blood sample
4. Analyze antigen-antibody reactions using the Ouchterlony double immunodiffusion technique.
5. Perform ELISA to detect specific antigen or antibody in a sample.

Course Outcomes: *By the end of the course, students will have a solid understanding of immunology. They will be able to explain the components of the immune system, and will have knowledge of immunoglobulin gene expression regulation, clonal selection theory, and the genetic basis of antibody diversity. Students will be able to understand the concept of antigen recognition and processing. Students will gain knowledge about autoimmune diseases as well as immunodeficiency diseases. Additionally, students will be attain the concept of vaccines, and able to describe the immunodiagnostics techniques such as ELISA, RIA, and immune-electrophoresis.*

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication

SEMESTER-III

BTC SEC 201
MOLECULAR BIOLOGY
Marks = 100 [ESE (50) IT (20) LAB (30)]

Course Objective: *The Genetics and Molecular Biology course aims to provide students with a comprehensive understanding of fundamental genetic processes and molecular mechanisms. It covers critical topics such as DNA structure and replication, DNA damage and repair mechanisms, RNA structure and transcription in both prokaryotes and eukaryotes, RNA processing, translation, the genetic code, and the operon concept. The course's objective is to equip students with a strong foundation in genetics and molecular biology.*

PART-A: Theory
Contact hours: 30

UNIT 1 *(9 Lectures)*

DNA structure: DNA as genetic material; structure of DNA; types of DNA. **DNA replication:** replication of DNA in prokaryotes; replication of DNA in eukaryotes; semi-conservative nature of DNA replication; bi-directional replication; DNA polymerases; rolling circle replication; unique aspects of eukaryotic chromosome replication.

UNIT 2 *(10 Lectures)*

DNA damage: deamination; depurination; altered bases; single strand breaks; double-strand breaks; cross-linking; DNA methylaton. **DNA repair:** photoreactivation; base excision repair; nucleotide excision repair; mismatch repair; translational synthesis; recombinational repair; Homologous recombination; non-homologous end-joining.

UNIT 3 *(9 Lectures)*

RNA: structure and function of mRNA, rRNA and tRNA. **Transcription in prokaryotes**: prokaryotic RNA polymerase; role of sigma factor; promoter; initiation, elongation and termination of RNA chains. **Transcription in eukaryotes:** eukaryotic RNA polymerase, transcription factors, promoters, enhancers, mechanism of transcription.

UNIT 4 *(8 Lectures)*

RNA processing: 5' cap formation, polyadenylation and splicing of pre-mRNA; mechanism of rRNA and tRNA splicing.

UNIT 5 *(9 Lectures)*

Translation: mechanism of initiation, elongation and termination of polypeptides; posttranslational modifications of proteins; genetic code and its characteristics. **Operon concept**: inducible (Lac operon) and repressible system (Trp operon).

PART-B: Practical /Project/Field work
Contact hours: 30

The following is the list of practicals:

1. Preparation of solutions for Molecular Biology experiments
2. Isolation of genomic DNA from plant or animal tissue.
3. Isolation of chromosomal DNA from bacterial cells.
4. Isolation of Plasmid DNA by alkaline lysis method.
5. Agarose gel electrophoresis of genomic DNA.
6. Agarose gel electrophoresis of plasmid DNA.
7. Preparation of restriction enzyme digests of DNA samples.

***Course Outcome**: By the end of this course, students will have acquired in-depth knowledge of DNA structure, replication, and repair mechanisms, including various forms of DNA damage and their repair pathways. They will be well-versed in transcription processes in prokaryotes and eukaryotes and understand the intricacies of RNA processing. Furthermore, students will comprehend the translation of genetic information into functional proteins, including the genetic code and its characteristics. They will also grasp the operon concept, including both inducible and repressible systems. This comprehensive understanding of genetics and molecular biology will prepare students for further studies or careers in genetics, biotechnology, and related fields.*

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

SYLLABI OF BIOTECHNOLOGY IDC PAPERS

SEMESTER-I

BTC IDC 101T
BIOTECHNOLOGY IN HUMAN WELFARE

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The objective of the course is to provide students with a comprehensive understanding of the applications of biotechnology in various aspects of human welfare, including medicine, healthcare, agriculture, environment, and industry. The course aims to introduce students to the principles and techniques of genetic engineering, production of therapeutic products, gene therapy, forensic science, plant biotechnology, environmental biotechnology, and industrial biotechnology. It also aims to highlight the potential benefits and challenges associated with the use of biotechnology in improving human well-being.*

UNIT 1 *(7 Lectures)*
Biotechnology: definition and scope; major milestones; applications in healthcare; agriculture, and industry; overview of genetically modified organisms (GMOs).

UNIT 2 *(10 Lectures)*
Medicine and healthcare biotechnology: introduction to genetic engineering; production of therapeutic products – e.g. insulin and growth hormone; gene therapy and its potential for treating genetic diseases. **Forensic science:** solving violent crimes such as murder and rape; solving claims of paternity; introduction to DNA finger printing – PCR and RFLP.

UNIT 3 *(10 Lectures)*
Plant Biotechnology: basic techniques of plant tissue culture; somaclonal variation – principle, application and limitations; somatic hybridization; biopesticides and biofertilizers – principles and applications; production of transgenic plants – BT cotton and golden rice.

UNIT 4 *(9 Lectures)*
Environmental Biotechnology: introduction to bioremediation and its role in cleaning up pollutants; treatment of municipal waste and industrial effluents; biogas production; use of biosensors for environmental analysis.

UNIT 5 *(9 Lectures)*
Industrial Biotechnology: introduction to bioprocess technology; principles of upstream processing- media preparation and sterilization; design of bioprocess vessels; introduction to downstream processing, product recovery and purification.

Course Outcome: *Students will gain a comprehensive understanding of biotechnology and its applications in healthcare, agriculture, industry, and the environment. They will learn about genetic engineering, plant tissue culture, environmental biotechnology, and industrial biotechnology. By the end of the course, students will be equipped with the knowledge and abilities to contribute to the field of biotechnology across various sectors.*

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
3. Ratledge, C., & Kristiansen, B. (Eds.). (2001). Basic biotechnology. Cambridge University Press.
4. Wang, L. K., Ivanov, V., Tay, J. H., & Hung, Y. T. (Eds.). (2010). Environmental biotechnology (Vol. 10). Springer Science & Business Media.

SEMESTER-II

BTC IDC 151T
HUMAN PHYSIOLOGY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The objective of the course in Human Physiology is to provide students with a comprehensive understanding of the physiological processes and systems in the human body. It covers topics such as the human digestive system, respiratory system, circulatory system, skeletal system, excretory system, and the nervous and endocrine systems. The course intends to equip students with knowledge of the structure, function, and coordination of these systems, enabling them to understand the complexities of human physiology.*

UNIT 1 *(8 Lectures)*

Digestion: definition of digestion; human digestive system; digestion in buccal cavity, stomach and intestine; basic composition of bile, saliva, pancreatic juice and intestinal juice; role of liver, gall bladder and pancreas in digestion.

UNIT 2 *(9 Lectures)*

Respiration: definition of respiration; aerobic and anaerobic respiration; human respiratory system; structure of lungs; inspiration and expiration; transport of O_2; transport of CO_2; exchange of gases; chloride shift.

UNIT 3 *(9 Lectures)*

Circulation: composition of blood; mechanism of blood coagulation; single and double circulation; structure of human heart; mechanism of blood circulation through human heart; cardiac cycle; ECG; pacemaker.

UNIT 4 *(9 Lectures)*

Locomotion: cardiac, smooth and skeletal muscles; actin and myosin; bone and cartilage; axial skeleton; appendicular skeleton; disorders of skeletal system. **Excretion:** definition of excretion; structure of kidney; structure of nephron; urea cycle; composition of human urine; sweat and sebum.

UNIT 5 *(10 Lectures)*

Neural and chemical co-ordination: types of nervous system; structure of human brain; cerebrum and cerebellum; structure of neuron; reflex action; definition of hormones; functions of hormones; pituitary; pineal gland; thyroid; thymus; pancreas as endocrine gland; testis; ovary.

Course Outcomes: *By the end of the course, students will have a comprehensive understanding of human physiology. They will be able to describe the digestive system, respiratory system, cardiovascular system, musculoskeletal system, excretory system, nervous system and endocrine system. Students will be able to explain the functions and interactions of various organs and systems in the human body. They will also gain knowledge of common disorders related to the skeletal system. Students will develop a strong foundation in human physiology and its importance in maintaining overall health.*

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.
3. VanPutte, C. L., Regan, J. L., & Russo, A. F. (2021). Seeley's essentials of anatomy & physiology. McGraw-Hill.

SEMESTER-III

BTC IDC 201T
PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Contact Hours: 45
Full Marks = 100 [ESE (70) CCA (30)]

Course Objective: *The Plant and Animal Biotechnology course aims to familiarize students with biotechnological applications in plants and animals. It covers plant tissue culture techniques, including micropropagation, and explores genetic modification in plants, addressing ethical concerns. In the animal biotechnology section, students learn about gene transfer methods, transgenic animals, animal propagation techniques, cloning methods, and gene therapy. The course equips students with knowledge relevant to plant and animal biotechnology, research, and ethical considerations.*

UNIT 1 *(9 Lectures)*

Plant tissue culture: definition; general techniques of plant tissue culture; culture media; micropropagation **Types of culture:** embryo culture; callus culture; organ cultures; endosperm culture; meristem and shoot tip culture.

UNIT 2 *(10 Lectures)*

Protoplast fusion and somatic hybridization: methods of protoplast isolation; mechanism of fusion - spontaneous fusion and induced fusion methods; somatic hybridization. **Genetically modified plants:** definition; methods of production (e.g. Bt cotton); advantages; ethical concern.

UNIT 3 *(9 Lectures)*

Gene transfer methods in animals: microinjection, embryonic stem cell, and retroviral gene transfer method. **Transgenic Animals:** introduction; production of transgenic mice.

UNIT 4 *(9 Lectures)*

Animal propagation: artificial insemination; in-vitro fertilization; embryo transfer techniques (e.g. cow). **Animal cloning:** definition and methods (somatic cell nuclear transfer and embryo splitting).

UNIT 5 *(8 Lectures)*

Gene therapy: definition, types, application, challenges and ethical issues. **Human genetic engineering:** problems and ethics.

Course Outcome: *By course completion, students will understand plant tissue culture, micropropagation, and genetic modification in plants. They will grasp gene transfer methods, transgenic animals, animal reproduction, cloning, and gene therapy in the context of animal biotechnology. This knowledge prepares students for careers in plant and animal biotechnology, research, and ethical decision-making.*

SUGGESTED READING

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
4. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
5. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
6. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.